From: Alison Guth
Sent: Wednesday, December 15, 2004 12:01 PM
To: Alan Stuart; Jason Moak; Shane Boring; KMASSEY@scana.com; BARGENTIERI@scana.com; 'ssummer@SCANA.com'; 'Mark_a_cantrell@fws.gov'; 'Hal Beard'; RMAHAN@scana.com; 'leachs@dnr.sc.gov'; 'Amanda Hill (amanda_hill@fws.gov)'; 'Dick Christie'; 'DougC@SCDNR.STATE.SC.US'; 'Prescott.Brownell@noaa.gov'; 'WadeB@SCDNR.STATE.SC.US'
Subject: Diadromous Fish Meeting Notes

Good morning all,

After much deliberation, the final copy of the notes for the Diadromous Fish Study Meeting, that was held on Nov. 10th, has been completed. As well as being attached to this email, the notes will be posted on the official Saluda Hydro Relicensing Website. Thanks again for your continued involvement and participation in regards to this issue.

Sincerely,
Alison

Alison Guth
Licensing Coordinator
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Meeting Minutes for
Diadromous...

Saluda Hydro Relicensing – Diadromous Fish Study Meeting – November 10, 2004
Meeting Location – SCE&G Training Center – Columbia, SC

Revision 12-10-04

Attendees:

Steve Summer	SCE&G	Dick Christie	SCDNR
Bill Argentieri	SCE&G	Steve Leach	SCDNR
Kristina Massey	SCE&G	Hal Beard	SCDNR
Randy Mahan	SCE&G	Amanda Hill	USFWS
Alan Stuart	Kleinschmidt	Mark Cantrell	USFWS
Shane Boring	Kleinschmidt	Alison Guth	Kleinschmidt

Action Items:

- Prepare a study plan for sampling diadromous fish on the Lower Saluda River and distribute to the resource agencies for review and comment.
- Obtain and distribute D.O. and flow data to the agencies. SCE&G will obtain data from the USGS.
- Organize canoes, transportation, etc. that is needed for a low flow float trip on the lower Saluda on the 29th of November (to be taken care of by Alison).
- Set up meeting with Prescott Brownell of NOAA fisheries about sturgeon issues.
- Check on permitting for studies, who needs to be there?
- Steve Leach and Mark Cantrell said that they could provide an electronic copy of the Santee Cooper Basin Diadromous Fish Passage Restoration Plan to anyone who needs it.

Meeting Notes:

These notes summarize the major items discussed during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart opened the meeting at 10:00 AM and noted that the focus of the meeting would be to discuss: (1) Target Species and Restoration Plans for the Lower Saluda River (LSR), (2) Historical data needs, (3) NOAA shortnose sturgeon sampling permit, (4) Lower Saluda River Sampling logistics, (5) Sampling in Lake Murray tributaries and, (6) Establish a date for low flow float trip on the Lower Saluda River & above Lake Murray.

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The agencies began this discussion by briefly stating the target species that they would like to see included in the diadromous fish study. The fish mentioned include: blueback herring, hickory and American shad, American eel, Atlantic and shortnose sturgeon, and striped bass. Dick Christie noted that the Broad River Basin is considered number one (most promising) for fish restoration in the Santee Cooper Diadromous Fish Passage Restoration Plan. He also mentioned that the restoration plan is considered a general, wide-reaching plan.

The group decided that more studies need to be performed in order for the agencies to more fully develop their restoration plan, which is considered a living document.

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Amanda Hill stated that it would be helpful to know the temperature data above and below the dam. This would allow the agencies to determine how far downstream the project influences. Steve Leach brought up the possibility of using USGS as a source for temperature data, possibly from the last 10-15 years. Dick Christie concurred that January through August would be good months to look at in regards to temperatures, flows, etc.

Amanda Hill asked if there were temperature and D.O. monitors on the Congaree itself. In response, it was stated that there was only stage data on Gervais Street. Also that there is possible data for city at sewer plant, which needs to be checked into. Moreover, around October of '88 through the present there should be data available at the dam. The agencies asked SCE&G to investigate locations for additional monitors, and the agencies will provide what data they already have. It was pointed out that SCDHEC may have some data prior to 1988.

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Mark Cantrell would like to know how stripers have been sampled historically. The group stated that the sampling performed by Hal Beard is the first sampling that has been done on a regular basis. Hal indicated he usually samples in May/October. Dick suggested that IFIM study work has been done by Isley and Jobsis.

NOAA Shortnose Sturgeon sampling permit:

- Will be discussed in a meeting with Prescott Brownell

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4am to 10am or 2pm to 8pm.

Where: One gillnet near the mouth of the Saluda River near the Congaree River and one towards the dam

Supplies: 2 ½” to 7” stretch mesh nets. One net should be constructed of 2.5-inch stretched mesh, the other of 5-inch stretched mesh.

How: Possibly set at an angle to the bank. Fish two nets (one net of each mesh size) at each site, to cover approximately one half of the river’s width if possible.

The group began to discuss gillnetting and its caveats. Hal Beard mentioned that he will be interested in how the gill netting is going to be performed; he has not had much luck with it in the past. However, he has achieved the most luck with it when the nets were set at an angle to the bank, rather than perpendicular. When considering a site for the net, one must consider both access and velocity. (i.e., Is velocity going to increase fish catch?)

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Kristina brought up the fact that flows may be a serious setback when gillnetting, all depending on how wet of a winter and spring we have.

The group decided that sampling should occur in 6 hour time periods. The time period for setting and monitoring gill nets should be during either 2:00 pm -8:00 pm, or possibly 4:00 am to 10:00 am. According to Dick Christie there should be a gill net set up at least at one site around the mouth of the Saluda River at the Congaree River and one in the upper reaches, near the dam (Saluda Shoals). Hal Beard suggested that one of the nets should be located about 100m below the zoo bridge.

Alan suggested using the passage rates at St Stephens as a catalyst to increase sampling efforts in the LSR. Coordination with SCDNR, as was done during the relicensing of Columbia Hydro, was proposed. There needs to be coordination with Doug Cooke and Steve Leach to find out when the fish are being passed. Steve Leach responded that the peak at Pinopolis Dam occurs around March 7th and at St. Stevens around the 20th of March.

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The agencies indicated that it may be acceptable to electrofish while gill nets were soaking.

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problems associated with access, site selection, and various trip-based logistical problems to be addressed.

After notification of "significant" alosine passage at the Santee Cooper dams, increase sampling dates to twice per week (The agencies suggested shooting for Monday and Thursdays, to allow for some variation due to hazardous weather conditions).

The sites should be run at least twice in a day, so that nets are checked without removing from the water, if possible, on the first run, and then retrieved on the second or third trip. The goal is to fish the nets for as much of the daylight period as possible. The number of trips will be dependent on the amount of time required to make one run of the nets, travel time, etc. and can be adjusted accordingly. Nets should be fished in this mode through April and then reduced to one run (on one day) per week through May if alosine catch has decreased significantly.

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One additional site in the Congaree River near the confluence of the Broad and Saluda Rivers would provide information on relative abundance of fish in the river and provide indications as to whether they are selecting for the Saluda or Congaree. Sampling with the same techniques and timing as in the Saluda River would also provide insight to the effectiveness of gear and techniques, and was strongly encouraged by the agencies. Fishing near the Rosewood landing on Congaree River may prove suitable for this site.

If the catch of non-target species is high at any of the sampling sites, the length of time nets are fished can be shortened to reduce by-catch.

Eel Traps:

When: February to April

Where: At the mouths of rivers, channels and islands

Supplies: Eel pots can possibly be ordered from Wildco

Amanda Hill of FWS mentioned that they would like eel pots to be set at the mouths of rivers, channels and islands and that they were looking for potential elvers. She also stated that these would not be as laborious as gillnetting, the eel traps only needed to be checked every couple of days. Hal Beard indicated that in the past he has caught about three eels in a 10 day sampling season on average, and also that he had 5 yrs of data. Amanda replied that she would like to get that data from him if at all possible. The group mentioned that the first step was to compile as much historical data as possible.

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<u>*Plankton Nets*</u>:

When: While gill netting

Where: DNR would prefer that plankton nets be set to fish off the bottom

Supplies ½ meter, 220/500 micron single nets, possibly with flow meter attached

Amanda Hill mentioned that they would like SCE&G to put up fixed plankton nets to gather eggs and larvae. In response, Alan mentioned that if gillnetting and electrofishing provide no results, plankton nets may be unnecessary. Amanda said that plankton nets are just another way of determining presence or absence, and they are definitely needed during the spring of 2005, if nothing else.

In regards to the nets themselves, Mark Cantrell mentioned that they would prefer tows but it may be difficult to do in the river, so maybe stationary nets would be better for a given period of time. Moreover, in regards to catching herring, shad and stripers, Mark pointed out that ½ meter, 220 micron would perform the best. He also stated that a flow meter would provide volume measurements, but you would need a meter attached to each net unless they are paired closely together. The group decided that single nets, not bongo nets, should be used. DNR would prefer that the river was fished off the bottom.

It was concluded that plankton nets can be sampled while electrofishing and gillnetting are taking place.

Note: *The following comments and clarifications were made by the resource agencies following the meeting*: Efforts should be made to fish plankton nets in conjunction with gillnets. Plankton nets may be anchored after the first gill net set at each site and retrieved upon the last gillnet retrieval of the day. This will allow for filtering the maximum volume of water during low flow periods, increasing the likelihood of sampling alosine eggs and larvae. However, if clogging with vegetation, detritus, etc. becomes problematic, plankton nets may be retrieved at the retrieval stage of the first run for gillnets each day. If clogging is still problematic, then shorter sampling times should be investigated.

Telemetry Study:

FWS expressed the desire to have a telemetry study preformed with some sentinel fish for American shad. This study will help the agencies determine if the shad utilize the Broad and LSR or just the Broad River. Also if they have thermal preferences and selection based upon the water temperature. Dick Christie believes it would be a good idea to do this because we do not know where they go. Dick Christie also mentioned that it would benefit SCE&G if the American Shad went up the Broad River.

Kristina made the point that if we were going to do this it needed to be done right, and it may be too late to put it together properly by the springtime.

It was discussed that the fish would probably be tagged in Pinopolis. However, SCE&G does not want to study the whole basin just to determine presence in the LSR. Alan suggested that it could possibly be combined with the Columbia fish passage project effectiveness testing and yield more information and better results. It was suggested that fish needed for the effectiveness tracking effort could be obtained from the Congaree River.

In the end, it was decided that telemetry will be performed as a second phase, along with studies associated with the Columbia Hydro Fish Passage Testing.

Temperature Monitoring:

The influence of the project, water temperature wise, downstream was again brought up. Mark Cantrell mentioned the possible need for temperature monitoring downstream, to the Congaree. Moreover, the most likely time that water temperature is affected is in the summer and fall. Amanda Hill stated that describing the thermal environment of the LSR would help determine if a possible temperature difference influences a fish's choice of sub-basin.

In regards to location, it was stated that there should be temperature sensors 1 mile downstream of dam and 1 mile upstream from zoo. Steve Summer mentioned that SCE&G could put some tidbits (temperature recorders) near the confluence on the left and right banks. Mark Cantrell suggested that they do a transect across the river and decide where equilibrium is reached in mixing of both rivers. However SCE&G mentioned that quite a few transects would be needed to determine this, which may be difficult. Steve Summer suggested that one tidbit should be placed in the Saluda and one in the Broad River near the confluence just to track the differences for now. Mark Cantrell stated that the tidbit needs to be positioned towards the bottom but still in the water column. SCE&G mentioned that there are continuous temperature monitors in the Saluda River about 1,000 feet downstream of the hydro plant, and upstream of the zoo that are operated by USGS. It was also mentioned that there is a continuous temperature monitor in the Broad River immediately downstream of Parr Hydro, also operated by the USGS. Data from all three of these gages is available on the USGS website.

Steve Leach stated that the preferred spawning water temperature range for sturgeon is 7-18 degrees C. He also pointed out that the divergence of water temperatures between the Broad and LSR begins earlier in year then previously thought, begins around April, and is also more of an obvious difference what was once thought.

Hal Beard pointed out that it is possible that fish orient themselves toward flow instead of temperature.

It was decided that this study would be "tabled" as well.

Sampling in Lake Murray tributaries:

The agencies indicated that they would like an evaluation of potential spawning areas in the Lake and in tributaries. Amanda Hill stated that a characterization of the physical habitat below the dam and above the Lake would be helpful. This can possibly be submitted in GIS format, and would be used to determine if there is potential diadromous fish spawning habitat.

Hal Beard pointed out that Gene Hayes did some cursory work to determine if stripers could possibly be reproducing in middle Saluda, and his determination concluded that numbers were insignificant.

"Tabled" Studies

- Telemetry Study
- Temperature Monitoring in LSR and Congaree.
- Will possibly do a future Habitat Evaluation if it is in conjunction with a required flow study.
- Will determine need of habitat study after video fly-over and float trip.

Low Flow Float Trip on the Lower Saluda River:

The meeting concluded with a discussion of the canoe trip that was going to be taking place on the Lower Saluda River during low flows (400-500 cfs). It was determined that the 29th of November was the best date for everyone.

Amanda and Alan will both ask Prescott Brownell to attend.

The meeting adjourned at approximately 3:00 pm.

Kacie Jensen

From: Alison Guth
Sent: Wednesday, December 15, 2004 12:05 PM
To: 'Prescott.Brownell@noaa.gov'
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Revision 12-10-04

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Supplies: Eel pots can possibly be ordered from Wildco

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It was concluded that plankton nets can be sampled while electrofishing and gillnetting are taking place.

Note: *The following comments and clarifications were made by the resource agencies following the meeting*: Efforts should be made to fish plankton nets in conjunction with gillnets. Plankton nets may be anchored after the first gill net set at each site and retrieved upon the last gillnet retrieval of the day. This will allow for filtering the maximum volume of water during low flow periods, increasing the likelihood of sampling alosine eggs and larvae. However, if clogging with vegetation, detritus, etc. becomes problematic, plankton nets may be retrieved at the retrieval stage of the first run for gillnets each day. If clogging is still problematic, then shorter sampling times should be investigated.

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Steve Leach stated that the preferred spawning water temperature range for sturgeon is 7-18 degrees C. He also pointed out that the divergence of water temperatures between the Broad and LSR begins earlier in year then previously thought, begins around April, and is also more of an obvious difference what was once thought.

Hal Beard pointed out that it is possible that fish orient themselves toward flow instead of temperature.

It was decided that this study would be "tabled" as well.

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The agencies indicated that they would like an evaluation of potential spawning areas in the Lake and in tributaries. Amanda Hill stated that a characterization of the physical habitat below the dam and above the Lake would be helpful. This can possibly be submitted in GIS format, and would be used to determine if there is potential diadromous fish spawning habitat.

Hal Beard pointed out that Gene Hayes did some cursory work to determine if stripers could possibly be reproducing in middle Saluda, and his determination concluded that numbers were insignificant.

“Tabled” Studies

- Telemetry Study
- Temperature Monitoring in LSR and Congaree.
- Will possibly do a future Habitat Evaluation if it is in conjunction with a required flow study.
- Will determine need of habitat study after video fly-over and float trip.

Low Flow Float Trip on the Lower Saluda River:

The meeting concluded with a discussion of the canoe trip that was going to be taking place on the Lower Saluda River during low flows (400-500 cfs). It was determined that the 29th of November was the best date for everyone.

Amanda and Alan will both ask Prescott Brownell to attend.

The meeting adjourned at approximately 3:00 pm.

Kacie Jensen

From: Dick Christie [dchristie@InfoAve.Net]
Sent: Wednesday, December 08, 2004 5:25 PM
To: Alison Guth
Subject: Notes from the diadromous fish meeting

Meeting Minutes for Diadromous...

Hi Alison - thanks to you and Alan for compiling and sending the notes from the diadromous fish meeting. We have reviewed the notes and have included our comments. Most of these comments reflect recommendations from our chief diadromous fish biologist, who was unable to attend the meeting. We recognize that the other decisions were made in a group setting, so we ran his comments past the other DNR staff and the USFWS, and they concurred with him on the proposed changes. I will forward that concurrence from Amanda Hill.

We appreciate your help in coordinating these early start studies, and we appreciate SCE&G's willingness to consider them for the upcoming spring. Please let me know if you have any questions, and especially with any of the proposed changes. Thanks.

Minutes for Diadromous Fish Study Meeting
November 10, 2004

Attendees:

Steve Summer	SCE&G	Dick Christie	SCDNR
Bill Argentieri	SCE&G	Steve Leach	SCDNR
Kristina Massey	SCE&G	Hal Beard	SCDNR
Randy Mahan	SCE&G	Amanda Hill	USFWS
Alan Stuart	Kleinschmidt	Mark Cantrell	USFWS
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Action Items:

- Prepare a study plan for sampling diadromous fish on the Lower Saluda River and distribute to the resource agencies for review and comment.
- Perform studies to determine presence/absence of species including blueback herring, American shad, hickory shad and American eel. Must order single nets, eel traps, and plankton nets. Order plankton nets?
- Obtain and distribute D.O. and flow data to the agencies. SCE&G will obtain data from the USGS.
- Organize canoes, transportation, etc. that is needed for a low flow float trip on the lower Saluda on the 29th of November (to be taken care of by Alison).
- Set up meeting with Prescott Brownell of NOAA fisheries about sturgeon issues.
- Check on permitting for studies, who needs to be there?

Meeting Notes:

These notes summarize the major items discussed during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart opened the meeting at 10:00 AM and noted that the focus of the meeting would be to discuss: (1) Target Species and Restoration Plans for the Lower Saluda River (LSR), (2) Historical data needs, (3) NOAA shortnose sturgeon sampling permit, (4) Lower Saluda River Sampling logistics, (5) Sampling in Lake Murray tributaries and, (6) Establish a date for low flow float trip on the Lower Saluda River & above Lake Murray.

Target Species and Restoration Plans:

The agencies began this discussion by briefly stating the target species that they would like to see included in the diadromous fish study. The fish mentioned include: blueback herring, hickory and American shad, American eel, Atlantic and shortnose sturgeon, and striped bass. Dick Christie noted that the Broad River Basin is considered number one (most promising) for fish restoration in the Santee Cooper Diadromous Fish Passage Restoration Plan. He also mentioned that the restoration plan is considered a general, wide-reaching plan.

The group decided that more studies need to be performed in order for the agencies to more fully develop their restoration plan, which is considered a living document. Steve Leach and Mark Cantrell said that they will provide an electronic copy of the Santee Cooper Basin Diadromous Fish Passage Restoration Plan to anyone who needs it.

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Mark Cantrell mentioned that the flows into Lake Murray vs. the flows out of Lake Murray would provide great comparison data from which to figure out a fish's response to flow. Amanda Hill mentioned that she would like to look at temperature distributions as requested by Doug Cooke. Simple temperature data comparing the Broad River and LSR may rule out the presence of sturgeon.

Amanda Hill stated that it would be helpful to know the temperature data above and below the dam. This would allow the agencies to determine how far downstream the project influences. Steve Leach brought up the possibility of using USGS as a source for temperature data, possibly from the last 10-15 years. Dick Christie concurred that January through August would be good months to look at in regards to temperatures, flows, etc.

Amanda Hill asked if there were temperature and D.O. stages on the Congaree itself. In response, it was stated that there was only stage data on Gervais Street. Also that there is possible data for city at sewer plant, which needs to be checked into. Moreover, around October of '88 through the present there should be data available at the dam. The agencies asked SCE&G to investigate locations for additional monitors, and the agencies will provide what data they already have. It was pointed out that SCDHEC may have some data prior to 1988.

Mark Cantrell of the USFWS asked how the project operations have changed since they first began. In response, Kristina Massey stated that since there is no flood storage pool, the project has always operated to pass large inflows so the dam won't be overtopped. Up to the late 1950s the project was operated as a base-load facility, and the lake fluctuated much more than it does at the present. From the 1960s to 1990s, the project moved into a load-following and peaking mode, generating when power was most needed on the system and reducing the amount of annual lake

fluctuation. The annual flow of water through the system has remained relatively unchanged. Currently the project is used primarily to meet system reserve needs.

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Mark Cantrell would like to know how stripers have been sampled historically. The group stated that the sampling performed by Hal Beard is the first sampling that has been done on a regular basis. Hal indicated he usually samples in May/October. Dick suggested that IFIM study work has been done by Isley and Jobsis. Historical data may also be found in Virginia Tech paper.

NOAA Shortnose Sturgeon sampling permit:

- Will be discussed in a meeting with Prescott Brownell

Saluda River Sampling Logistics:
Gill Netting:

When: Start in the beginning of March (1x a week) then increase to 3x's a week from the third week in March through April
4am to 10am or 2pm to 8pm. Starting in February, set nets once a week for one run. A run will include setting nets at each site and then returning to the first site to retrieve the nets. The nets should be allowed to fish for at least 4 hours. In addition to sampling for early run fish, this would allow for resolution of problems associated with access, site selection, and various trip-based logistical problems to be addressed.

After notification of "significant" alosine passage at the Santee Cooper dams, increase sampling dates to twice per week (We'd suggest shooting for Monday and Thursdays, to allow for some variation due to hazardous weather conditions).

The sites should be run at least twice in a day, so that nets are checked without removing from the water, if possible, on the first run, and then retrieved on the second or third trip. The goal is to fish the nets for as much of the daylight period as possible. The number of trips will be dependent on the amount of time required to make one run of the nets, travel time, etc. and can be adjusted accordingly. Nets should be fished in this mode through April and then reduced to one run (on one day) per week through May if alosine catch has decreased significantly.

Where: One gillnet near the mouth of the Saluda River near the Congaree River and one towards the dam The sites should be run at least twice in a day, so that nets are checked without removing from the water, if possible, on the first run, and then retrieved on the second or third trip. The goal is to fish the nets for as much of the daylight period as possible. The number of trips will be dependent on the amount of time required to make one run of the nets, travel time, etc. and can be adjusted accordingly. Nets should be fished in this mode through April and then reduced to one run (on one day) per week through May if alosine catch has decreased significantly. Proposed sampling changes - the sites should be determined by locating adequate fishing habitat in close proximity to a private, public or improvised launching facility. Ideally, three sampling locations should be sampled. These locations should roughly correspond to upper, middle and lower sections of the river. A potential upper-river site should be near the SCE&G ramp at Saluda Shoals. The middle river should be generally between Fourteen Mile Creek and the Interstate 20 Bridge; the lower-river site suggested is in the vicinity of Riverbanks Zoo. Actual locations may have to be adjusted at the time of sampling due to varying flow conditions.

One additional site in the Congaree River near the confluence of the Broad and Saluda Rivers would provide information on relative abundance of fish in the river and provide indications as to whether they are selecting for the Saluda or Congaree. Sampling with the same techniques and timing as in the Saluda River would also provide insight to the effectiveness of gear and techniques, and is strongly encouraged. Fishing near the Rosewood landing on Congaree River may prove suitable for this site.

If the catch of non-target species is high at any of the sampling sites, the length of time nets are fished can be shortened to reduce by-catch.

Supplies: 2 ½" to 7" stretch mesh nets. One net should be constructed of 2.5-inch stretched mesh, the other of 5-inch stretched mesh.

How: Possibly set at an angle to the bank. Fish two nets (one net of each mesh size) at each site, to cover approximately one half of the river's width if possible.

The group began to discuss gillnetting and its caveats. Hal Beard mentioned that he will be interested in how the gill netting is going to be performed; he has not had much luck with it in the past. However, he has had the most luck with it when the nets were set at an angle to the bank, rather than perpendicular. When considering a

Deleted: is

site for the net, one must consider both access and velocity. Is velocity going to increase fish catch?

According to Dick, in order to target American shad and blueback herring, the smallest mesh size needs to be 2 ½ " for smaller fish and as much as 7" for larger adults. Moreover, net panels need to be made to the right length and height in order to cover the channel. The group mentioned that SCE&G may want to test the feasibility of gillnetting in 2004.

Mark Cantrell clarified that the goals of this early study were as follows: to determine the presence or absence of target species, what their distribution is in the habitat, and where along the river they are located.

Kristina brought up the fact that flows may be a serious setback when gillnetting, all depending on how wet of a winter and spring we have.

The group decided that sampling should occur in 6 hour time periods. The time period for setting and monitoring gill nets should be during either 2:00 pm -8:00 pm, or possibly 4:00 am to 10:00 am. According to Dick Christie there should be a gill net set up at least at one site around the mouth of the Saluda River at the Congaree River and one in the upper reaches, near the dam (Saluda Shoals). Hal Beard suggested that one of the nets should be located about 100m below the zoo bridge.

Alan suggested using the passage rates at St Stephens as a catalyst to increase sampling efforts in the LSR. Coordination with SCDNR, as was done during the relicensing of Columbia Hydro, is what was proposed and accepted. There needs to be coordination with Doug Cooke and Steve Leach to find out when the fish are being passed. Steve Leach responded that the peak at Pinopolis Dam occurs around March 7th and at St. Stevens around the 20th of March.

The discussion turned to possible sampling times and dates. It was mentioned that SCE&G may only need to sample using gill nets once a week until end of March, beginning of April, and then increase up to around 3x's a week. Hal cautioned against sampling too far into April because of the large amount of stripers.

The agencies indicated that it may be acceptable to electrofish while gill nets were soaking.

Eel Traps:

When: February to April
Where: At the mouths of rivers, channels and islands
Supplies: Eel pots can possibly be ordered from Wildco

Amanda Hill of FWS mentioned that they would like eel pots to be set at the mouths of rivers, channels and islands and that they were looking for potential elvers. She also stated that these would not be as laborious as gillnetting, the eel traps only needed to be checked every couple of days. Hal Beard indicated that in the past he has caught about three eels in a 10 day sampling season on average, and also that he had 5 yrs of data. Amanda replied that she would like to get that data from him if at all possible. The group mentioned that the first step was to compile as much historical data as possible.

The discussion turned to time periods in which to sample. Mark Cantrell said that February to April would be the best time to deploy eel pots.

The USFWS will provide info on equipment suppliers such as Wildco.

Additional comments: efforts should be made to determine whether eel traps can be fished on a corresponding schedule with gill nets sets. If locations as previously described (e.g. creek entrances) can be located near gill net sites, they should be utilized. Eel traps should be set there upon first deployment of the day, and checked at the end of the day. They could also be left set until the next trip (once twice a weekly sampling starts), when they should be checked and re-baited.

Plankton Nets:

When: While gill netting
Where: DNR would prefer that plankton nets be set to fish off the bottom
Supplies ½ meter, 220/500 micron single nets, possibly with flow meter attached

Amanda Hill mentioned that they would like SCE&G to put up fixed plankton nets to gather eggs and larvae. In response, Alan mentioned that if gillnetting and electrofishing provide no results, plankton nets may be unnecessary. Amanda said that plankton nets are just another way of determining presence or absence, and they are definitely needed during the spring of 2005, if nothing else.

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Kacie Jensen

From: Alison Guth
Sent: Tuesday, November 30, 2004 2:43 PM
To: Alan Stuart; Shane Boring; 'Amanda Hill (amanda_hill@fws.gov)'; 'Hal Beard'; 'mark_a_cantrell@fws.gov'; KMASSEY@scana.com; BARGENTIERI@scana.com; 'ssummer@SCANA.com'; RMAHAN@scana.com; 'dchristie@infoave.net'; 'leachs@dnr.sc.gov'
Subject: Study Notes

These are the notes that should have been attached to the previous email.
Thanks,
Alison

Meeting Minutes for Diadromous...

Minutes for Diadromous Fish Study Meeting
November 10, 2004

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Kristina brought up the fact that flows may be a serious setback when gillnetting, all depending on how wet of a winter and spring we have.

The group decided that sampling should occur in 6 hour time periods. The time period for setting and monitoring gill nets should be during either 2:00 pm -8:00 pm, or possibly 4:00 am to 10:00 am. According to Dick Christie there should be a gill net set up at least at one site around the mouth of the Saluda River at the Congaree River and one in the upper reaches, near the dam (Saluda Shoals). Hal Beard suggested that one of the nets should be located about 100m below the zoo bridge.

Alan suggested using the passage rates at St Stephens as a catalyst to increase sampling efforts in the LSR. Coordination with SCDNR, as was done during the relicensing of Columbia Hydro, is what was proposed and accepted. There needs to be coordination with Doug Cooke and Steve Leach to find out when the fish are being passed. Steve Leach responded that the peak at Pinopolis Dam occurs around March 7th and at St. Stevens around the 20th of March.

The discussion turned to possible sampling times and dates. It was mentioned that SCE&G may only need to sample using gill nets once a week until end of March, beginning of April, and then increase up to around 3x's a week. Hal cautioned against sampling too far into April because of the large amount of stripers.

The agencies indicated that it may be acceptable to electrofish while gill nets were soaking.

Eel Traps:

When:	February to April
Where:	At the mouths of rivers, channels and islands
Supplies:	Eel pots can possibly be ordered from Wildco

Amanda Hill of FWS mentioned that they would like eel pots to be set at the mouths of rivers, channels and islands and that they were looking for potential elvers. She also stated that these would not be as laborious as gillnetting, the eel traps only needed to be checked every couple of days. Hal Beard indicated that in the past he has caught about three eels in a 10 day sampling season on average, and also that he had 5 yrs of data. Amanda replied that she would like to get that data from him if at all possible. The group mentioned that the first step was to compile as much historical data as possible.

The discussion turned to time periods in which to sample. Mark Cantrell said that February to April would be the best time to deploy eel pots.

The USFWS will provide info on equipment suppliers such as Wildco.

Plankton Nets:

When:	While gill netting
Where:	DNR would prefer that plankton nets be set to fish off the bottom
Supplies	½ meter, 220/500 micron single nets, possibly with flow meter attached

Amanda Hill mentioned that they would like SCE&G to put up fixed plankton nets to gather eggs and larvae. In response, Alan mentioned that if gillnetting and electrofishing provide no results, plankton nets may be unnecessary. Amanda said that plankton nets are just another way of determining presence or absence, and they are definitely needed during the spring of 2005, if nothing else.

In regards to the nets themselves, Mark Cantrell mentioned that they would prefer tows but it may be difficult to do in the river, so maybe stationary nets would be better for a given period of time. Moreover, in regards to catching herring, shad and stripers, Mark pointed out that ½ meter, 220 micron would perform the best. He also stated that a flow meter would provide volume measurements, but you would need a meter attached to each net unless they are paired closely together. The group decided that single nets, not bongo nets, should be used. DNR would prefer that the river was fished off the bottom.

It was concluded that plankton nets can be sampled while electrofishing and gillnetting are taking place.

Telemetry Study:

FWS expressed the desire to have a telemetry study preformed with some sentinel fish for American shad. This study will help the agencies determine if the shad utilize the Broad and LSR or just the Broad River. Also if they have thermal preferences and selection based upon the water temperature. Dick Christie believes it would be a good idea to do this because we do not know where they go. Dick Christie also mentioned that it would benefit SCE&G if the American Shad went up the Broad River.

Kristina made the point that if we were going to do this it needed to be done right, and it may be too late to put it together properly by the springtime.

It was discussed that the fish would probably be tagged in Pinopolis. However, SCE&G does not want to study the whole basin just to determine presence in the

LSR. Alan suggested that it could possibly be combined with the Columbia fish passage project effectiveness testing and yield more information and better results. It was suggested that fish needed for the effectiveness tracking effort could be obtained from the Congaree River.

In the end, it was decided that telemetry will be performed as a second phase, along with studies associated with the Columbia Hydro Fish Passage Testing.

Temperature Monitoring:

The influence of the project, water temperature wise, downstream was again brought up. Mark Cantrell mentioned the possible need for temperature monitoring downstream, to the Congaree. Moreover, the most likely time that water temperature is affected is in the summer and fall. Amanda Hill stated that describing the thermal environment of the LSR would help determine if a possible temperature difference influences a fish's choice of sub-basin

In regards to location, it was stated that there should be temperature sensors 1 mile downstream of dam and 1 mile upstream from zoo. Steve Summer mentioned that SCE&G could put some tidbits (temperature recorders) near the confluence on the left and right banks. Mark Cantrell suggested that they do a transect across the river and decide where equilibrium is reached in mixing of both rivers. However SCE&G mentioned that quite a few transects would be needed to determine this, which may be difficult. Steve Summer suggested that one tidbit should be placed in the Saluda and one in the Broad River near the confluence just to track the differences for now. Mark Cantrell stated that the tidbit needs to be positioned towards the bottom but still in the water column.

Steve Leach stated that the preferred spawning water temperature range for sturgeon is 7-18 degrees C. He also pointed out that the divergence of water temperatures between the Broad and LSR begins earlier in year then previously thought, begins around April, and is also more of an obvious difference what was once thought.

Hal Beard pointed out that it is possible that fish orient themselves toward flow instead of temperature.

Sampling in Lake Murray tributaries:

The agencies indicated that they would like an evaluation of potential spawning areas in the Lake and in tributaries. Amanda Hill stated that a characterization of the physical habitat below the dam and above the Lake would be helpful. This can possibly be submitted in GIS format, and would be used to determine if there is potential diadromous fish spawning habitat.

Hal Beard pointed out that Gene Hayes did some cursory work to determine if stripers could possibly be reproducing in middle Saluda, and his determination concluded that numbers were insignificant.

“Tabled” Studies

- Telemetry Study
- Will possibly do a future Habitat Evaluation if it is in conjunction with a required flow study.
- Will determine need of habitat study after video fly-over and float trip.

Low Flow Float Trip on the Lower Saluda River:

The meeting concluded with a discussion of the canoe trip that was going to be taking place on the Lower Saluda River during low flows (400-500 cfs). It was determined that the 29th of November was the best date for everyone.

Amanda and Alan will both ask Prescott Brownell to attend.

The meeting adjourned at approximately 3:00 pm.

Kacie Jensen

From: Dick Christie [dchristie@InfoAve.Net]
Sent: Wednesday, December 28, 2005 11:22 AM
To: Alison Guth
Subject: FW: Fish and Wildlife Draft Notes

Hi Alison - hope you had a great holiday. My comments are in red. Thanks.

-----Original Message-----
From: Alison Guth [mailto:Alison.Guth@KleinschmidtUSA.com]
Sent: Monday, December 05, 2005 4:28 PM
To: 'bargentieriscanacom'; Alan Stuart; 'SUMMER STEPHEN E'; Shane Boring; 'rmahanscanacom'; 'PrescottBrownellNOAAgov'; 'dchristieinfoavenet'; Gina Kirkland; 'bseibelsriverbanksorg'; 'marshallbdnrscgov'; 'ahlerdnrscgov'; 'PatrickMsccclorg'; 'bellsteve9339bellsouthnet'; 'amanda_hillfwsgov'; 'Malcolm Leaphart'; 'kayakdukebellsouthnet'; 'tbowlesscanacom'; 'leachsdnrscgov'; 'dianlog8aolcom'; Hal Beard; 'Jeff_DuncanNPSgov'; 'bill_hulslandernpsgov'
Subject: Fish and Wildlife Draft Notes

Good Afternoon Everyone,

Attached is a copy of the draft November 10th Fish and Wildlife Meeting Notes for your review. Please have comments back to me by December 19th for revisions. You may also present any comments you have on the meeting notes to me before or after the combined RCG meeting Wednesday. Thanks for your time, and as always, feel free to email me with any questions. ~Alison

<<2005-11-10 draft Meeting Minutes - Fisheries and Wildlife.doc>>

Alison Guth
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MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
FISHERIES AND WILDLIFE RESOURCE GROUP

SCE&G Training Center
November 10, 2005

Draft 12-5-05 acg

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Alison Guth, Kleinschmidt Associates
Steve Summer, SCANA Services
Shane Boring, Kleinschmidt Associates
Randy Mahan, SCANA Services
Prescott Brownell, NOAA Fisheries
Dick Christie, SCDNR
Gina Kirkland, SCDHEC
Bob Seibels, Riverbanks Zoo
Bill Marshall, SCDNR & LSSRAC
Ron Ahle, SCDNR
Patrick Moore, SCCCL/Am. Rivers
Steve Bell, Lake Murray Watch
Amanda Hill, USFWS
Malcolm Leaphart, TU
Tom Bowles, SCE&G
George Duke, LMHOC
Steve Leach, SCDNR
Joe Logan, Midlands Stripers
Hal Beard, SCDNR
Jeff Duncan, National Park Service
Bill Hulslander, Congaree National Park

DATE: November 10, 2005

HOMEWORK ITEMS:

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- Review the ICD and the water quality report at the back of the ICD.

AGENDA TOPICS FOR NEXT MEETING:

- Presentation: Water Quality Standards and Classifications of Lake Murray and the Lower Saluda River
  Gina Kirkland
- Presentation: Status on impaired areas within Lake Murray
  Andy Miller
- Presentation: A Review of 25 years of Water Quality in Lake Murray
  Jim Ruane - Reservoir Environmental Management

- A Review of the QUAL 2 -E Water Quality Model and its Application to Lake Murray
  Jim Ruane
- A Review of the Site-Specific Dissolved Oxygen Standard
  Alan Stuart/Shane Boring

DATE OF NEXT MEETING: **December 7, 2005 at 9:00 a.m. (Combined Meeting with Fish and Wildlife Resource Group)**
Located at the Saluda Shoals Park Rivers Center

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

INTRODUCTIONS

Alan opened the meeting and began introductions. He noted that the RCG's were formed to let the diverse interests be expressed and to discuss some of the many issues that individuals may have.

DISCUSSION

Alan held up a copy of the study requests that were sorted out by resource groups. He noted that if you feel that your comment is not on there it may be categorized under another RCG. "If you still feel it should be in this group, let us know."

Alan noted that the water quality group, held the day earlier, discussed the different presentations that are going to occur in conjunction with the fisheries and wildlife group. He noted that the date for that multi group meeting was set yesterday for December 7th. He continued to discuss the presentations that are going to occur in the meeting (see 11-9-05 notes). He noted that typically we pick the date at each meeting; however, we saw this as a good opportunity.

He asked if there were any conflicts. No one expressed any conflicts.

Alan began to discuss the mission statement.

Jeff Duncan- "One important thing to the NPS is the floodplain inundation in the Congaree National Park. One thing I see neglected is the vegetation."

Gina Kirkland – "What about water quality. One of the things that we are going to talk about is the issue of standards and things that have to include other considerations as well."

The group began to discuss that there was much overlap between the Fish and Wildlife and Water Quality groups and it was proposed that the two groups be combined.

Gina Kirkland –"Do you see after initial meeting the possible of combining meetings?

Randy Mahan –"We don't have any problem, it is only that not as many issues are going to be discussed in each meeting."

Steve Summer suggested that the separation could occur more at the TWC.

Alan Stuart noted, "Well having a joint meeting on the 7th, we might want to raise that we will just have to be more cognizant of the agenda."

Randy Mahan- "We still need to work towards the elements of a mission statement even though we may amalgamate these into one."

Alan Stuart then pointed out, "We are encouraging that if there is a topic being discussed at the other RCG you are certainly welcome to attend as an observer. As an aside, we received comments from several NGOs on the Operating procedures, those comments have been evaluated and we are receiving several other comments from Patrick Moore's group very soon."

The group began to look at and discuss the draft mission statements drafted up in the Water Quality meeting. Randy noted that the objective was to create a straw man that everyone could look at.

Prescott Brownell noted, "I think it is important to have an high, overarching goal in the statement such as 'we will seek to achieve the highest level of water quality, etc.' You may not achieve that, but it is good to have it in there."

People continued to discuss additions into the mission statement.

George Duke questioned how you measure your success in meeting your mission statement. "I think we need to look at this at every meeting and ask 'are we in fact doing this'."

Randy Mahan noted, "I think the goal is to get to a point where everyone can sign on the dotted line. It goes into the license application and presumably the FERC will adopt that."

Randy then noted that he did not like the term "Settlement Agreement" and Jeff Duncan agreed with Randy, that the term has a negative connotation.

Alan Stuart added, "Could you instead call it the PM&E Agreement, protection mitigation and enhancement."

Ron Ahle – "I think that is a good mission goal is to develop the PM&E."

Prescott noted, "When you get this mission statement finalized, I think it will be good to have a framed one with signatures on it."

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The group then discussed that they may not want to combine F&W and WQ yet and wait until SCE&G and KA come up with a work plan for each and see where they mesh and then decide whether or not to combine them.

SCE&G will work on drafting up a mission statement for scrutiny.

BREAK

Alan asked the group if there were any issues that have come up since comments were submitted.

Gina Kirkland- "As an aside we met as a board this morning and we are looking at making the waters of the Congaree an outstanding national resource."

Dick Christie noted, "One thing we need to do is review study requests and determine on which committees they should be should addressed. Sorting through the comments and study requests will help us decide whether we need to merge any committees. We may want to put the IFIM study on this committee."

Jeff Duncan added, "We hoped that along with the hydrologic operations model we would like to couple it with a model that looks at the inundations of the park, in respect to the ecological management with the park as affected by the dam releases."

Ron Ahle – "I have a concern about waterfowl populations on the lake as well as the state of waterfowl in the lake, which is becoming more critical."

Steve Bell added, "We have other animals, we need a comprehensive wildlife assessment."

Alan Stuart noted that we need any information needs as soon as possible.

Hal Beard asked, "Who decided what will be addressed and what will be performed?"

Alan Stuart – "All will be addressed."

Hal Beard- "who determines which studies will be conducted?"

Randy Mahan replied, "If the group wants to develop a study and SCE&G disagrees, the FERC will come in and settle a dispute. If we think we are going to be told we are going to do it by the FERC, we are going to go ahead and do it. Ultimately we have the statutory obligation to put the application together and get it filed…we have to study the issues appropriately. We may have some disputes where we believe there is enough information out there and someone else may disagree. We will try and address each and every one of the issues…we may not believe we may have to perform a study in order to get information."

Jeff Duncan- "The thing that FERC will look at is whether the study requests has a nexus to the project and if there is a dispute out there on whether information is inadequate, you have to clearly specify on how the information is inadequate."

Alan Stuart –"One study request that came to mind is fish community surveys, the lake and river has been studied has been studied for many years."

Amanda Hill replied, "We (USFWS) requested that existing data be compiled and if there is a gap in the information then do a study from that."

Steve Summer suggested, "SCE&G did do a helicopter video of the river from the confluence up and we tried to do it at low flows. We also have some footage from the Santee all the way up to the Saluda River at high flows. We have that on DVD and we can bring that up and look at it as a group."

Alan Stuart added, "I believe it was done at least 3 flows."

Prescott noted, "I think that is one of the best things to look at to start with."

Randy Mahan- "That points out that there is a tremendous amount of data out there that many people may not be aware of."

Alan Stuart added, "We advocate using existing data as much as possible."

Alan began to discuss how the TWC are going to be structured. He noted that if an issue were to come up then a TWC would be formed from the RCG.

Malcolm Leaphart asked, "Are most of the studies you have done, Steve (Summer), over the years been peer reviewed? Will the agencies be there?"

Randy Mahan replied, "They won't be peer reviewed for publication."

Gina Kirkland added, "There is quite a bit of quality data and information out there that is not peer reviewed, but that doesn't mean that it is not good or valid data."

Jeff Duncan – "Both FERC and the RCG will function as the peer review."

Prescott Brownell noted, "What we do often is have a back up group of engineer/experts we use. We do the same with instream flow studies and we may get some independent review."

Alan Stuart – "When we do these studies we also encourage involvement from resource agencies."

Gina Kirkland added, "What gives people a certain feeling of confidence is what the quality assurance quality control standards are going to be, and there is nothing to say that the technical committees don't establish what the QAQC is going to be."

Jeff Duncan noted, "As a scientist, we don't know exactly what the answer is, and adaptive management allows you through time to make adaptations."

Bill Marshall asked, "Do license conditions become adaptive to fish communities etc."

Jeff Duncan replied, "It can be written that way, it can include reopener clauses, etc."

Dick Christie added, "Some things are easier to think about from the adaptive management perspective, like shoreline management plans or recreation needs."

Randy Mahan noted, "We just spent 300 million dollars, and we would like to have a 50 year license to expand that money over a longer period of time. We recognize there are issues that need to be re evaluated before a 50 year period of time.

Jeff Duncan noted, "I was involved in a license where we supported the licensee to get a 50 year license because we got what we wanted from it."

Malcolm Leaphart- "I think it is healthy to promote education, and having the TWC coordinate with the RCG to promote education."

Alan listed the HW assignments were to review the ICD and the WQ appendix to the ICD.

Randy Mahan noted that SCE&G will send out a strawman mission statement.

As an aside, Dick Christie brought up the need for this committee to have a good understanding of the meaning of baseline and Alan added that FERC views the baseline as the project is today. Not pre-project.

Jeff Duncan added, "The courts have interpreted what the baseline is, but that doesn't preclude us from doing what is better or looking at historical aspects as fisheries etc."

Randy Mahan replied, "We don't have any problem at all with understanding historical issues.

Prescott Brownell noted, "The issue of continuing impacts has been addressed by the courts."

Randy Mahan replied, "If the current baseline is not good it does not mean we will keep a bad baseline.

Dick Christie noted, "The reason I brought up baseline is that in the ICD I think SCE&G attempted to describe the baseline. The DNR provided comments regarding some of the information presented in the ICD, and we would like to discuss those comments as they relate to establishing that baseline."

Gina Kirkland added, "Even if we consider the ICD a starting point…nothing in the document is Final and we can even work on the baseline."

Alan Stuart noted that although the ICD was not a draft, we will take the ICD and build on it for the application. He added that it should not be confused, that we will not distribute multiple versions of the ICD.

Dick Christie added, "I think that with a few possible exceptions, the ICD pretty accurately reflects the current status of fish and wildlife resources."

Kleinschmidt
Energy & Water Resource Consultants

Bill Argentieri added, “SCE&G did send an acknowledgement of receiving your comments on the ICD, but we did not say whether we agree or disagree with them. We thought they would be established in these committees.”

LEE’S PRESENTATION

Lee’s Powerpoint Presentation of Saluda Hydro System Control can be viewed through the website as well as through the November 1st Operations meeting notes.

From: Alison Guth
Sent: Wednesday, December 21, 2005 2:07 PM
To: BARGENTIERI@scana.com; Alan Stuart; 'SUMMER, STEPHEN E'; Shane Boring; RMAHAN@scana.com; 'Prescott.Brownell@NOAA.gov'; 'dchristie@infoave.net'; 'Gina Kirkland'; 'bseibels@riverbanks.org'; 'marshallb@dnr.sc.gov'; 'ahler@dnr.sc.gov'; 'PatrickM@scccl.org'; 'bellsteve9339@bellsouth.net'; 'amanda_hill@fws.gov'; 'Malcolml@mailbox.sc.edu'; 'kayakduke@bellsouth.net'; 'tbowles@scana.com'; 'leachs@dnr.sc.gov'; 'dianlog8@aol.com'; 'Hal Beard'; 'Jeff_Duncan@nps.gov'; 'bill_hulslander@nps.gov'
Subject: Draft Fish and Wildlife RCG Meeting Notes

Hello All:

Comments on the Draft F&W RCG Meeting notes from November 10th were due back on December 19th. Please forward any additional comments you may have on these to me by Friday, December 23. Thanks to all of you who have already provided comment and to all for your participation in this process. Happy Holidays, Alison

2005-11-10 draft Meeting Minut...

Attached is an original copy of the draft meeting notes, no changes have yet been made to this copy:

Alison Guth
Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
P: (803) 822-3177
F: (803) 822-3183

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
FISHERIES AND WILDLIFE RESOURCE GROUP

SCE&G Training Center
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Draft 12-5-05 acg

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Gina Kirkland added, “There is quite a bit of quality data and information out there that is not peer reviewed, but that doesn’t mean that it is not good or valid data.”

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Gina Kirkland added, “What gives people a certain feeling of confidence is what the quality assurance quality control standards are going to be, and there is nothing to say that the technical committees don’t establish what the QAQC is going to be.”

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Bill Marshall asked, “Do license conditions become adaptive to fish communities etc.”

Jeff Duncan replied, “It can be written that way, it can include reopener clauses, etc.”

Dick Christie added, “Some things are easier to think about from that approach, like shoreline management plans or recreation needs.”

Randy Mahan noted, “We just spent 300 million dollars, and we would like to have a 50 year license to expand that money over a longer period of time. We recognize there are issues that need to be re evaluated before a 50 year period of time.

Jeff Duncan noted, "I was involved in a license where we supported the licensee to get a 50 year license because we got what we wanted from it."

Malcolm Leaphart- "I think it is healthy to promote education, and having the TWC coordinate with the RCG to promote education."

Alan listed the HW assignments were to review the ICD and the WQ appendix to the ICD.

Randy Mahan noted that SCE&G will send out a strawman mission statement.

As an aside, Dick Christie brought up the topic of baseline and Alan added that FERC views the baseline as the project is today. Not pre-project.

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Randy Mahan replied, "We don't have any problem at all with understanding historical issues.

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Alan Stuart noted that although the ICD was not a draft, we will take the ICD and build on it for the application. He added that it should not be confused, that we will not distribute multiple versions of the ICD.

Dick Christie added, "My opinion of what we read it is a pretty accurate portrayal of the Fish and wildlife resources."

Bill Argentieri added, "SCE&G did send an acknowledgement of receiving your comments on the ICD, but we did not say whether we agree or disagree with them. We thought they would be established in these committees."

LEE'S PRESENTATION

Lee's Powerpoint Presentation of Saluda Hydro System Control can be viewed through the website as well as through the November 1st Operations meeting notes.

Kacie Jensen

From: Alison Guth
Sent: Monday, December 05, 2005 4:28 PM
To: BARGENTIERI@scana.com; Alan Stuart; 'SUMMER, STEPHEN E'; Shane Boring; RMAHAN@scana.com; 'Prescott.Brownell@NOAA.gov'; 'dchristie@infoave.net'; 'Gina Kirkland'; 'bseibels@riverbanks.org'; 'marshallb@dnr.sc.gov'; 'ahler@dnr.sc.gov'; 'PatrickM@scccl.org'; 'bellsteve9339@bellsouth.net'; 'amanda_hill@fws.gov'; 'Malcolm Leaphart'; 'kayakduke@bellsouth.net'; 'tbowles@scana.com'; 'leachs@dnr.sc.gov'; 'dianlog8@aol.com'; 'Hal Beard'; 'Jeff_Duncan@NPS.gov'; 'bill_hulslander@nps.gov'
Subject: Fish and Wildlife Draft Notes

Good Afternoon Everyone,

Attached is a copy of the draft November 10th Fish and Wildlife Meeting Notes for your review. Please have comments back to me by December 19th for revisions. You may also present any comments you have on the meeting notes to me before or after the combined RCG meeting Wednesday. Thanks for your time, and as always, feel free to email me with any questions. ~Alison

2005-11-10 draft Meeting Minut...

Alison Guth
Licensing Coordinator
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F: (803) 822-3183

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
FISHERIES AND WILDLIFE RESOURCE GROUP

SCE&G Training Center
November 10, 2005

Draft 12-5-05 acg

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Alison Guth, Kleinschmidt Associates
Steve Summer, SCANA Services
Shane Boring, Kleinschmidt Associates
Randy Mahan, SCANA Services
Prescott Brownell, NOAA Fisheries
Dick Christie, SCDNR
Gina Kirkland, SCDHEC
Bob Seibels, Riverbanks Zoo
Bill Marshall, SCDNR & LSSRAC
Ron Ahle, SCDNR
Patrick Moore, SCCCL/Am. Rivers
Steve Bell, Lake Murray Watch
Amanda Hill, USFWS
Malcolm Leaphart, TU
Tom Bowles, SCE&G
George Duke, LMHOC
Steve Leach, SCDNR
Joe Logan, Midlands Stripers
Hal Beard, SCDNR
Jeff Duncan, National Park Service
Bill Hulslander, Congaree National Park

DATE: November 10, 2005

HOMEWORK ITEMS:

- Go through list of study requests.
- Review the ICD and the water quality report at the back of the ICD.

AGENDA TOPICS FOR NEXT MEETING:

- Presentation: Water Quality Standards and Classifications of Lake Murray and the Lower Saluda River
  Gina Kirkland
- Presentation: Status on impaired areas within Lake Murray
  Andy Miller
- Presentation: A Review of 25 years of Water Quality in Lake Murray
  Jim Ruane - Reservoir Environmental Management

- A Review of the QUAL 2 -E Water Quality Model and its Application to Lake Murray
  Jim Ruane
- A Review of the Site-Specific Dissolved Oxygen Standard
  Alan Stuart/Shane Boring

DATE OF NEXT MEETING: **December 7, 2005 at 9:00 a.m. (Combined Meeting with Fish and Wildlife Resource Group)**
Located at the Saluda Shoals Park Rivers Center

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

INTRODUCTIONS

Alan opened the meeting and began introductions. He noted that the RCG's were formed to let the diverse interests be expressed and to discuss some of the many issues that individuals may have.

DISCUSSION

Alan held up a copy of the study requests that were sorted out by resource groups. He noted that if you feel that your comment is not on there it may be categorized under another RCG. "If you still feel it should be in this group, let us know."

Alan noted that the water quality group, held the day earlier, discussed the different presentations that are going to occur in conjunction with the fisheries and wildlife group. He noted that the date for that multi group meeting was set yesterday for December 7th. He continued to discuss the presentations that are going to occur in the meeting (see 11-9-05 notes). He noted that typically we pick the date at each meeting; however, we saw this as a good opportunity.

He asked if there were any conflicts. No one expressed any conflicts.

Alan began to discuss the mission statement.

Jeff Duncan- "One important thing to the NPS is the floodplain inundation in the Congaree National Park. One thing I see neglected is the vegetation."

Kleinschmidt
Energy & Water Resource Consultants

Gina Kirkland – "What about water quality. One of the things that we are going to talk about is the issue of standards and things that have to include other considerations as well."

The group began to discuss that there was much overlap between the Fish and Wildlife and Water Quality groups and it was proposed that the two groups be combined.

Gina Kirkland –"Do you see after initial meeting the possible of combining meetings?

Randy Mahan –"We don't have any problem, it is only that not as many issues are going to be discussed in each meeting."

Steve Summer suggested that the separation could occur more at the TWC.

Alan Stuart noted, "Well having a joint meeting on the 7th, we might want to raise that we will just have to be more cognizant of the agenda."

Randy Mahan- "We still need to work towards the elements of a mission statement even though we may amalgamate these into one."

Alan Stuart then pointed out, "We are encouraging that if there is a topic being discussed at the other RCG you are certainly welcome to attend as an observer. As an aside, we received comments from several NGOs on the Operating procedures, those comments have been evaluated and we are receiving several other comments from Patrick Moore's group very soon."

The group began to look at and discuss the draft mission statements drafted up in the Water Quality meeting. Randy noted that the objective was to create a straw man that everyone could look at.

Prescott Brownell noted, "I think it is important to have an high, overarching goal in the statement such as 'we will seek to achieve the highest level of water quality, etc.' You may not achieve that, but it is good to have it in there."

People continued to discuss additions into the mission statement.

George Duke questioned how you measure your success in meeting your mission statement. "I think we need to look at this at every meeting and ask 'are we in fact doing this'."

Randy Mahan noted, "I think the goal is to get to a point where everyone can sign on the dotted line. It goes into the license application and presumably the FERC will adopt that."

Randy then noted that he did not like the term "Settlement Agreement" and Jeff Duncan agreed with Randy, that the term has a negative connotation.

Alan Stuart added, "Could you instead call it the PM&E Agreement, protection mitigation and enhancement."

Ron Ahle – "I think that is a good mission goal is to develop the PM&E."

Prescott noted, "When you get this mission statement finalized, I think it will be good to have a framed one with signatures on it."

Randy Mahan replied, "That is not a bad idea."

The group then discussed that they may not want to combine F&W and WQ yet and wait until SCE&G and KA come up with a work plan for each and see where they mesh and then decide whether or not to combine them.

SCE&G will work on drafting up a mission statement for scrutiny.

BREAK

Alan asked the group if there were any issues that have come up since comments were submitted.

Gina Kirkland- "As an aside we met as a board this morning and we are looking at making the waters of the Congaree an outstanding national resource."

Dick Christie noted, "One thing we need to do is review study requests and discuss the appropriateness of where such studies are placed. As sorting the comments will help us decide whether or not you would like to merge any committees. We may want to put the IFIM on this committee."

Jeff Duncan added, "We hoped that along with the hydrologic operations model we would like to couple it with a model that looks at the inundations of the park, in respect to the ecological management with the park as affected by the dam releases."

Ron Ahle – "I have a concern about waterfowl populations on the lake as well as the state of waterfowl in the lake, which is becoming more critical."

Steve Bell added, "We have other animals, we need a comprehensive wildlife assessment."

Alan Stuart noted that we need any information needs as soon as possible.

Hal Beard asked, "Who decided what will be addressed and what will be performed?"

Alan Stuart – "All will be addressed."

Hal Beard- "who determines which studies will be conducted?"

Randy Mahan replied, "If the group wants to develop a study and SCE&G disagrees, the FERC will come in and settle a dispute. If we think we are going to be told we are going to do it by the FERC, we are going to go ahead and do it. Ultimately we have the statutory obligation to put the application together and get it filed…we have to study the issues appropriately. We may have some disputes where we believe there is enough information out there and someone else may disagree. We will try and address each and every one of the issues…we may not believe we may have to perform a study in order to get information."

Jeff Duncan- "The thing that FERC will look at is whether the study requests has a nexus to the project and if there is a dispute out there on whether information is inadequate, you have to clearly specify on how the information is inadequate."

Alan Stuart –"One study request that came to mind is fish community surveys, the lake and river has been studied has been studied for many years."

Amanda Hill replied, "We (USFWS) requested that existing data be compiled and if there is a gap in the information then do a study from that."

Steve Summer suggested, "SCE&G did do a helicopter video of the river from the confluence up and we tried to do it at low flows. We also have some footage from the Santee all the way up to the Saluda River at high flows. We have that on DVD and we can bring that up and look at it as a group."

Alan Stuart added, "I believe it was done at least 3 flows."

Prescott noted, "I think that is one of the best things to look at to start with."

Randy Mahan- "That points out that there is a tremendous amount of data out there that many people may not be aware of."

Alan Stuart added, "We advocate using existing data as much as possible."

Alan began to discuss how the TWC are going to be structured. He noted that if an issue were to come up then a TWC would be formed from the RCG.

Malcolm Leaphart asked, "Are most of the studies you have done, Steve (Summer), over the years been peer reviewed? Will the agencies be there?"

Randy Mahan replied, "They won't be peer reviewed for publication."

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LEE'S PRESENTATION

Lee's Powerpoint Presentation of Saluda Hydro System Control can be viewed through the website as well as through the November 1st Operations meeting notes.

Kacie Jensen

From: Alison Guth
Sent: Monday, November 07, 2005 1:42 PM
To: 'Amanda_Hill@fws.gov'; 'bill_hulslander@nps.gov'; 'bseibels@riverbanks.org'; 'cheetahtrk@yahoo.com'; 'dchristie@infoave.net'; 'ediebold@riverbanks.org'; 'kayakduke@bellsouth.net'; 'gjobsis@americanrivers.org'; 'KIRKLAGL@dhec.sc.gov'; 'Jeff_Duncan@NPS.gov'; 'wildlife@sc.rr.com'; 'dianlog@aol.com'; 'Malcolml@mailbox.sc.edu'; 'mark_Leao@fws.gov'; 'lucky8lady@aol.com'; 'Norm@sc.rr.com'; 'PatrickM@scccl.org'; 'Prescott.Brownell@noaa.gov'; 'crafton@usit.net'; 'ahler@dnr.sc.gov'; 'samnancydrake@aol.com'; Shane Boring; 'bellsteve9339@bellsouth.net'; 'leachs@dnr.sc.gov'; 'ssummer@scana.com'; 'suzrhodes@juno.com'; 'BeardH@dnr.sc.gov'; 'BalesW@dnr.sc.gov'; Alan Stuart; BARGENTIERI@scana.com
Subject: Fish.&Wildlife RCG Agenda

Good Afternoon All:

Attached to this email is the agenda for the Fisheries and Wildlife Resource Conservation Group. If you know that you will **not** be able to attend Thursday's meeting, please let me know by tomorrow morning, if at all possible. This will allow me enough time to make any adjustments with the catering service. Thanks so much, and hope to see you all Thursday.

Alison

Fish and Wildlife RCG Agenda.p...

Alison Guth
Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
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F: (803) 822-3183

Saluda Hydro Relicensing
Fisheries and Wildlife Resource Conservation Group

Meeting Agenda

November 10, 2005
9:30 AM
Lake Murray Training Center

- **9:35 to 9:45** Introductions
  - SCE&G and KA Staff
  - Resource Agency Representatives
  - NGO Representatives
  - Individuals
- **9:45 to 10:00** Purpose of Resource Groups
- **10:00 to 11:00** **Presentation – Saluda Hydro Operations – Lee Xanthakos SCANA Services**
- **11:00 to 11:45** Develop Fisheries and Wildlife RCG Mission Statement
- **11:45 to 12:45** Lunch
- **1:00 to 2:00** Discuss Fisheries and Wildlife RCG Procedures
- **2:00 to 2:30** Develop List of Homework Assignments
- **2:30 to 2:45** Develop an Agenda for Next Meeting
- **2:45 to 3:00** Set Next Meeting Date

Adjourn

Kacie Jensen

From: Alison Guth
Sent: Monday, November 07, 2005 4:04 PM
To: 'Amanda_Hill@fws.gov'; 'bill_hulslander@nps.gov'; 'bseibels@riverbanks.org'; 'cheetahtrk@yahoo.com'; 'dchristie@infoave.net'; 'ediebold@riverbanks.org'; 'kayakduke@bellsouth.net'; 'gjobsis@americanrivers.org'; 'KIRKLAGL@dhec.sc.gov'; 'Jeff_Duncan@NPS.gov'; 'wildlife@sc.rr.com'; 'dianlog@aol.com'; 'Malcolml@mailbox.sc.edu'; 'mark_Leao@fws.gov'; 'lucky8lady@aol.com'; 'Norm@sc.rr.com'; 'PatrickM@scccl.org'; 'Prescott.Brownell@noaa.gov'; 'crafton@usit.net'; 'ahler@dnr.sc.gov'; 'samnancydrake@aol.com'; Shane Boring; 'bellsteve9339@bellsouth.net'; 'leachs@dnr.sc.gov'; 'ssummer@scana.com'; 'suzrhodes@juno.com'; 'BeardH@dnr.sc.gov'; 'BalesW@dnr.sc.gov'; BARGENTIERI@scana.com; Alan Stuart
Subject: New F&W agenda

Hello all:

There was a mistake with the previous agenda for the Fish and Wildlife Resource Conservation Group. Please note that Lee Xanthakos will be giving his presentation at 1:00 instead of 10:00. Thanks, Alison

Fish and Wildlife RCG Agenda.p...

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Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
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F: (803) 822-3183

Saluda Hydro Relicensing
Fisheries and Wildlife Resource Conservation Group

Meeting Agenda

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- **2:45 to 3:00** Set Next Meeting Date

Adjourn

Kacie Jensen

From: Alison Guth
Sent: Monday, June 13, 2005 4:04 PM
To: BARGENTIERI@scana.com; Alan Stuart; 'ssummer@scana.com'; 'Prescott Brownell'; Shane Boring; 'Doug Cooke'; 'Jennifer F. Jefferies (Jennifer.Jefferies@noaa.gov)'
Subject: May 5th Conference Call on SNS Sampling Permit

Goodafternoon Everyone,

Attached is a final copy of the meeting minutes drafted for the meeting which was held via conference call on May 5 regarding the SNS Sampling Permit Application for the Saluda Hydro Relicensing. Thanks to all for your involvement in this.

Sincerely,
Alison Guth
Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
P: (803) 822-3177
F: (803) 822-3183

Final Shortnose
Sturgeon Permi...

Saluda Hydro Relicensing
Meeting with NOAA Fisheries Regarding 2006 Shortnose Sturgeon Sampling

Via Conference Call – May 5, 2005

Revised 6-13 ACG

Attendees:

Prescott Brownell	NOAA Fisheries	Bill Argentieri	SCE&G
Shane Boring	Kleinschmidt	Alison Guth	Kleinschmidt
Carrie Hubard	NOAA Fisheries	Jennifer Jefferies	NOAA Fisheries

Meeting Notes:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane opened the meeting at approximately 1:30 pm, noting that the purpose of the day's meeting would be to discuss Jennifer Jefferies' comments on the draft application for a shortnose sturgeon (SNS) research permit (comments received via email 5/5/05).

Jennifer noted that there could be only one permit holder which was non-transferable for the duration of the permit. She continued to state that there could also be only one Principle Investigator listed, although this could change if need be. Jennifer noted that if anyone was to act as the Principle Investigator in the absence of the Principle Investigator then they must be listed as a Co-Investigator, however, the PI is ultimately the responsible party. She mentioned that CI's are relatively easy to add, there just needs to be a request letter sent in by the PI along with an up to date CV for the requested individual.

Bill asked if the requirements would allow for SCE&G to contract out work, to which Jennifer replied that it would. Bill then noted that SCANA would be the permit holder with Steve Summer being the principle investigator.

Jennifer mentioned that, if the radio/acoustic tagging is to be done by SCDNR, it may be possible to remove this more controversial methodology from SCE&G's permit application. Shane replied that SCE&G is not planning on performing any transmitter implanting. Jennifer recommended discussing this issue with Doug Cooke to ensure their permit has adequate take numbers to accommodate any sturgeon that might be caught during SCE&G's sampling, and if so, this language should be removed from SCE&G's permit application.

Jennifer posed the question as to whether there were any sources for the statements made about the dam-locked population mentioned in the last paragraph of F.1. Shane noted that he had spoken with Doug Cooke on this issue and Doug noted that they are unsure of the numbers of sturgeon above the Santee-Cooper Dams. Prescott added that the fishable area above the lake is small, having few places to fish, which could explain the low numbers recorded. Jennifer replied that it would be important to talk with Doug in order to decide what kind of numbers needed to be listed as maximum take. She continued to

Saluda Hydro Relicensing
Meeting with NOAA Fisheries Regarding 2006 Shortnose Sturgeon Sampling

Via Conference Call – May 5, 2005

Revised 6-13 ACG

note that due to the lack of information available, it would be beneficial to state the existing information, even if it included catch rates from lower in the river. Jennifer then stated that discussions with Doug could be cited as "personal communication" in the permit application.

Discussions turned to sampling seasons and Shane asked Prescott to discuss during what seasons sampling should be performed. Prescott noted that sampling should take place during the spawning season, January-April, and also possibly in the late summer and early fall when sturgeon often seek out cooler water sources in Piedmont rivers. Jennifer noted that this information needs to be included in the application. She added that some additional information should also be added justifying why the sampling is needed. Specifically, rather than just saying that the Saluda Project is within the historic range of shortnose sturgeon, the application should state whether or not the sampling would help address the recovery plan goals or other restoration efforts for the species.

Shane stated that he received the new guidelines for the permit application and questioned if that entailed a format change to the current draft permit application. Jennifer affirmed that it did.

Bill enquired as to how much time it would take NOAA to process the permit application. Jennifer replied that it would be around 8 months. Prescott noted that he believed that the sampling should begin around mid-January. However, he mentioned that the best time could be determined through conversations with Doug, including factors such as water temperatures, which could greatly impact migration.

Kacie Jensen

Subject:	IFIM/Aquatic Habitat TWC Meeting
Location:	Lake Murray Training Center
Start:	Tue 12/19/2006 9:30 AM
End:	Tue 12/19/2006 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Fish & Wildlife TWC - IFIM/Aquatic Habitat; Jennifer O'Rourke

Hello All,

Just a reminder that we will be having a IFIM/Aquatic Habitat Meeting next Tuesday, December 19th. This meeting will be located at the Lake Murray Training Center and will begin at 9:30. Shane should be sending out a meeting Agenda in the next day or so. Also, please RSVP by the close of business on Friday. Thanks, Alison

Kacie Jensen

From: Jennifer Summerlin
Sent: Monday, December 11, 2006 4:43 PM
To: 'Wade Bales (balesw@dnr.sc.gov)'; 'Amanda Hill'; 'Bill Argentieri'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; 'Jim Glover'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
Subject: Saluda Relicensing: Nov 27th Instream Flow/Aquatic Habitat draft meeting notes

Hello Folks,

Attached are the November 27, 2006 IFIM draft meeting notes. Please note that comments to the Draft IFIM Study Plan and Guild Matrix are attached within the meeting notes. Please have comments back to me by December 27th.

2006-11-27
ıstream Flow-Aquat.

Thanks,

Jennifer Summerlin
Scientist Technician
Kleinschmidt Associates
101 Trade Zone Drive, Suite 21A
West Columbia, SC 29170
P:803.822.3177
F:803.822.3183

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT TECHNICAL WORKING COMMITTEE

SCE&G Training Center
November 27, 2006

draft jms/bhk/csb 11-27-06

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Bill Argentieri, SCE&G
Brandon Kulik, Kleinschmidt Associates
Dick Christie, SCDNR
Gerrit Jobsis, American Rivers/CCL
Hal Beard, SCDNR
Jeni Summerlin, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Randy Mahan, SCANA Services
Ron Ahle, SCDNR
Scott Harder, SCDNR
Shane Boring, Kleinschmidt Associates
Theresa Thom, National Park Service

ACTION ITEMS:

- Find out if Prescott has HSI curves for Atlantic/shortnose sturgeon

Amanda Hill

- Ask Steve Summer if he has any flow data for the LSR

Milton Quattlebaum

- Provide HSI curves for brown/rainbow trout from Savannah River/Catawba Wateree IFIM studies

Dick Christie

- Contact Jim Ruane about obtaining HSI curves for trout in the Chattahoochee River basin and research other potentially applicable trout curves

Brandon Kulik

- Research applicable smallmouth bass HSI curves

Brandon Kulik

- Edit the guild matrix and send out to committee members

Brandon Kulik

- Plan a meeting to discuss the guild matrix and *HSI* curves in more detail

Shane Boring

- Edit the draft IFIM study plan and send out to committee members

Brandon Kulik / Shane Boring

- Edit mesohabitat descriptions and send out to committee members

Brandon Kulik

DATE OF NEXT MEETING[1]: **December 19, 2006 at 9:30 a.m.**
Located at the Lake Murray Training Center

[1] this meeting will be to discuss issues pertaining to the Congaree River

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT TECHNICAL WORKING COMMITTEE

SCE&G Training Center
November 27, 2006

draft jms/bhk/csb 11-27-06

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Review of Action Items from Previous Meeting:

Shane Boring opened the meeting and noted that the first discussion topic was to review action items from the previous meeting. Shane noted that Brandon Kulik sent the draft IFIM study plan to committee members for review; Gerrit Jobsis provided a link to the Pee Dee HSI curves; and Dick Christie sent the Catawba Wateree HSI curves to Brandon. Shane noted that the purpose of today's meeting is to: (1) review the draft IFIM study plan, (2) review the lower Saluda River (LSR) aerial video, (3) discuss the guild matrix and HSI curves, (4) discuss the classification, types, and definition of mesohabitats, and (5) discuss field site locations that study participants wish to visit on November 28th.

Review of Draft IFIM Study Plan:

Comments on the draft IFIM study plan can be viewed in track changes in attachment A. A copy of the draft IFIM study plan was distributed and Shane asked committee members if they had any comments. There were several editorial and organizational recommendations made by SCDNR and American Rivers to better describe the context of river fishery resources, and clarify the scope and role of this study. Dick and Hal noted that recent DNR studies reveal that striped bass use the LSR as a thermal refuge (as much as 50% of the population), and that there may be potential for the river to be managed for smallmouth bass in the future, as smallmouth bass are colonizing the Broad River near the confluence with the Saluda and DNR anticipates that they will begin to inhabit the Saluda in the near future. Gerrit recommended that the project description include a reference to other historic operating regimes that the Saluda project has employed during the life of its current license besides the current operating mode (reserve).

Regarding the technical approach, Scott Harder asked about the number of velocity sets that will be taken at each transect. Brandon noted that velocity measurements will be taken on a transect basis. Brandon went on to explain that at least one velocity set will be taken at each transect. There will be three calibration flows (low, medium and high), and velocity data are collected at the middle calibration flow. In the case of transects with complex hydraulics (usually riffles and shoals) additional velocity sets will likely be collected at the low flow since hydraulic parameters such as friction coefficients and turbulence will likely be different due to the substrates and supercritical flows inherent in such sites. This is decided on a case-specific basis with input from a hydraulic engineer, In order to provide a suitable stage-discharge curve for the hydraulic model to project

Weighted Usable Area (WUA) for a flow range from 40 to over 20,000 cfs, the three calibration flows to be used are expected to be approximately:(350-500 cfs, 1200-1500 cfs, and 10,000 cfs. Scott inquired how error will be treated in the model. Brandon indicated that for each flow increment at each transect, the Velocity Adjustment Factor (VAF) obtained during each transect's calibration is used as an indicator of accuracy. If VAF's for some flow range is out of range, additional modeling or supplemental .flow data may be required. Brandon agreed to supplement the modeling discussion in the draft plan methodology with additional details.

In regards to the fish passage evaluation, Gerrit explained that the 1990 IFIM study that he participated in came up with a 1300 cfs fish passage flow based on SCDNR criteria for Millrace Rapids. This was based on data obtained at a location in Millrace Rapids chosen by Steve De Kozlowski. Gerrit questioned the need to redo this part of the study, because the criteria will not change much, and he believes that the river channel characteristics have not changed much. Brandon noted that the study plan was written so as not to foreclose on the need to conduct a new analysis, but that the full study team would make the final decision. Another option might be to obtain and review the original data sets and Steve De Kozlowski input if practical. Dick Christie felt that the study should take advantage of new fish passage hydraulic criteria that may be specifically applicable to anadromous fish species. Brandon added that he had obtained these criteria from Alex Haro of the Conte Anadromous Fish Laboratory in Turners Falls, MA, and that they rate temperature fish swimming strength, slope and water velocity in ascending rapids.

Hal Beard asked how braided sections in the LSR will be evaluated. Brandon indicated to the extent the team desires that these be modeled, that each channel braid selected will be treated as a separate stream channel, with separate transects. Manual flow gauging will be required during calibration to provide an estimate of how water flows through each braid. Scott inquired as to how the Acoustic-Doppler Current Profiler (ADCP) will be used with the large amounts of vegetation in the LSR. Brandon explained that if these mats of vegetation are extensive, they may effect the model simulation, in that they act as ephemeral objective cover and may change the velocity relative to unvegetated periods. Brandon specifically noted that vegetation will certainly be considered when evaluating the mesohabitats. Hal noted that vegetation in the LSR has increased over the years; about 70% of the river has vegetation, specifically from Twelvemile Creek to the I-20 Bridge. Vegetation is most pronounced in areas of lower velocity and comparatively less pronounced in rapids and riffles. Hal mentioned that the group may want to consider talking to Cindy Aulbach. She conducts fly-over's for SCE&G to evaluate vegetation in the LSR.

Review of Lower Saluda River Aerial Video:

To gain a better understanding of the different types of habitats, the group viewed flows of the LSR at 540 and 840 cfs video graphed from a helicopter flying from downstream to upstream during spring 2005. Gerrit noted that transects at Corley Island, Oh Brother Rapids and Shandon Rapids should be evaluated. Through discussion, the group separated the LSR into four segments: (1) Lake Murray Dam to Rawls Creek; (2) Rawls Creek to I-26 Bridge; (3) I-26 Bridge to Millrace Rapids; and (4) Millrace Rapids to the confluence of the lower Saluda and Broad river's. The group noted that segment (2) was extremely uniform in width, depth, and channel shape.

Classification, Types and Definition of Mesohabitats:

Comments on the guild matrix can be viewed in track changes in Attachment B. Brandon explained that in order to simplify the WUA analysis, the TWC had agreed to sort species and life stages into habitat-use guilds. Brandon noted that for purposes of this straw man, the guild groups (shallow-slow, shallow-fast, *etc*) categories were the commonly-used categories developed by Mark Bain. Brandon explained that life stages of each species were assigned to habitat use guilds based on life history and habitat preference using Dilts et al. (2003) *Application of New Approaches to Instream Flow: Use of Two Dimensional Modeling and Habitat-Use Guilds in a Southeastern Stream* as a generalized model. He asked that the TWC review this approach for reasonableness and welcomed any river- or species-specific refinements that the group cared to recommend.

Gerrit pointed out that spawning and adult life stages of shortnose sturgeon should be added to the guild matrix. He mentioned that the Catawba Wateree, Pee Dee, and Santee Cooper may have developed HSI curves for shortnose/Atlantic sturgeon. Amanda Hill noted that Prescott Brownell may have developed these curves. Amanda recommended adding spawning life stage for striped bass. Dick indicated that there has been no indication of spawning striped bass in the LSR. He clarified that striped bass use the LSR as a thermal refuge area rather than for spawning. Dick noted that if striped bass spawning is included, we may be able to use HSI curves from the Savannah River or Catawba Wateree. There was a brief discussion about the type of HSI curves that could be used for brown trout and Shane noted Dick had observed that it may not be feasible to use Catawba Wateree curves because it would not be reflective of the LSR. In response to a question, Brandon noted that USFWS "bluebook" adult and juvenile HSI trout curves from the have been criticized as non-transferable curves, at least in most eastern rivers. He was aware of some recent trout curve development in Pennsylvania, and New England that may have potential transferability. Hal noted that SCDNR is more concerned with adult trout from a resource perspective; they would like to include some southeastern trout HSI curves. Alan Stuart noted that TVA may have developed HIS curves for trout in the Chattahoochee basin. Gerrit mentioned that the USFWS HSI curves for trout are from 1984/1985. He mentioned that Jim Ruane may be able to provide some information on these curves. It was generally agreed that if Brandon could find and circulate these HSI curves for committee members to review that satisfactory adult curves could be identified by the group. Brandon will also research and summarize smallmouth bass HSI criteria.

Shane inquired if committee members were satisfied with the guild approach. The group noted that they were comfortable with this guild approach, but certain species should be stand alone. Specifically, Dick noted that smallmouth bass, spottail shiner, gizzard and threadfin shad species are not easily categorized into specific guilds. Gerrit noted that the group should reexamine each species and how they are categorized into each guild, specifically the northern hogsucker. Brandon noted that he would update the guild matrix and send out to committee members for review. Shane noted, and the group agreed, that a meeting devoted entirely to finalizing the guilds is needed.

Classification, Types and Definition of Mesohabitats:

Comments on the mesohabitat classifications can be viewed in track changes in Appendix C. Brandon displayed various mesohabitats definitions for the group and noted that it is important to reach a common understanding of these definitions. These definitions are in part a way to link life stages to habitat-use guilds, but is primarily a tool to facilitate habitat mapping. The distribution and abundance of mesohabitats in each reach will in turn be used as a mechanism to select study sites and transects at a later stage. He pointed out that the definition of each mesohabitat was adopted from the Catawba Wateree, and Santee Cooper studies and Dunn and Leopold, 1998). Brandon read through each habitat type and a few comments were made.

The group agreed to meet at the guard shack located at the Saluda Hydro Dam at 9:30AM to visit specific sites of interest, gain a common understanding of the river from a habitat perspective, and test and refine the definitions of mesohabitats on the LSR.

ATTACHMENT A

COMMENTS ON THE DRAFT IFIM STUDY PLAN

SOUTH CAROLINA ELECTRIC & GAS COMPANY
COLUMBIA, SOUTH CAROLINA

SALUDA HYDROELECTRIC PROJECT
(FERC NO. 516)

INSTREAM FLOW STUDY OF THE LOWER SALUDA RIVER

DRAFT – November 8, 2006

1.0 INTRODUCTION

The Saluda Hydro project is a 202.6 megawatt (MW) licensed hydroelectric facility located on the Saluda River in Lexington, Newberry, Richland, and Saluda counties of South Carolina and is owned and operated by South Carolina Electric & Gas (Figure 1). The project consists of Lake Murray, the Saluda Dam, the new back-up Saluda Berm, spillway, powerhouse, intakes, and penstocks. The project is currently licensed by the Federal Energy Regulatory Commission (FERC No. 516) and the present license is due to expire in the year 2010.

To initiate the Project relicensing process, SCE&G prepared and issued the Initial Consultation Document (ICD) on May 20, 2005. The Licensee submitted the document to a number of state and federal resource agencies for their review and comment. As a result, the United States Fish and Wildlife Service (USFWS), South Carolina Department of Natural Resources (SCDNR), National Marine Fisheries Service (NMFS), and several Non-governmental Organizations (NGO's) requested studies to determine the potential impact of Project operation on downstream fishery resources and aquatic habitat, including a Instream Flow Incremental Methodology Study for the lower Saluda River downstream of the Project. A separate study will be conducted to evaluate effects of project operation on the Congaree River.

1.1 Existing Operations

Saluda Hydro occupies a specific, very important niche in SCE&G's generating portfolio in that it is a facility in the SCE&G system that provides *reserve capacity*. Reserve capacity means the Project generators can increase output immediately in response to a major generator or transmission *outage* and can reach full output within 15 minutes to comply with the North American Electric Reliability Council's Control Performance Standard.

Comment: This section should focus on the hydrologic affects of operations not VACAR or reserves. Delete below and insert summary of project op effects on downstream hydrology. Document that project operations have varied under the existing license term from Peaking to Load-Following to Reserve Capacity - document years under each operation mode.-Gerrit Jobsis

SCE&G is a member of the Virginia-Carolinas Southeastern Electric Reliability Council sub-region (VACAR), whose members are bound in a reserve-sharing agreement by which each has agreed to assist any other member in generation emergencies. SCE&G must employ its reserves (Saluda Hydro) to meet its own generation emergencies before calling on assistance from other VACAR members, but it also must be constantly ready to provide reserve generation to other VACAR members to meet SCE&G's contractual reserve obligations.

Under SCE&G's obligations as a member of VACAR, it must be able to supply approximately 200 MW within 15 minutes in the event of an out-of-system emergency. The Saluda Project's greatest single value in support of SCE&G's system obligations is its ability to provide up to 202 MW of generation almost instantly. In the case of any system emergency, Saluda may be dispatched for up to full capacity generation for minutes or even hours.
Add intro section on Saluda River - state's first scenic river, trophy striped bass fishery, significant refuge habitat for Santee-Cooper striped bass spawning stock, unique trout fishery; this river segment is of high statewide priority

1.2 Use of Study Results

In general, the TWC is interested in exploring the protection of instream habitat in the lower Saluda River (LSR) below the Saluda Project (see Appendix A for a detailed summary of discussions).

- Identify a minimum flow for the LSR
- Determine flows needed for target species and lifestages, as well as the downstream floodplain
    - Determine the range of flows acceptable to meet these criteria
    - Determine how project operations affect these flows
    - Mimic the natural hydrograph of the LSR
    - Consider impact of providing these flows on Lake Murray

The TWC has identified the following issues that this study will provide data for:

Comment: New Section - Information provided by this study-Gerrit Jobsis

- evaluate alternative flow regimens for the LSR;
- identifying flow regimens that are protective of aquatic habitat;
- provide data that can be used to weigh the effects of managing Lake Murray water levels on downstream habitat; and
- provide data that can be used to weigh the effects of project operations on downstream habitat.

1.3 Purpose of This Study

The scope of this study is to provide data quantifying the effects of flows on aquatic habitat suitability in the LSR for the aquatic community and its managed fish resources, including diadromous and resident fish species, and aquatic invertebrates and to assist the TWC in identifying flow regimens that support habitat requirements for a balanced aquatic community. These data will then be used in conjunction the Congaree River flow study, and hydrologic, operational and other models to evaluate the costs and benefits of providing alternate flows to the lower Saluda River.

Comment: Move this sentence to top paragraph

2.0 DESCRIPTION OF STUDY AREA

The Saluda River rises on the east slope of the Appalachian Mountains, and flows southwest across the Piedmont geomorphic province to its confluence at the fall line (Hunt 1974) with the Broad River in Columbia, South Carolina, where the combined flows form the Congaree River. Between the Lake Murray dam and the confluence, LSR flows for approximately ten miles through generally low gradient[2] riverine geomorphology (Figure 2). The drainage area at Lake Murray dam is 2,420 square miles. Real time stream flow gages exist at USGS 02168504 (*Saluda River below Lake Murray Dam*), and USGS 02169000 (*Saluda River near Columbia, SC*).

2.1 Upstream and Downstream Boundaries

The LSR segment between Lake Murray and the confluence with the Broad River, (Figure 2) was identified by the TWC as the study area for purposes of this study. Flow in this reach is primarily influenced by releases from the Saluda Project powerhouse, although there are some additional contributions from small tributaries such as Rawls, Twelvemile , Kinley , and Stoop creeks and Senn Branch, which collectively contribute approximately 100 square miles of additional drainage area.

2.2 Habitat and Geomorphology

The LSR flows southeasterly through a river corridor that gradually shifts from rural to suburban to urban land uses, and in general the river banks and riparian zones are forested. Overall the river is relative straight, with gentle bends and little sinuosity. The upper segment of the LSR is dominated by well-defined banks, relatively low-gradient pools and glides periodically segmented by short shoals and alluvial riffles. The lowermost segment also contains pools, glides and runs, but exhibits higher gradient, more pronounced riffles, and features ledge and boulder substrates which reflect down cutting through the piedmont terrace at the fall line. There is some evidence of localized bank erosion and ephemeral alluvial shoaling. Beginning downstream of Riverbanks Zoo, the LSR becomes highly braided, with the lowermost mile becoming backwatered by the Broad River (Isely, et. al, 1995). There are a few scattered islands with pronounced side channels and/or braids in both the upper and lower reaches of the LSR.

An important macrohabitat consideration on the LSR is that the ambient water temperature and dissolved oxygen (DO) is influenced by cold water releases from below the thermocline of Lake Murray via the project powerhouse. Average water temperatures below the Project dam range from approximately 9.5^{o}C in February to 17.5^{o}C in early-October, and from approximately 10 to 18.5^{o}C in the vicinity of Riverbanks Zoo[3]. A site-specific study aimed at gaining greater understanding of the downstream extent and mixing characteristics of temperature impacts is underway. Average DO levels below the

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[2] Reach is punctuated by short, higher gradient reaches (3-4%), such as Millrace Rapids, but generally gradient is 1% or less.
[3] Based on monthly averaged 2000 to 2006 data as measured at USGS Gage # 02168504 (below Murray Dam) and at USGS Gage # 2169000 (Columbia).

dam range from 6.2 mg/L during September to 11.0 mg/L during February, with periodic excursions below 1.0 mg/L for short periods of time[4].

Comment: May want to mention trout fishery is enabled by project operations

2.3 Fishery, Fish Management Objectives, and Seasonal Habitat Uses

The LSR supports a diverse community of coldwater and warm water fish species and provides a variety of fishing opportunities (Beard, 1997). This two-story fishery has been established through SCDNR stocking to enhance LSR recreational fishing opportunities. In 1995, the SCDNR investigated the potential to establish a smallmouth bass fishery in the LSR. SCDNR's findings suggested that while many criteria to support a smallmouth bass fishery were present, it was not feasible to implement this strategy as a fishery management goal in the LSR because suitable habitat was found to be inadequate.

Comment: Add that water quality (DO and temperature) of Saluda is recognized as affecting fish community.-Gerrit Jobsis

Comment: Add paragraph on LSR being a state scenic rive and a valuable fishery

Comment: Add that DNR stocked smallmouth bass in mid-1980s but this was generally recognized as unsuccessful.-Hal Beard

Resident Fishery Resources

The LSR resident fishery is typical of many southern tailwater systems, and includes an assortment of resident game and non-game species (Table 1). Studies conducted as early as 1991 found approximately 50 species of fish, 48 of which are considered endemic to the region (Jobsis, 1991). Cite Crane 1987 study

Comment: Include table of resident fish species.-Theresa Thom

Redbreast sunfish were the most abundant game species found in the 1991 study. Bluegill were also typically found in relatively high abundance but abundance was highly variable based on specific habitat types (Jobsis, 1991). Redbreast sunfish were dominant in the upper sections as compared to the lower and middle sections. LSR redbreast sunfish growth studies indicated that this species grows slowly compared to those of other rivers in the southeast (Jobsis, 1991). However, this is not surprising since coldwater temperatures have been shown to limit growth of warmwater fish in similar watersheds (Ruane et al., 1986).

SCE&G data show that gizzard shad comprised approximately 25% of the catch prior to 1997. After 1997, a marked decline was observed in LSR gizzard shad abundance, while sport fish species abundance increased. Recent SCDNR sampling indicates similar trends. SCDNR theorized a significant increase in chain pickerel populations is due to recent increases in the aquatic macrophyte community (personal communication, H. Beard, SCDNR, 2003).

Comment: Turbine venting??

Comment: Suggest clarification or delete. Has not necessarily increased.-Hal Beard

Cold water releases from the Saluda Hydro Project have supported a unique put, grow, and take rainbow and brown trout recreational fishery in the LSR since the early 1950's. According to stocking records, SCDNR typically stocks the LSR with approximately 28,000 to 30,000 trout annually, at a 3:1 ratio of brown trout to rainbow trout. The fish length at time of stocking is typically 7-8" for brown trout and 9-10" for rainbow trout. Trout are typically stocked from November – March throughout the LSR. These trout do not represent a native population, and are presently restocked annually to offset angling exploitation and predation. However, angler reports of trophy fish of 4 to 8 pounds indicate that some rainbow trout may survive up to several years (Kleinschmidt, 2003).

Comment: Add recent striped bass information

[4] Based on monthly averaged 2000 to 2006 data as measured at USGS Gage # 02168504 (below Murray Dam).

A fishery management plan for the LSR is currently being revised by the SCDNR. However, a recent SCDNR creel census suggested that the fishery generates approximately 1.8 million dollars annually, with the trout fishery being responsible for the majority of the revenues (Beard, 2000).

Diadromous Fishery Resources

American shad, striped bass, and Atlantic and shortnose sturgeon have historically used Project waters. Mills reported as early as 1826 that American shad and sturgeon ascended rivers above the fall-line, more specifically the Saluda River (USFWS, 2001). Striped bass, the only known anadromous fish to consistently use the LSR, migrate upstream from the Santee Cooper lakes in early spring and use areas of the LSR in late summer as thermal refuge. LSR anglers have reported catching individuals exceeding 50 pounds (personal Communication, Hal Beard, SCDNR, 2002). SCE&G's 1995–2003 spring electrofishing sampling revealed only sporadic catches of striped bass. The SCDNR has reported no presence of diadromous species such as blueback herring or American shad in the LSR (Beard, 2002); however, sampling conducted by SCE&G in the spring of 2003 detected the presence of three American shad in the LSR. The American eel is the only know catadromous fish reported to inhabit Project waters (Beard, 2002). Recent sampling during 2005 and 2006 resulted in the capture of only one eel, and electrofishing by SCE&G and SCDNR has yielded only sporadic eel captures (Kleinschmidt, 2005; Kleinschmidt, 2006; personal communication, H. Beard, SCDNR, 2006; S. Summer, SCANA Services, Inc., 2006), suggesting that eel densities in the LSR are likely limited in abundance.

Comment: Make sure this statement is correct

Anadromous fish restoration efforts for the Santee Basin appear to focus on restoring runs of anadromous fish primarily up the Congaree and Broad Rivers. The Santee Cooper Basin Diadromous Fish Passage Restoration Plan reports that the Broad River and its tributaries are the highest priority for diadromous fish restoration (USFWS, 2001). The Saluda along with Catawba and Wateree sub-basins are listed as next in priority. The Plan states that the cold hypolimnetic water significantly reduces the ambient LSR water temperature, and thus migrating fish may choose to use the warmer waters of the Broad rather than the Saluda (USFWS, 2001). Furthermore, alteration of the existing thermal regime of the LSR would be an engineering challenge and likely adversely affect the coldwater trout fishery in the tailwater.

Comment: May want to mention fish use LSR during active seasons

Comment: Sentence may need to be revised-based on engineering enhancement

3.0 PROPOSED METHODS

3.1 Field Reconnaissance and Habitat Mapping

The TWC concluded that the an Incremental Instream Flow Methodology (IFIM) study would be appropriate to develop an understanding of key habitat-flow relationships in the LSR, and elected to use a Physical Habitat Simulation (PHABSIM) model to quantify these relationships. The model will be used to quantify flows that meet habitat requirements to support a balanced aquatic community based on model results representing selected diadromous and resident fish, and aquatic biota (*i.e.* macroinvertebrates). In addition, empirical data and/or a flow demonstration approach may be required to document flows that provide adequate fish passage at falls such as Millrace Rapids.

Consistent with IFIM protocol, a study team comprised of agency and licensee biologists will be formed for the purpose of making technical decisions regarding input parameters and review of study output. Specifically, that team will designate the 1) boundaries of the study area, 2) locations of specific representative or critical study sites, 3) locations of study site transects, 4) Habitat Suitability Index (HSI) criteria, and 5) calibration flows and range of flows to be assessed. The study team may participate in field and analytical activities as deemed feasible.

Mesohabitat Classification

A field reconnaissance survey will be conducted with the study team to determine:

1) the classification and distribution of mesohabitats in the LSR study area; and
2) the location(s) of potentially limiting zone of passage for migratory fish movement.

Mesohabitat mapping will include a review of a Isely, et al.(1995), aerial photographs, fly-over video, followed by ground verification. Mesohabitat will be field-mapped to delineate the relative quantity and spatial distribution of each habitat type in the study area. The team will define each mesohabitat type of interest, and assign specific attributes to each that can be used for field delineation. Delineation will occur during a period of relatively low-to-moderate flow so that breaks in mesohabitat, substrate, object cover and hydraulics representative of approximate base flow conditions can be readily observed. Study team members are encouraged to participate in delineation to the extent feasible. The upstream and downstream boundary of each mesohabitat within the study area will be classified and geo-referenced in the field, and the information transferred to a Geographic Information System (GIS) format. GIS will then be used to provide both a visual map and quantitative tabular information on the abundance of mesohabitat types in the study area. Additional features relevant to differentiation of mesohabitats, such as geomorphic and physiographic characteristics, will also be collected where appropriate.

Selection of Reaches, Study Sites And Transects

The study team will consult to define study reaches and select applicable mesohabitat study sites within each reach, as well as transects within each study reach. Study reach boundaries are typically placed at significant breaks in geomorphic, hydrologic or habitat use in the study area (Bovee, et al., 1998)[5]. Within each study reach, the study team will identify candidate study sites that represent typical and/or unique but critical mesohabitats, and select upstream and downstream cell boundaries within each study site based on localized observable shifts in stream width, cover, substrate, and hydraulics. The field crew will subsequently locate a transect within each longitudinal cell.

3.2 Field Data Collection

3.2.1 PHABSIM Study Sites

General Approach

The second phase will entail the determination of habitat-discharge relationships for selected species, lifestages, and guilds in the LSR. Standard PHABSIM data collection and flow modeling procedures of the Instream Flow Incremental Methodology (IFIM) (Bovee, 1982, Bovee et al. 1998) will be used to evaluate habitat suitability, and empirical flow measurements will be obtained to evaluate zone-of-passage hydraulics at a limiting river channel site.

Modeling will be based on hydraulic data developed from cross-sectional depth, velocity, and substrate measurements following Milhouse, *et al.* (1989), using PHABSIM for Windows (V 1.2), developed by the United States Fish and Wildlife Service and distributed by the USGS Fort Collins (CO) Science Center.

Flow Range to Be Modeled

Based on TWC consultation (See Appendix A), SCE&G anticipates that habitat-discharge relations would be developed for flows ranging up to approximately 20,000 cfs, and that the modeling effort would focus on both representative mesohabitat types and the limiting fish passage channel site selected by the study team.

Suitability Index Criteria

The TWC is presently gathering and considering specific habitat Suitability Index (SI) rating curves for use in this study. Based on TWC

[5] As noted above, the upper and lower ends of the study area have distinct differences in slope and substrate, suggesting that at least two geomorphic reaches may be justifiable. Hydrologic reach breaks are conventionally set at points where a tributary adds 10% of more additional drainage area to the study area.

consultation, SCE&G proposes the use of HSI curves adopted primarily from those previously used in instream flow studies in the Catawba-Wateree and Pee Dee River studies. These curves, which are contained in Appendix B, were developed in support of recent IFIM studies and PHABSIM models conducted for similar fish assemblages with similar geomorphic and ecoregion characteristics. To the extent possible, species and lifestages of interest will be classified into habitat guild classes (*i.e*. deep slow, shallow slow, shallow fast, deep fast), and representative HSI curves for each guild selected by the team in consultation.

In some cases, stand-alone species and lifestages may be modeled, such as rainbow and brown trout. Additional HSI curves for brown trout, rainbow trout, and a surrogate for fish passage will be obtained from other studies and reviewed for applicability, discussed, modified as necessary and approved by the study team.

Transect Data Collection

The location of each transect will be field blazed with flagging or other appropriate means. Each study site and cell will be mapped sufficiently to quantify the area represented by each transect. The transect headpin and tailpin ends will be located at or above the top-of-bank elevation, and secured by steel rebar or other similar means. A measuring tape accurate to 0.1 ft will be secured at each transect to enable repeat field measurements to occur at specific stream loci[6]. Stream bed and water elevations tied to a local datum will be surveyed to the nearest 0.1 ft using standard optical surveying instrumentation and methods.

Depth, velocity, and substrate data will be gathered at intervals (verticals) along each transect. Each vertical will be located to the nearest 0.1 ft wherever an observed shift in depth or substrate occurs. Between 20 and 99 verticals per transect will be established as necessary to define cross-sectional habitat. Verticals will be arranged so that no more than 10% of the river discharge passes between any pair, thus enhancing hydraulic model calibration. At least one staff gage will be located per study site, and will be monitored at the beginning and end of each set of hydraulic measurements to confirm stable flow during measurements. If flow is found to be insufficiently stable, the related data will be discarded and re-measured once stable flow is established.

Mean column velocity will be measured to the nearest 0.1 ft/second with either a calibrated electronic velocity meter mounted on a top-setting wading rod, or alternatively an Acoustic-Doppler Current Profiler (ADCP) transducer. In water less than 2.5 ft depth, measurements will be made at 0.6 of total depth (measured from the water surface); at greater depths, paired measurements will be made at 0.2 and 0.8 of total depth and averaged.

Each calibration flow will be provided by scheduled releases from the Project via unit operation. Turbine rating curves, USGS gaging, and study-site

[6] Supplemental transects may be located as needed to record water surface and bed elevation data at hydraulic controls to establish backwatering parameters necessary for hydraulic modeling.

field gaging will be collectively used to estimate each calibration flow release. The hydraulic model will be built from measurements gathered at a *minimum* of three calibration flows to facilitate extrapolation of hydraulic data across the range of interest. To accomplish calibration, a full set of depth, velocity and water surface elevation (WSEL) data will be gathered at the intermediate flow, and WSEL will be measured at each transect for the low and high flow calibrate. At transects with complex hydraulics such as braided channels or riffles, and/or sites with unusual backwatering or eddy effects, supplemental velocity data may be gathered at the low and/or high calibration flows. This will be determined in the field on a case-by-case basis.

Each calibration flow should ideally be separated by about an order of magnitude to provide a suitable stage-discharge curve for the hydraulic model. At a minimum, SCE&G anticipates utilizing calibration flows of approximately: 350-500; 1200-1500; and 10,000 cfs. Depending on calibration quality, this should allow the PHABSIM model to theoretically project Weighted Usable Area (WUA) for a flow range from 40 to over 20,000 cfs. The need for additional calibration flow data may vary by transect and will be evaluated on a case-by-case basis.

Hydraulic Modeling

Hydraulic modeling will be accomplished by correlating each surveyed water stage with discharge to develop a stage-discharge relationship for each transect. PHABSIM uses a family of hydraulic models such as IFG4, MANSQ and WSP. Once this relationship is established, the model then adjusts velocities obtained at calibration flows to other flow increments of interest for which defined water stages have been calculated. The model is then calibrated by comparing simulated hydraulics to empirical measurements taken at the calibration flows. Coefficients such as relative stream channel roughness are then iteratively adjusted as needed to optimize model accuracy across the full flow range.

Comment: Add details on calibration measurements and accuracy

Habitat Suitability

Once the hydraulic model is calibrated, estimates of habitat suitability at each flow increment of interest will be generated by combining the HSI and hydraulic model data using the HABTAE and supporting programs within PHABSIM. These ultimately produce output known as Weighted Usable Area (WUA) for each transect at each flow increment. WUA is an index of habitat suitability based on units of square ft of optimal habitat available per 1,000 ft of represented stream length. WUA output for all transects in a given mesohabitat type are then weighted according to actual linear distance each transect represents within the mesohabitat, as mapped in the field, to provide a mesohabitat habitat-flow curve. All mesohabitat WUA within a given study reach is then weighted and summed for each flow increment to provide a net WUA estimate for the entire study reach.

3.2.2 Fish Passage Study Site(s)

The TWC identified fish passage through shoals as a critical habitat concern, specifically at Millrace Rapids, a location where the LSR descends through a demolished mill dam at the Piedmont fall line boundary. This location is characterized by large rubble, boulder, and other object cover that produces complex hydraulics and interstitial flow that is difficult to model. The TWC concluded that an alternate approach will be required at this site. The objective at this site is to establish sufficient water depth to facilitate volitional upstream fish passage through the most limiting portion of the channel. SCE&G proposes to conduct a site visit with the study team during a period of low wadable flow when channel geometry and probable zone of passage routes can be readily be observed. The study team will then select a representative transect location at a critical passage site to allow characterization of hydraulics (wetted depth, width, and velocity) at a range of flows bracketing what the team feels will produce suitable fish passage conditions according to the established HSI criteria. The field crew will then proceed to obtain water elevation and velocity measurements at the transect at each flow of interest, with gaging data obtained from the USGS 02169000 gage, which is located in close proximity to Millrace Rapids. These data will then be displayed graphically and in tabular format to identify flows that promote hydraulics that can provide suitable fish passage.

Comment: Is another study needed? Little channel morphometry changes are anticipated since 1980's study.-Gerrit Jobsis

Comment: Include reference to passage releases (1500 cfs?) by SCE&G requested by Bulak in 1991(?) that resulted in fish passing Millrace Shoals. – Gerrit Jobsis

4.0 REPORTING

A draft report will be prepared for study team review and comment, documenting methods and results as encountered in the field and during modeling. WUA and supporting hydraulic data will be presented in graphic and tabular form, along with an analysis of trends in the data, and documentation of study team consultation. Appendices will also include cross-sectional survey data and reference photographs of study sites. The report will be finalized and provided to the TWC following receipt of input from the study team.

5.0 CONSULTATION

Upon receipt of the final report, the TWC may elect to apply these data to further analyses such as assessing project operation issues, lake level management, and overall flow regime evaluation (see section 1.3).

6.0 SCHEDULE

TASK	COMPLETION DATE
Finalize target species/guilds	February 1, 2007
Finalize HSI curves to be used	February 15, 2007
Mesohabitat characterization; select transect locations	April 15, 2007
Collect transect data	May 15, 2007
Complete modeling	July 15, 2007
Issue draft report	August 15, 2007
Issue final report	October 1, 2007

7.0 LITERATURE CITED

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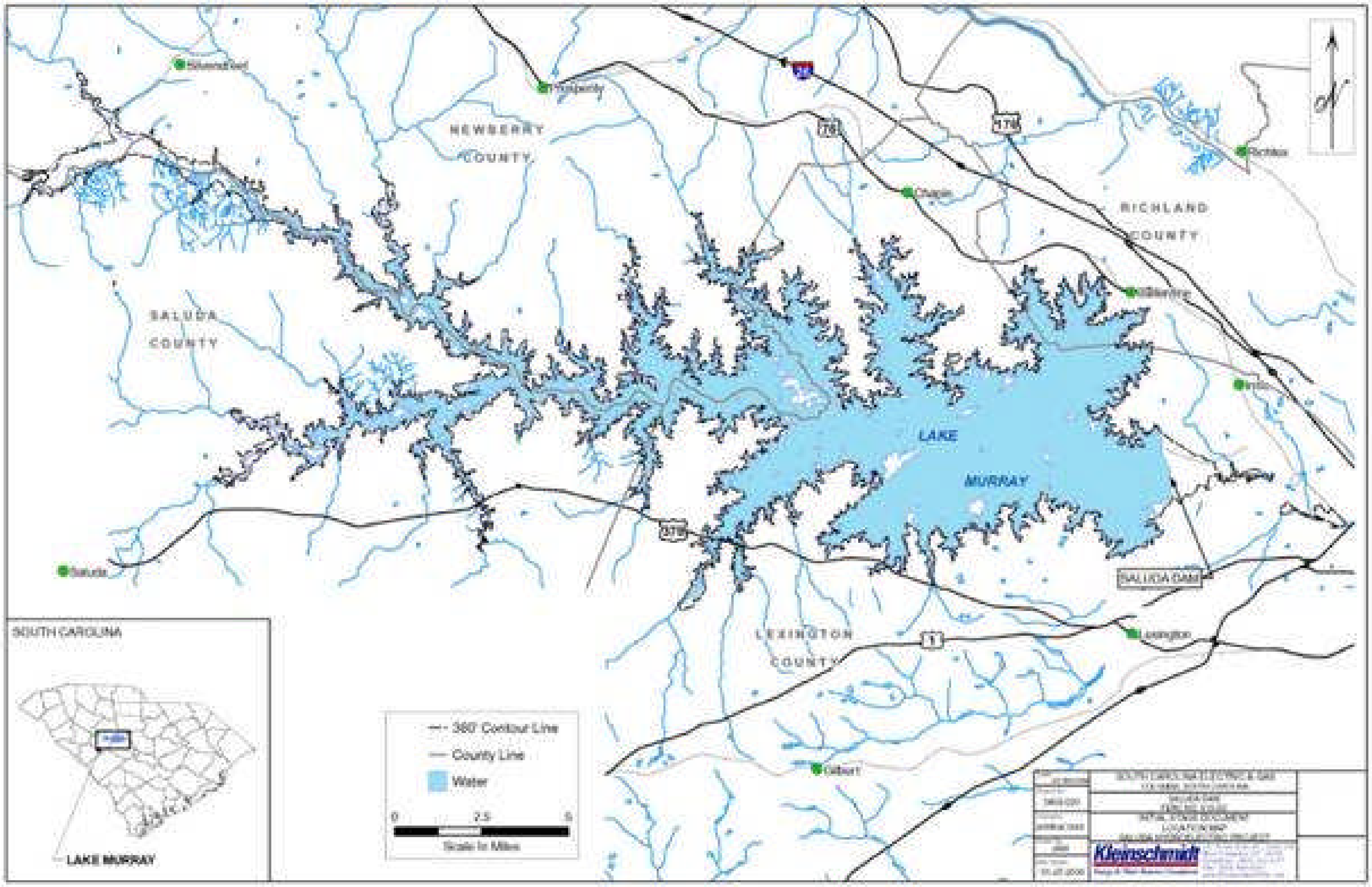
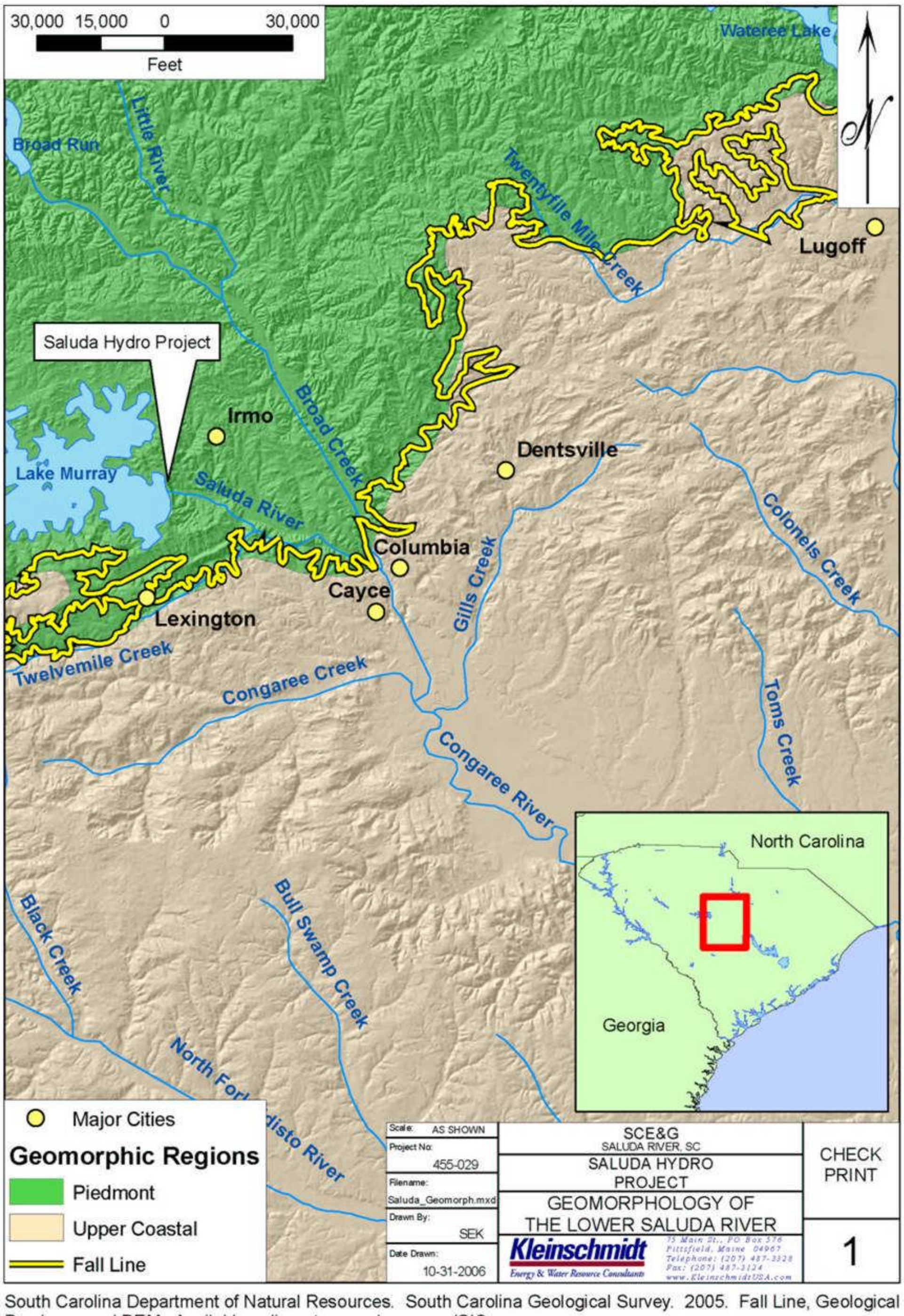


NEWBERRY
COUNTY
RICHLAND
COUNTY
SALUDA
COUNTY
LAKE
MURRAY
LEXINGTON
COUNTY
SALUDA DAM
Saluda
Chapin
Lexington
Gilbert
SOUTH CAROLINA
LAKE MURRAY
380' Contour Line
County Line
Water
0
2.5
5
Scale In Miles
Kleinschmidt



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APPENDIX A

SALUDA HYDROELECTRIC PROJECT

INSTREAM FLOW/AQUATIC HABITAT

TECHNICAL WORKING COMMITTEE MEETING NOTES

Included as a separate file.

APPENDIX B

SALUDA HYDROELECTRIC PROJECT

HABITAT SUITABILITY CURVES FOR TARGET SPECIES/GUILDS

This information is currently being developed by the Instream Flow TWC.

ATTACHMENT B

COMMENTS ON THE GUILD MATRIX

Legend: guild selection change recommended 11/27/06

SI curve research and review desired

habitat generalist no specific guild or SI curve required at this time

SPECIES	LIFE STAGE	GUILD CATEGORY: Shallow Slow	Shallow Fast	Deep Slow	Deep Fast	Habitat Generalist	Limiting Rapid	SI CURVE SOURCE	SPECIES
robust redhorse	spawning		X					Catawba-Wateree	Generic or robust redhorse
robust redhorse	fry/YOY	X						Catawba-Wateree	*guild surrogate*
robust redhorse	juvenile			X				Catawba-Wateree	golden redhorse
robust redhorse	adult			X				Catawba-Wateree	golden redhorse
Norrthern hogsucker	spawning				X			Catawba-Wateree	*guild surrogate*
Norrthern hogsucker	fry/YOY				X			Catawba-Wateree	*guild surrogate*
Norrthern hogsucker	juvenile				X			Catawba-Wateree	*guild surrogate*
Norrthern hogsucker	adult			X				Catawba-Wateree	*guild surrogate* (redbreast sunfish adult?)
spotted sucker	spawning		X					Catawba-Wateree	*guild surrogate*
spotted sucker	fry/YOY	X						*TBD*	*guild surrogate* (redbreast sunfish spawning?)
spotted sucker	juvenile	X		X				*TBD*	*guild surrogate* (redbreast sunfish spawning?)
spotted sucker	adult			X				*TBD*	*guild surrogate* (redbreast sunfish adult?)
brown trout	spawning		X					Catawba-Wateree *(if transferable)*	TVA, other source studies
brown trout	fry/YOY	X						Catawba-Wateree *(if transferable)*	TVA, other source studies
brown trout	juvenile	X						Catawba-Wateree *(if transferable)*	TVA, other source studies
brown trout	adult			X	X			Catawba-Wateree *(if transferable)*	TVA, other source studies
rainbow trout	spawning		X					Catawba-Wateree *(if transferable)*	TVA, other source studies
rainbow trout	fry/YOY	X						Catawba-Wateree *(if transferable)*	TVA, other source studies
rainbow trout	juvenile		X		X			Catawba-Wateree *(if transferable)*	TVA, other source studies
rainbow trout	adult				X			Catawba-Wateree *(if transferable)*	TVA, other source studies
redbreast sunfish	spawning	X						Catawba-Wateree	
saluda darter	adult		X					Catawba-Wateree or Pee Dee	fantail darter surrogate
spottail shiner			X						
redbreast sunfish	adult			X				Catawba-Wateree	
shorthead redhorse	adult				X			Catawba-Wateree	golden redhore
threadfin shad								*get SCDNR staff input*	
American shad	spawning				X			Catawba-Wateree	
American shad	YOY			X	X			Catawba-Wateree	American shad spawning *or deep slow guild*
American shad	passage						X	Conte Lab-American Rivers	
blueback herring	spawning	X						*TBD*	shallow-slow guild surrogate
blueback herring	YOY	X						*TBD*	shallow-slow guild surrogate
blueback herring	passage						X	Conte Lab-American Rivers	
striped bass	passage						X	Conte Lab-American Rivers	
striped bass	adult							Catawba-Wateree & Savannah	*thermal refuge in summer*
shortnose sturgeon	passage						X	Conte Lab-American Rivers	
shortnose sturgeon	spawning							NMFS	
shortnose sturgeon	adult							NMFS	
shortnose sturgeon	juvenile							NMFS	
American eel	juvenile					X		none recommended at this time	
benthic macroinver.	juvenile		X					Catawba-Wateree	
smallmouth bass	spawning								
smallmouth bass	YOY								
smallmouth bass	juvenile								
smallmouth bass	adult								

Kacie Jensen

From: Shane Boring

Sent: Monday, December 04, 2006 5:29 PM

To: Wade Bales (balesw@dnr.sc.gov); Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart

Subject: FW: Shad/striper passage

All:
Attached are the Alex Haro fish passage papers that were referenced during the last IFIM TWC meeting. Dr. Haro's discussion below provides some background regarding the documents. Thanks.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

-----Original Message-----
From: Alexander J Haro [mailto:alex_haro@usgs.gov]
Sent: Tuesday, October 31, 2006 11:56 AM
To: Brandon Kulik
Subject: Shad/striper passage

Brandon -

Good to talk to you today. Attached are the Sprintswim spreadsheet and the chapter for the American Rivers report (contact Laura Wildman for a copy of the full report). Please be sure to read the disclaimer on the first OVERVIEW tab of the Sprintswim spreadsheet, which describes limits to the application. It also needs some updating, but can be used as-is in a general sense. A reference describing how the model was derived is also attached.

Thanks in advance for the DIDSON study results.

- Alex

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Alex Haro, Ph. D.
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1 Migratory Way, P.O. Box 796
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voice: (413) 863-3806
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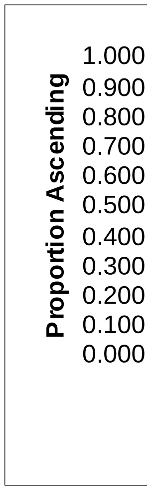
email: Alex_Haro@usgs.gov
~~~~~~

ALEWIFE (Gamma distribution)

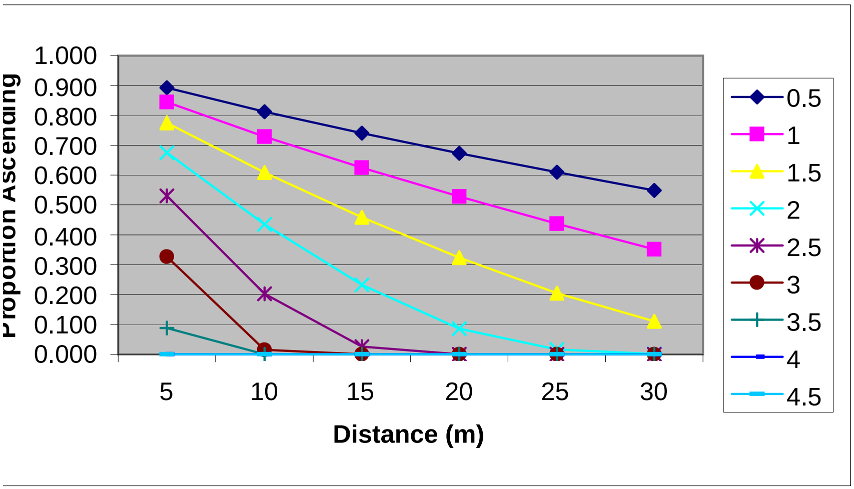
	Value	LIMITS
Temp	10.4	8.5-13.0
FL	236	225-255
Sex	M	M,F

PROPORTION ASCENDING

		Distance (m)					
		5	**10**	**15**	**20**	**25**	**30**
Water Velocity (m/sec)	**0.5**	0.893	0.813	0.741	0.673	0.610	0.548
	1	0.845	0.729	0.625	0.528	0.437	0.351
	1.5	0.775	0.608	0.459	0.324	0.205	0.110
	2	0.675	0.435	0.232	0.085	0.016	0.001
	2.5	0.531	0.203	0.026	0.000	0.000	0.000
	3	0.327	0.015	0.000	0.000	0.000	0.000
	3.5	0.088	0.000	0.000	0.000	0.000	0.000
	4	0.000	0.000	0.000	0.000	0.000	0.000
	4.5	0.000	0.000	0.000	0.000	0.000	0.000



σ	δ	Intercep	V	Temp	FL	Sex	Sex x Fl	Year	μ	ω D=	ω D=
0.513	2.431	4.571	-0.92							5	10
			0.5	10.4	236	0	0		4.111	1.6094	2.3026
			1	10.4	236	0	0		3.651	1.6094	2.3026
			1.5	10.4	236	0	0		3.191	1.6094	2.3026
			2	10.4	236	0	0		2.731	1.6094	2.3026
			2.5	10.4	236	0	0		2.271	1.6094	2.3026
			3	10.4	236	0	0		1.811	1.6094	2.3026
			3.5	10.4	236	0	0		1.351	1.6094	2.3026
			4	10.4	236	0	0		0.891	1.6094	2.3026
			4.5	10.4	236	0	0		0.431	1.6094	2.3026



ω D= 15	ω D= 20	ω D= 25	ω D= 30	a	b (5)	b (10)	b(15)	b(20)	b(25)	b(30)
2.7081	2.9957	3.2189	3.4012	0.1692	1.2E-06	3.21E-05	0.000219	0.000857	0.002468	0.005856
2.7081	2.9957	3.2189	3.4012	0.1692	1.06E-05	0.000284	0.00194	0.007583	0.021833	0.0518
2.7081	2.9957	3.2189	3.4012	0.1692	9.41E-05	0.002512	0.017159	0.067075	0.193108	0.458166
2.7081	2.9957	3.2189	3.4012	0.1692	0.000832	0.02222	0.151774	0.593277	1.708023	4.052444
2.7081	2.9957	3.2189	3.4012	0.1692	0.007361	0.196532	1.342434	5.247489	15.10734	35.84357
2.7081	2.9957	3.2189	3.4012	0.1692	0.065104	1.738311	11.87373	46.41366	133.6233	317.0338
2.7081	2.9957	3.2189	3.4012	0.1692	0.575842	15.37523	105.0223	410.5254	1181.888	2804.141
2.7081	2.9957	3.2189	3.4012	0.1692	5.09328	135.9928	928.9143	3631.067	10453.71	24802.42
2.7081	2.9957	3.2189	3.4012	0.1692	45.04969	1202.846	8216.179	32116.52	92462.34	219375.6

Passage of American Shad Through Natural and Experimental High Velocity Flow Environments

Alex Haro

CAFRC Internal Report No. 2002-02
June 2002

***CAFRC* - S. O. Conte Anadromous Fish Research Center**

Biological Resources Discipline, U. S. Geological Survey
One Migratory Way
Turners Falls, MA 01376

Passage of American Shad Through Natural and Experimental High Velocity Flow Environments

Alex Haro

S. O. Conte Anadromous Fish Research Center
Biological Resources Division, U. S. Geological Survey
One Migratory Way
Turners Falls, MA 01376

June, 2002

Introduction
Knowledge of locomotory and energetic capabilities of upstream migrant fishes is essential for determining their ability to negotiate and ascend riverine obstructions and passage structures, where water velocities and turbulence can be high. The relatively high speeds (>10 body lengths/sec) of sprint (or burst) swimming can be maintained only for very short periods (<20 sec), thus limiting the distance a fish can ascend through high velocity flows (Beamish 1978). The need for reliable data on volitional fish swimming performance continues as new designs of fish passage structures evolve, including breaches or notches in low head dams, culverts, natural fish bypasses, or other structures that may require fish to negotiate high water velocities over short distances.

Existing Data and Laboratory Studies
Although some estimates are available for sustained, critical, and sprint swimming speeds for a variety of riverine and anadromous species (Bainbridge 1958, Beamish 1978), many of the data are incomplete, underestimated, or valid only for individuals of a particular size. Classic experiments for determining swimming characteristics have usually been performed by forcing fish to swim in small chambers or respirometers where fish movements and maximum obtainable speeds are limited (usually below sprint speeds).

Only a few experiments have attempted to quantify sprint swimming speed and duration of anadromous clupeid fishes, including alewives *Alosa pseudoharengus* (Dow 1962) and American shad *Alosa sapidissima* (Weaver 1963, 1965) in experiments that approximate natural conditions and allow fish to express normal upstream migratory behaviors.

Weaver (1963, 1965) performed a series of volitional sprint swimming duration experiments with upstream migrant American shad in a large-scale channel at water velocities of up to 4.1 $m \cdot sec^{-1}$ (Fig. 1). From these studies, several important general conclusions were drawn: 1) for a given water velocity, the percentage of fish ascending a given distance decreased with distance, 2) at higher water velocities, swimming speed increased, but fewer fish were able to ascend a given distance, 3) overall ascent success increased with fish size (within species), and 4) ascent success was variable between species.

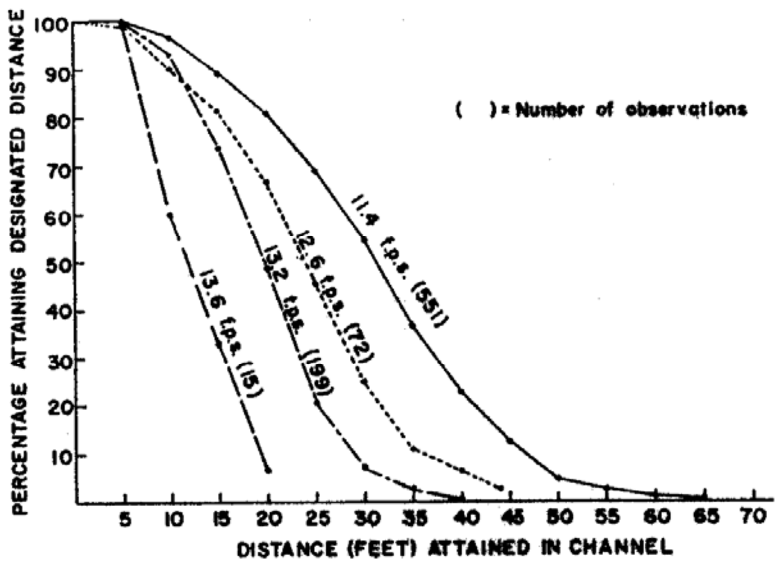


Figure 1. Sprint swimming performance (maximum distance swum) of adult American shad as quantified by Weaver (1965) in an 85 ft long linear flume channel at water velocities of 11.4, 12.6, 13.2, and 13.6 ft · sec^{-1} and a water temperature of approximately 21 C.

Powers and Orsborn (1985) continued studies of volitional sprint swimming in Pacific salmonids using a smaller channel at steeper slopes. They noted considerable variability in performance due to fish condition, as well as characteristic swimming behaviors of fish relative to the hydraulic environment, such as pausing within a hydraulic jump and seeking low velocity zones near wall boundaries caused by friction forces. Addition of roughness elements in the channel increased passage success, presumably by lowering water velocities (but increasing turbulence) near the elements. Relatively crude estimates of instantaneous maximum sprint speeds (but not durations) are given in most manuals for fish passage designers and engineers (e.g., Beach 1984, Bell 1990, Clay 1995).

Recent experiments performed at the S.O. Conte Anadromous Fish Research Laboratory (Haro et al., in prep.) have quantified sprint swimming performance of adult American shad in terms of swimming speed, distance ascended, and duration over a wider range of test parameters. These experiments were conducted in an open channel flume 1 m wide, 1 m deep, 23 m long, under linear flow conditions with low turbulence. Test velocities ranged from 1.5 to 4.5 m · sec^{-1}, and a predictive model was generated using survival analysis to yield estimates of percent of fish able to ascend a given distance under a particular water velocity (Fig. 1). Minor but significant effects of fish size, water temperature, and sex on sprint swimming ability of adult shad were also noted.

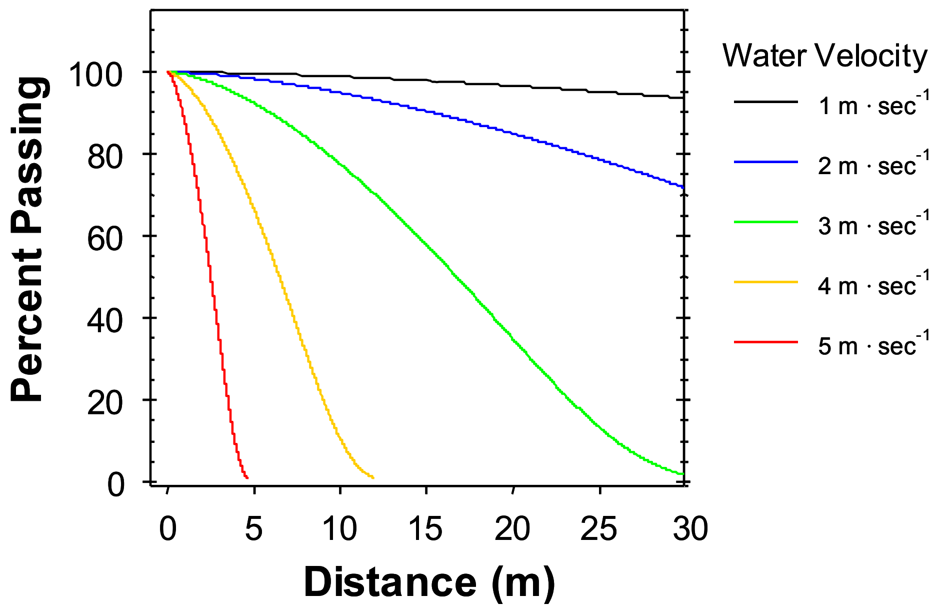


Figure 2. Estimates of percent of adult American shad ascending to a given distance under water velocities of 1 to 5 m · sec^{-1}, based on results from flume studies at CAFRL. Curves shown represent performance of shad 420 mm TL, at a water temperature of 17 ° C. Data from Haro et al., in prep.

Passage of American Shad at Natural High Gradient Reaches

To gain better understanding of the types of hydraulic regimes of high gradient river reaches that American shad are able to ascend, descriptions of several of these types of reaches in the northeastern United States are given in the following section. These reaches are known to pass shad in appreciable numbers; however, it should be noted that the actual efficiency of passage (i.e. proportion of fish successful in negotiating the reach) has not be quantified for any site. Also, flows can be variable during the migration season; passability of most reaches is highly dependent on flow. Generally, American shad traverse high gradient reaches when flows increase and there is less head drop throughout the reach. However, very high flows may inhibit passage if water velocities are high throughout and/or across the reach. Similarly, passage may be reduced at very low flows, where water depth is very shallow or zones of passage become restricted.

Site characteristics are based on measurements taken from USGS 1:25,000 topographic maps (location, length and width of reach), USGS hydrographic gauge data (mean monthly flows), FEMA or FIS profile data, and visits to each site during the migratory season (late May, 2002; depth range, water velocity, substrate type). Water velocities were estimated visually (rate of movement of bubbles or debris in surface flow) during the site visits, or calculated from standard hydraulic formulae for open channel water velocity over a sharp-crested weir.

Enfield Dam and Rapids, Connecticut River, CT

Location: N 41° 59’19”, W 72° 36’13”

Mean Monthly Flows:

- May – 27,160 cfs
- June – 10,417 cfs

River Width: 330 m

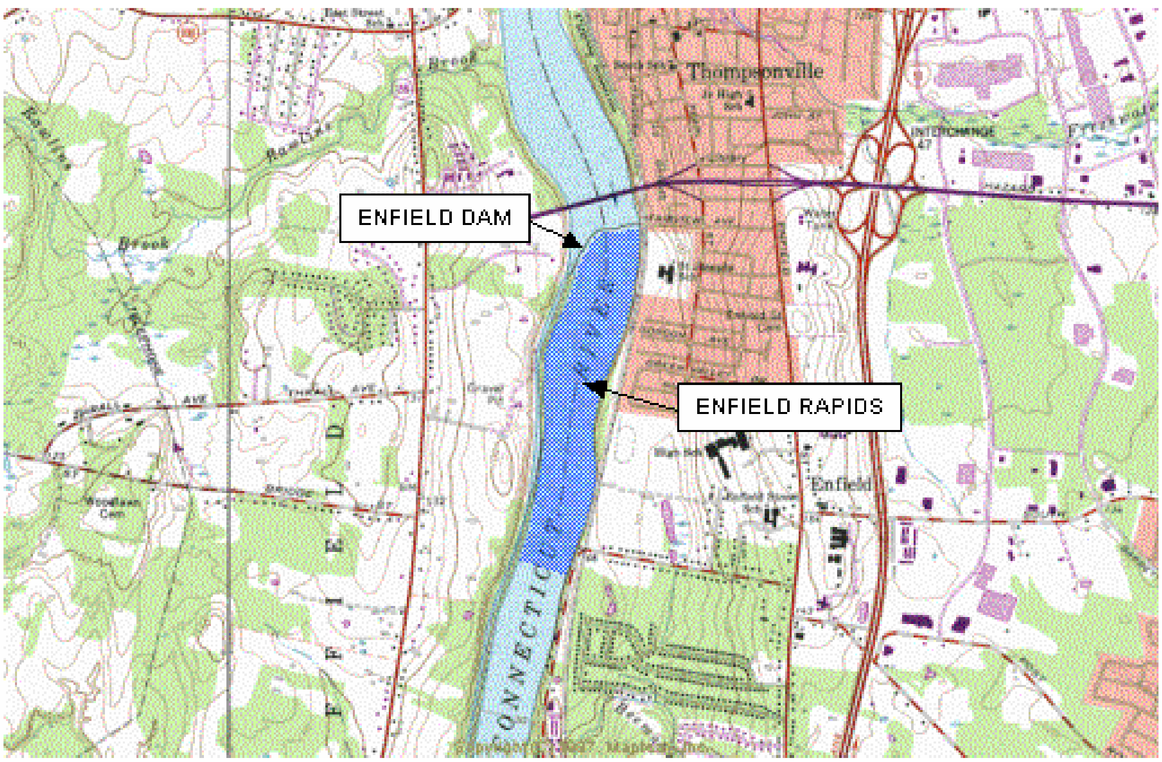
Depth Range: 0.5 m (low flow) to 3+ m (high flow)

Length of Reach: 1.5 km

Vertical Drop: dam - 2 m; rapids – 2 m (0.13%)

Water Velocity Range: 0.5 – 2.0 m · sec^{-1}

Substrate: bedrock, cobble, broken concrete and timber crib dam



Description:

Constructed in 1880, Enfield Dam originally served as a wing dam to feed water to a boat lock and canal to allow boat access above the Enfield Rapids. Due to its low height and addition of plank ramps at the eastern and western shores, the dam has always been passable to shad (especially at high flows) and has since eroded to the point where it is only a minimal barrier to upstream fish passage, even at low flow.

Enfield Dam from the western shore, looking upstream. River flow at the time the photograph was taken was approximately 14,000 cfs.

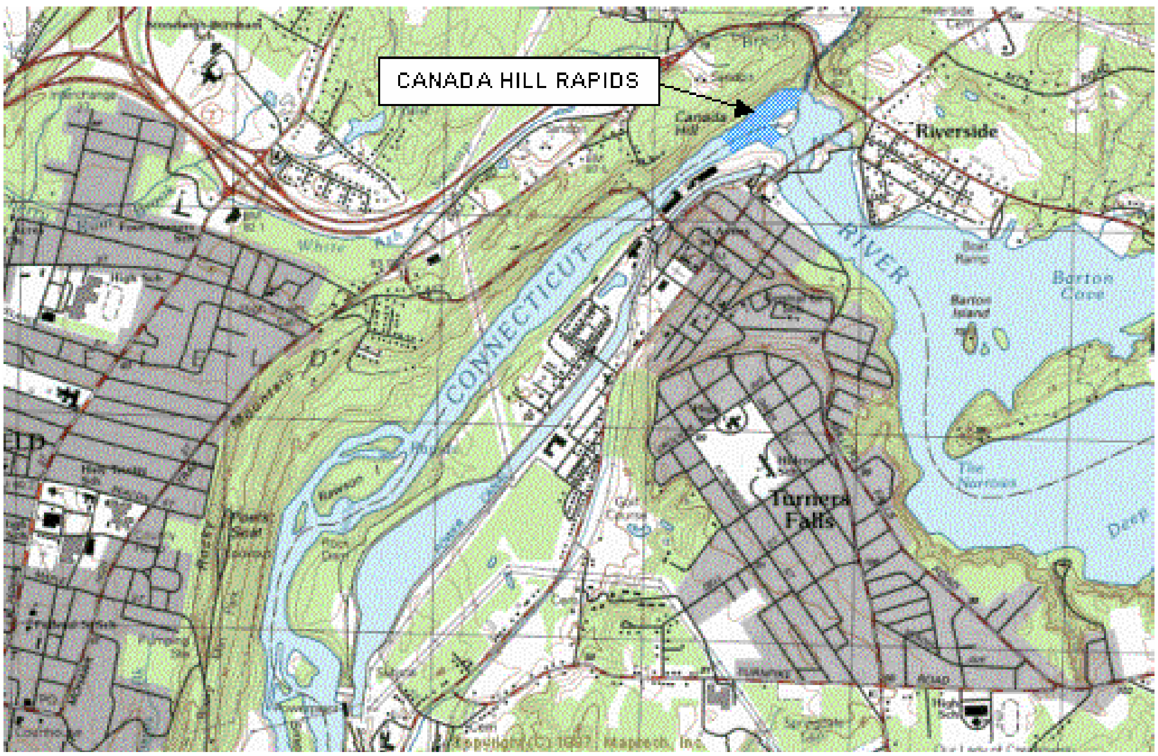
Enfield Rapids , looking downstream from Enfield Dam at the western shore. The reach of rapids extends approximately 1.5 km downstream of Enfield Dam

Passability:

Enfield Dam was historically a partial barrier to shad passage, but currently only poses a minor delay to ascending fish in its current eroded state. The rapids below are low gradient and generally possess enough depth to be passable even at low flows. However, at low flows the site tends to concentrate upstream migrants as they search for a suitable route around the dam base. Although passage efficiency of shad at this site is thought to be high, it has not been quantified and the period of delay through the reach is unknown.

Canada Hill Rapids, Connecticut River, MA

Location: N 42◦ 36’43”, W 72◦ 33’19”
Mean Monthly Flows:
  May – 21,620 cfs*
  June – 10,417 cfs*
River Width: 128 m
Depth Range: 0.5 m (low flow) to 2+ m (high flow)
Length of Reach: 250 m
Vertical Drop: 2.5 m (1%)
Water Velocity Range: 0.5 to 2.5 m · sec^{-1}
Substrate: bedrock, cobble



Description:

Canada Hill Rapids is a remnant of the lower portion of the original falls at Great Falls (Turners Falls) at river kilometer 196.7, which was historically passable to American shad. The upper portion of the falls has been inundated by construction of the Turners Falls Dam, and up to 25,000 cfs of total river flow can be diverted into the adjacent power canal. The rapids consist of eroded sedimentary bedrock that form riffles and step pools, although some narrow (1-2 m wide) channels have been cut through the bedrock by constant low flow conditions. Although flows through this reach average 10,000 to 20,000 cfs, only 400 cfs is typically passed through the reach during the latter half of the run, as per minimum flow requirements.

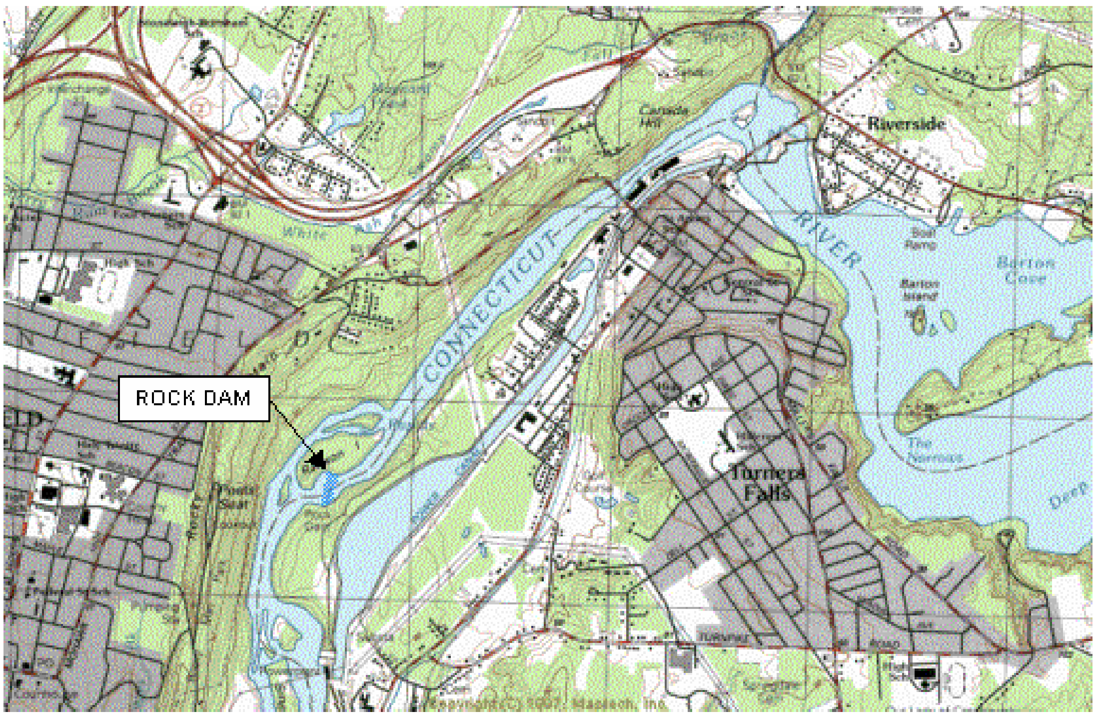
Canada Hill Rapids, Turners Falls, Massachusetts (Connecticut River) looking downstream Turners Falls Bridge at north shore. Flow through the bypass reach at the time the photograph was taken was approximately 9500 cfs.

Passability:

Canada Hill Rapids is passable by American shad at both high and low flows during the migratory season. Significantly more fish are noted entering the Spillway fishway, 200 m upstream of the rapids during moderate to high flows (8,000-15,000 cfs), but when flows exceed 15,000 cfs, fish are unable to enter the fishway due to high turbulence at the fishway entrance, hence passage efficiency through this reach at higher flows is unknown. At low (minumum; 400 cfs) flows, few shad are observed entering the fishway, although some are probably capable of ascending the reach. It is thought that the higher numbers observed entering the fishway during moderate flows are due to increased attractiveness of this route (as opposed to attraction to flows from Cabot Station, 4 km downstream), rather than absolute passability of the reach itself.

Rock Dam, Connecticut River, MA

Location: N 42◦ 35’44”, W 72◦ 34’ 47”
Mean Monthly Flows:
May – 10,000 cfs*
June – 5,000 cfs*
River Width: 151 m
Depth Range: 0.5 – 1.0 m
Length of Reach: 10 m
Vertical Drop: 2 m (20%)
Water Velocity Range: 2.0 – 3.0 m · sec^{-1}
Substrate: bedrock



*This section of the bypass reach is split approximately 50% between the two channels formed by Rawson Island

Description:

The Rock Dam on the bypass reach (natural river channel) of the Connecticut River at Turners Falls is a natural volcanic dike exposed by river erosion, approximately 2 m in height. Flow conditions for this reach are similar to those described previously for Canada Hill Rapids; the main difference is that flow through this section of the bypass reach is split approximately 50% between the two channels formed by Rawson Island. Therefore the rock dam receives monthly mean flows of approximately 10,000 cfs (May) and 5,000 cfs (June), although flows are much less (roughly 200 cfs) during minimum flow conditions. The rock ledge itself measures approximately 10 m across in an upstream-downstream axis. At bypass reach flows above approximately 9000 cfs, water spills over the entire crest of the dike. At lower flows, most of the water in this reach is channeled through a natural narrow (~15 m wide, 6 m in length) channel at the southernmost end of the dam. There is a deep pool below the channel, and the jet of water through the channel creates strong turbulence and air entrainment in the upstream end of the pool. There are large flatwater pools above and below the Rock Dam.

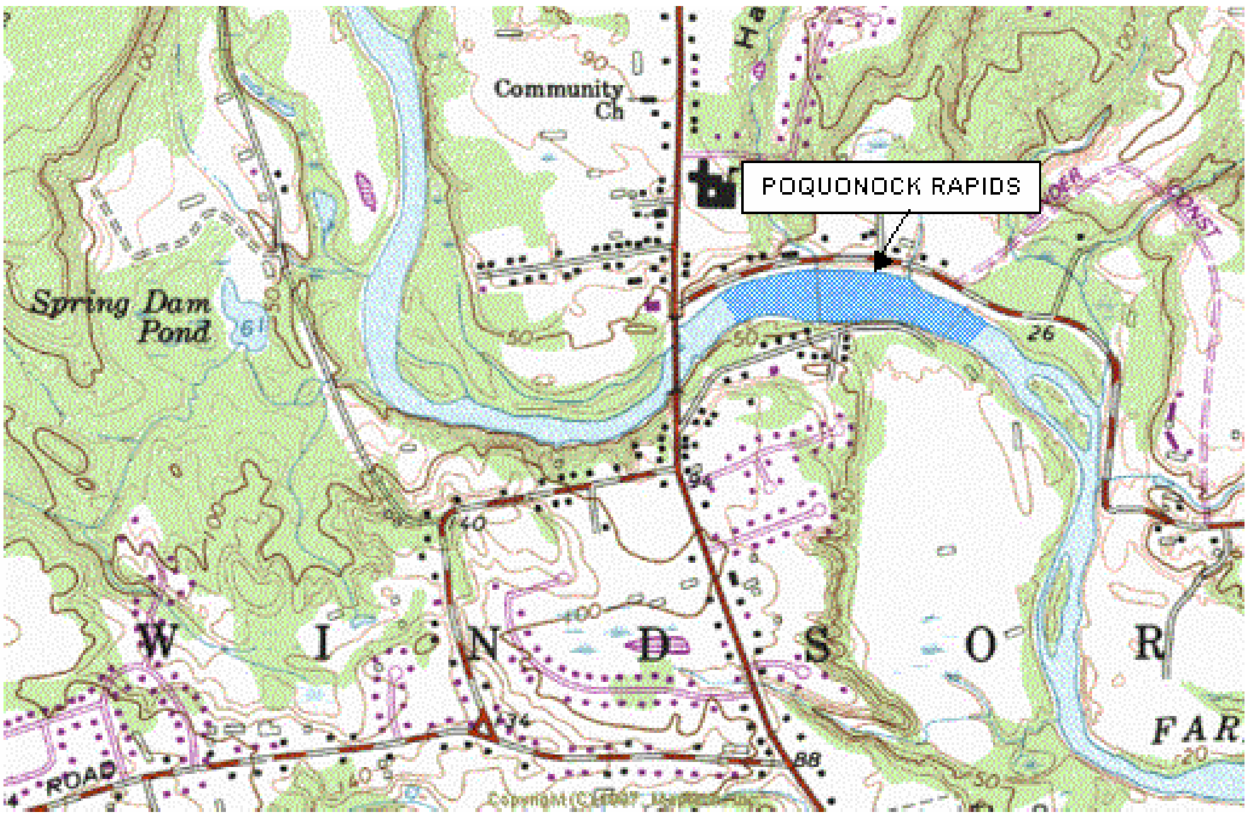
Rock Dam at Turners Falls, Massachusetts (Connecticut River). American shad ascend through the central notch in the volcanic dike spanning the river width (vertical drop 2 m) at moderate to low flows. Flow at the time the photograph was taken was approximately 9500 cfs through the entire bypass reach, although this total flow is split between the Rock Dam reach and the alternate reach on the opposite side of Rawson Island.

Passability:

The Rock Dam is passable by American shad at low to moderate flows. Shad can occasionally be observed ascending the natural cut in the dam at sprinting swim speeds when water clarity is good. Water velocity through the cut under these conditions is approximately 2.0 to 3.0 $m \cdot sec^{-1}$. Many shad congregate in the pool below the cut; this is a known spawning area for shad, so it is unknown whether the Rock Dam delays upstream passage of shad or not. Passage efficiency of the Rock Dam has not been quantified.

Poquonock Rapids, Farmington River, CT

Location: N 41° 54’ 06”, W 72° 40’ 30”
Mean Monthly Flows:
May – 1484 cfs*
June – 1176 cfs*
River Width: 82 m
Depth Range: 0.5 – 2.0 m
Length of Reach: 450 m
Vertical Drop: 3 m (0.67%)
Water Velocity Range: 0.5 - 2.0 m · sec^{-1}
Substrate: bedrock, cobble



*Flow through this reach is estimated from gauge data from Tariffville Gorge (12.6 km upstream) but is probably slightly higher than the values given here.

Description:

Poquonock Rapids is a relatively long reach of rapids and riffles on the Lower Farmington River, Connecticut, 13.3 km upstream of the junction of the Farmington and Connecticut River. The overall gradient through the reach is low, yet the increased width of the river creates shallow areas with relatively high velocity. Flow through the rapids is also highly dependent on generation at the Stanley Works hydroelectric project 3.5 river km upstream.

Poquonock Rapids, looking downstream from Route 75 bridge. Flow at the time the photograph was taken was approximately 800 cfs

Poquonock Rapids, looking across the river at mid-reach. Maximum water velocities upstream of the standing waves were approximately 1.5 m · sec^{-1}

Passability:

Poquonock Rapids is passable by American shad, as evidenced by the hundreds to thousands of shad that appear at the Rainbow fishway (3.5 km upstream) each year. It does not appear to be a significant barrier to shad migration, likely due to its low overall gradient, moderate water velocities, and presence of low velocity zones where shad can swim at cruising speeds or rest within the reach. Effects of variability of flow due to generation and delays on migratory movements of shad through the reach have not been quantitatively evaluated.

Tariffville Gorge, Farmington River, CT

Location: (upper gorge) N 41° 54' 16", W 72° 45' 39"
(lower gorge) N 41° 54' 04", W 72° 45' 26"

Mean Monthly Flows:

May – 1,484 cfs

June – 1,176 cfs

River Width: (upper gorge) 55 m, (lower gorge) 61 m

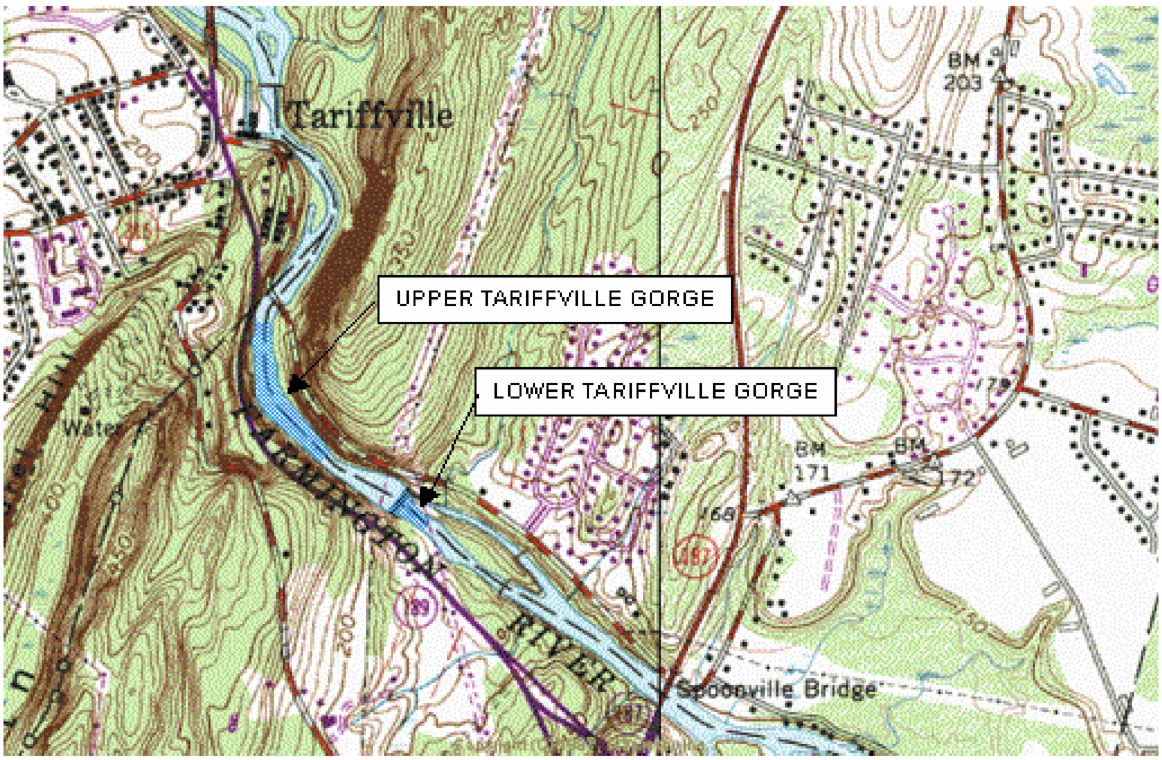
Depth Range: 0.5 – 1 m

Length of Reach: (upper gorge) 500 m, (lower gorge) 10 m (dam thickness)

Vertical Drop: (upper gorge) 4.4 m over 161 m (2.7%); (lower gorge) 1.75 m through breach in dam (17.5%)

Water Velocity Range: 0.5 –3 m · sec^{-1}

Substrate: bedrock, cobble, broken concrete dam



Description:

Tarriffville Gorge consists of two high gradient regions on the Lower Farmington River, Connecticut, 25.9 km upstream of the junction of the Farmington and Connecticut River. The upper gorge reach is a natural gorge through bedrock with class IV and V rapids. This reach is used as a whitewater kayak and canoe course. The lower gorge reach, 300 m downstream of the upper gorge, consists of a cut through a broken concrete dam, creating a short chute with high water velocity.

Upper Tariffville Gorge, looking downstream through class IV-V rapids and whitewater course. Flow at the time the photograph was taken was approximately 700 cfs

Lower Tariffville Gorge, looking upstream through breached concrete dam. Flow at the time the photograph was taken was approximately 700 cfs. Vertical drop through the dam was approximately 1.75 m, with an estimated maximum velocity of 2.5 m · sec^{-1}

Passability:

Tariffville Gorge passes American shad, as evidenced by the presence of juvenile shad in the upstream reaches. The exact proportion of fish that are passed is unknown; however, the annual numbers passing are likely to be small as relatively low numbers (hundreds to a few thousand) of adult shad are passed each year through Rainbow Fishway, 26 km downstream. The time of year and flow conditions at which shad are able to pass this reach are also unknown, but shad likely pass this reach when flows are lower, due to the high gradient and water velocities at this site. It is also possible that shad pass through this reach at high flows, when the drop through the breached dam may be lower due to higher tailwater elevations.

Other Passage/Barrier Sites on Northeastern Rivers

The following information and description of known high gradient reaches or barriers to passage of American shad on other rivers in the Northeast and Maritime Canada was provided by: Mark E. Chittenden, Jr., College of William and Mary, Virginia; Scott Carney, Pennsylvania Fish and Boat Commission, and Clem Fay, Penobscot Indian Nation.

St Croix River: Salmon Falls (head of tidewater); historically passable.

Penobscot River: Historically passed to as far as the sites on the following branches and tributaries (C. Fay, pers. comm..):
Piscataquis River: Barrows Falls; historically impassable
West Branch: Grand Falls; historically passable
Passadumkeag River: Grand Falls; historically impassable

Kennebec River: Norridgewock Falls; historically impassable.

Merrimack River: Shad historically ascended through a series of large rapids to Lake Winnepesaukee in one branch; they apparently did not enter the Pemidgewasset.

Connecticut River: Bellows Falls; historically impassable

Hudson River: Glens Falls, Cohoes Falls (Mohawk River); historically impassable

Delaware River: Skinners Falls (class III to IV rapids); passable

Susquehanna: Shad historically passed well above Binghamton, NY on the North Branch to Otsego Lake; on the West Branch to at least Lockport. Shad also historically passed Half Falls on the Juniata River (tributary to the Susquehannah); 1.1 m drop over 450 m; 0.24% (S. Kearney, pers. comm.).

Potomac River: Little Falls; historically passable, Great Falls; historically impassable

Rappahannock River: Shad historically passed to at least 30 miles above Fredericksburg through some Class II and III rapids

James River: Shad historically passed well into the Jackson and Cowpasture R, through a series of Class II, III, and IV rapids.

Summary

Passage of American shad through natural high gradient or high velocity reaches appears to be primarily dependent on water velocity and the distance to be traversed, over which fish must be able to sustain high speed, anaerobic swimming. Because of the heterogeneous morphology of rapids, dam breaches, and cascades, shad may utilize boundary zones, zones of separation, or small eddies (i.e., behind boulders or bedrock outcrops) to rest and recover from bouts of high speed swimming. If a barrier consists of a steep section of linear, high velocity flow with no flow refuges (i.e., notch or breach of a dam or rock outcrop), shad may be able to pass if the speed and duration of swimming required to traverse the barrier is within the limits of instantaneous sprint swimming. Gradients of up to 2.7% over 100 to 200 m in length and rapids of class IV to V appear to be passable to shad, but it is not known at what flow conditions they do so, or what proportion of individuals attempting passage through such reaches are actually successful.

Passability of a natural reach is also dependent on flow variability, and is reflected in an interaction between flow velocity, water depth, and physical obstruction to passage. For example, at low flow, a reach may have low water velocity, but water depth may be shallow and obstructions to swimming in a linear, upstream direction may become more numerous (i.e., boulders in the main route of flow). At higher flow, the obstructions may be reduced (low head dams or other barriers may actually become inundated) or eliminated, but velocities may be much higher. Under this latter condition, shad might be expected to seek routes along the margins of the reach where velocities are lower, but must also avoid obstructions and shallow water depths. This is a behavior typically seen in tailrace environments where ascending shad seek lower velocities in boundary flow along channel walls, but avoid making contact with the channel wall or bottom.

From behavioral observations, shad appear to prefer to pass obstructions in groups or schools, although they can ascend high velocity structures individually (e.g., Denil-type fishways; Haro et al. 1999). This gregarious habit accentuates the requirement for adequate depth and width in zones of passage through natural structures, to accommodate for movement of shad through such structures as a school. Minimum dimensions for such a zone of passage are on the order of approximately 1 m width by 0.5 m depth, based on observations in the Conte Laboratory flume and existing fishway structures (A. Haro, pers. obs.).

Passage of shad may also be inhibited by excessive turbulence and air entrainment, although shad readily ascend structures such as Denil and steeppass fishways, which are highly turbulent and nearly completely air entrained (surface to bottom). However, it should be noted that these structures are rarely more than 20 m in total length, and usually designed with resting pools where turbulence and air entrainment are reduced. Shad may have an adaptive behavior that permits them to negotiate high velocity, high turbulence, and air entrained flow for very limited periods of time, when no alternative routes are available.

In contrast, shad also tend to aggregate in pools within reaches of high gradient flow and in resting and turnpools of technical fishways. This behavior sometimes creates problems in long fishways, where shad are delayed in their upstream progress when they hesitate in resting or turnpools for long periods of time. The reason for this behavior is unknown, although it may be related to the species' tendency to school, inability to find an exit, or physiological stress/exhaustion. Any design for a natural bypass or other fishway for shad should attempt to minimize this behavior by making pools no larger than absolutely necessary and incorporating stimuli for shad to continue upstream movement (i.e., elimination of eddies, provision of prominent streaming flow into the pool, and provision of adequate sizing of exit channels).

An additional related design consideration is the length of the natural bypass channel itself. Long technical fishways tend to have poor efficiency in passing shad. Most of these fishways have weir or slot velocities of only 2 to 2.5 $m \cdot sec^{-1}$ over short distances (1 m or less) which in themselves are not a significant barrier to shad passage. However, when such weirs are extended over many pools, overall passage efficiency of the fishway is reduced. It appears that there may be a behavioral, as well as physiological, limit to the willingness of shad to negotiate multiple weirs. Similar repetitive hydraulic environments in a natural bypass fishway might be expected to have similar effects.

A final consideration in the design of natural bypass fishways is whether the American shad is the most difficult species to pass in this fishway type. As a large, pelagic swimmer, the American shad has an extensive capability to ascend high velocity flow and turbulence. Among anadromous species, only adult salmonids appear to posess greater swimming performance in terms of ability to ascend and penetrate high gradient riverine habitats. However, shad are different from salmonids in that they tend to school, are limited to migrating primarily during the daylight hours, and are adapted to migrate through and spawn in large, riverine environments. Because their spawning habitat generally consists of riffle areas in larger rivers, shad have the option of spawning in suitable low gradient habitat or continuing up river to exploit additional suitable habitat. If flow or gradient conditions are not suitable for passage, shad can opt to seek alternative habitat downstream. Thus, shad can be viewed to be behaviorally dynamic with respect to passage through high gradient environments, which makes design aspects of any upstream fish passage structure for shad highly critical. The criteria for these design features, however, are only generally understood for this species, even for technical fishways.

If passage of a variety of fish species is considered for design of natural bypass fishways, the American shad may not be an adequate proxy species. Different fish species require other design criteria to be met, such as lower water velocities (smaller species, slower or poorer swimmers), adequate zones of passage for species that are benthically oriented (sturgeon, suckers), and passage zones along channel margins (eels and smaller potamodromous species). Accommodation for all of these species in the design of a natural bypass fishway will pose a major challenge, and behavioral/hydraulic criteria for passage of many of these species are unknown. The natural bypass fishway has the advantage of potential to incorporate a variety of hydraulic environments to meet this challenge. In this respect, a natural bypass fishway holds more promise as a "generic" fishway that will efficiently pass a larger number of species than a technical fishway. However, much work remains to be done in identifying behavioral passage criteria for novel species, evaluation of bypass length, substrate structure, and hydraulics. In the absence of these criteria, experimental natural bypass fishways still can and should be constructed and evaluated with target species, if general characteristics of known passable reaches can be replicated within the bypass. These empirical studies will help to advance knowledge about passage behavior and hydraulics within these new fishway designs, and further refine design criteria.

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Swimming performance of upstream migrant fishes in open-channel flow: a new approach to predicting passage through velocity barriers

Alex Haro, Theodore Castro-Santos, John Noreika, and Mufeed Odeh

Abstract: The ability to traverse barriers of high-velocity flow limits the distributions of many diadromous and other migratory fish species, yet very few data exist that quantify this ability. We provide a detailed analysis of sprint swimming ability of six migratory fish species (American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), striped bass (*Morone saxatilis*), walleye (*Stizostedion vitreum*), and white sucker (*Catostomus commersoni*)) against controlled water velocities of 1.5–4.5 $m \cdot s^{-1}$ in a large, open-channel flume. Performance was strictly voluntary: no coercive incentives were used to motivate fish to sprint. We used these data to generate models of maximum distance traversed, taking into account effects of flow velocity, body length, and temperature. Although the maximum distance traversed decreased with increasing velocity, the magnitude of this effect varied among species. Other covariate effects were likewise variable, with divergent effects of temperature and nonuniform length effects. These effects do not account for all of the variability in performance, however, and behavioral traits may account for observed interspecific differences. We propose the models be used to develop criteria for fish passage structures, culverts, and breached dams.

Résumé : Bien que la capacité de traverser des barrières de débits très rapides limite la répartition de plusieurs poissons diadromes et autres poissons migrateurs, il existe peu de données quantitatives sur le sujet. Nous présentons une analyse détaillée de la capacité de nage en sprint de six espèces de poissons migrateurs (l'alose savoureuse *Alosa sapidissima*, le gaspareau *Alosa pseudoharengus*, l'alose d'été *Alosa aestivalis*, le bar rayé *Morone saxatilis*, le doré *Stizostedion vitreum* et le meunier noir *Catostomus commersoni*) dans des courants de vitesse contrôlée de 1,5–4,5 $m \cdot s^{-1}$ dans une grande canalisation ouverte. La performance y était totalement volontaire; il n'y avait pas de stimulation coercitive pour pousser les poissons à la nage rapide. Ces données nous ont servi à mettre au point des modèles de la distance maximale traversée, en fonction des effets de la vitesse du courant, de la longueur du corps et de la température. Bien que la distance maximale traversée diminue avec l'augmentation de la vitesse du courant, l'importance de cet effet varie d'une espèce à l'autre. Les autres effets qui sont en covariation avec les premiers, comme les effets de la température et ceux des longueurs non uniformes, sont aussi variables. Ces effets n'expliquent pas, cependant, toute la variabilité de la performance; les caractéristiques comportementales expliquent peut-être les différences observées entre les espèces. Nous suggérons que nos modèles soient utilisés pour mettre au point des critères pour l,aménagement de passes migratoires de poissons, de canaux et de barrages comportant des brèches.

[Traduit par la Rédaction]

Introduction

Zones of high-velocity flow characterize many natural rivers and are often unavoidable, or even intentional, features of fishways, dams, and culverts (Clay 1995; Haro et al. 1998). These zones may constitute velocity barriers that exceed the physiological or behavioral capabilities of fishes and so define the upstream boundaries of their populations. The swimming performance of diadromous and other riverine fishes limits their ability to traverse these velocity barriers and is therefore central to their life history.

Many studies describe swimming endurance at sustained and prolonged speeds (for reviews, see Beamish 1978; Videler 1993), but few provide empirical measures of sprinting performance (throughout this text, we follow Webb's (1975) definition of sprinting as steady-state burst swimming). Of those studies that do measure sprinting performance (Beamish 1978), most are largely anecdotal, based on small sample sizes and collected under poorly controlled conditions. Even less common are studies that allow fish to volitionally ascend large-scale experimental open-channel flumes that more closely approximate natural conditions, allowing fish to express normal upstream migratory behaviors (for examples, see Dow 1962; Weaver 1963; Colavecchia et al. 1998).

Brett et al. (1958), Bainbridge (1958), and Beamish (1978) recognized the relevance of this information to improved fish passage and fishway design, but only Dow (1962) and Weaver (1963, 1965) quantified performance in units of the

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distance that fish were able to negotiate against a velocity challenge, the appropriate units for most applications. Weaver's (1963, 1965) work is exceptional, describing various aspects of swimming performance of thousands of individual salmon (*Oncorhynchus* spp.) and American shad (*Alosa sapidissima*) that entered his structure volitionally, with no handling and minimal human interference. Weaver's (1963, 1965) analyses were limited, however, to describing species-specific performance during fixed-velocity tests and gave only cursory treatment to covariates such as length and temperature. Moreover, hydraulic conditions varied down the length of his flume apparatus, complicating interpretation of his results.

Although the techniques used by Dow (1962) and Weaver (1963, 1965) provide close approximations to conditions fishes encounter in nature, most studies on swimming performance have followed the approach of Brett (1964) in which fishes swim against carefully controlled flow within enclosed chambers. None of these studies has matched the scale of Weaver's (1963, 1965) work, however, and the ability of fish to traverse velocity barriers has remained poorly quantified.

The lack of information on sprinting performance is problematic for the design of structures for passing fish around dams and other obstacles. Most fishway manuals (e.g., Powers et al. 1985; Bell 1991; Clay 1995) use figures presented by Beach (1984) to estimate maximum swimming capacities. Beach's (1984) models were derived from the swimming energetics of sockeye salmon (*Oncorhynchus nerka*) (Brett 1965), in vitro muscle kinematics data (Wardle 1975, 1980), and numerous assumptions, including homogeneity of glycogen stores across populations and taxa. Clearly, these models do not support the breadth of their current application. Moreover, they do not predict traversable distance through velocity barriers, only maximum swim speeds and expected endurance. If maximum sprinting ability is underestimated (and this may often be the case (Videler and Wardle 1991)), then some fish passage designs could be simplified, facilitating mitigation efforts and making available much-needed habitat.

The value of low-cost mitigation efforts is not trivial. A recent inventory identifies more than 77 000 dams greater than 8 m throughout the United States, and smaller structures that also impede passage of anadromous and riverine fishes are even more numerous (US Army Corps of Engineers 2001). Similar densities of riverine obstructions can be found throughout the developed world (e.g., several references in Jungwirth et al. 1998). Of the lower-head structures, many are nonfunctional or in disrepair and could be easily breached to form routes of passage, provided that fishes are capable of traversing the resulting velocity barriers (Odeh 1999).

Because of the lack of detailed information on sprinting performance, however, engineers and managers often are unable to assess whether species of concern will be able to pass such simple structures as breaches, culverts, etc. Existing manuals for fish passage engineers provide scant estimates of instantaneous maximum sprint speeds and no estimates of sprint distances through high-velocity flow (e.g., Bell 1991; Clay 1995). The need for reliable data on volitional fish swimming performance is increasing as fish passage issues and concerns expand to include riverine species that are not anadromous but that may regularly migrate considerable distances throughout a watershed. Relatively little is known about swimming performance of these species.

In this study, we provide a detailed description and analysis of high-speed swimming performance (i.e., prolonged and sprint modes) by six species of anadromous, amphidromous, and potamodromous fishes commonly found in rivers of eastern North America. We present species-specific models of maximum ascent distances of fish swimming against steady, open-channel flow velocity conditions ranging from 1.5 to 4.5 $m \cdot s^{-1}$. These data will help identify distributional limits and can also be used to design and evaluate new and existing passage structures or, conversely, to create velocity barriers for nuisance species.

Methods

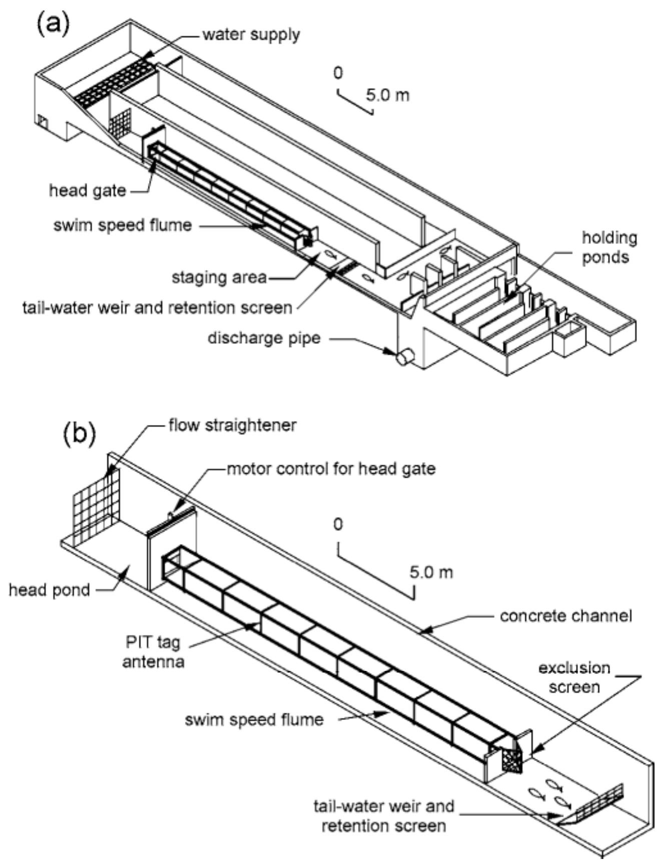
Flume apparatus

To simulate conditions found at natural and anthropogenic velocity barriers, we built a large open-channel flume (1 m width × 1 m depth × 24 m length, zero slope) in the S.O. Conte Anadromous Fish Research Laboratory fish passage complex (Fig. 1) located at Turners Falls, Massachusetts, next to the Connecticut River. The flume was constructed of a wood and steel frame, with the floor and one wall made of plywood. The opposite wall was made of 2.5-cm-thick clear acrylic sheet. Mirrors installed at a 45° angle to the transparent wall permitted simultaneous side and top views to video cameras arrayed above the flume. The plywood wall and floor were covered with white retroreflective material (3M Corp.) (Scotchlite 6780) on which reference marks (black crosses 10 cm × 10 cm) were painted at 0.5-m (horizontal and vertical) intervals. To prevent the formation of organized eddies (macroturbulence), the floor and walls were made smooth, straight, and level. To ensure uniform lighting and to block sunlight from the skylights of the fish passage complex, a black tarp was laid out on a grating 4.5 m above the flume, covering its full length, and the flume was illuminated with eight 90-W halogen flood lamps.

Ambient river water was supplied to the flume from an adjacent hydroelectric power canal fed by the Connecticut River. Water entered the fish passage complex through a 1.8-m-diameter pipe into an upstream diffusion chamber to the test flume head pond. Water from the head pond entered the test flume through an electronically actuated sliding gate (head gate) and exited the flume into a downstream staging area (8 m long × 3 m wide × 0.60–1.35 m deep). Mean velocities were slower in the staging area because of its greater width and depth, the latter being controlled by a variable-height weir (tail-water weir) at the downstream end. This weir was fitted with a screen to retain fish in the staging area while allowing water to pass through. After passing over the tail-water weir, water was returned to the river downstream of the fish passage complex through a 1.4-m-diameter pipe. Water velocities within the flume were controlled by the head-pond level, the head-gate opening, and the tail-water weir level.

We used a 1:6 scale physical model of the flume to establish experimental hydraulic test conditions. The model was constructed to be geometrically, kinematically, and dynami-

Fig. 1. Fish passage complex at the S.O. Conte Anadromous Fish Research Center. (*a*) Installation of swimming speed flume showing holding ponds and route of introduction for test fish; (*b*) detail of swimming speed flume showing flow control mechanism and arrangement of PIT tag antennas.



cally similar to the full-scale flume, ensuring identical hydraulic characteristics (Chow 1959). The model was used to identify the gate settings and water surface elevations in the head pond, flume, and staging area that characterized four test velocities (U_f; nominally 1.5, 2.5, 3.5, and 4.5 m·s^{-1}) and to quantify the response of flow velocity within the flume to variations in these conditions.

Open-channel flow is characterized as super- or sub-critical, depending on whether velocities are dominated by inertial or gravitational forces, respectively. The Froude number, F, which equals the ratio of these two forces, identifies the state of flow:

$$(1)\qquad F = \frac{U_f}{\sqrt{gL}}$$

where g is gravitational acceleration and L is the depth of flow in a channel with a rectangular cross section (Chow 1959). Flow is supercritical at $F > 1$ and subcritical at $F < 1$. At $F = 1$, the flow is critical, and a standing gravity wave (or hydraulic jump) may be propagated up the length of the flume (e.g., Weaver 1963). These unsteady flow conditions were unacceptable for this study, so depth of flow was varied to maintain either super- or sub-critical conditions over the full length of the flume.

At 1.5 m·s^{-1}, flow in the test flume and staging area was subcritical and was set at a depth of 96 cm. At higher velocities, however, this depth of flow created excessive velocity and turbulence in the staging area. Reducing the depth lowered the total flow within the flume, thus maintaining a quiescent staging area. Velocity was sufficient under the 3.5 and 4.5 m·s^{-1} conditions to maintain supercritical flow down the length of the flume at about 45 cm depth. At 2.5 m·s^{-1}, however, flow was unstable and became critical midway down the flume at this depth, so depth was reduced to 26 cm at this velocity to maintain the supercritical condition. For each of these supercritical conditions, tail-water depth was greater than the depth of flow within the flume and was set such that a hydraulic jump was maintained within the flume 0.5–1.0 m from the downstream entrance.

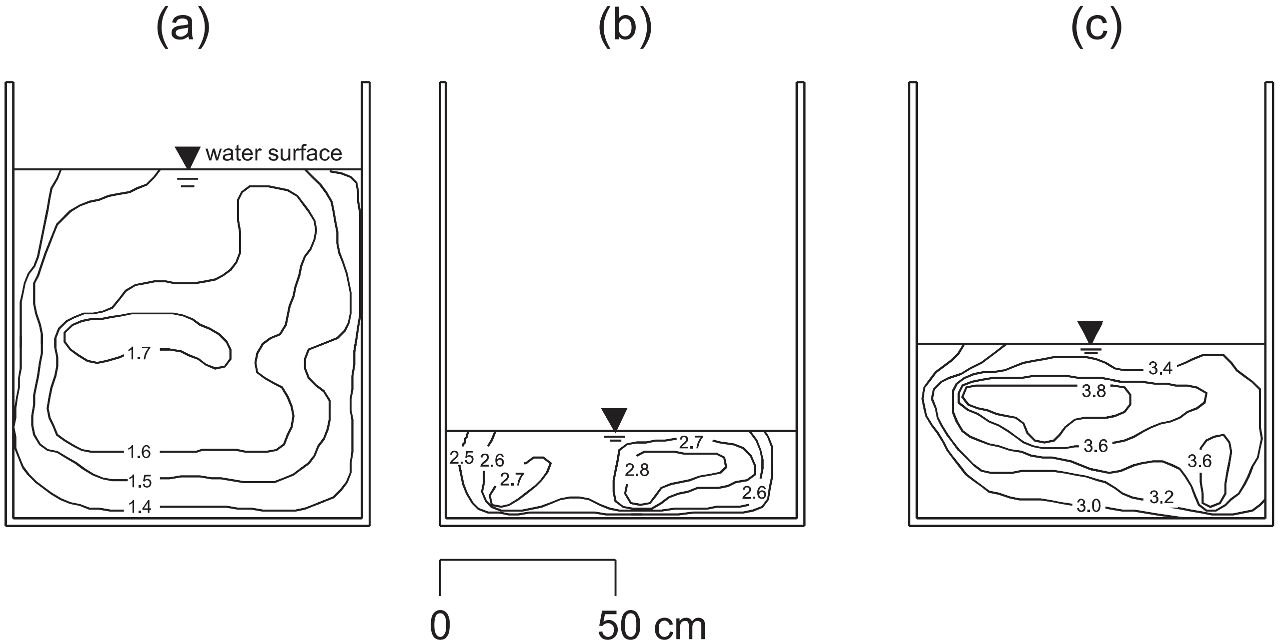
Detailed velocity measurements were made in the model to describe the flow field through which fish would swim. A two-directional electromagnetic velocity meter (Marsh-McBirney model 523) with a 13-mm probe was used to measure model velocities; actual velocities were then measured throughout representative cross sections of the full-scale flume on a 5-cm grid using a propeller meter (Ott model 1-113040). Two-dimensional flow velocity profiles were generated for 1.5, 2.5, and 3.5 m·s^{-1} trial conditions, respectively (Fig. 2). We were unable to collect similar data for the 4.5 m·s^{-1} condition because of excessive forces on the velocity probe; however, hydraulic principles dictate that the velocity profile will be similar to that of the 3.5 m·s^{-1} condition (Chow 1959). To characterize the turbulence of the flow, three-dimensional velocities were measured in the model using a 3D SonTek acoustic doppler anemometer. Measurements were made at mid-depth, both at the center and at distances equivalent to 12.7 cm from the wall of the full-scale flume and 12 m from its downstream end.

Data collection

We used an automated passive integrated transponder (PIT) system to record the position of fish swimming up the length of the flume. Fish were externally tagged without anaesthesia by bonding PIT tags (32 mm in length, 3.9 mm in diameter) to a small fishhook, which was inserted into the cartilage at the base of the dorsal fin (second dorsal in the case of percomorphs; see Castro-Santos et al. (1996) for a description of the PIT system, tagging method, and its application). Ten PIT antennas were mounted along the length of the flume at 2.5-m intervals (from 0.5 to 23.0 m); of these, eight were in place for the first half of the study, and two more were added in May 1998. Tags were detected within 0.5 m of the plane of each antenna loop. A control computer logged tag detection data (tag code, date, time to the nearest 0.1 s, and antenna location) from PIT readers.

Fish were collected and tested during the period from April through July 1997–1999. Six species of migratory fishes were captured from traps at nearby fishways (American shad (*Alosa sapidissima*), striped bass (*Morone saxatilis*), and white sucker (*Catostomus commersoni*)) and coastal streams (alewife (*Alosa pseudoharengus*) from the Herring River, Bourne, Massachusetts, and blueback herring (*Alosa aestivalis*) from the Charles River, Watertown, Massachusetts) or electrofished (blueback herring, striped bass, walleye (*Stizostedion vitreum*), and white sucker from the

Fig. 2. Cross-sectional velocity profiles ($m \cdot s^{-1}$) of swimming speed flume under nominal (*a*) 1.5 $m \cdot s^{-1}$, (*b*) 2.5 $m \cdot s^{-1}$, (*c*) and 3.5 $m \cdot s^{-1}$ mean water velocity conditions 2 m upstream of the flume entrance.



Connecticut River) on dates corresponding to the periods of upstream migration for each species. Fish were transported to the flume facility in one of two truck-mounted tanks (1000 and 4000 L capacity). After transport, fish were measured (fork length), sexed, and fitted with a PIT tag (Castro-Santos et al. 1996); we assume that this very small tag had no substantial effect on swimming performance. Fish were transferred into open, flow-through holding ponds (Burrows and Chenoweth 1970) that were hydraulically continuous with the fish passage complex and held 24 h before testing. Fish were usually tested within 24 h of capture and were released after each trial. In some cases, fish were held longer before testing, but never for more than 7 days.

At the start of a trial, groups of 20–30 fish were seined from the holding ponds into the staging area, and the tailwater weir and screen were raised to confine the fish to this area. Fish were initially prevented from entering the flume by an exclusion screen. Once the water velocity in the flume was brought to the desired level, the exclusion screen was opened and fish were allowed to ascend the flume of their own volition. Only those fish that entered the flume during a given trial were included in our analyses. Although duration of runs ranged from 1 to 6 h, we use only the first hour's data from each trial to maintain consistency in our analyses.

Light level in the flume was 2.5 $\mu W \cdot m^{-2}$ for all species except walleye and white sucker. To encourage attempts by these species, which typically migrate at night, we darkened the flume to 0.03 $\mu W \cdot m^{-2}$. Mean hourly water temperatures were logged using a data logger (Licor LI-1000) and thermocouple probe (Omega T-type). Average temperatures for times corresponding to each trial were included as a covariate in the analyses.

Data analysis

Because the PIT antennas effectively graduated the flume into 2.5-m intervals, we were able to estimate maximum distance of ascent (D_{max}) by selecting the location farthest upstream that was logged for each fish during the trial. This is an incremental measure and provides a conservative bias to the D_{max} estimate: the reader might detect a fish as far as 0.5 m below an antenna, but the same fish could also be as much as 2 m above that antenna without being logged at the next location.

The configuration of the PIT antennas imposed restrictions on the methods used to develop predictive models. Since PIT antennas were installed only for the first 18 m of the flume during the first half of the study, and the first 23 m thereafter, D_{max} values do not reflect the true maximum ability of the fish, but rather the maximum that our apparatus was able to measure — the actual performance capacities may have been higher. This condition, in which the magnitude of a measured variable exceeds the ability of an instrument to measure it, constitutes censoring (Lee 1992). Ordinary least-squares regression techniques are unable to accommodate censoring, so we applied the maximum likelihood regression techniques commonly used in survival analysis (Allison 1995; Castro-Santos 2002; Castro-Santos and Haro 2003) to develop our predictive models. For the reasons just described, as well as to negate any effect of fish avoiding the upstream end of the flume, fish attaining D_{max} values of 18 m or greater were included in the analyses as censored observations.

The regression models used here follow the form

$$(2) \qquad (\ln D_{max})_p = \beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k + w_p$$

where $(\ln D_{max})_p$ is the pth quantile of the natural log of D_{max}, βs are coefficients, x_is are the k-covariates, and w_p is the pth quantile of the baseline distribution. One advantage of this regression approach is that it does not require the error term to be normally distributed. For this reason, it takes on a more complex structure than that of ordinary least-squares regression, with scale (σ) and shape (δ) parameters that influence the value of w_p.

We determined which distribution best described our data by first including all three covariates: velocity, temperature, and body length. We then generated separate models based on exponential, lognormal, Weibull, log-logistic, and generalized gamma distributions (Lawless 1982) as well as their nonlogged counterparts. Next, we ranked these models using Akaike's information criterion and selected the one with the best fit (Allison 1995; Burnham and Anderson 1998). Finally, we refined the models by removing covariates in a stepwise fashion, retaining only those with P values less than 0.15.

Results

Flume hydraulics and tolerances

Mean velocities differed consistently from the projected nominal velocities (Table 1). Test velocities varied little, with most standard deviations less than 0.1 $m \cdot s^{-1}$. This variability arose primarily as a result of fluctuating head-pond levels in the power canal.

Flow is either laminar or turbulent depending on its Reynolds number, R. This is the ratio of inertial to viscous forces:

$$(3) \qquad R = \frac{U_f d}{\nu}$$

where d is a characteristic length (in this case, the cross-sectional area divided by the length of its wetted perimeter) and ν is the kinematic viscosity of the working fluid. Open-channel flow becomes turbulent at $R > 2500$ (Chow 1959). Under all of the velocity and depth conditions used here (Table 1), $R > 300\,000$, well within the turbulent regime.

Turbulence is typically quantified by the standard deviation of the velocity vector (u') or alternatively by its coefficient of variation (CV) or relative turbulence intensity:

$$(4) \qquad \mathrm{CV} = u'/\overline{U_f}$$

where $\overline{U_f}$ is the mean channel velocity. In geometrically similar channels, turbulence scales directly with velocity, regardless of Froude and Reynolds numbers, and so its CV is constant (Nezu and Nakagawa 1993). The acoustic doppler anemometer data indicated that turbulence intensity within the flume was 0.11–0.17, which is characteristic of open-channel flow over smooth surfaces. The turbulence was disorganized, however, consisting of random fluctuations and microeddies with no evident periodicity (Fig. 3) (Nezu and Nakagawa 1993). The measured level of turbulence in our flume was representative of flows through long open channels (i.e., culverts, dam notches) but less than that within technical pool and weir and Denil-type fishways.

Velocities were lowest near the walls and floor of the flume (Fig. 2) and were within 10% of the mean cross-sectional velocity throughout its length. However, assertions that fish will consistently seek out zones of lowest velocity (e.g., Beamish 1978; Pavlov et al. 2000) were not borne out by our observations. Although some species (most notably white suckers) actively selected these low-velocity zones at the 1.5 and 2.5 $m \cdot s^{-1}$ conditions, all species swam near the cross-sectional center of the flume at the higher velocities (Castro-Santos 2002).

The presence of the hydraulic jump 0.5–1.0 m from the flume entrance under the supercritical flow conditions may have provided some advantage to the fish, particularly at higher velocity flow, allowing them to ascend the first half metre with greater ease than they would have had the jump been outside the flume. The jump was kept within the flume to reduce the strength of the jet issuing into the staging area and to help encourage fish to enter the flume. Researchers seeking to replicate our results should maintain similar conditions; those seeking to predict ascent distances at field sites should measure from 1.0 m below the hydraulic jump in conducting their calculations.

Swimming capacity

Because impingement of smaller species (alewife, blueback herring, and walleye) on the tail-water weir screen occurred in initial 4.5 $m \cdot s^{-1}$ trials, and because performance was poor under the 3.5 $m \cdot s^{-1}$ condition (Fig. 4), these smaller species were not run at 4.5 $m \cdot s^{-1}$. Percentages of fish entering the flume varied both among species and among velocities within species (Table 1).

Increasing water velocity consistently reduced D_{max} for each species (negative β, Table 2). Coefficients indicate the relative effect of each covariate on log distance of ascent, i.e., each unit increase in covariate results in an increase in distance of $100 \times [1 - \exp(\beta)]$ percent. Thus, although all species showed the expected negative effect of water velocity on D_{max}, the degree of this effect varied widely among species (e.g., 49% decrease in distance per metre per second for walleye versus a 69% decrease for blueback herring).

Body lengths and temperatures (Table 1) represent values typical for active migrants of these species in our region (northeastern United States). Blueback herring and alewife had the smallest size ranges (45 and 55 mm, respectively) followed by American shad and walleye (195 mm each) and white sucker (220 mm). Our walleye sample, however, did not include the largest individuals present in the adult migratory spawning population (this was to accommodate concerns of local fisheries managers). Striped bass, in contrast, showed the greatest size variability of all (735 mm). This is because upstream migration of striped bass includes both juvenile and spawning individuals, so the tested fish of this species are not necessarily mature adults.

Performance improved significantly with length for American shad, blueback herring, striped bass, and walleye. This effect varied over an order of magnitude, being least for American shad and greatest for blueback herring. However, over the range of lengths represented by ±1 SD, the predicted effect on D_{max} was greatest for striped bass (277% increase in D_{max} from small to large individuals) and least for American shad (16% increase), with 60% and 36% increases among blueback herring and walleye, respectively. Note that the narrow scope of sizes of blueback herring means that these data should be viewed with caution.

Trial temperatures reflected ambient river conditions. Alewife experienced the narrowest temperature range (4.7 °C) and white sucker and striped bass the largest (12.4 and 13.6 °C, respectively). Trials of the remaining species had similar temperature ranges (8.3–8.5 °C). These temperature

Table 1. Species characteristics, sample sizes, and hydraulic conditions of tests performed in the swimming flume by nominal water velocity, all years pooled.

					Hydraulics			
Species	N	%	Fork length (mm)	Temperature (°C)	Nominal velocity ($m \cdot s^{-1}$)	Measured velocity ($m \cdot s^{-1}$)	Water depth (m)	Q ($m^3 \cdot s^{-1}$)
American shad	92	86	421±34 (355–495)	16.8±1.5 (15.3–19.1)	1.5	1.74±0.07	0.96	1.67
	233	68	417±33 (355–495)	18.9±2.1 (13.4–21.6)	2.5	2.69±0.09	0.26	0.70
	285	71	415±36 (325–520)	18.4±2.0 (13.4–21.5)	3.5	3.43±0.09	0.45	1.54
	92	33	416±35 (350–510)	18.2±2.4 (13.3–21.5)	4.5	4.53±0.04	0.46	2.08
Alewife	122	55	235±12 (210–265)	10.2±1.4 (8.5–13.2)	1.5	1.60±0.15	0.96	1.54
	60	30	238±11 (215–265)	10.4±1.4 (8.9–13.0)	2.5	2.60±0.06	0.26	0.68
	40	37	235±11 (215–260)	11.2±1.4 (9.1–13.0)	3.5	3.40±0.03	0.45	1.53
Blueback herring	19	17	229±11 (210–245)	16.7±2.3 (13.2–18.2)	1.5	1.61±0.09	0.96	1.55
	24	18	219±11 (205–245)	16.7±3.4 (13.0–21.4)	2.5	2.69±0.07	0.26	0.70
	38	34	216±11 (200–240)	17.1±2.4 (13.0–20.6)	3.5	3.40±0.13	0.45	1.53
Striped bass	10	33	558±270 (290–970)	18.6±0.0 (18.6)	1.5	1.58±0.05	0.96	1.52
	57	38	430±118 (235–780)	19.9±2.7 (16.3–23.6)	2.5	2.64±0.07	0.26	0.69
	62	33	478±120 (280–760)	19.3±2.8 (10.7–24.3)	3.5	3.40±0.06	0.45	1.53
	48	70	554±162 (285–835)	17.2±1.3 (16.2–21.9)	4.5	4.55±0.09	0.46	2.09
Walleye	13	24	314±45 (240–395)	12.6±2.5 (9.3–14.4)	1.5	1.74±0.11	0.96	1.67
	24	30	315±41 (270–410)	15.7±3.4 (10.0–17.8)	2.5	2.73±0.11	0.26	0.71
	12	22	317±53 (225–415)	10.3±0.7 (9.7–11.1)	3.5	3.34±0.01	0.45	1.50
White sucker	35	65	385±41 (285–505)	11.8±0.9 (10.9–14.4)	1.5	1.75±0.05	0.96	1.68
	35	41	384±29 (305–430)	14.9±3.6 (11.0–18.4)	2.5	2.62±0.05	0.26	0.68
	31	36	392±30 (340–450)	17.6±5.6 (10.7–22.8)	3.5	3.36±0.03	0.45	1.51
	31	49	398±26 (340–450)	15.0±3.6 (10.4–21.5)	4.5	4.51±0.04	0.46	2.07

Note: Sample size (N) is presented as total number of fish entering the flume followed by the percentage that this represents of the total number of fish introduced into the staging area. Lengths, temperatures, and measured velocities are given as means ±1 SD; length and temperature ranges are in parentheses. Q is the total flow within the flume.

ranges should have been sufficient to detect any effect of temperature on performance. This effect, however, was ambiguous. Performance increased with temperature for blueback herring, walleye, alewife, and striped bass (although the effect was nonsignificant for the latter two species) but decreased with temperature among American shad.

Duration of holding times before testing varied because the timing of trials was contingent on availability of fish. Although 89% of fish were tested within 48 h of capture, some collections, most notably among white sucker, were held for as long as 7 days before testing. Inclusion of this factor in the regression models (Table 2) indicated that holding time had no significant effect on D_{max} for any of the species tested ($P > 0.07$ among walleye, $P > 0.42$ for all others). Likewise, collection point and method did not substantially affect D_{max} ($P > 0.19$).

The distributions that best describe the performance data differed among species (Table 2). The gamma distribution provided the best fit to the data for American shad, alewife, striped bass, and walleye; the Weibull distribution best described the blueback herring and white sucker data. The scale (σ) and shape (δ) parameters of the regression models describe the shape of the underlying error distribution. Evaluation of probability plots (SAS Institute Inc. 1999) and Cox–Snell residuals (Allison 1995) suggests that these models provide a reasonable fit to the data.

The purpose of the regression models (Table 2) is not only to identify significant factors influencing swimming performance but also to quantify these effects in a way that enables managers and engineers to apply our data to similar hydraulic environments. By setting covariate values to levels representative of specific situations, managers can use these models to predict proportions of populations able to pass barriers under various velocity conditions (Fig. 5). Proportions can be estimated for each model as Weibull

$$(5) \qquad S(D) = \exp\left[-\exp\left(\frac{\omega - \mu}{\sigma}\right)\right]$$

and gamma

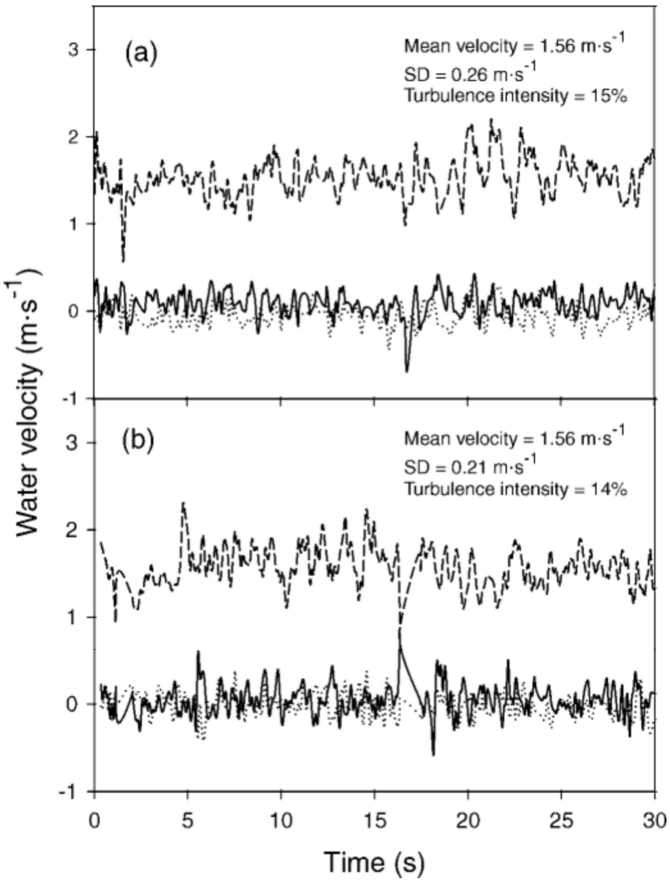
$$(6) \qquad S(D) = \frac{\Gamma\left\{\delta^{-2}, \delta^{-2}\exp\left[\delta\left(\frac{\omega-\mu}{\sigma}\right)\right]\right\}}{\Gamma(\delta^{-2})}$$

where the survivorship function $S(D)$ is the proportion of fish successfully passing a velocity barrier of distance D, $\omega = \ln(D)$, σ is the the scale parameter, δ is the the shape parameter, $\Gamma(a)$ and $\Gamma(a,b)$ are the complete

$$(7) \qquad \Gamma(a) = \int_0^\infty D^{a-1}\exp(-D)\mathrm{d}D$$

and incomplete

Fig. 3. Time series of three-dimensional water velocity within the flume apparatus at 1.5 m·s^{-1} nominal velocity 12 m upstream from the flume entrance and 50 cm from the floor at positions (*a*) near the side wall and (*b*) at the flume midline. Dashed line, *X* velocity; solid line, *Y* velocity; dotted line, *Z* velocity.



$$\Gamma(a,b)\int_0^{\infty} D^{a-1}\exp(-D)\mathrm{d}D \tag{8}$$

gamma functions, respectively (Lawless 1982), and $\mu = \boldsymbol{X\beta}$, the vector product of covariate values and their coefficients.

Discussion

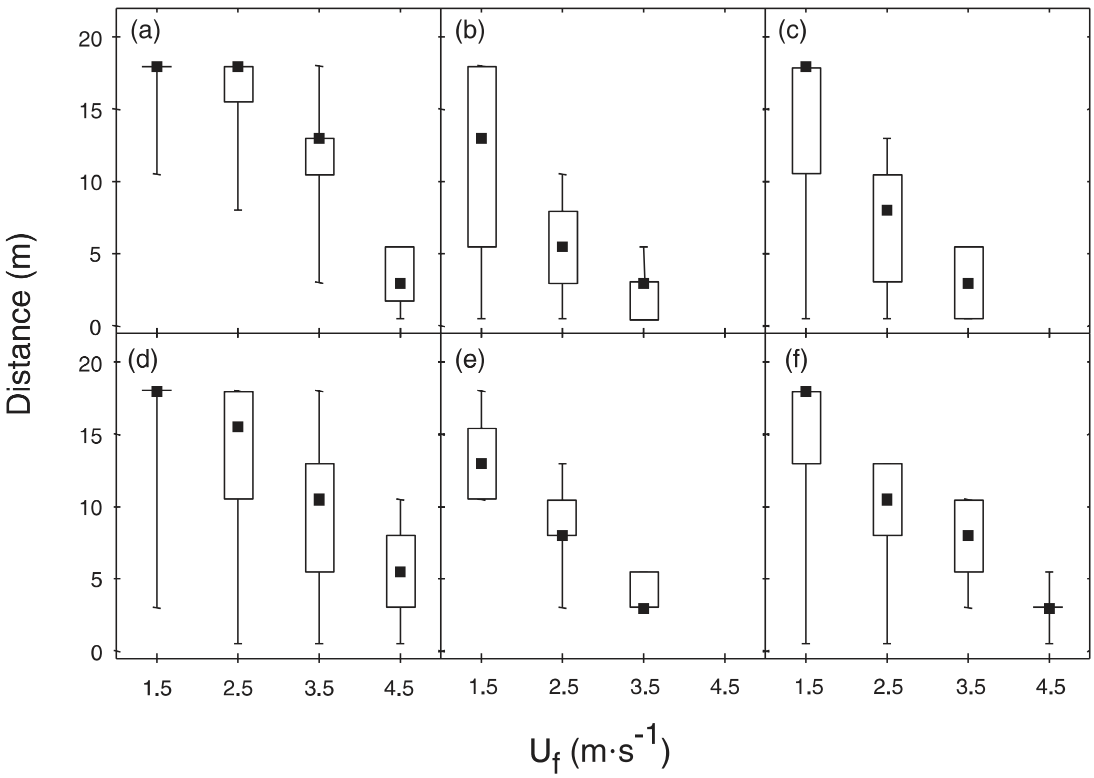
Current criteria for the design of fishways and velocity barriers are based on biological data collected under very artificial conditions. Often, these conditions are a necessary feature of controlled laboratory studies. For example, respirometry studies require a uniform flow profile to prevent fish from taking advantage of low-velocity zones. Also, fish are typically required to swim within enclosed tubes, and it is not known how representative the resulting data are of natural situations. Our data represent a departure from and improvement over these methods: fish swam volitionally in open-channel flow, and $D_{\max}$ values represent behavioral rather than explicitly physiological fatigue.

Our results can be readily compared with published direct measures of sprint swimming and distance ascended. Weaver (1965) measured a median distance of ascent of 9.4 m for American shad at a flow velocity (U_{f}) of 3.47 m·s^{-1} and of 5.94 m at a U_{f} of 4.02 m·s^{-1} (temperature 20.8 °C, fish lengths not given). For comparable U_{f} values, temperatures, and a mean fork length of 417 mm, our model predicts 50% passage at 10.1 and 5.9 m (respectively) for American shad. It is also interesting to note that Weaver's (1965) estimates of sprint swimming performance of adult Pacific salmonids greatly exceeded that of any of our test species. Thus, our data do not conflict with previous observations of swimming performance of salmonids; rather, they point to superior swimming performance measured in open-channel flow. Dow (1962) and Stringham (1924) observed alewives swimming in open-channel flows against velocities of 3–4.5 m·s^{-1}, but their data were poorly quantified. Because we did not directly measure relationships between swimming speed and fatigue time, our data do not readily compare with most published information on these metrics. However, we did observe that many fish swam at speeds of 10–20 body lengths·s^{-1} (Castro-Santos 2002), which are well above those measured by earlier investigators employing forced swimming techniques (Beamish 1978; Videler 1993).

There are, however, limits to the application of our data. Natural rivers, fishways, and culverts often have roughness elements, weirs, or objects in the flow that impart structure to the turbulence (macroeddies). In some situations, fish are able to use this structure to assist their forward movement (Hinch and Rand 2000; Pavlov et al. 2000) or station holding abilities (Webb 1998; Liao et al. 2003*a*, 2003*b*). In other situations, turbulence structures can hinder these same behaviors (Hinch and Rand 1998; Webb 1998). Because our flume was an open channel, with smooth walls and floor, the turbulence was characterized by microeddies (much smaller than the length of a fish), which can be expected to increase the cost of swimming (Enders et al. 2003). Thus, the models presented here should be applied only to those situations that are hydraulically similar to our laboratory conditions. Examples include box culverts, breached dams (with minimal structure in the flow), and zones of supercritical flow within fishways. The models may reasonably provide guidance for situations that deviate moderately from those presented here, such as culverts with corrugated roughening elements. Also, some fishway types (e.g., Alaska steeppass) are characterized by zones of axial flow surrounded by zones that are more turbulent (Odeh 2003). If fish ascend these fishways using the less turbulent zones, then the models presented here may have some relevance. Application to any such situation should be viewed with skepticism, unless information on the behaviors of the fish is available to justify it. Future work should focus on providing detailed descriptions of the behaviors of fish traversing zones of turbulent flow, characterizing the turbulence, and identifying those conditions that act to increase or decrease $D_{\max}$. The methods described here can serve as a model for this work.

Because we constructed the flume to be of such a length as to provide realistic estimates of passage ability past obstacles of relatively short length (e.g., breached low-head dams), some individuals could successfully negotiate the full length of the flume, particularly at the lowest velocities. Other places where high velocities exist, such as culverts, natural obstructions, etc., may extend well beyond the length of our structure, and our data may have limited relevance to such situations. Using the survival analysis approach, our data al-

Fig. 4. Maximum distance of ascent (D_{max}) by species and nominal water velocity (U_f). (*a*) American shad; (*b*) alewife; (*c*) blueback herring; (*d*) striped bass; (*e*) walleye; (*f*) white sucker. Data are presented as median (■), 25–75 percentiles (boxes), and 5–95 percentiles (whiskers). Note that actual water velocities deviated from nominal velocities. Smaller species (alewife, blueback herring, and walleye) were not run against the 4.5 m·s^{-1} condition. Data are truncated to 18 m for consistency.



low for modest extrapolation beyond the actual length of the flume and for interpolation between and extrapolation beyond the experimental test velocities (Hosmer and Lemeshow 1999). We recommend limiting such extrapolations to velocities of 0.5 m·s^{-1} greater or less than the test velocities and total distances of 25 m. These values are similar to those required for interpolation between test conditions and antenna locations; extrapolation beyond these limits is not justified. It should be noted, however, that at lower speeds, fish might shift to prolonged, or even sustained, mode (Webb 1975). These modes are characterized by different swim speed – fatigue time relationships, and estimates of D_{max} based on sprint data can be expected to be low (Castro-Santos 2002).

Keeping in mind that caution should be used when applying these equations to situations much different from our experiments, the following example might help elucidate their application. To estimate the proportion of 50-cm striped bass passing a 10-m-long velocity barrier of 3.0 m·s^{-1} flow at 18 °C, values from Table 2 are entered into eq. 6 to generate an estimate of 65.9% passage through this barrier. A similar process could be used to describe a population with a range of sizes by breaking it down into more meaningful ranges (e.g., by age class).

Few studies of unsustained (i.e., prolonged and sprint) swimming performance have been conducted on this scale, and this is the first to quantify performance in terms of distance traversed against controlled open-channel velocity barriers with such resolution and large sample sizes and on such a range of taxa. Weaver (1963, 1965) provided empirical quantile curves for American shad, steelhead (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*) but did not rigorously evaluate effects of temperature, fish length, or flume hydraulics. Other efforts have focused on timing the movements or recording the success of individuals ascending fishways (Dow 1962) or on angled fish running out a line attached to a tachometer (Gero 1952). All of these approaches have been done under poorly controlled conditions or failed to gather detailed individual information.

As a result of the large sample sizes and individual information that we were able to collect, we could construct models that accurately describe the shapes of probability functions, thus permitting realistic estimates of percentiles of populations capable of passing barriers of specific velocities. This allows for the ability to target for passage of a particular proportion of the population, which is an improvement over use of means and medians that only describe midpoints for proportion of fish passed and do not account for variability (Venditti et al. 2000; Castro-Santos and Haro 2003).

One caveat to consider when applying these data is that we do not include all fish in our analyses, only those that initiated attempts within 1 h. This was done to eliminate the effect of motivation or attraction (quantified in this study by the percentage of fish entering the flume from the staging area), which differed nonlinearly between velocities (Castro-Santos 2002). Thus, our models are conditional on the fish staging attempts and may not be representative of those achievable by fish that made no attempts to ascend the

Table 2. Regression models of covariate effects on log maximum distance of ascent (ln (D_{max})).

Species*	Variable Intercept	Velocity ($m \cdot s^{-1}$)	Temperature (°C)	Fork length (mm)	Scale (σ)	Shape (δ)
American shad (702, 263,–569,gamma)						
β	5.706	–0.983	–0.029	0.0022	0.316	2.070
SE	0.291	0.032	0.010	0.0005	0.022	0.173
$P > \chi^2$	<0.001	<0.001	0.003	<0.001		
Alewife (222, 39, –319, gamma)						
β	4.571	–0.920	—	—	0.513	2.431
SE	0.169	0.074	—	—	0.075	0.412
$P > \chi^2$	<0.001	<0.001	<0.15	>0.15		
Blueback herring (81, 12, –94.9, Weibull)						
β	–0.435	–1.165	0.079	0.0196	0.665	
SE	1.991	0.149	0.029	0.0079	0.070	
$P > \chi^2$	0.827	<0.001	0.006	0.0131		
Striped bass (177, 36, –159, gamma)						
β	3.309	–0.854	0.024	0.0035	0.324	2.175
SE	0.440	0.050	0.015	0.0003	0.039	0.331
$P > \chi^2$	<0.001	<0.001	0.106	<0.001		
Walleye (49, 3, –15.3, Weibull)						
β	2.304	–0.679	0.039	0.0035	0.250	
SE	0.370	0.067	0.010	0.0009	0.031	
$P > \chi^2$	<0.001	<0.001	<0.001	<0.001		
White sucker (136, 24, –155, Weibull)						
β	4.399	–0.720	—	—	0.574	
SE	0.197	0.058	—	—	0.050	
$P > \chi^2$	<0.001	<0.001	>0.15	>0.15		

*Numbers in parentheses represent total *N*, censored *N*, log-likelihood, and distribution, respectively.

flume. Among those fish that did stage attempts, these models are conservative because they do not take into account the additional attempts that might have been staged had trial duration been extended for more than 1 h. In contrast, if fish that stage attempts quickly also swim farther (e.g., owing to superior condition or motivation), then the results shown here may be greater than expected for the population as a whole. This issue, as well as the effects of trial duration and attempt rate on estimates of swimming performance, is explored extensively elsewhere (Castro-Santos 2004).

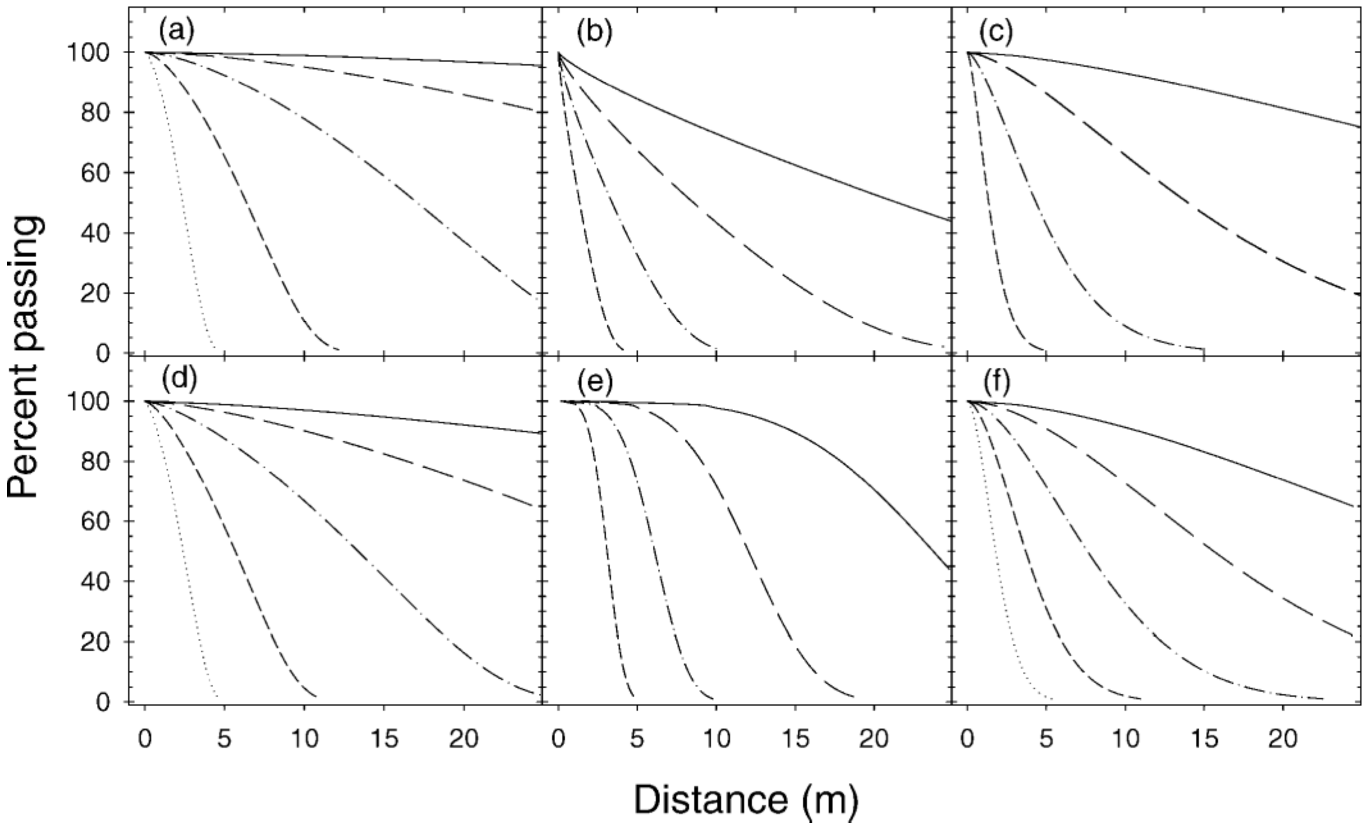
Similarly, managers intending to apply these models should consider the potential effect of fatigue: the rate and distance of successive attempts may be affected by the extent to which fish exhaust their glycogen stores or other metabolic resources. Once depleted, these stores can take hours or even days to recover (Black et al. 1962) and, in some cases, can lead to postexercise mortality (Brobbel et al. 1996; Wilkie et al. 1997; Brick and Cech 2002).

This did not appear to be a concern here: fish showed no obvious signs of fatigue at the end of the trials, and no significant mortality occurred within 24 h after each trial. Moreover, biochemical analyses of blood and white muscle of American shad suggested that these fish did not swim to physiological exhaustion (Castro-Santos et al. 2000 and unpublished data). American shad did take longer to stage second attempts than their first attempt, and D_{max} tended to decrease with attempt number (Castro-Santos 2002). Later attempts occurred at greater rates, however, suggesting that the cause of the reduced distance may not have been physiological fatigue. By contrast, walleye and white sucker showed no evidence of reduced attempt rate on successive attempts (if anything, it increased), and distance of ascent was consistent across attempts (Castro-Santos 2004). Taken together, these data suggest that these species do not volitionally swim to physiological exhaustion when attempting to traverse velocity barriers.

The results of the regression models highlight some important differences among these species. Although all six species exhibited the expected decline in D_{max} with increasing velocity, variation among species in the magnitude of this effect differed from our expectations. For example, because American shad are by far the largest of the three alosine species, we expected the velocity effect to be smaller than among blueback herring and alewife. Instead, the effect was similar among the three species, with alewife showing the smallest and blueback herring the greatest response to increasing velocity. The contrast between blueback herring and alewife is interesting because of the morphological and ecological similarity of these two species. This difference occurred primarily because several alewife abandoned their efforts at short distances against the lowest velocity, resulting in a smaller overall velocity effect compared with the blueback herring. Despite this difference, blueback herring had greater overall D_{max} values, which is consistent with the fact that they often have greater migration distances and spawn in more lotic habitat (Loesch 1987).

Numerous studies have shown that temperature is positively correlated with endurance, especially at sustained

Fig. 5. Model predictions of percentages of (*a*) American shad, (*b*) alewife, (*c*) blueback herring, (*d*) striped bass, (*e*) walleye, and (*f*) white sucker successfully traversing velocity barriers. Velocities: solid line, 1 $m \cdot s^{-1}$; long-dashed line, 2 $m \cdot s^{-1}$; dashed-dotted line, 3 $m \cdot s^{-1}$; short-dashed cline, 4 $m \cdot s^{-1}$; dotted line, 5 $m \cdot s^{-1}$. All other covariates are set to their mean values. To keep extrapolations on the same order as the interpolations, modeled velocities extend only to 4 $m \cdot s^{-1}$ for alewife, blueback herring, and walleye. Note that these predictions apply only to those fish that stage attempts within the first hour (see Castro-Santos (2002, 2004) for appropriate adjustments to account for attempt rates).



speeds (Brett 1964; Videler and Wardle 1991). Few studies quantify this effect on sprinting performance, however, and there is disagreement over its importance (Beamish 1978). We observed a positive correlation between temperature and D_{max} for blueback herring and walleye, but the opposite was true of American shad, and the effect among other species was not significant. Lack of significance should not be confused in this case with absence of effect: the range of temperatures at which species were run was variable and, because it corresponds to periods of fitness-crucial activity, may reflect a performance optimum for these species (Castro-Santos 2002). Thus, the signs of these coefficients may owe as much to nonlinear effects of migratory motivation as to physiological capacity. Also, because sprinting is largely powered by anaerobic processes, the temperature effects on sustained swimming may not be relevant. Temperature does not seem to be correlated with performance or recovery times during sprinting (Brett 1964; Schreer et al. 2001; Castro-Santos 2004).

As with temperature, many studies have shown length to be correlated with swimming performance, so much so that performance data are usually normalized for length, particularly when there is substantial variation in the lengths of the study animals (Bainbridge 1960; Brett 1965; Brett and Glass 1973). We, too, found significant correlations between length and D_{max}, but the effect was not universal and was much stronger among striped bass than among other species. Sexual dimorphism can obscure the effect of length on performance. In the case of American shad, females are larger than males, but much of their mass is devoted to eggs rather than to propulsive musculature. The small magnitude of the length effect in this species may be due to differences in performance between the sexes (see Castro-Santos (2002) for a detailed discussion of the effects of sex and length). The absence of a significant length effect among alewife and white sucker may be due to the relatively small variance in length for these species; similarly, and for the same reason, the strong length effect among blueback herring should be viewed with skepticism.

The information gained in this study defines performance of upstream migrant fishes swimming through velocity barriers in a novel way and at a realistic scale. The distance that fish are able to ascend high-velocity flow is a useful parameter for defining swimming performance and identifying potential distributional limits. Thus, the technical and numerical approaches that we have described have broad applicability both to site-specific fish passage problems and to understanding implications of velocity barriers for population ecology of migratory riverine species.

Acknowledgements

Several individuals contributed meaningfully to this work. David Hosmer and Mike Sutherland provided guidance on application of survival analysis methods; Phil Herzig (US Fish and Wildlife Service), Phil Brady (Massachusetts Division of Fisheries and Wildlife), and Ken Sprankle (New Hampshire Fish and Game) provided essential equipment and assistance with fish collections; Phil Rocasah and Steve Walk directed construction and instrumentation, respectively; Joe Capece and Greg Baccos helped run the experiments; and Willy Bemis, Beth Brainerd, George Lauder, Mike Sutherland, and two anonymous reviewers all provided helpful suggestions for the final manuscript.

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Kacie Jensen

From: Alison Guth
Sent: Wednesday, November 22, 2006 11:49 AM
To: Alison Guth; 'Wade Bales (balesw@dnr.sc.gov)'; 'Amanda Hill'; 'Bill Argentieri'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; 'Theresa Thom'; Brandon Kulik; Alan Stuart
Subject: Final IFIM Meeting Notes - Oct 16

Hello all,

Attached are the final meeting notes from the October 16th IFIM/Aquatic Habitat TWC Meeting. Thanks and have a wonderful Thanksgiving!   Alison

2006-10-16 Final Meeting Minut...

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MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
IFIM/Aquatic Habitat TWC

SCE&G Training Center
October 16, 2006

Final acg 11-22-06

ATTENDEES:

Alison Guth, Kleinschmidt Associates
Alan Stuart, Kleinschmidt Associates
Ron Ahle, SCDNR
Dick Christie, SCDNR
Shane Boring, Kleinschmidt Associates
Malcolm Leaphart, TU
Bill Argentieri, SCE&G
Randy Mahan, SCANA Services, Inc.
Scott Harder, SCDNR
Hal Beard, SCDNR
Brandon Kulik, Kleinschmidt Associates
Gerrit Jobsis, American Rivers

HOMEWORK:

- Perform literature review for existing studies on widths and depths necessary for fish passage – *Brandon Kulik*
- Distribute draft IFIM study plan to group by email prior to 27th meeting – *Brandon Kulik*
- Send Catawba Wateree HSI curves to Brandon K - *SCDNR*
- Forward Brandon K. an example list of species to be considered under each guild - *SCDNR*
- Send Pee Dee HSI curves to Brandon K. – *Gerrit Jobsis*

UPCOMING AGENDA ITEMS:

- *Addressing the influences of Saluda Operations on the Congaree*

DATE OF NEXT MEETING: **November 27, 2006 at 9:30 a.m.**
Lake Murray Training Center

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Review of Homework Items from Previous Meeting:

Shane Boring opened the meeting and noted that the first discussion topic was to review action items from the previous meeting. Shane noted that Gerrit Jobsis was charged with finding the HSI curves used in 1989-90 LSR IFIM Study. Gerrit replied that they could be found in the study report. Shane also noted that he had talked to Theresa Thom regarding her homework assignment to check with USC Geography Dept. for GIS habitat coverages for the LSR. Shane explained that she was not able to find any GIS habitat layers. Shane also noted that he has contacted MaryAnn Taylor to discuss potential for using existing LIDAR photography to develop GIS-based habitat layers, as was his homework assignment. He noted that Clarence at Orbis was investigating this issue.

Discussion About the Meeting Topic:

The group then discussed the recommendations for instream flows that DNR presented in their ICD comments (1170 cfs during the month of January through April, 879 cfs during May and June, 586 during July through November, and 879 cfs during December). Bill Argentieri noted that SCE&G has reviewed the flow options presented. Bill noted that the flows that were proposed were apparently reflective of the USGS gage at the lower end of the confluence, adding about a hundred sq. miles to the drainage area. Bill explained that based on the 20/30/40 proposal, SCE&G came up with 493 740 and 986 cfs based on the gage directly below the dam. Bill also reiterated that at the last meeting Gerrit provided numbers from the study of the Saluda River by the Water Resources Commission/Wildlife and Marine Resource Department (Bulak, J.S. and G.J. Jöbsis. 1989) which are 575 950 and 1326 cfs. Gerrit noted that the numbers provided in the report are based on physical measurements from the Saluda river to meet the criteria for passage.

As the group began to discuss the existing DNR IFIM report in a little more detail, Dick Christie gave the group a little more background to the report. Dick noted that when the study was done in the 80's, there was only one gage on the lower Saluda River, the gage down by the zoo. He noted that mean daily flow was calculated from that gage. Dick noted that when DNR made the flow recommendations they were actually recommendations for that site in particular, so by default there is a little bit of inflow between the dam and that gage. Dick continued to explain that there may be room for calculating and that they would support the updating of the numbers if the group can come to terms of doing that. Dick asked Bill if SCE&G had developed their flow estimates by subtracting what was calculated to be the drainage area. Bill replied that they had. Gerrit noted that they have dealt with this in the past by using the monthly calculated inflow rather than annual averages, because the drainage areas would have less contribution in the summer.

The group then began to discuss what would be involved in performing a new site specific test. Gerrit suggested a real time analysis to look at the habitat available, looking at flows not based on annual average but on daily or hourly flows. Bill pointed out that the new study would probably not be performed before next year due to the low lake levels. Dick noted that the transects could probably be laid out and the low flow data could be obtained, while the high flow data could be reserved for times when the lake level is higher. Gerrit noted that he believed that the fish passage transects provided in the Bulak, J.S. and G.J. Jöbsis 1989 study were important to consider. He explained that a panel of experts was assembled to weigh in on what they felt was necessary for unimpeded fish passage. At that time the panel felt that a 10 ft wide, by 18 inch deep slot was necessary for this, or 10% of the channel width. Alan Stuart asked the group if there have been any studies preformed that further address passage. Brandon Kulik noted that he does know of a few studies that they could look into. Brandon also noted that a mesh model could be developed at the rapids that would allow the rapids to be modeled probably better than transects.

Dick noted that he was curious as to whether consideration was given to the time or timing on the flows for fish passage in the existing IFIM report. Hal Beard was asked to give an account of his experience fish sampling on the lower Saluda. Hal noted that based on the years that he has worked, both drought and normal, he has not seen an absence of striped bass in the river. However he noted that he could not comment as to the relative abundance of striped bass. He mentioned that he could compare the data he collected to flows.

Malcolm Leaphart asked for an reiteration as to why the flows had been requested for those particular times during the year. Dick noted that the 20/30/40 recommendation is based on a typical hydrograph and is also something that the utilities are able to implement.. Dick continued to explain that if you look at a typical hydrograph you will see the highest flows are in the spring, and that it is commonly understood that the fish have probably adapted to the hydrograph. Thus, the policy should be adapted to the hydrograph, to which the fish have adapted to.

Presentation and Review of Scoping Elements:

After a short break, Brandon gave a brief presentation on PHABSIM. (Can be viewed on the website). Alan suggested reviewing the video flyovers to help decide what areas to use in the study and what reach breaks to use. Brandon explained that during a study they would have to come up with commonly understood definitions of runs and riffles along the lower Saluda.

After lunch the group discussed the 7 basic instream flow study scoping elements, listed below.

BASIC INSTREAM FLOW STUDY SCOPING ELEMENTS

1. Specify habitat and resource management objectives
2. Define geographic boundary of study area
3. Define type of problem (*i.e.* diversion, maintenance of minimum flow, alteration of existing flow regime, *etc*)
4. Define macrohabitat influences (*e.g*. water quality, temperature, etc.)
5. Select and justify evaluation criteria
6. Define temporal periods and units
7. Define flow ranges and increments of interest

During discussions on item number 2, defining geographic boundary of study area, Gerrit noted that he believed the Congaree river was important to consider as well. Gerrit further asked that the group have an agenda item at an upcoming meeting to specifically address Saluda's potential influence on the Congaree.

Brandon moved to item number three, Define the type of problem. Dick explained that it could be defined as the alteration of an existing regulated flow. He also asked if there would be an evaluation of peaking included in the study. It was explained that peaking over a 12 hour period would have quite a different impact than peaking over a 1 hour period (Reserve usage). The group noted that the duration of high flows would be taken into account in a dual flow analysis.

The group progressed through the scoping elements, pausing for brief discussion on number 6. Ron noted that he preferred the idea of initially taking smaller temporal units and lumping them together if need be. Gerrit suggested using the same temporal periods for setting up life stages as used in the Pee Dee. Brandon noted that there were advantages to using monthly units, and asked the group if they would like the units to be smaller than that.

The group discussed how to look at the reserve component during this study. Brandon noted that if reserve is used for only a few hours there is probably some sort of measurable effect just below the powerhouse, however these effects will probably attenuate throughout the stretch of river. The group agreed that in order to best look at the reserve use is to have a few transects close to the dam.

On item 7, Alan noted that the flow range would be up to 20,000 cfs, or what the top-end of the potential upgrade is going to be.

Discussion of Proposed Target Species List:

The group then began to discuss the Proposed Target Species list and the group interactively changed a few items (attached below). Brandon noted that it would be helpful to begin mapping out the different life stages for diadromous fish at different months of the year, as well as what type of meso-habitat is necessary.

As the group discussed the proposed target species, the guild approach as well as potential stand alone species, it was noted that an HSI curve did not exist for the Saluda Darter, so a surrogate curve would have to be used for that species. The group noted that general HSI curves would be used, unless specific curves were needed for a species. A list of the individual species contained in each HSI curve will be made as well. The group emphasized keeping the amount of species considered at a manageable level that the group could comfortably handle. Alan asked the group if there were any species that are not on the target species list that should be. The group indicated that the list was satisfactory. Kleinschmidt Associates will look at combining some of the species, where applicable. Concurrently, the agencies will also look at obtaining HSI curves from Catawba

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Wateree data. SCDNR will also send an example to Brandon of a list of species considered under each guild. Gerrit will forward the Pee Dee HSI curves to Brandon.

Brandon noted that he felt comfortable drafting a study plan with the information gleaned from the meeting and the group closed. Brandon noted that he would send out the study plan for review prior to the next meeting. The group scheduled the next meeting date for November 27th at the Training Center.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
IFIM/Aquatic Habitat TWC

SCE&G Training Center
October 16, 2006

Final acg 11-22-06

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife and Freshwater Fisheries
Environmental Programs Office

MEMORANDUM

To: L & LM TWC (Saluda Hydro Project)
From: Ron Ahle
Date: 5-05-06
Subject: Proposed Species List for IFIM Study

Guild Approach - use Catawba-Wateree and possibly Pee Dee curves

1) Shallow Slow Guild (<2 ft, <1 ft/sec); redbreast sunfish spawning
2) Shallow Fast Guild (<2 ft, >1 ft/sec); spottail shiner, ~~margined madtom~~,
3) Deep Slow Guild (>2 ft, <1 ft/sec); redbreast sunfish adult
4) Deep Fast Guild (>2 ft, >1 ft/sec); shorthead redhorse

Potential Stand Alone Species

1) Diadromous Fish
    a. American shad
    b. Blueback herring
    c. Striped bass
    d. Shortnose sturgeon
2) Resident Fish
    a. Robust redhorse (golden redhorse)
    ~~b. Highfin carpsucker~~
    c. Northern hogsucker
    d. Spotted sucker
    e. Brown trout
    f. Rainbow trout
    g. Threadfin/Gizzard shad
    h. Smallmouth bass
    i. Saluda darter (fantail darter)

3) Others
    a. Native mussels (wetted perimeter study)
    b. Benthic macro-invertebrates (EPT)

Deleted: Saluda darter

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Deleted: <#>Spider lily¶

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Kacie Jensen

From: Jennifer Summerlin
Sent: Wednesday, November 22, 2006 3:46 PM
To: 'Steve Bell'; Alan Stuart; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Columbia Individual (jdjaco@columbiasc.net)'; 'Dee Bennett '; 'Dick Christie'; 'Harold Moxley'; Jennifer Summerlin; 'Prescott Brownell'; Shane Boring
Subject: Columbia Hydro Fishway/Saluda Hydro Relicensing, November 2nd meeting notes

Hello Folks,

Attached for your review are the November 2, 2006 Columbia Hydro Fishway/Saluda Hydro Relicensing Joint Diadromous Fish meeting notes. Please have comments back to me by December 12, 2006.

2006-11-02
olumbia Fishway-Sa.

Thanks and hope everyone has a wonderful Thanksgiving!

Jennifer Summerlin
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MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Columbia Hydro Fishway/Saluda Relicensing Joint Diadromous Fish Meeting

SCE&G offices at Carolina Research Park
November 2, 2006

Draft jms 11-14-06

ATTENDEES:

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Ross Self, SCDNR
Shane Boring, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Dee Bennett, City of Columbia
Dick Christie, SCDNR

ACTION ITEMS

- Email aerial photographs of the Columbia Hydro fish passage to all committee members

Bret Hoffman

- Research monitoring methods from other fish passage studies

Everyone

- Find out if fin clipping have been performed on all previously tagged shortnose sturgeon

Ross Self

- Provide a dozen PIT tags for Kleinschmidt's shortnose sturgeon study

Ross Self

- Provide the locations of receivers located on the lower Saluda, Congaree, and Broad River's

Ross Self

- Contact the company that the SCDNR orders their transmitters from and ask what type of coding system they use for the transmitters

Ross Self

- Draft the Columbia and Operations Maintenance Plan for the Columbia Hydro fish passage and send out to committee members for review

Bret Hoffman

- Draft a study plan for monitoring diadromous fish at the Columbia Hydro fish passage and send out to committee members for review

Shane Boring

- Reserve a room for the next meeting at Carolina Research Park for January 23, 2007

Harold Moxley

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Columbia Hydro Fishway/Saluda Relicensing Joint Diadromous Fish Meeting

SCE&G offices at Carolina Research Park
November 2, 2006

Draft jms 11-14-06

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart of Kleinschmidt Associates opened the meeting at approximately 9:30 PM and meeting attendees introduced themselves. Alan noted that the focus of the meeting would be to discuss: (1) the Columbia Hydro Operations and Maintenance Plan, (2) sampling plans for Columbia Hydro fishway, (3) the 2007 lower Saluda River (LSR) sturgeon sampling, and (4) need/type of LSR diadromous fish sampling for 2007.

Columbia Hydro Operations and Maintenance Plan

Bret noted that Kleinschmidt is currently drafting an Operation and Maintenance Manual for the entire Columbia Hydro Project. He explained that the first point of prevention for cleaning was relocation of the log boom. The relocation of the log boom will enhance the inability of debris accumulation in the fish ladder. Also, grizzly racks on the attraction flow and broad racks should be cleaned periodically. He mentioned that there has been some algal growth on the viewing window and the best recommendation was to scrub the algae off. He explained that floating debris that enters the fish ladder will usually work it's way out. He pointed out that there is a slush gate for the diffusion area. He noted that currently they are planning to clean the ladder annually before the passage season begins. Amanda noted that the ladder should be cleaned before the fish passage season, which would be sometime around February 1st. Dick mentioned that the group should define some period of time prior to February 1st that cleaning of the fish passage should take place. He specifically noted that it is important to establish an exact time frame, such as a four week window, which will provide flexibility for maintenance. Harold noted that if manpower was available, it would take a week to clean the ladder. The group agreed that there should be a window time frame for cleaning and the head gate should be installed during this time to keep the ladder clean until February 1st. Bret mentioned that SCE&G should be notified when the passage season begins for operational purposes.

There was a discussion as to when the head gates should be opened and Prescott noted that for the first year, we should keep in contact with St. Stephen's to discuss the out migrating season of shad. Alan noted that small numbers of shad will start passing through St. Stephen's early February and eventually the numbers of shad will increase to 5,000, which means s[awning runs have begun. Prescott noted that once the number of shad reach 5,000 at St. Stephen, then Columbia should open the gate. He also noted that the fish ladder should be ready for passage by February 1st at least for the first year, just in case something unusual happens, such as high flows. Amanda noted that from a resource agencies perspective, they would like to run the fish passage year around. Harold noted that the passage could be ran year around, but they would not have the personnel to clean it beyond the passage season. Tentatively, for this year, the group agreed that the SCDNR should notify Kleinschmidt Associates when 5,000 shad have passed per day at St. Stephen's and the head gates should be opened within a week of this time frame. In summary, the group agreed on the following:

- annual cleaning;
- weekly maintenance during passage season;
- Columbia Hydro operational schedule;
- Notification for problems (contact list)

Dee from the City of Columbia noted that the plan seems reasonable. Bret noted that he would have a draft of the Columbia Operations and Maintenance Plan by January 1st, 2007 and will be submitted to State Agencies and FERC.

Sampling Plans For The Columbia Hydro Fish Passage

Bret noted that in previous studies, Kleinschmidt has used video cameras for fishway monitoring. He explained that a camera would be favorable if fish of concern are not constantly passing. He then noted that it would be beneficial to have a person monitor during peak fish migration season. Amanda noted that state agencies would like to video tape fish passage throughout the year. Steve noted that if a camera is used for monitoring at the fish passage, it will have to be waterproof. Steve explained during high flows, water is elevated 3 to 4 feet above the dam. Alan noted and the group agreed to video tape the viewing window with a camcorder to examine the effectiveness of video taping.

Steve mentioned that turbidity in the spring may effect the visibility through the viewing window. Amanda noted that turbidity, duration time of turbidity and rain events should be documented for future monitoring efforts. Dee noted that the City of Columbia monitors turbidity and would find out the frequency of these turbidity readings. The group discussed criteria for monitoring during the peak season and Steve noted that it may be beneficial to document diurnal movements. Dick noted that it may be best to have short monitoring shifts for the random sampling. Amanda explained that the peak season is defined as 100,000 shad passing through St. Stephens, which usually occurs in March/April time frame. She added that there should be intense monitoring during the peak season. There was a brief discussion about monitoring fish downstream of the fish passage and the group agreed that backpack/boat shocking would be beneficial with knowing if the fish are present downstream of the fish passage. Alan noted that Kleinschmidt would draft a study plan for sampling at the Columbia Hydro fish passage for the first year. He added that this draft study plan would be out by the end of December. Committee members agreed to research both diurnal movements of shad and electronic devices that can be used for monitoring at the Columbia Hydro fish passage.

2007 Lower Saluda River Shortnose Sturgeon Sampling

Shane noted that the purpose of the sturgeon study will be to document shortnose sturgeon usage downstream of the Saluda Hydro Project. He noted that the temporal scope of the study is scheduled to begin in February 2007 and continue through 2008 (two years of study). On an annual basis, sampling will be conducted during late-winter and spring (February 1 through the end of April) when shortnose sturgeon would be expected to migrate into the Piedmont rivers to spawn. He explained that there are four potential sample sites:

1. Downstream and in the vicinity of the Saluda Hydro dam;
2. The vicinity of Gardendale canoe landing on the lower Saluda River;
3. Upstream of the old Granby Lock and Dam on the Congaree River; and
4. The vicinity of the Rosewood Boat Landing on the Congaree River.

Shane explained that the sampling permit states that we have authorization to capture, handle, weigh, measure, PIT and dart tag, tissue sample and release shortnose sturgeon that are caught. Steve mentioned that they have had some problems with inserting streamer tags in shortnose sturgeon, that it seems to wound them and are considering not using these tags. Shane noted that a tissue sample will be taken from the pelvic fin of the sturgeon for genetic testing. Shane asked Ross if the SCDNR would donate a handful of PIT tags for the Saluda sturgeon sampling. Shane explained it may be beneficial to keep the tag numbers consistent with the SCDNR, if possible.

Need/Type lower Saluda River Diadromous Fish Sampling for 2007

Alan noted that no shad or herring were captured during the 2006 diadromous fish sampling on the lower Saluda and Congaree River's. Shane mentioned that river velocities combined with high amount of debris made sampling on the Congaree River problematic for gillnets. However, Shane explained that these results were reflective of what was going on because Isely did not have sampling problems in the LSR.

The group then discussed ichthyoplankton sampling and Shane noted that the nets were deployed midway of the surface and the bottom of the water column for three minutes while gillnets were fished. Amanda questioned whether the three minute duration time of the ichthyoplankton nets was a sufficient sampling time. She explained that ichthyoplankton nets should be fished for at least 20 minutes. Shane noted that ichthyoplankton sampling will be performed during sturgeon sampling next year, which is the peak migration season for shad/herring and the data will be applicable. Prescott noted that ½ meter ichthyoplankton nets should be fished from the middle to the bottom of the water column for shad, herring, and sturgeon for approximately 15 to 20 minutes at each station.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Columbia Hydro Fishway/Saluda Relicensing Joint Diadromous Fish Meeting

SCE&G offices at Carolina Research Park
November 2, 2006

Draft jms 11-14-06

Alan noted that because gillnetting does not prove to be an effective way to capture shad/herring in high velocity waters, we are thinking about conducting a telemetry study. He mentioned that Isely captured a large number of shad around the 601 Bridge location by means of electrofishing. We could sample this location and tag 50 to 100 shad. Alan explained that the telemetry study would not only monitor movements of shad through the LSR, but it would also monitor shad moving through the Columbia Hydro fish passage. Ross noted that instead of tagging 100 fish at once, we might want to consider tagging two batches of 50 fish. Ross mentioned that the first step would be to find out the array of each receiver. He also mentioned that he needs to find out the number of unique tags that are available for these receivers. The group briefly discussed the locations of the receivers that are currently sampling in the lower Saluda, Congaree, and Broad river's. Ross noted that he would find out and provide the group with that information. The group agreed that receivers for the telemetry study should potentially be placed in the vicinity of the Saluda tailrace, Harbison State Park, Parr Shoals, and Columbia fish passage. Alan noted that a draft study plan will sent out to all committee members by the end of January 2007.

Alan informed committee members that American eel sampling on the LSR by means of an eel ramp is currently being conducted and is expected to run through the end of October 2007. He mentioned that the eel ramp located at the Saluda spillway will be taken out next week (November 7th), due to spillway testing and will be reinstalled as soon as possible.

Date/Location of Next Meeting

The group agreed that the next Columbia Hydro/Saluda Hydro Relicensing Joint Diadromous Fish meeting will tentatively occur on January 23rd, 2007 at the Carolina Research Park, starting at 9:30 AM. Shane will send out an electronic meeting announcement confirming date, time and location.

Kacie Jensen

Subject:	IFIM/Aquatic Habitat TWC Meeting
Location:	Lake Murray Training Center
Start:	Mon 11/27/2006 9:30 AM
End:	Mon 11/27/2006 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Fish & Wildlife TWC - IFIM/Aquatic Habitat; mpqandrhq@bellsouth.net

Hello All,

Just a reminder that we have a IFIM/Aquatic Habitat TWC Meeting Scheduled for Monday, November 27 at 9:30 at the **Lake Murray Training Center**. There is also a tentative field visit scheduled for Tuesday, November 28. I will be sending out a separate reminder for the 28th shortly. **Please RSVP by 12:00 pm Wednesday for lunch**. The agenda for Monday is attached below. Thanks, Alison

LSR IFIM agenda
11-27-2006.doc...

Saluda Hydroelectric Project Relicensing
Instream Flow/Aquatic Habitat Technical Working Committee (TWC)

MEETING AGENDA

November 27, 2006
9:30 AM
Lake Murray Training Center

9:30 – 10:00	**Welcome and Review of Action Items**
10:00 – 11:30	**Review of Draft Study IFIM Study Plan**
11:30 – 12:30	**Lunch**
12:30 - 1:00	**Review of Lower Saluda Aerial Video**
1:00 – 2:00	**Discussion of HSI Curves**
2:00 – 3:00	**Classification, Types and Definition of Mesohabitats**
3:00- 3:30	**Discussion of Field Sites Participants Wish to See on 11/28**
3:30	**Adjourn**

Kacie Jensen

From: Shane Boring
Sent: Friday, October 13, 2006 1:43 PM
To: Shane Boring; 'Wade Bales (balesw@dnr.sc.gov)'; 'Amanda Hill'; 'Bill Argentieri'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; 'Theresa Thom'; Brandon Kulik; Alan Stuart
Cc: Alison Guth
Subject: RE: Saluda Hydro Relicense: Oct 16 Instream Flow/Aquatic Habitat TWC Meeting Reminder

All:

I incorrectly stated the meeting site as Carolina Research Park in the header that I sent out earlier this morning. Please note that the meeting location is Lake Murray Training Center. A corrected agenda is attached.

Shane

Instream Flow TWC Agenda 10-16...

-----Original Message-----
From: Shane Boring
Sent: Friday, October 13, 2006 10:31 AM
To: Wade Bales (balesw@dnr.sc.gov); Amanda Hill; Bill Argentieri; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart
Subject: Saluda Hydro Relicense: Oct 16 Instream Flow/Aquatic Habitat TWC Meeting Reminder

All:

This is just a reminder that the Instream Flow/Aquatic Habitat TWC will meet on Monday, October 16th, beginning at 9:30 am @ the Lake Murray Training Center. A meeting agenda is attached. Please accept our apologies for the lateness of the agenda. Please let me know if anyone needs directions to the meeting site.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183
<< File: Instream Flow TWC Agenda 10-16-06.doc >>

Saluda Hydro Relicensing
Instream Flow/Aquatic Habitat and Technical Working Committee

Meeting Agenda

October 16, 2006
9:30 AM
Lake Murray Training Center

- **9:30 to 9:45** Welcome, Review of Action Items and Meeting Purpose
- **9:45 to 11:00** Additional clarification of SCDNR's flow proposal and flow regime proposed in existing IFIM study (Isely et al. 1995)
- **11:00 to 12:00** Discussion of need for additional flow study
- **12:00 to 1:00** Lunch
- **1:00 to 2:30** Scoping of additional IFIM study (if deemed necessary)
- **2:30 to 3:00** Next steps
- **3:00** Adjourn

Saluda HYDRO RELICENSING

Kacie Jensen

From: Shane Boring
Sent: Friday, October 13, 2006 10:31 AM
To: Wade Bales (balesw@dnr.sc.gov); Amanda Hill; Bill Argentieri; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart
Subject: Saluda Hydro Relicense: Oct 16 Instream Flow/Aquatic Habitat TWC Meeting Reminder

All:

This is just a reminder that the Instream Flow/Aquatic Habitat TWC will meet on Monday, October 16th, beginning at 9:30 am @ the Lake Murray Training Center. A meeting agenda is attached. Please accept our apologies for the lateness of the agenda. Please let me know if anyone needs directions to the meeting site.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

Instream Flow TWC
Agenda 10-16...

Saluda Hydro Relicensing
Instream Flow/Aquatic Habitat and Technical Working Committee

Meeting Agenda

October 16, 2006
9:30 AM
SCE&G Offices at Carolina Research Park

- **9:30 to 9:45** Welcome, Review of Action Items and Meeting Purpose
- **9:30 to 11:00** Additional clarification of SCDNR's flow proposal and flow regime proposed in existing IFIM study (Isely et al. 1995)
- **11:00 to 12:00** Discussion of need for additional flow study
- **12:00 to 1:00** Lunch
- **1:00 to 2:30** Scoping of additional IFIM study (if deemed necessary)
- **2;30 to 3:00** Next steps
- **3:00** Adjourn

Saluda HYDRO RELICENSING

Kacie Jensen

From: Shane Boring
Sent: Tuesday, October 10, 2006 4:03 PM
To: Wade Bales (balesw@dnr.sc.gov); Amanda Hill; Bill Argentieri; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart
Cc: Cheryl Balitz; Alan Stuart; Alison Guth; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; Ralph Crafton; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: September 7th Instream Flow/Aquatic Habitat Technical Working Committee Meeting Notes - Final

All:

Attached for your records are the final meeting notes from the September 7th Instream Flow/Aquatic Habitat TWC meeting. Thanks to all who contributed.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2006-09-07
stream Flow&Aquat.

Cheryl: Please post to the Saluda Relicensing website under the Fish and Wildlife RCG, under the Sept 7 Instream Flow/Aquatic habitat sub-heading. Thanks

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT
TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
September 7, 2006

ATTENDEES:

Bill Argentieri, SCE&G
Randy Mahan, SCANA Services
Alan Stuart, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates
Dick Christie, SCDNR
Amanda Hill, USFWS
Scott Harder, SCDNR
Shane Boring, Kleinschmidt Associates
Malcolm Leaphart, Trout Unlimited
Theresa Thom, National Park Service
Brandon Kulik, Kleinschmidt Associates
Ron Ahle, SCDNR
Gerrit Jobsis, Am. Rivers
Hal Beard, SCDNR

ACTION ITEMS:

- Provide Brandon Kulik with HSI curves used in 1989-90 LSR IFIM Study
Gerrit Jobsis
- Check with USC Geography Dept. for GIS habitat coverages for the LSR
Theresa Thom
- Provide Theresa Thom with bibliography of Congaree floodplain flow studies found thus far
Shane Boring
- Discuss acceptability of SCDNR flow proposal with SCE&G management
Bill Argentieri
- Contact MaryAnn Taylor to discuss potential for using existing LIDAR photography to develop GIS-based habitat layers
Shane Boring

DATE OF NEXT MEETING: **October 16th, 2006, at Lake Murray Training Center, beginning at 9:30 am.**

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:30 AM with a review of action items from the last meeting (June 14). Specifically, Shane noted that he had completed the literature review for studies with potential to help address the National Park Service (NPS) request for floodplain flow studies to assess the impact of project operations on Congaree National Park. Shane indicated he would compile the studies he found into a bibliography, which he would forward to Theresa Thom. Theresa Thom indicated that she would compare the bibliography to NPS studies/data that she is aware of and report back to the group. Scott Harder noted that he had spoken with Bud Badr and that Bud was not aware of any additional studies.

In reference to the request for a comprehensive habitat assessment of shallow aquatic areas of Lake Murray, Shane noted that he had received contact info for MaryAnn Taylor (GIS Analyst, SCANA) from Bill Argentieri and that he would be contacting her in the coming week to discuss the potential for using the existing LIDAR photography to develop GIS-based habitat layers. Shane noted that he would report back to the group at the next meeting regarding this issue.

Shane then noted that, since Brandon Kulik was in attendance, the remainder of the meeting would focus on utilizing his knowledge of IFIM studies to review the existing Saluda study, assess its applicability to the current relicensing, and to define goals of any future IFIM study, if deemed necessary.

IFIM Goals for the Saluda River

Brandon encouraged the group to make IFIM goals as specific as possible. After some discussion, the group outlined the following as potential goals of an IFIM study:

- Identify a minimum flow for the Lower Saluda River (LSR)
- Determine flows needed for target species and lifestages, as well as the downstream floodplain
    - Determine the range of flows acceptable to meet these criteria
    - Determine how project operations affect these flows
    - Mimic the natural hydrograph of the LSR
    - Consider impact of providing these flows on Lake Murray

Malcolm Leaphart requested that reproduction of trout be included in any new IFIM analysis. Alan Stuart noted that a white paper outlining the habitat requirements for trout spawning is being drafted by Kleinschmidt and will be distributed to the TWC for review within the next couple of weeks. Dick Christie noted that, in additional to summarizing the needed habitat, the paper will summarize the agency management objectives for the LSR as they relate to trout reproduction.

Dick Christie noted the need to clearly define the "impact area" for any IFIM studies, noting that it likely extends beyond the Project Boundary. Gerrit Jobsis agreed and emphasized the need to consider the downstream floodplain when developing the IFIM goals.

Discussions of Target Species

Shane noted that, at the June 14th meeting, Ron Ahle had distributed a draft list of IFIM targets, which included both species and guilds (Attachment A). He added, and Brandon agreed, that typically either a species-specific or guild approach is used for such studies. Ron clarified, noting that the list was intended to be a starting point and that his preference was to take a guild approach, but also include certain priority species (i.e. smallmouth bass and threadfin shad). Amanda Hill noted the importance of keeping diadromous species on the list USFWS, adding that it may be acceptable to remove American eel. Gerrit recommended going back and looking at the HSI curves for compatibility with the guild approach. Gerrit agreed to provide Brandon with the HSI curves used in the previous study.

In reference to the species list category "other", Shane enquired as to whether generalized (multi-species) HSI curves exist for categories such as benthic macroinvertebrates and mussels. Dick noted that there are HIS curves for EPT's. Gerrit added that there were generalized curves for freshwater mussels that were used for the Duke Power relicensing.

After considerable discussion, it was determined that defining the specific target species/guild may not be possible at today's meeting. It was determined that the existing IFIM study should be reviewed more thoroughly and a determination made as to whether an additional study is needed. The group agreed to revisit the issue of target species/guild after such a determination is made.

Discussion of Existing IFIM Study and Need for Additional Study

The group then discussed the memo prepared by Brandon Kulik providing a critical review of the existing IFIM study (Attachment B). Brandon pointed out several aspects of the study that he feels need further clarification, including:

- Choice of HIS curves and how they were weighted;
- Number of curves (too many curves resulted in difficult interpretation of result); and

- Applicability of transects to current conditions (i.e. potential changes in stream geomorphology).

The group then briefly discussed the accuracy of the existing transect information relative to current conditions. Gerrit noted potential changes in the areas of the transects due to sedimentation, and added that he felt instream aquatic vegetation has also increased. Ron Ahle noted that there has been considerable channel widening in the upper LSR due to streambank erosion. Several group members enquired as to whether there are GIS layers and/or aerial photography that could be used to determine the degree of change in the transect areas. Shane indicated that he had recently conducted a search and was unable to find any GIS data. Theresa Thom noted that she would check with the Geography Department at USC for potentially applicable GIS layers. Gerrit and Ron A. subsequently suggested a possible field visit to determine the degree to which transects have changed.

Brandon Kulik noted that the model in the previous study was calibrated at low flows, thus the accuracy of the model likely starts to decrease at flows greater than 1000 cfs. Gerrit noted that, during execution of the study, Jeff Isely did have problems with calibrations and thus limited the flow range to lower flows. Scott Harder added that SCDNR has concerns about model accuracy in riffle and pool areas at higher flows.

Dick Christie reiterated the flow proposal provided by SCDNR in their comments on the ICD. Specifically, he noted that SCE&G could forego an additional IFIM study if they implement the proposed flow of 1170 cfs during the month of January through April, 879 cfs during May and June, 586 during July through November, and 879 cfs during December. Dick added that these flows are based on the SC State Water Plan and were developed using the 20%, 30%, 40% method (of mean annual flow). Several group members noted that, despite the many shortcoming that have been pointed out, the flows recommended in the existing IFIM study report (1326 cfs January – April; 950 cfs May – June; 575 cfs July – November; 950 cfs in December) are very similar those being proposed by SCDNR.

Gerrit Jobsis noted that he would have to give some consideration as to whether his group would be satisfied with the flows being proposed by SCDNR, adding that he would prefer the flows recommended through study of the Saluda River by the Water Resources Commission/Wildlife and Marine Resource Department (Bulak, J.S. and G.J. Jöbsis. 1989[1]) as this study provides site-specific information (i.e. on channel morphology, fish passage, hydrography). Bill Argentieri noted that the project is being operated much differently than when these site-specific recommendations were

[1] Bulak, J.S. and G.J. Jöbsis. 1989. *South Carolina instream flow studies: a status report*. South Carolina Wildlife and Marine Resources Department. 51 pages.

developed. Alan Stuart pointed out that the primary difference between the two proposals is the magnitude of the high flow period (1170 vs. 1326 cfs). Gerrit added that the higher flow in the report was based on providing passage for adult striped bass at Millrace Rapid, the most limiting area. He clarified that the recommendation was based on development of a stage – discharge relationship, which took into consideration a number of site-specific factors (i.e., wetted perimeter, depth needed for adult passage, natural hydrography). The existing IFIM study took measurements at Corley's Island and Millrace Rapids and verified that Millrace was the most limiting.

Gerrit added that the existing study does not take into the account potential negative impacts associated with infrequent higher flow (> 10,000 cfs), adding that this should be taken into account in any future studies. Attendees added that the frequency, duration, and magnitude of such flow should also be taken into consideration. Amanda Hill and Gerrit cited the potential for using a dual flow analysis to address this issue. Gerrit and others also raised interests in how project operations affect the Congaree River, e.g. striped bass and diadromous fish spawning, flows for floodplains and the Congaree National Park, that would not be addressed under the DNR proposal.

After some discussion, it was determined that there are too many uncertainties with the existing study. The group then began to discuss what the next steps should be considering this decision. It was determined that it is up to SCE&G to determine whether proposed flow regime is acceptable. Agency staff noted that if the proposed flows are deemed not acceptable, SCE&G will need to conduct an additional IFIM study. Bill Argentieri agreed to discuss the proposed flows with SCE&G management and report their decision back to the group. Bill requested, and the group agreed, to give SCE&C until mid to late-October to evaluate the proposal.

Date/Location of Next Meeting

The group agreed that the next Instream Flow TWC meeting will occur on October 16th, 2006 at the Lake Murray Training Center, starting at 9:30 AM. Shane B. will send out an electronic meeting announcement confirming date, time and location. The meeting adjourned at approximately 3:00pm.

Attachment A

Proposed List of IFIM Target Species/Guilds
(Source: SCDNR)

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife and Freshwater Fisheries
Environmental Programs Office

Guild Approach
1) Shallow Slow Guild (<2 ft, <1 ft/sec); redbreast sunfish spawning
2) Shallow Fast Guild (<2 ft, >1 ft/sec); margined madtom, Saluda darter
3) Deep Slow Guild (>2 ft, <1 ft/sec); redbreast sunfish adult
4) Deep Fast Guild (>2 ft, >1 ft/sec); shorthead redhorse

Potential Stand Alone Species
1) Diadromous Fish
    a. American shad
    b. Blueback herring
    c. Striped bass
    d. Shortnose sturgeon
    e. American eel
2) Resident Fish
    a. Robust redhorse
    b. Highfin carpsucker
    c. Northern hogsucker
    d. Spotted sucker
    e. Brown trout
    f. Rainbow trout

3) Others
    a. Native mussels
    b. Benthic macro-invertebrates
    c. Spider lily

REMBERT C. DENNIS BUILDING * P.O. BOX 167 * COLUMBIA, SC 29202
TELEPHONE: (803) 734-2728 * FACSIMILE: (803) 734-6020

Attachment B

Memo: Technical Review of Existing Lower Saluda River Instream Flow Study
(Source: Brandon Kulik, Kleinschmidt Associates)

MEMORANDUM

TO: Instream Flow/Aquatic Habitat Technical Working Committee (TWC)

FROM: Brandon Kulik, Kleinschmidt Associates

DATE: July 31, 2006

RE: Review of Lower Saluda River Instream Flow Study

It is my understanding that TWC is interested in evaluating how much of the study entitled "*Instream Flow Requirements for the fishes of the lower Saluda River*" dated March 28, 1995 can be applied to contemporary relicensing decisions about the Saluda Hydroelectric Project. The stated purpose of this study was "*to evaluate the effects of rate from the Lake Murray Dam on the amount of suitable habitat for fishery resources of the LSR*".

At your request I have reviewed the report, and am providing some observations.

General Comments

The field study and methods of computer modeling as described appear to generally adhere to methods described by Bovee (1982), and thus the raw Weighted Usable Area (WUA) vs. flow relationships are probably reasonable at least for the lower flow range. A few aspects of this report, that at face value may not be entirely consistent with study design elements recommended by Bovee, *et al.* (1998), may or may not affect how the extrapolated and weighted WUA data in the existing report can be used, but to start the discussion, I have flagged a few of these items as they may be worth group discussion.

Specific Comments

The following comments are arranged by report topic heading.

1. *Study Area:* The overall study area boundaries appear logical, as it extends from the point of flow control (Lake Murray Dam) to the influence from another large and independent source of flow (Broad River).

    a. The report does not clearly articulate a rationale for establishing the boundaries for the three reaches. It appears that the reaches were divided into thirds. Reach boundaries are typically placed where there is a shift in conditions that may influence hydraulics (*e.g.* river channel morphology, slope), habitat (geomorphology, dominant cover, substrate, or mesohabitat composition), or hydrology (contribution of tributary inflow, such as a 10% increase in flow or drainage area) (Bovee, *et al*., 1998).

b. It is not clear from the description (pp 6-7) if model output was weighted according to the relative linear abundance of each habitat type (see Table 2) within each reach or globally for the entire study area (*i.e.* all three reaches combined). Reach weighting can influence the shape of the wetted area and WUA curves.

c. Model results obtained in rapids and riffles usually will show a different sensitivity to flow changes from pools and runs. However, frequently, certain species and lifestages may only use a subset of the overall habitat types. The report as written leads to a conclusion that all habitats were blended together for each lifestage to develop a WUA curve. Thus it may be worth some group discussion to clarify how this was handled.

2. *Target Species and Criteria*

a. Fish Passage: An adult striped bass habitat Suitability Index (SI) was used as a criterion for shoal zone-of-passage passage requirements. This SI curve is driven by the resting and foraging requirements of a large pelagic predator. For the purpose of fish migration passage, it may be worthwhile to consider other criteria such as zone-of-passage criteria in natural channels set forth by Bovee (1982), and/or principals of ichthyomechanics and hydraulics (Clay 1995, Bell 1991).

b. Brown trout and rainbow trout: I note that the spawning lifestage for trout is employed, which I take to mean that there is a management objective to establish or maintain a wild population of these species. If so, both fry and juvenile lifestages for these species should also be included but were not. Because spawning/incubation, and fry lifestages of these species occur only for a limited portion of the year; these WUA curve should probably not be employed as part of a blended year-round flow recommendation, but assigned to a time series that targets applicable weeks or months when the lifestage is specifically expected to be present (see suggested matrix below). Because salmonids are not habitat generalists, this analysis would also benefit by documenting the following:

i. Does fishery management rely on natural reproduction?
ii. Does suitable macrohabitat and mesohabitat exist to support each lifestage?
iii. Is suitable fry and YOY habitat available in contiguous reaches?
iv. Can fry and YOY lifestage flows be evaluated and applied during appropriate months?

c. Suitability Index Criteria (*general comment*). SI criteria appear to generally be taken from the literature with no transferability evaluation. For example, Raleigh (1984 and 1986) criteria for brown and rainbow trout were primarily developed from general literature and habitat studies on large western rivers. Use of these criteria on dissimilar ecosystems and regions without some documented transferability assessment, while expedient, has been criticized in many recent IFIM studies (Bovee, *et al.* 1998, K. Bovee, personal communication). The TWC may wish to discuss overall comfort using such curves.

3. *Discharge Measurements:* Three calibration flows were employed to construct this model, with a single set of calibration velocities taken at the lowest of the three flows. For purposes of a low-flow IFIM model this is probably adequate; however. The accuracy of model hydraulics as flow approaches the middle-to-higher flow range is potentially questionable without further documentation that Velocity Adjustment Factors fell within an acceptable range. The report should explicitly state the range of modeled flows that meet hydraulic accuracy standards. If greater accuracy is deemed important at higher flows, there may be cost effective ways to obtain such data.

4. *Presentation of WUA Data*

These are just some observations about how the WUA results are presented and how that could be enhanced to support decision-making.

a. Although the general statement is made that "*WUA increased rapidly to maximum levels for flows between 300-1000 cfs for most species and life stages…*", this is still a wide range, perhaps due mostly to the blending of species/lifestages, habitat types, and timeframes together. Optimizing habitat for one species at 300 cfs may impair habitat suitability for others that are optimized at higher flows, and visa versa. Also, not all species/lifestages coexist at the same time and in all habitats. Thus the analysis should provide a biological rational for:

   i. Prioritizing species/life stages or at least balancing trade-offs when conflicting WUA curves occur (Bovee 1982, Bovee et al. 1998).
   ii. Correlating species/lifestages to applicable seasonal or monthly periods so seasonally varying flows can be assessed (see example matrix attached below).

b. WUA data are only presented in a "normalized" (*i.e.* percent-of-optimal format) in the main body of the report. (I realize that they are presented in Appendix I as individual graphs, but in that format the relative WUA comparisons among lifestages are difficult to make). Easily viewing the relative magnitude of WUA potentially available at a given flow among species and lifestages would facilitate prioritization of species and lifestages so that inter-lifestage trade-offs can be better evaluated. Along those same lines, WUA data are presented only in graphs; tabular WUA data would enhance the assessment of trade-offs at the finer increments of flow ranging in the zone of interest, and enhance flow recommendations and negotiation.

c. A flow recommendation using a percentage of "optimal" WUA as the sole metric, can potentially be difficult to defend, because optimal WUA is merely an artifact of stream geometry hydraulics and SI information that doesn't factor in site-specific, seasonally varying flow availability. For example, if a flow supporting "optimal" WUA is an infrequent event, then an alternate habitat metric might be the amount of WUA that results from the naturally occurring median for the time increment of interest (*i.e.* seasonal, annual, monthly).

5. *Suggestions*

Model Accuracy

Two primary areas that PHABSIM models are most sensitive to error or bias are in SI criteria, (especially depth and velocity curves), and in how results obtained from study reaches and mesohabitat types are weighted (J. Henrikson, USGS/MESC, personal communication). Related to this is study site stability. If, (as noted by Ron Ahle on June 14, 2006), the river channel geometry has changed, then it would be worth re-surveying at least a subset of the transects to confirm if that has happened, and if it has, the extent to which the potential for past data to be transferable may be lost. If the channel profile details have shifted, but the overall geometry, slopes and widths remain similar, the differences may not be significant.

Assuming the transects remain representative of current and anticipated future conditions, secondary area for potential error in this instance could be in extrapolation of hydraulic data from calibration data.

SI Criteria

The TWC may wish to evaluate if the SI criteria applied to the original model is sufficiently accurate for this application, and update and/or refine criteria if needed. In some cases, new SI criteria may need to be developed to account for new species or lifestages identified at the June 14, 2006 TWC meeting.

Reach Weighting

The TWC may wish to seek clarification as to how individual reach WUA/flow curves were weighted together, and make revisions if deemed necessary. Also consider looking at transect data representing individual mesohabitats that best correlate to use by guild groups and/or lifestages identified at the June 14, 2006 TWC meeting. To the extent supporting data exists, the TWC may wish to re-analyze and re-calculate WUA's. For some species objectives, such as the wild trout fishery some additional habitat mapping and transect data collection may be required, at least to account for early lifestages.

Hydraulic Model Calibration

Of the three calibration data sets, only the low flow contains velocity as well as stage data. The other flows have stage data only. Assuming that the historic transects are found to still be representative of existing channel conditions, the TWC may wish to assess if additional velocity data at a higher flow are necessary to satisfactorily calibrate the model throughout the entire flow range of interest. If the historic transects are adequately geo-referenced, then additional velocity data may be readily collected.

Flow Analysis

Contemporary instream flow recommendations typically recommend flows or flow targets that vary seasonally, rather than provide a single flat minimum flow (Annear et al., 2000). The conventional problem-solving steps would be to:

1. Time series: prioritize species /lifestages according to management objectives, season of occurrence within and throughout the study reaches so that trade-offs among species, lifestages and other water uses can be assessed.
2. Establish a benchmark flow for each month (or season) that represents "typical" inflow for that period, such as a median (50th percentile) flow.
3. Develop a matrix, by month or season (if applicable), of flow and species and lifestages present (see attached example).
4. Based on that flow matrix, select the discharge corresponding to the lowest-flow period during which each species and lifestage is present.
5. Calculate the ambient WUA occurring during that flow period. The month featuring the lowest WUA value is the naturally-occurring maximum WUA and should be used in comparisons. For some species and lifestages, this may require breaking out WUA results from separate habitat types contained in the model.

These next two steps are iterative:

6. Compare WUA produced under alternative flow releases to determine which alternatives provide an acceptable amount of WUA relative to what would exist compared to the naturally-limiting monthly or seasonal WUA.
7. Based on the prioritizations established under steps 1 and 2, determine what species/lifestage(s) drive the flow recommendation for each month, and what the trade-offs if any are to other lifestages and human water uses. If further balancing is required, return to step 6 and assess a different scenario.

Hypothetical Times Series Prioritization Matrices
(N*ote: For illustrative purposes only; seasonality and flow information will be refined in coordination with the TWC.)*

Species- Based Prioritization Matrix

Month	LSR median flow (cfs)	American shad	blueback herring	striped bass	shortnose sturgeon	American eel	robust redhorse	highfin carpsucker	northern hogsucker	spotted sucker	brown trout	rainbow trout
January	1,930			x		x	x	x	x	x	x	x
February	2,090	x	x	x	x	x	x	x	x	x	x	x
March	2,250	x	x	x	x	x	x	x	x	x	x	x
April	1,100	x	x	x	x	x	x	x	x	x	x	x
May	745	x	x	x		x	x	x	x	x	x	x
June	843			x		x	x	x	x	x	x	x
July	1,250			x		x	x	x	x	x	x	x
August	1,330			x		x	x	x	x	x	x	x
September	1,380			x	x	x	x	x	x	x	x	x
October	1,570			x	x	x	x	x	x	x	x	x
November	1,526			x	x	x	x	x	x	x	x	x
December	1,760			x		x	x	x	x	x	x	x

Early Lifestage (ELS)- Based Prioritization Matrix

Month	LSR median flow (cfs)	Robust Redhorse ELS	highfin carpsucker ELS	northern hogsucker ELS	spotted sucker ELS	brown trout spwn & incub.	brown trout ELS	rainbow trout spwn & incub.	rainbow trout ELS
January	1,930						x		
February	2,090						x	x	
March	2,250						x	x	
April	1,100							x	
May	745	x	x	x	x				x
June	843	x	x	x	x				x
July	1,250	x	x	x	x				x
August	1,330								
September	1,380								
October	1,570					x			
November	1,526					x			
December	1,760					x			

Guild - Based Prioritization Matrix

		shallow slow guild	*shallow fast guild*		*deep slow guild*	*deep fast guild*
Month	**LSR median flow (cfs)**	**redbreast sunfish spawning**	**margined madtom**	**Saluda darter**	**redbreast sunfish adults**	**shorthead redhorse**
January	1,930		x	x	x	x
February	2,090		x	x	x	x
March	2,250		x	x	x	x
April	1,100		x	x	x	x
May	745	x	x	x	x	x
June	843	x	x	x	x	x
July	1,250		x	x	x	x
August	1,330		x	x	x	x
September	1,380		x	x	x	x
October	1,570		x	x	x	x
November	1,526		x	x	x	x
December	1,760		x	x	x	x

Kacie Jensen

From: Shane Boring
Sent: Friday, December 15, 2006 3:35 PM
To: Wade Bales (balesw@dnr.sc.gov); Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart
Subject: Agenda - Dec 19 Meeting to Discuss Impacts of Saluda Hydro on Congaree Floodplain and Congaree National Park

Hello Folks:

Attached is a brief agenda for next Tuesday's meeting (Dec 19), which will focus on the requested study on impacts of Saluda Hydro operation on the Congaree Floodplain and Congaree National Park. If you have not already, please let Alison know if you plan to attend.

Thanks and have a good weekend,
Shane

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

LSR IFIM agenda
12-19-2006.doc...

Saluda Hydroelectric Project Relicensing
Instream Flow/Aquatic Habitat Technical Working Committee (TWC)

MEETING AGENDA

December 19, 2006
9:30 AM
Lake Murray Training Center

Meeting Focus: Impacts of Project Operations on the Downstream Floodplain and Congaree National Park

9:30 – 10:15	**Review of Study Requests**
10:15 – 11:45	**Review of Existing Studies** - **USC Study (Plewa, 2005)** - **Other Studies?**
11:45 – 12:45	**Lunch**
12:45 – 2:15	**Need for Additional Studies / Refinement of Study Objectives**
2:15	**Adjourn**

Saluda HYDRO RELICENSING

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:30 PM and noted that the focus of the meeting would be to discuss: (1) the LSR/Lake Murray mussel survey results, (2) comments on the draft study plan for continued LSR macroinvertebrate sampling, and (3) the next meeting date (including need for an RCG meeting).

Review of the LSR/Lake Murray Mussel Survey Results

Shane briefly reviewed results of the mussel survey conducted by John Alderman on Lake Murray, lower Saluda and Congaree Rivers. Shane presented a map that described the 61 locations that were sampled throughout the survey. He noted that timed surveys were conducted at each site and method type depended upon depth of the water. Methods throughout the survey included wading, batiscope, snorkeling, and/ or scuba. Shane noted that particular attention was placed on the Savannah lilliput in the backwater areas of the Saluda River. This species inhabits areas with gentle sloping banks. There were a total of 15 mussel species documented within the areas surveyed. He noted that most of the specimens collected were live, except for the Savannah lilliput. He noted that there were no mussel species found in the Lower Saluda River. Shane noted that mussel species collected in the upper portion of the Congaree River were for the most part distributed along the Broad River side. Ron Ahle noted that the cold water temperatures of the LSR should not have any effect on the freshwater mussel population and diversity. Ron noted that in order to find out if project operations has an affect on the freshwater mussel population, tributaries of the LSR should be included in this survey. Ron questioned whether the middle portion (Ocean Boulevard) of the LSR was sampled. He noted that the Ocean Boulevard stretch provides potential habitat for freshwater mussels and should be included in the survey. There was a brief discussion on water quality conditions in the LSR and Ron noted that dissolved oxygen may be the reason for low population of mussels in the LSR. Amanda Hill noted that methods for each sampling station need to be clearly stated in the report. Shane noted that he would contact John Alderman to address these questions and provide an explanation in the report. Shane mentioned that he would also find out if he's available to sample the tributaries and middle portion of the LSR.

Shane briefly discussed how freshwater mussels' use anadromous fish species as a host. Alan Stuart noted that there have not been any anadromous fish species documented in the LSR during 2005 or 2006 diadromous fish sampling. Shane noted that the report should detail the host species of those mussels that were found.

Comments on the Draft Study Plan for LSR Macroinvertebrate Sampling

Shane noted that Dan Carnegie holds Shealy's certification and will examine possible areas to sample macroinvertebrates along the LSR. Shane briefly explained methods that would be used throughout the survey and Ron suggested that Ocean Blvd. be a possible sampling location. Alan noted that this study should be top priority because he was concerned that the lake may turn over early this year. Shane noted that the deadline for comments on the study plan is August 2nd and any comments should be emailed to him as soon as possible.

There was a brief discussion as to whether a macroinvertebrate study on Lake Murray was needed. Ron noted that this is a standard limnological study that is conducted on reservoirs. He suggested using the Lake Murray water quality stations as index points to set up shallow water stations. Ron explained that by examining the substrate of Lake Murray, we may be able to determine whether project operations has an effect on the macroinvertebrate community. Ron noted that he would research benefits to justify the need for this study.

Date/Location of Next Meeting

The group agreed to have the next meeting in early 2007. Shane noted that he would issue an electronic meeting invitation to confirm a date with individual members.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
RARE THREATENED AND ENDAMGERED SPECIES TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
July 26, 2006

draft jms 7-26-06

ATTENDEES:

Bill Argentieri, SCE&G
Alison Guth, Kleinschmidt Associates
Tom Eppink, SCANA Services
Amanda Hill, USFWS
Bob Perry, SCDNR
Alan Stuart, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Ron Ahle, SCDNR
Bob Seibels, Riverbanks Zoo

ACTION ITEMS:

- Contact Arnie Eversol about crafting a white paper for the Saluda crayfish
Alison Guth
- Email committee members Saluda crayfish information
Amanda Hill

DATE OF NEXT MEETING: **TBA**

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring welcomed committee members and noted that the focus of the meeting would be to discuss: (1) Rocky Shoals Spider Lilly (RSSL) survey results, (2) species tracking table, and (3) the next meeting date (including need for an RCG meeting).

Rocky Shoals Spider Lilly Survey Results

The group briefly reviewed notes from the RSSL float trip. Amanda Hill noted that the most of the RSSL observed along the LSR were single plants. Amanda specifically pointed out that plants found further downstream seemed to be smaller in size with no blooms.

Species Tracking Table

Shane projected the updated tracking table of all federally listed species that may occur in the project area. He reminded the group that this list was prepared by the USFWS in the initial consultation document. He mentioned that in light of the mussel survey conducted on Lake Murray, Lower Saluda and Congaree Rivers, several species such as the Carolina heelsplitter were not found. Shane inquired as to how to deal with species that are federally listed, but not found within the project boundary during the course of their studies. Amanda noted that it should be documented that they were not found during the studies and that project operations was not likely to adversely affect these species. Ron Ahle suggested adding state RT&E species along with the federally listed species. He also recommended listing the species according to priority according to SCDNR's conservation priority list.

In discussion with the RT&E species, Shane informed the group that he has received the sampling permit from NOAA for shortnose sturgeon and sampling will begin in February 2007. Alison Guth noted that in regards to the Saluda Crayfish, she will contact Arnie Eversol about crafting a white paper. Amanda noted that she found some information on the Saluda Crayfish and would send it out through email to all committee members. There was a brief discussion about habitat preferences of the red cockaded woodpecker. Shane noted that there have not been any sittings of these species within the project boundaries, which may be due to the lack of longleaf pine habitat around the Lake. Shane then directed attention to the ivory billed woodpecker and noted that potential habitat for this species exists around the Congaree National Park. Amanda noted that because this species has not been documented, it does not raise much concern. However, she noted that it may be beneficial to mention the surveys currently being performed in the Congaree National Park. Shane explained to the group that he is in the progress of compiling information for other species listed in the tracking table.

Date/Location of Next Meeting

The group agreed to have the next meeting in early 2007. Shane noted that he would issue an electronic meeting invitation to confirm a date with individual members.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
TERRESTRIAL RESOURCE
TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
Draft jms 7/26/06 ***July 26, 2006***

ATTENDEES:

Bill Argentieri, SCE&G
Tom Eppink, SCANA Services
Ron Ahle, SCDNR
Amanda Hill, USFWS
Bob Seibels, Riverbanks Zoo
Alan Stuart, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Alison Guth, Kleinschmidt Associates
Bob Perry, SCDNR

ACTION ITEMS:

- Sort the bird data by family
Shane Boring
- Add brown pelican to the bird data
Shane Boring
- Contact Dick Christie about the use of high resolution photography by using GIS for the shallow water fish habitat assessment
Ron Ahle

DATE OF NEXT MEETING: **TBA**

Kleinschmidt
Energy & Water Resource Consultants

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring welcomed committee members and noted that the focus of the meeting would be to discuss: (1) the species list developed from existing data, (2) development of framework for winter waterfowl survey study plan, and (3) the next meeting date (including need for an RCG meeting).

Review of Species List Developed From Existing Data

Shane distributed the species list that was developed from the 2005 and 2006 bird data and noted that all sources were cited. He explained that the list from Dreher Island State Park was recently updated. It was suggested that the list should be sorted out by family. Shane reminded the group that committee members agreed in the previous meeting that this comprehensive species list would satisfy the migratory bird data study request. He noted that this list will be part of exhibit E in the final report for the license application. Ron Ahle asked if the wadding bird rookeries would be included as well. Shane explained that the two known rookeries are currently being examined in the wood stork survey and will be described in the license application. It was noted that the brown pelican should be added to the list.

Development of Framework for Winter Waterfowl Survey Study Plan

Shane directed attention to the Waterfowl Survey Study Plan and Alan Stuart noted that this is a standard aerial survey protocol. There was some discussion as to whether the study would be conducted over a three year period. Alan asked how a three year survey would fit in the relicensing timeframe. Bob Perry noted that it would continue to build the waterfowl historical database and it would also give us information on habitat use. Ron Ahle noted that waterfowl hunting and observation are two recreational attributes of the project that would provide a nexus for this survey. He added that by conducting these surveys over a longer period, it may answer the question of whether or not the recreational needs of the project are being met in these areas. Through further discussion, the group agreed that the study would be conducted over a two year period, with an interim report being issued after the two year timeframe. It was also agreed that they survey would be conducted up to the project boundary, which should include wood stork habitat. Shane noted that this study may explain the rapid decrease in waterfowl population in recent years.

Date/Location of Next Meeting

Before the meeting closed, there was a brief discussion about a shallow water fish habitat assessment. To gain a better understanding of the available habitat around the project boundary, Ron mentioned the use of high resolution photography, by using GIS. He added that this method would allow for shallow water habitats to be examined. Amanda noted that this would satisfy her interest in regards to this topic, however Ron should check with Dick Christie. Ron noted that he would check with Dick before sending Shane criteria for GIS mapping.

The group agreed to have the next meeting in early 2007. Shane noted that he would issue an electronic meeting invitation to confirm a date with individual members.

Kacie Jensen

From: Dick Christie [dchristie@InfoAve.Net]
Sent: Wednesday, August 02, 2006 9:55 AM
To: Alison Guth
Cc: Val Nash; Steve DeKozlowski; Ron Ahle
Subject: Proposed wording for SMP

Hi Alison - my homework assignment from the last SMP Technical Working Committee meeting was to propose language to address aquatic plant management. Here it is:

SCE&G will continue to work with the South Carolina Department of Natural Resources (SCDNR) and the South Carolina Aquatic Plant Management Council to develop, support, and implement appropriate aquatic plant management strategies for Lake Murray and the Saluda River through the State's annual aquatic plant management planning process.

Kacie Jensen

Subject:	Terrestrial, Freshwater Mussels/Benthic Macroinverts, & RTE Species Technical Committee Meetings
Location:	Carolina Research Park
Start:	Wed 7/26/2006 9:30 AM
End:	Wed 7/26/2006 3:30 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Fish & Wildlife TWC - Terrestrial; Fish & Wildlife TWC - RT&E Species; Fish & Wildlife TWC - Mussels/Inverts

Hello All,

There will be a series of Fish and Wildlife TWC meetings next Wednesday, July 26th at 9:30. The TWCs that will be meeting are Terrestrial, Freshwater Mussels/Benthic Macroinverts, & RTE Species, and these meetings will occur at the SCE&G offices at Carolina Research Park. If you plan on attending through lunch, please let me know by Monday so that I may order the correct amount. Thanks, Alison

Fish and Wildlife
TWC Agenda 7...

Saluda Hydro Relicensing
Fisheries and Wildlife Technical Working Committees:
Terrestrial, Freshwater Mussels/Benthic Macroinverts, & RTE Species

Meeting Agenda

July 26, 2006
9:30 AM
SCE&G Offices at Carolina Research Park

- **9:30 to 11:00** **Freshwater Mussels/Benthic Macroinvertebrates TWC**
  - Review LSR/Lake Murray mussel survey results
  - Comments on draft Study Plan for continued LSR macroinvertebrate sampling
  - Next meeting date (including need for an RCG meeting)

Members:	Shane Boring	Ron Ahle	Amanda Hill
	Jennifer Price	Jim Glover	Steve Summer
	Gerrit Jobsis		

- **11:00 to 12:00** **RT&E Species TWC**
  - 2006 Wood Stork survey observations
  - Rocky Shoals Spider Lily survey results
  - Update of species tracking table
  - Next meeting date (including need for an RCG meeting)

Members:	Shane Boring	Ron Ahle	Gerrit Jobsis
	Bob Seibels	Amanda Hill	Tom Eppink

- **12:00 to 1:00** **Lunch**

- **1:00 to 2:30** **Terrestrial Resource TWC**
  - Review of species list developed from existing data
  - Development of framework for winter waterfowl survey Study Plan
  - Next Meeting Date (including need for an RCG meeting)

Members:	Shane Boring	Amanda Hill	Dick Christie
	Ron Ahle	Bob Seibels	Buddy Baker
	Brandon Stutts		

- **3:30** **Adjourn**

Saluda HYDRO RELICENSING

Kacie Jensen

From: Jennifer Summerlin
Sent: Tuesday, July 18, 2006 9:47 AM
To: 'Wade Bales (balesw@dnr.sc.gov)'; 'Amanda Hill'; 'Bill Argentieri'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; 'Jim Glover'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
Cc: Shane Boring
Subject: Saluda Relicensing: Instream Flow/Aquatic Habitat TWC final meeting notes

All:

Attached are the final Instream Flow / Aquatic Habitat TWC meeting notes from June 14, 2006. They have also been posted on the Saluda Hydro website.

2006-06-14
nstream FlowAquati.

Thanks,

Jennifer Summerlin
Research Technician
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21 A
West Columbia, SC 29170
P: (803) 822.3177
F: (803) 822.3183

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT
TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
Final 6/23/2006 ***June 14, 2006***

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates
Dick Christie, SCDNR
Amanda Hill, USFWS
Scott Harder, SCDNR
Anthony Green, SCDNR
Randy Mahan, SCANA Services
Tom Eppink, SCANA Services
Kelly Miller, Kleinschmidt Associates
Ron Ahle, SCDNR
Gerrit Jobsis, Am. Rivers
Wade Bales, SCDNR

ACTION ITEMS:

- Contact Bud Bader with SCDNR to obtain possible inundation studies for the Congaree and/or LSR

Scott Harder

- Continue the search for Congaree River floodplain/inundation studies from NPS and other sources

Shane Boring

- Quantify habitat types in Lake Murray

Dick Christie/Amanda Hill

- Contact Brandon Kulik to determine his availability and set potential instream flow workshop dates

Alan Stuart

DATE OF NEXT MEETING: **TBA**

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart opened the meeting at approximately 9:30 AM and new attendees introduced themselves. Alan noted that the focus of the meeting would be to discuss: (1) the 1989-1990 IFIM study and it's relevance in the current relicensing project, (2) available inundation studies, (3) possibilities for a comprehensive habitat assessment for Lake Murray, and (4) establishment of an initial framework for addressing the potential self-sustaining trout fishery in the lower Saluda River (LSR).

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In summarizing the study results, Gerrit noted that flows in the Saluda ranged between 100 and 18,000 cfs during the study period. He explained that the flow range was modeled from 50 cfs to 10,000 cfs and added that analyzing WUA at flows above 6,000 cfs were less reliable. He added that, from the results, the recommended flow range of 300-1,000 cfs was developed for the Lower Saluda River. Gerrit pointed out that fish passage through Mill Race Rapids was limited but found that a flow of 1,326 cfs provided adequate passage for fish species. In closing, Gerrit added that he

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Dick C. suggested that the group approach the trout fishery issues by first examining how to improve the habitat in the LSR, rather than trying to develop a self-sustaining trout population. Dick C. mentioned that, even if the habitat improves, the reproduction success of trout would be limited primarily by the warmwater predators found within the system. The group developed a strawman outlining issues that should to be considered for the LSR trout fishery (attachment C)

Date/Location of Next Meeting

Alan S. noted that he would contact Brandon K. about his availability and would schedule a potential IFIM workshop in August sometime. The meeting adjourned at approximately 2:00pm.

Attachment A

Recommended Target Species for Lower Saluda River IFIM Studies
(Source: SCDNR)

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife and Freshwater Fisheries
Environmental Programs Office

Guild Approach
1) Shallow Slow Guild (<2 ft, <1 ft/sec); redbreast sunfish spawning
2) Shallow Fast Guild (<2 ft, >1 ft/sec); margined madtom, Saluda darter
3) Deep Slow Guild (>2 ft, <1 ft/sec); redbreast sunfish adult
4) Deep Fast Guild (>2 ft, >1 ft/sec); shorthead redhorse

Potential Stand Alone Species
1) Diadromous Fish
    a. American shad
    b. Blueback herring
    c. Striped bass
    d. Shortnose sturgeon
    e. American eel
2) Resident Fish
    a. Robust redhorse
    b. Highfin carpsucker
    c. Northern hogsucker
    d. Spotted sucker
    e. Brown trout
    f. Rainbow trout

3) Others
    a. Native mussels
    b. Benthic macro-invertebrates
    c. Spider lily

REMBERT C. DENNIS BUILDING * P.O. BOX 167 * COLUMBIA, SC 29202
TELEPHONE: (803) 734-2728 * FACSIMILE: (803) 734-6020

Attachment B

Framework for Evaluating Existing Lower Saluda River IFIM Study

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If possible, the group would like to evaluate each of the following using the 1995 IFIM Report and Water Resources Report (velocity data collected at 200 cfs).

- Effects of high discharges / Mitigation
- Base flow regime
- Thermal influences / longitudinal variation
- Seasonal variations
- Cover analyses
- Effects of Broad River on the confluence (confluence is defined as Shandon Rapids downstream to Senate Street).
- Scope of project influences (Saluda vs. confluence)
- Types of species to model
- Use the 1989 IFIM report using a wetted perimeter analysis to normalize the USGS gage records. Then run it through an IHA / RVA analysis
- Dissolved oxygen component of the IFIM

Attachment C

Draft Framework for Evaluating the Potential for a Reproducing Trout Fishery in the Lower Saluda River Trout Fishery

Draft Framework for Evaluating the Potential for a Reproducing Trout Fishery in the Lower Saluda River Trout Fishery

1. Species / Requirements / Needs

2. Current Habitat / Management Strategy

   a. Water Quality
   b. Substrate
   c. Food Preferences
   d. Flow Regime

3. Feasibility

   a. Trout predators (striped bass / other warm water species)
   b. Water quality limitations (metals dissolved oxygen)
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   d. Harvesting of adult trout
   e. Available spawning habitat

4. Potential for success self-sustaining trout population with no augmentation

5. Potential for success self-reproducing trout population

Kacie Jensen

From: Jennifer Summerlin
Sent: Friday, June 23, 2006 11:16 AM
To: 'Wade Bales (balesw@dnr.sc.gov)'; 'Amanda Hill'; 'Bill Argentieri'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; 'Jim Glover'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
Cc: Shane Boring
Subject: Saluda Relicensing: 6-14-06 IFIM TWC meeting notes

All:

Attached for your review are the June 14, 2006 IFIM TWC meeting notes. There are three attachments within the meeting notes: (A) recommended target species for LSR IFIM studies, (B) framework for evaluating existing LSR IFIM study, and (C) draft framework for evaluating the potential for reproducing trout fishery in the LSR trout fishery. Please have comments back to me by July 7th.

Thanks,

2006-06-14
nstream FlowAquati.

Jennifer Summerlin
Research Technician
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21 A
West Columbia, SC 29170
P: (803) 822.3177
F: (803) 822.3183

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
INSTREAM FLOW/AQUATIC HABITAT
TECHNICAL WORKING COMMITTEE

SCE&G Offices at Carolina Research Park
June 14, 2006

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates
Dick Christie, SCDNR
Amanda Hill, USFWS
Scott Harder, SCDNR
Anthony Green, SCDNR
Randy Mahan, SCANA Services
Tom Eppink, SCANA Services
Kelly Miller, Kleinschmidt Associates
Ron Ahle, SCDNR
Gerrit Jobsis, Am. Rivers
Wade Bales, SCDNR

ACTION ITEMS:

- Contact Bud Bader with SCDNR to obtain possible inundation studies for the Congaree and/or SLR

Scott Harder

- Continue to the search for Congaree River floodplain/inundation studies from NPS and other sources

Shane Boring

- Quantify habitat types in Lake Murray

Dick Christie/Amanda Hill

- Contact Brandon Kulik to determine his availability and set potential instream flow workshop dates

Alan Stuart

DATE OF NEXT MEETING: **TBA**

MEETING NOTES

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June 14, 2006

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Kleinschmidt
Energy & Water Resource Consultants

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Kacie Jensen

From: Alison Guth
Sent: Thursday, June 08, 2006 12:08 PM
To: Kelly Miller; Wade Bales (balesw@dnr.sc.gov); Amanda Hill; BARGENTIERI@scana.com; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Prescott Brownell; RMAHAN@scana.com; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Subject: Agenda and Action Items

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Fish and Wildlife TWC Agenda 6...

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Alison Guth
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West Columbia, SC 29170
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F: (803) 822-3183

Saluda Hydro Relicensing
Fisheries and Wildlife Technical Working Committees:
Instream Flow/Aquatic Habitat

Meeting Agenda

June 14, 2006
9:30 AM
Carolina Research Park

- **9:30 to 9:45** **Review Purpose of TWC**
- **9:45 to 11:00** **Presentation on the 1989-1990 IFIM Study – *Gerrit Jobsis***
- **11:00 to 11:15** **Break**
- **11:15 to 12:00** **Discussions on IFIM Study and Relevance in Current Relicensing**
- **12:00 to 12:30** **Lunch**
- **12:30 to 1:00** **Distribution of Congaree Flood Plain Studies/Data – *Shane Boring***
- **1:00 to 2:00** **Comprehensive Habitat Assessment Discussion**
  - Amanda Hill and Dick Christie to give further consideration to what is needed and report back to the group on their thoughts.
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Adjourn

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Sent: Thursday, June 08, 2006 12:08 PM
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Adjourn

Saluda HYDRO RELICENSING

Kacie Jensen

From: Shane Boring
Sent: Wednesday, May 24, 2006 5:01 PM
To: Shane Boring; Bret Hoffman; 'Wade Bales (balesw@dnr.sc.gov)'; Alan Stuart; Alison Guth; 'Amanda Hill'; BARGENTIERI@scana.com; 'Bill East'; 'Bill Hulslander'; 'Bill Marshall'; 'Bob Seibels'; 'Charlene Coleman'; 'Daniel Tufford'; 'Dick Christie'; 'Ed Diebold'; 'George Duke'; 'Gerrit Jobsis (American Rivers)'; 'Gina Kirkland'; 'Hal Beard'; 'Jeff Duncan'; 'Jennifer O'Rourke'; 'Jim Glover'; 'Jim Goller'; 'Joe Logan'; 'Joy Downs'; 'Larry Turner (turnerle@dhec.sc.gov)'; 'Malcolm Leaphart'; 'Mark Leao'; 'Mike Sloan'; 'Norman Ferris'; 'Patrick Moore'; 'Prescott Brownell'; 'Ralph Crafton'; RMAHAN@scana.com; 'Reed Bull (rbull@davisfloyd.com)'; 'Robert Lavisky'; 'Ron Ahle'; 'Sam Drake'; Shane Boring; 'Steve Bell'; 'Steve Leach'; 'Steve Summer'; 'Suzanne Rhodes'; 'Tom Bowles (tbowles@scana.com)'
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Subject: Saluda Hydro: 2006-04-17 Diad Fish TWC meeting notes (eel ramp)

Saluda Eel Ramp Study Plan _fi...   2006-04-17 Diad Fish TWC meeti...

Hello All:

Attached for your records are the final meeting notes from our April 17 conference call of the Diadromous Fish Technical Working Committee to discuss potential locations for eel sampling ramps. The final eel ramp study plan is also attached. As always, these will be posted to the Saluda Relicensing Website. Thanks for your input.

Shane

C. Shane Boring
Environmental Scientist
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Cheryl: Could you please post these to the Saluda website -- thanks.

Saluda Hydroelectric Project (FERC No. 516)

Study Plan: Evaluation of Usage of the Lower Saluda River by Inmigrating Juvenile American Eels (*Anguila rostrata*)

Diadromous Fish Technical Working Committee
May 23, 2006

I. Study Objective

To determine presence/absence of inmigrating juvenile American eels (*Anguila rostrata*) in the Lower Saluda River (LSR) downstream of the Saluda Hydroelectric Project.

II. Geographic and Temporal Scope

Sampling for juvenile eels (elvers) will focus on the LSR immediately downstream of the Saluda Hydroelectric Project (from the project spillway upstream to the Saluda Dam).

Sampling is slated to begin in May 2006, or as soon as experimental eel sampling ramps can be installed (see Section III for additional detail), and will continue through October 2007.

III. Methodology

Experimental eel sampling ramps will be deployed at Saluda Project spillway (Figure 1) and at the USGS gage located on the LSR's mainstem downstream of the Saluda Project Dam (# 02168504; Figure 2). Eel ramps will be constructed of corrugated plastic pipe (4' to 10' diameter) or similar materials; a continuous flow will be provided using a pump or gravity feed to provide an attraction flow and to protect ascending eels from desiccation. Ramps will be anchored such that the downstream end remains submerged under normal low flow conditions (approximately 450 ft^3/second). The upstream opening will extend above normal high water and will be outfitted with a secured holding chamber of sufficient design to minimize predation or other mortality of captured animals. Captured eel will be counted, photo-documented, and measured, if size allows.

Figure 1 **Potential Eel Ramp Location: Saluda Spillway**

Figure 2. **Potential Eel Ramp Location: USGS Gage Below Saluda Dam (# 02168504)**

IV. Schedule and Required Conditions

Sampling will begin in May 2006, or as soon as experimental eel sampling ramps can be installed, and will continue through October 2007. Diadromous Fish TWC members will be notified via e-mail in the event that juvenile eels are captured, and an e-mail update will be issued monthly thereafter. A final report summarizing the study findings will be issued upon completion of the study period. All data collected will be provided in electronic format to agencies and interested stakeholders. Study methodology, timing, and duration may be adjusted based on consultation with the resource agencies and interested stakeholders.

V. Use of Study Results

Study results will be used as an information resource during discussion of relicensing issues with the SCDNR, USFWS, NOAA – Fisheries (National Marine Fisheries Service), Fish & Wildlife RCG, Diadromous Fish TWC, and other relicensing stakeholders.

VI. Study Participants

NAME	ORGANIZATION	PHONE	E-MAIL
Diadromous Fish Technical Working Committee			
Gerrit Jobsis	Am. Rivers/CCL	(803)771-7114 x 22	gjobsis@americanrivers.org
Alan Stuart	Kleinschmidt	(803)822-3177	Alan.stuart@kleinschmidtusa.com
Richard Kidder	LMA	(803)892-6539	rkidder@pbtcomm.net
Stephen E. Summer	SCANA Services	(803)217-7357	ssummer@scana.com
Dick Christie	SCDNR	(803)289-7022	dchristie@infoave.net
Steve Leach	SCDNR	(843)825-3388	leachs@dnr.sc.gov
Prescott Brownell	NOAA Fisheries	(843)953-7204	Prescott.brownell@noaa.gov
Amanda Hill	USFWS	(843)727-4707, x303	Amanda_hill@fws.gov
Shane Boring	Kleinschmidt	(803)822-3177	shane.boring@kleinschmidtusa.com
Additional Applicant Contacts			
William Argentieri	SCE&G	(803)217-9162	bargentieri@scana.com
Randy Mahan	SCANA Services	(803)217-9538	rmahan@scana.com

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
DIADROMOUS FISH TECHNICAL WORKING COMMITTEE

Via Conference Call
April 17, 2006

final csb 05/23/06

ATTENDEES:

Bill Argentieri, SCE&G
Pres Brownell, NOAA Fisheries (NMFS)
Amanda Hill, USFWS
Bret Hoffman, Kleinschmidt
Alan Stuart, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Steve Leach, SCDNR

ACTION ITEMS:

- Draft study plan for eel ladder sampling
  Shane Boring

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opening the meeting at approximately 10:00 AM, noting that, during the February Diadromous Fish TWC meeting, three potential locations for experimental eel sampling ramps were identified: (1) the concrete wing wall adjacent to the Saluda powerhouse taildeck (north bank), (2) the USGS gage downstream of Saluda Dam, and (3) the project spillway. He added that since that time, he and Bret Hoffman had made field visits to these sites and that the purpose of today's meeting would be to review the field visits and determine if any of the sites are suitable for deployment of an experimental ramp. Discussions regarding each of the sites are summarized below:

Concrete Wall Adjacent to Powerhouse

Bret Hoffman noted that a ramp deployed in this area would be subject to highly variable tailwater elevations and high flows when multiple units are in operation. Bret added, and Bill Argentieri agreed, that an application at this location would require a significant engineering effort and expensive installation to withstand potential water velocities. After some additional discussion, the group agreed that this location likely was not suitable for the materials proposed for the experimental ramp (i.e., corrugated plastic pipe or similar materials) and that the USGS gage and spillway are likely better locations for deployment.

Kleinschmidt
Energy & Water Resource Consultants

USGS Gage Below Saluda Dam

Shane noted that, while there is sufficient flow at the USGS gage to attract eels, it is generally consistent across the channel and does not provide an attraction flow specifically at the gage location. Steve Leech agreed that a ramp at the gage likely would not sample the entire population migrating up the river (due to lack of an attraction flow directly at the gage); however, a ramp at this location might help in determining presence/absence of elvers in the area immediately downstream of the dam. He added that inmigrating elvers are bank-oriented; thus making this location potential suitable for sampling. After some discussion, the group agreed that, considering the low cost of building the experimental ramps, it would be worth it to deploy a ram at this location.

Spillway

After reviewing the pictures from the field visit (distributed to the TWC via e-mail on (03/17/2006), Shane noted that the spillway presents the easiest installation for an eel ramp, adding that a small attraction flow is provided at the base of the spillway's rocky reach by leakage from the gates. He added, however, that he has some concerns about whether inmigrating eels will enter the spillway channel from the Saluda's mainstem due to lack of flow at the spillway mouth. He added that, under certain conditions (i.e. rising river level) the spillway downstream of the rocks may actually flow backwards. Steve Leach reiterated that, while this site has limitations, it still may be beneficial for determining presence/absence. Noting the ease and relative inexpensive of installation, the group agreed that an attempt should be made to install an experimental ramp at this location.

Following review of the potential eel ramp locations, Shane was tasked with drafting and distributing a study plan focusing on the spillway and USGS gage locations. The meeting adjourned at approximately 10:45 AM.

Kacie Jensen

From: Jennifer Summerlin
Sent: Thursday, April 27, 2006 11:00 AM
To: 'Steve Summer'; 'Amanda Hill'; 'Bill Argentieri'; 'Gerrit Jobsis (American Rivers)'; 'Jennifer Price '; 'Jim Glover'; 'Randy Mahan'; 'Ron Ahle'; Shane Boring
Cc: Shane Boring
Subject: Saluda Relicensing: SCDHEC Macroinvert. Data

Hello Everyone:

As promised in our March 8 Freshwater Mussel/Macroinvertebrates Technical Working Committee meeting, here is the data from Jim Glover (SCDHEC) regarding macroinvertebrate sampling from Tributaries of the Lower Saluda River collected by the SCDHEC. The data is attached for your review and reference.

Jennifer Summerlin
Scientist Technician
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

Kacie Jensen

From: Jennifer Summerlin
Sent: Thursday, April 27, 2006 11:19 AM
To: Jennifer Summerlin; 'Steve Summer'; 'Amanda Hill'; BARGENTIERI@scana.com; 'Gerrit Jobsis (American Rivers)'; 'Jennifer Price '; 'Jim Glover'; RMAHAN@scana.com; 'Ron Ahle'; Shane Boring
Cc: Shane Boring
Subject: RE: Saluda Relicensing: SCDHEC Macroinvert. Data

Sorry, forgot to attach!

Lower Saluda Tributaries.xls (...

-----Original Message-----
From: Jennifer Summerlin
Sent: Thursday, April 27, 2006 11:00 AM
To: Steve Summer; Amanda Hill; Bill Argentieri; Gerrit Jobsis (American Rivers); Jennifer Price ; Jim Glover; Randy Mahan; Ron Ahle; Shane Boring
Cc: Shane Boring
Subject: Saluda Relicensing: SCDHEC Macroinvert. Data

Hello Everyone:

As promised in our March 8 Freshwater Mussel/Macroinvertebrates Technical Working Committee meeting, here is the data from Jim Glover (SCDHEC) regarding macroinvertebrate sampling from Tributaries of the Lower Saluda River collected by the SCDHEC. The data is attached for your review and reference.

Jennifer Summerlin
Scientist Technician
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

PHYLUM	CLASS	ORDER	FAMILY	TAXA	S-052 7/1/1997
Annelida	Hirudinea	NA	NA	Hirudinea	
Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Placobdella sp.	
Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Placobdella papillata	
Annelida	Oligochaeta	Lumbriculida	Lumbriculidae	Lumbriculidae	1
Annelida	Oligochaeta	NA	NA	Oligochaeta	2
Arthropoda	Crustacea	Amphipoda	Gammaridae	Crangonyx serratus	6
Arthropoda	Crustacea	Decapoda	Cambaridae	Cambaridae	
Arthropoda	Crustacea	Decapoda	Cambaridae	Procambarus sp.	
Arthropoda	Hexapoda	Coleoptera	Dytiscidae	Coptotomus sp.	
Arthropoda	Hexapoda	Coleoptera	Elmidae	Ancyronyx variegatus	7
Arthropoda	Hexapoda	Coleoptera	Elmidae	Dubiraphia sp.	
Arthropoda	Hexapoda	Coleoptera	Elmidae	Dubiraphia vittatata	1
Arthropoda	Hexapoda	Coleoptera	Elmidae	Macronychus glabratus	36
Arthropoda	Hexapoda	Coleoptera	Elmidae	Microcylloepus pusillus	24
Arthropoda	Hexapoda	Coleoptera	Elmidae	Stenelmis sp.	3
Arthropoda	Hexapoda	Coleoptera	Gyrinidae	Dineutus sp.	1
Arthropoda	Hexapoda	Coleoptera	Haliplidae	Peltodytes sp.	
Arthropoda	Hexapoda	Coleoptera	Hydrophilidae	Berosus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Ablabesmyia mallochi	
Arthropoda	Hexapoda	Diptera	Chironomidae	Brillia sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Chironomus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Conchapelopia Group	
Arthropoda	Hexapoda	Diptera	Chironomidae	Corynoneura sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Cricotopus/Orthocladius	
Arthropoda	Hexapoda	Diptera	Chironomidae	Cryptochironomus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Cryptotendipes sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Dicrotendipes sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Labrundinia sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Micropsectra sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Nanocladius sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Natarsia sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Omisus pica	
Arthropoda	Hexapoda	Diptera	Chironomidae	Parachironomus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Paratanytarsus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Paratendipes sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Pentaneura sp.	1
Arthropoda	Hexapoda	Diptera	Chironomidae	Phaenopsectra sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum aviceps	
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum convictum	1
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum fallax	
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum halterale	
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum illinoense	
Arthropoda	Hexapoda	Diptera	Chironomidae	Polypedilum scalaenum	
Arthropoda	Hexapoda	Diptera	Chironomidae	Procladius sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Rheocricotopus robacki	
Arthropoda	Hexapoda	Diptera	Chironomidae	Rheotanytarsus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Stenochironomus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Synorthocladius sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Tanytarsus sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Thienemaniella sp.	

Arthropoda	Hexapoda	Diptera	Chironomidae	Thienemannimyia GR	1
Arthropoda	Hexapoda	Diptera	Chironomidae	Tribelos jucundus	
Arthropoda	Hexapoda	Diptera	Chironomidae	Tribelos sp.	
Arthropoda	Hexapoda	Diptera	Chironomidae	Xenochironomus sp.	
Arthropoda	Hexapoda	Diptera	Simuliidae	Simulium sp.	2
Arthropoda	Hexapoda	Diptera	Tipulidae	Hexatoma sp.	
Arthropoda	Hexapoda	Diptera	Tipulidae	Tipula sp.	
Arthropoda	Hexapoda	Ephemeroptera	Baetidae	Baetis flavistriga	
Arthropoda	Hexapoda	Ephemeroptera	Baetidae	Baetis intercalaris	10
Arthropoda	Hexapoda	Ephemeroptera	Baetidae	Baetis pluto	
Arthropoda	Hexapoda	Ephemeroptera	Baetidae	Labiobaetis propinquus	17
Arthropoda	Hexapoda	Ephemeroptera	Caenidae	Caenis diminuta	
Arthropoda	Hexapoda	Ephemeroptera	Caenidae	Caenis sp.	
Arthropoda	Hexapoda	Ephemeroptera	Caenidae	Caenis hilaris	
Arthropoda	Hexapoda	Ephemeroptera	Caenidae	Caenis diminuta/punctata	
Arthropoda	Hexapoda	Ephemeroptera	Heptagenidae	Stenonema modestum	6
Arthropoda	Hexapoda	Ephemeroptera	Isonychiadea	Isonychia sp.	2
Arthropoda	Hexapoda	Ephemeroptera	Tricorythidae	Tricorythodes sp.	14
Arthropoda	Hexapoda	Megaloptera	Corydalidae	Corydalus cornutus	2
Arthropoda	Hexapoda	Megaloptera	Corydalidae	Nigronia serricornis	1
Arthropoda	Hexapoda	Neuroptera	Sisyridae	Climacia areolaris	
Arthropoda	Hexapoda	Odonata	Aeshnidae	Basiaeschna janata	
Arthropoda	Hexapoda	Odonata	Aeshnidae	Boyeria vinosa	18
Arthropoda	Hexapoda	Odonata	Calopterygidae	Calopterygidae	2
Arthropoda	Hexapoda	Odonata	Calopterygidae	Calopteryx sp.	
Arthropoda	Hexapoda	Odonata	Calopterygidae	Hetaerina tittia	1
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Argia sp.	5
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Coenagrionidae	
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Enallagma sp.	2
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Ischnura sp.	
Arthropoda	Hexapoda	Odonata	Coenagrionidae	Ischnura/Anomalagrion	
Arthropoda	Hexapoda	Odonata	Corduliidae	Neurocordulia sp.	4
Arthropoda	Hexapoda	Odonata	Corduliidae	Tetragoneuria sp.	
Arthropoda	Hexapoda	Odonata	Gomphidae	Gomphus sp.	3
Arthropoda	Hexapoda	Odonata	Gomphidae	Hagenius brevistylus	
Arthropoda	Hexapoda	Odonata	Gomphidae	Progomphus sp.	
Arthropoda	Hexapoda	Odonata	Libellulidae	Libellulidae	
Arthropoda	Hexapoda	Odonata	Macromiidae	Macromia sp.	2
Arthropoda	Hexapoda	Trichoptera	Hydropsychidae	Cheumatopsyche sp.	29
Arthropoda	Hexapoda	Trichoptera	Hydropsychidae	Hydropsyche betteni	1
Arthropoda	Hexapoda	Trichoptera	Hydropsychidae	Hydropsyche venularis	31
Arthropoda	Hexapoda	Trichoptera	Leptoceridae	Nectopsyche exquisita	7
Arthropoda	Hexapoda	Trichoptera	Leptoceridae	Oecetis persimillis	9
Arthropoda	Hexapoda	Trichoptera	Leptoceridae	Triaenodes ignitus	20
Mollusca	Gastropoda	Basommatophora	Physidae	Physella sp.	
Mollusca	Gastropoda	Basommatophora	Planorbidae	Helisoma anceps	
Mollusca	Pelecypoda	Heterodonta	Corbiculidae	Corbicula fluminea	
Mollusca	Pelecypoda	Heterodonta	Sphaeriidae	Sphaeriidae	

Count-	272
Taxa Richness-	33
EPT-	11

Biotic Index-	5.18
EPT Score-	2.0
Biotic Index Score-	5.0
Combined Score-	3.3
Bioclassification-	Good-Fair
Aquatic Life Use Designation*-	PS

*PS=Partially Supporting

*NS=Not Supporting

S-260 7/27/2001	S-260 7/3/1997	S-287 8/15/2003	S-287 7/3/1997	S-848 7/27/2001	S-848 7/1/1997
7		9		1	
	1				
			2		
7	5	21	2		10
2	3			1	
1					
				1	
		1		25	11
				4	
	2		1		1
		1	1	19	2
				1	
14	35	2	1	45	4
1					
	1				
3	7	3	7	3	5
					2
					2
	6		6		11
			1		
	2	2		1	7
3				2	2
3					
3			1	1	
		1			
					1
			1		
	3				
			1		
			1		
4		1	3	3	
		1			
					1
	1				1
29	2	10	14	25	7
					2
		2			
13	9	1	9	1	2
1	3	1	1	1	1
2				1	
1	5		1		4
24		11	59	4	10
		1			
			1		9
3		3		5	4
					3

10		1		13	
3			2		13
		3			
1					
4	1	7	5	22	10
1					
3	4		1	11	2
9				2	
			2		2
2		2		6	
				2	2
			1		
		19			
					1
	1			1	
				10	2
				2	
			2		
3	3				
1	3		2		14
3				17	1
24	15	2	1	7	4
		2		17	
22	6	6	2		3
				1	
2	10		4		1
	2		3		
2					
					2
					1
				3	
1					
			1		10
95	2	49	60	55	5
1	9			4	
5	4		2		
4					
17	1	6	3	7	9
			6		
334	146	168	210	324	191
38	28	26	35	35	41
4	3	5	3	7	5

	6.96		7.34		6.41		6.47		6.34		6.42
	1.0		1.0		1.0		1.0		1.4		1.0
	2.0		2.0		3.0		2.6		3.0		3.0
	1.5		1.5		2.0		1.8		2.2		2.0
Poor		Poor		Fair		Fair		Fair		Fair	
NS		NS		PS		PS		PS		PS	

Kacie Jensen

Subject:	Updated: Saluda Hydro: May 3 Terrestrial, RT&E Species, Instream Flow, Freshwater Mussels/Benthic Inverts Technical Working Committee Meetings
Location:	SCE&G offices at Carolina Research Park (111 REsearch Dr, Columbia, SC 29203)
Start:	Wed 5/3/2006 9:00 AM
End:	Wed 5/3/2006 4:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Fish & Wildlife TWC - IFIM/Aquatic Habitat; Jennifer Price; Buddy Baker ; Tom Bowles (tbowles@scana.com); Brandon Stutts ; Bob Seibels; EPPINK, THOMAS G

Just a reminder that the following Fish and Wildlife Technical Working Committees (TWCs) are scheduled to meet on Wednesday, May 3 at the SCE&G offices at Carolina Research Park: **Freshwater Mussels/Benthic Macroinvertebrates (9:00 - 10:00 AM); Instream Flow/Aquatic Habitat (10:00 AM - 12:00 PM); Rare, Threatened and Endangered Species (12:30 - 2:00 PM); and Terrestrial Resources (2:00 - 3:30 PM).** The meeting agenda is attached below. Thanks for your continued participation, and I look forward to seeing you on May 3.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

Fish and Wildlife
TWC Agenda 5...

Saluda Hydro Relicensing
Fisheries and Wildlife Technical Working Committees:
Terrestrial, Freshwater Mussels/Benthic Macroinverts, Instream Flow/Aquatic Habitat, & RTE Species

Meeting Agenda

May 3, 2006
9:00 AM
SCE&G Offices at Carolina Research Park

- **9:00 to 10:00** **Freshwater Mussels/Benthic Macroinvertebrates TWC**
  - Review action items
  - Comments on draft Study Plan for reconnaissance mussel survey
  - Review of LSR Macroinvert reports prepared by Shealy Environmental; determination of need for additional studies.
  - Next meeting date (including need for an RCG meeting)

Members:			
	Shane Boring	Ron Ahle	Amanda Hill
	Jennifer Price	Jim Glover	Steve Summer
	Gerrit Jobsis		

- **10:00 to 12:00** **Instream Flow/Aquatic Habitat TWC**
  - Review action items
  - Review of data from 1989 SCDNR LSR Instream Flow Study
  - Target species / methodology (Models to be used)
  - Next meeting date (including need for an RCG meeting)

Members:			
	Steve Summer	Shane Boring	Alan Stuart
	Hall Beard	Brandon Kulik	Wade Bales
	Ron Ahle	Gerrit Jobsis	Dick Christie
	Amanda Hill	Prescott Brownell	

- **12:00 to 12:30** **Lunch**

Saluda HYDRO RELICENSING

Saluda Hydro Relicensing
Fisheries and Wildlife Technical Working Committees:
Terrestrial, Freshwater Mussels/Benthic Macroinverts, Instream Flow/Aquatic Habitat, & RTE Species

Meeting Agenda

May 3, 2006
9:00 AM
SCE&G Offices at Carolina Research Park

- **12:30 to 2:00** **RT&E Species TWC**
  - Review of action items
  - 2006 Wood Stork survey observations
  - Roll-out and review of species tracking table
  - Next meeting date (including need for an RCG meeting)

Members:	Shane Boring	Ron Ahle	Gerrit Jobsis
	Bob Seibels	Amanda Hill	Tom Eppink

- **2:00 TO 3:30** **Terrestrial Resource TWC**
  - Review action items
  - Review of Riverbanks Zoo, Columbia Audubon, and other migratory and resident songbird data
  - Review of SCDNR's Lake Murray waterfowl survey data
  - Determine if additional surveys of songbirds are needed
  - Next Meeting Date (including need for an RCG meeting)

Members:	Shane Boring	Amanda Hill	Dick Christie
	Ron Ahle	Bob Seibels	Buddy Baker
	Brandon Stutts		

- **3:30** **Adjourn**

Saluda HYDRO RELICENSING

Kacie Jensen

From: Shane Boring
Sent: Wednesday, April 26, 2006 9:57 AM
To: Bret Hoffman; Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Alison Guth; Amanda Hill; BARGENTIERI@scana.com; Bill East; Bill Hulslander; Bill Marshall; Bob Seibels; Charlene Coleman; Daniel Tufford; Dick Christie; Ed Diebold; George Duke; Gerrit Jobsis (American Rivers); Gina Kirkland; Hal Beard; Jeff Duncan; Jennifer O'Rourke; Jim Glover; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Malcolm Leaphart; Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; Prescott Brownell; Ralph Crafton; RMAHAN@scana.com; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; Ron Ahle; Sam Drake; Shane Boring; Steve Bell; Steve Leach; Steve Summer; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: 2006-04-17 Diad Fish TWC meeting notes (draft).doc

2006-04-17 Diad Fish TWC meeti...

Hello All:

Attached for your review are the draft meeting notes from last Monday's (April 17) conference call of the Diadromous Fish Technical Working Committee to discuss potential locations for eel sampling ramps. The draft study plan for the 2 locations chosen during the meeting (the spillway and the USGS gage below Saluda dam) is also attached. Please have your comments on both documents to me by Friday May 5th. Timely comments on the study plan are of particular importance, as we would like to get the ramps in the water as soon as possible. As always, thanks for your input and commitment to the Saluda relicensing process.

Shane

2006-04-17 Diad Fish TWC meeting notes (draft).doc

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
DIADROMOUS FISH TECHNICAL WORKING COMMITTEE

Via Conference Call
April 17, 2006

Draft csb 04/25/06

ATTENDEES:

Bill Argentieri, SCE&G
Pres Brownell, NOAA Fisheries (NMFS)
Amanda Hill, USFWS
Bret Hoffman, Kleinschmidt
Alan Stuart, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Steve Leach, SCDNR

ACTION ITEMS:

- Draft study plan for eel ladder sampling
  Shane Boring

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opening the meeting at approximately 10:00 AM, noting that, during the February Diadromous Fish TWC meeting, three potential locations for experimental eel sampling ramps were identified: (1) the concrete wing wall adjacent to the Saluda powerhouse taildeck (north bank), (2) the USGS gage downstream of Saluda Dam, and (3) the project spillway. He added that since that time, he and Bret Hoffman had made field visits to these sites and that the purpose of today's meeting would be to review the field visits and determine if any of the sites are suitable for deployment of an experimental ramp. Discussions regarding each of the sites are summarized below:

Concrete Wall Adjacent to Powerhouse

Bret Hoffman noted that a ramp deployed in this area would be subject to highly variable tailwater elevations and high flows when multiple units are in operation. Bret added, and Bill Argentieri agreed, that an application at this location would require a significant engineering effort and expensive installation to withstand potential water velocities. After some additional discussion, the group agreed that this location likely was not suitable for the materials proposed for the experimental ramp (i.e., corrugated plastic pipe or similar materials) and that the USGS gage and spillway are likely better locations for deployment.

USGS Gage Below Saluda Dam

Shane noted that, while there is sufficient flow at the USGS gage to attract eels, it is generally consistent across the channel and does not provide an attraction flow specifically at the gage location. Steve Leech agreed that a ramp at the gage likely would not sample the entire population migrating up the river (due to lack of an attraction flow directly at the gage); however, a ramp at this location might help in determining presence/absence of elvers in the area immediately downstream of the dam. He added that inmigrating elvers are bank-oriented; thus making this location potential suitable for sampling. After some discussion, the group agreed that, considering the low cost of building the experimental ramps, it would be worth it to deploy a ram at this location.

Spillway

After reviewing the pictures from the field visit (distributed to the TWC via e-mail on (03/17/2006), Shane noted that the spillway presents the easiest installation for an eel ramp, adding that a small attraction flow is provided at the base of the spillway's rocky reach by leakage from the gates. He added, however, that he has some concerns about whether inmigrating eels will enter the spillway channel from the Saluda's mainstem due to lack of flow at the spillway mouth. He added that, under certain conditions (i.e. rising river level) the spillway downstream of the rocks may actually flow backwards. Steve Leach reiterated that, while this site has limitations, it still may be beneficial for determining presence/absence. Noting the ease and relative inexpensive of installation, the group agreed that an attempt should be made to install an experimental ramp at this location.

Following review of the potential eel ramp locations, Shane was tasked with drafting and distributing a study plan focusing on the spillway and USGS gage locations. The meeting adjourned at approximately 10:45 AM.

Saluda Hydroelectric Project (FERC No. 516)

Study Plan: Evaluation of Usage of the Lower Saluda River by Inmigrating Juvenile American Eels (*Anguila rostrata*)

Diadromous Fish Technical Working Committee
Draft -- April 25, 2006

I. Study Objective

To determine presence/absence of inmigrating juvenile American eels (*Anguila rostrata*) in the Lower Saluda River (LSR) downstream of the Saluda Hydroelectric Project.

II. Geographic and Temporal Scope

Sampling for juvenile eels (elvers) will focus on the LSR immediately downstream of the Saluda Hydroelectric Project (from the project spillway upstream to the Saluda Dam).

Sampling is slated to begin in May 2006, or as soon as experimental eel sampling ramps can be installed (see Section III for additional detail), and will continue through October 2007.

III. Methodology

Experimental eel sampling ramps will be deployed at Saluda Project spillway (Figure 1) and at the USGS gage located on the LSR's mainstem downstream of the Saluda Project Dam (# 02168504; Figure 2). Eel ramps will be constructed of corrugated plastic pipe (4' to 10' diameter) or similar materials; a continuous flow will be provided using a pump or gravity feed to provide an attraction flow and to protect ascending eels from desiccation. Ramps will be anchored such that the downstream end remains submerged under normal low flow conditions (approximately 450 ft^3/second). The upstream opening will extend above normal high water and will be outfitted with a secured holding chamber of sufficient design to minimize predation or other mortality of captured animals. Captured eel will be counted, photo-documented, and measured, if size allows.

Figure 1 Potential Eel Ramp Location: Saluda Spillway

Figure 2. Potential Eel Ramp Location: USGS Gage Below Saluda Dam (# 02168504)

IV. Schedule and Required Conditions

Sampling will begin in May 2006, or as soon as experimental eel sampling ramps can be installed, and will continue through October 2007. Diadromous Fish TWC members will be notified via e-mail in the event that juvenile eels are captured, and an e-mail update will be issued monthly thereafter. A final report summarizing the study findings will be issued upon completion of the study period. All data collected will be provided in electronic format to agencies and interested stakeholders. Study methodology, timing, and duration may be adjusted based on consultation with the resource agencies and interested stakeholders.

V. Use of Study Results

Study results will be used as an information resource during discussion of relicensing issues with the SCDNR, USFWS, NOAA – Fisheries (National Marine Fisheries Service), Fish & Wildlife RCG, Diadromous Fish TWC, and other relicensing stakeholders.

VI. Study Participants

NAME	ORGANIZATION	PHONE	E-MAIL
Diadromous Fish Technical Working Committee			
Gerrit Jobsis	Am. Rivers/CCL	(803)771-7114 x 22	gjobsis@americanrivers.org
Alan Stuart	Kleinschmidt	(803)822-3177	Alan.stuart@kleinschmidtusa.com
Richard Kidder	LMA	(803)892-6539	rkidder@pbtcomm.net
Stephen E. Summer	SCANA Services	(803)217-7357	ssummer@scana.com
Dick Christie	SCDNR	(803)289-7022	dchristie@infoave.net
Steve Leach	SCDNR	(843)825-3388	leachs@dnr.sc.gov
Prescott Brownell	NOAA Fisheries	(843)953-7204	Prescott.brownell@noaa.gov
Amanda Hill	USFWS	(843)727-4707, x303	Amanda_hill@fws.gov
Shane Boring	Kleinschmidt	(803)822-3177	shane.boring@kleinschmidtusa.com
Additional Applicant Contacts			
William Argentieri	SCE&G	(803)217-9162	bargentieri@scana.com
Randy Mahan	SCANA Services	(803)217-9538	rmahan@scana.com

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at 10:30 AM. Shane reminded the group that, at the February 22nd Fish and Wildlife RCG meeting, the Technical Working Committees (TWCs) were formed and study requests were assigned to the TWCs[1]. He added that the purpose of today's meeting would be to further discuss the study requests assigned to the Terrestrial Resources TWC to begin evaluating the need for a study, available data, data needs (gaps), study objectives and scope, and to assign tasks toward addressing each study request.

Migratory Bird Study Request

Shane asked agency staff in attendance to further clarify their objectives for the study request. Amanda Hill summarized the USFWS's objectives for this study as essentially three-fold: 1) continuation of the Wood Stork survey to provide additional information on usage at the project; 2) identification of all bald eagle sites; and 3) identification of all species that are using the project (i.e., a species list). Shane noted that the first two are being addressed. He added that the woodstork surveys are ongoing and are being jointly conducted by Kleinschmidt and SCNDR staff (Shane Boring and Tom Murphy, respectively). He added that Tom Murphy is also conducting bald eagle nest surveys for SCDNR again this year and that data should be available to the group. Amanda noted that, as long as the data is made available during the relicensing process, these efforts should satisfy the first two objectives.

In regards to the USFWS request to identify all species known to use the project (item 3 above), Shane suggested that, if the primary objective is simply a measure of diversity for the project area, this probably can be accomplished using existing data. He added that a number of data sources have potential to provide a fairly comprehensive species list, including the Columbia Audubon observations from Dreher Island State Park, data compiled by Riverbanks Zoo, and Jerrold Grigg's (professor at USC) observations from Saluda Shoals Park and other areas of the LSR. Bob Seibels noted that the zoo's data is available in an Excel spreadsheet, which could easily be shared with the group. Ed Diebold provided additional background on the Zoo's efforts, noting that they have begun to do faunal inventory of the zoo site, with migratory birds being a primary component of the survey efforts. He added that they are currently seeking funding for this effort and hope to hire a fulltime conservation biologist, as well as potentially expand their survey efforts beyond just the zoo grounds, possibly to a regional level. The group agreed that the available data should be

[1] See February 22nd, 2006, Fish and Wildlife RCG meeting notes for study request summaries and assignments.

gathered and distributed to TWC members for review to determine if further studies are needed. Alan Stuart added that a fairly comprehensive species list was provided in the ICD and urged group members to review that section in evaluating data needs.

Shane noted that a similar request was made for the Catwaba-Wateree relicensing and suggesting a review of the study plan and final report might be beneficial in evaluating the need for a study at Saluda. The group agreed and Shane was tasked with distributing electronic copies of these documents to the TWC members.

Shane noted that information regarding waterfowl usage of Lake Murray (i.e. species present, numbers, seasonality) was requested by both the USFWS and SCDNR. Buddy Baker noted that his group at SCDNR has conducted boat-based surveys on the main lake pool during the winter months for the last 3 years. He added that this data could provide information regarding general species distribution, but likely will be of limited value in assessing seasonal and/or year-to-year trends. Bob Perry and Buddy noted that, should the TWC determine that trend data is needed, additional aerial survey, similar to those done for the Santee-Cooper relicensing, would likely be needed. Buddy agreed to pass the data collected thus far on to Shane for distribution to the group. The group agreed that it should meet again after reviewing the data to determine whether further surveys are warranted.

Bob Perry noted that SCDNR is concerned that abundance and diversity of ducks using Lake Murray have declined from historic levels due to habitat loses associated with shoreline development and increased noise, boat traffic, and other disturbances associated with increased popularity of the lake. He added that it might be useful to compare current and historical data on waterfowl usage to examine these factors. He added that it might also be useful to examine the influence of current versus historical operations (i.e. lake levels) on waterfowl usage. Shane noted that this had not been previously submitted as a study request, and that he had some uncertainly regarding the feasibility of such a study and what its objectives would be. Shane proposed, and the group agreed, that SCNDR prepare a study request to further clarify their objectives and the project nexus. Bob and Buddy baker agreed to draft a study request for distribution to the TWC.

Bob Perry also enquired as to whether there is benthic macroinvertebrate data for the lake, noting their importance as prey for diving ducks. Shane noted that the status of benthic macroinvertebrate data for the lake is being evaluated by the Freshwater Mussels/Benthic Macroinvertebrates TWC. Finally, Shane noted that the request regarding designation of additional waterfowl hunting areas would be addressed in the Recreation RCG and TWCs.

Date/Location of Next Meeting

The group agreed to meet again on May 3, 2006, at Carolina Research Park. Shane noted that an effort would be made to hold several TWC meetings on a single day to cut down on travel for agency staff. He added that he will issue an electronic meeting invitation to confirm the date with individual members and provide directions to the meeting site. The meeting was adjourned at approximately 11:35 am.

Kacie Jensen

From: Shane Boring
Sent: Tuesday, March 14, 2006 2:37 PM
To: Steve Summer; Alan Stuart; Amanda Hill; BARGENTIERI@scana.com; Dick Christie; Gerrit Jobsis (American Rivers); Prescott Brownell; RMAHAN@scana.com; Shane Boring; Steve Leach
Cc: Alison Guth; Jennifer Summerlin; Wade Bales (balesw@dnr.sc.gov); Alison Guth; Bill East; Bill Hulslander; Bill Marshall; Bob Seibels; Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Hal Beard; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Malcolm Leaphart; Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; Ralph Crafton; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; Ron Ahle; Sam Drake; Steve Bell; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: Feb 22 Diadromous Fish TWC Meeting Notes

Dear Saluda Diadromous Fish Technical Working Committee Members:

Attached for your review are the draft meeting notes from the Diadromous Fish Technical Working Committee meeting, which was held following the RCG meeting on Feb 22. For those in attendance, please provide comments (preferably in MS Word track changes) by Friday, march 24th. All Fish and Wildlife RCG members have been copies in an effort to keep folks up-to-date, so please accept my apologies for any duplicate e-mails. Thanks again for your interest and continued contributions to the Saluda relicensing process.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2006-02-22 Diad
Fish TWC meeti...

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
DIADROMOUS FISH TECHNICAL WORKING COMMITTEE

SCE&G Training Center
February 22, 2006

Draft-jms - 3-13-06

ATTENDEES:

Bill Argentieri, SCE&G
Alison Guth, Kleinschmidt Associates
Gerrit Jobsis, SCCCL & Am. Rivers
Dick Christie, SCDNR
Steve Leach, SCDNR
Alan Stuart, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Jennifer Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Steve Summers, SCE&G

ACTION ITEMS:

- Provide Jimmy Livingston's (Eel fisherman) contact information – *Steve Leach*
- Conduct site visit with Bret Hoffman to potential eel ladder locations – *Alan Stuart, Shane Boring*
- Propose a date for the next Diadromous Fish TWC – *Shane Boring*

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shortly after the fish and wildlife RCG meeting (notes prepared separately), the group agreed to proceed with the Diadromous Fish Technical Working Committee (TWC) meeting. Shane Boring opened the meeting at approximately 2:05 pm, noting that, as agreed in the RCG meeting, the primary focus of the meeting would be discussion of American eel sampling. He noted that USFWS recommended the use of an eel ramp to sample for elvers due to ineffectiveness of the eel pot sampling.

Amanda Hill noted that water temperature should be taken into account in determining when a ramp needs to be in place; she added that eel migration generally occurs from spring to fall when water temperature are above approximately 15˚C. It was mentioned that 15˚C water temperatures in the Lower Saluda River (LSR) usually occurs beginning in June. Due to time constraints, the group agreed to continue sampling with eel pots until potential eel ramp sites/design can be further evaluated.

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The group reviewed SCE&G's fly-over video of the LSR and briefly discussed possible locations for an eel ramp. The group identified several potential ramp locations including attaching a ramp directly to the downstream side of the dam (i.e., to the taildeck or the wall adjacent to the powerhouse), the spillway, and the USGS gauge below the dam. It was agreed the spillway was the most likely location. Alan Stuart noted that Bret Hoffman, a Kleinschmidt engineer, had been involved with eel ramp design and proposed that Bret make a site visit to evaluate feasibility and design considerations for each of the locations. The group agreed that this was acceptable, and Alan and Shane were tasked with coordinating a field visit with Bret. Steve Leach noted that, due to the feasibility concerns at various sites, it may be beneficial to use an inexpensive ramp design to allow for relocation if sampling at a particular site proves ineffective. Use of corrugated plastic pipe supported by rebar was noted as a potential design.

Steve Leach noted that it might be beneficial to discuss eel trapping strategies with commercial fishermen. He added that SCDNR has been in contact with a gentleman in the Santee area (Jimmy Livingston), which ahs proven effective for their eel sampling efforts. Steve L. agreed to obtain Mr. Livingston's contact information and send it to Shane.

There was a brief discussion on the shortnose sturgeon project. Shane noted that the application was submitted around eight months ago and a permit has still not been issued. He added they expect to have the permit issued in about 9 to 10 weeks.

The meeting adjourned at approximately 3:45 pm. Shane agreed to arrange the next meeting of the Diadromous Fish TWC once a site visit has been made to the potential ell ramp locations.

Kacie Jensen

From: Shane Boring
Sent: Friday, March 10, 2006 4:53 PM
To: 'Ron Ahle (ahler@dnr.sc.gov)'; Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Alison Guth; Amanda Hill; Bill East; Bill Hulslander; Bill Marshall; Bob Seibels; Charlene Coleman; Dick Christie; Ed Diebold; George Duke; Gerrit Jobsis (American Rivers); Gina Kirkland; Hal Beard; Jeff Duncan; Jim Goller; Joe Logan; Malcolm Leaphart; Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; Prescott Brownell; Ralph Crafton; Robert Lavisky; Ron Ahle; Sam Drake; Shane Boring; Steve Bell; Steve Leach; Steve Summer; Suzanne Rhodes
Cc: BARGENTIERI@scana.com; Jennifer Summerlin; RMAHAN@scana.com; 'Tom Eppink'; 'tbowles@scana.com'; 'bstutts@scana.com'; 'Steve Summer (ssummer@scana.com)'
Subject: Saluda Hydro Relicense: Feb 22 Fish & Wildlife RCG Draft Meeting Notes

All:

Attached for your review are the draft notes from the Feb 22nd Fish and Wildlife RCG meeting. Many thanks to Jeni Summerlin for assistance in drafting the notes. For those in attendance, please provide comments (preferably in track changes) by Wednesday, March 22nd. Thanks your for your continued participation and dedication to the Saluda relicensing process.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2006-02-22 F&W
RCG meeting no...

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
FISH AND WILDLIFE RESOURCE CONSERVATION GROUP

SCE&G Training Center
February 22, 2006

draft jms 3-09-06

ATTENDEES:

Bill Argentieri, SCE&G
Alison Guth, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates*
Tom Eppink, SCANA Services
Randy Mahan, SCANA Services
Gerrit Jobsis, SCCCL & Am. Rivers
Dick Christie, SCDNR
Malcolm Leaphart, Trout Unlimited
Amanda Hill, USFWS
George Duke, LMHOC
Tom Bowles, SCE&G
Gina Kirkland, SCDHEC
** Facilitator*

Alan Stuart, Kleinschmidt Associates
Steve Bell, Lake Watch
Bill East, Lake Murray Assoc.
Jennifer Summerlin, Kleinschmidt Associates
Hal Beard, SCDNR
Wade Bales, SCDNR
Joe Logan, Midland Stripers
Bob Seibels, Riverbanks Zoo
Ron Ahle, SCDNR
Brandon Stutts, SCANA Services
Bill Marshall, SCDNR & LSSRAC
Steve Leach, SCDNR

ACTION ITEMS:

- Prepare a study plan on fish entrainment and submit to the Fish Entrainment TWC for review
Alan Stuart, Shane Boring

- Provide raw data and other information for the 1989 Saluda IFIM study
Ron Ahle

- Compile available studies on resident fish fauna and distribute for review
Shane Boring, Alan Stuart, Steve Summer

- Schedule next Fish & Wildlife RCG meeting
Fish and Wildlife TWCs – Shane Boring will coordinate

MEETING NOTES:

These notes summarize the major items discussed during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:00 am, and meeting attendees introduced themselves. It was noted that the primary purpose of today's meeting would be to form the Technical Working Committees (TWCs) for the Fish and Wildlife Resource Conservation Group (RCG) and assign study request to the TWCs.

Mission Statement

Shane reviewed the following mission statement for the Fish and Wildlife RCG, noting that it had been finalized and placed on the Saluda Relicensing website:

> *The mission of the Fish and Wildlife RCG is to develop a Protection, Mitigation, and Enhancement Agreement (PM&E Agreement) relative to fisheries and wildlife management for inclusion within the Saluda Hydroelectric Project license application. The objective of the PM&E Agreement shall be to assure the development and implementation of a level of integrated management best adapted to serve the public interests. To achieve this mission, the Fish and Wildlife RCG shall identify the need for, define the scope of, and manage or influence as appropriate, data collection and/or studies relative to potentially impacted fish, wildlife, and plant species and ecological communities, ecosystems and/or habitat within the Saluda Hydroelectric Project.*

Gerrit Jobsis is asked that "within the Saluda Hydroelectric Project" be changed to "within the project vicinity" since some impacts can be outside of the project boundary. Alan Stuart and Alison Guth noted that it would require some work to change the mission statement as it had already been distributed to stakeholders and posted to the website as final. The group agreed that it was implicit in the mission statement that the project has potential to impact areas outside of the project boundary.

Formation and Membership of TWCs / Assignment of Study Requests

Shane reminded the group that, at the initial RCG meeting, a document was distributed that summarizes the study request received in response to issuance of the Initial Consultation Document (ICD). He added that the primary purpose of today's meeting would be to review the fish-and-wildlife-related study requests (see attached handout from the meeting), form appropriate TWCs to handle these requests, and solicit (volunteer) membership for the TWCs. It was noted that, while all RCG members are welcome to attend the technical meetings, the TWC membership should consist of individuals with technical expertise in the resource area.

Following a review of the study requests received to date, 6 TWCs were formed; these TWCs, their membership, and their study request assignments are summarized below:

1) Freshwater Mussels/Benthic Macroinvertebrates TWC

Membership: Shane Boring, Amanda Hill, Gerrit Jobsis, Steve Summer, Ron Ahle, Jennifer Price, SCDHEC Representative

Study Requests[1] to be Addressed: Mussel Surveys, Benthic Macroinvertebrate Study

2) Terrestrial Resources TWC

Membership: Shane Boring, Amanda Hill, Ron Ahle, Dick Christie, Buddy Baker, Brandon Stutts

Study Requests to be Addressed: Migratory Bird Study (includes wood storks, waterfowl, and bald eagles)

3) Rare Threatened and Endangered Species/Habitat Studies TWC

Membership: Shane Boring, Ron Ahle, Amanda Hill, Gerrit Jobsis, Bob Seibels, Tom Eppink

Study Requests to be Addressed: Rare, Threatened and Endangered Species/Habitat Studies

4) Diadromous Fish TWC

Membership: Alan Stuart, Gerrit Jobsis, Dick Christie, Steve Leach, Amanda Hill, Steve Summers, Prescott Brownell

Study Requests to be Addressed: Diadromous Fish Studies

[1] Study Requests correspond to the study request summaries included in the attached meeting handout.

5) Instream Flow / Aquatic Habitat TWC

Membership:

Alan Stuart	Shane Boring
Steve Summers	Gerrit Jobsis
Ron Ahle	Amanda Hill
Hal Beard	Dick Christie
Brandon Kulik	Prescott Brownell
Wade Bales	

Study Requests to be Addressed: Instream Flow Studies, Floodplain Flow Elevations, Ecologically Sustainable Water Management, Comprehensive Habitat Assessment, Sediment Regime and Sediment Transport Studies, Evaluation of Potential for Self-Sustaining Trout Population

6) Fish Entrainment TWC

Membership:

Alan Stuart	Wade Bales
Amanda Hill	Hal Beard
Tom Bowles	Shane Boring

Study Requests to be Addressed: Fish Entrainment Desktop Study

Discussion/Comments on Study Requests

Diadromous Fish Studies

Shane noted that the sampling of diadromous species is among the early studies that SCE&G decided to begin prior to relicensing. He added that sampling is currently being done by Dr. Jeff Isely from Clemson University and that the study plan is available on the Saluda relicensing website. Amanda Hill explained that state and federal agencies, including NMFS, USFWS, and SCDNR, have an interest in restoring diadromous species in the Santee basin, and as such, have cooperatively developed a restoration plan to guide such efforts. She added that the diadromous study was requested to help understand potential impacts operation of Saluda may have on migration and/or spawning of the diadromous species in the Saluda and Congaree.

Shane then provided the group with a brief summary of SCE&G's effort to obtain a scientific research permit from NOAA Fisheries – National Marine Fisheries Service (NMFS) to sample for shortnose sturgeon in the Saluda and Congaree. Specifically it was noted that the application had

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been submitted since June of 2005 (informally since April 2005), and to date, a permit has still not been issued. Shane noted that he had spoken with Shane Guan at NMFS, and they are expecting to have the permit issued in 9 to 10 weeks.

Amanda Hill enquired as to the status of American eel sampling. Shane provided a quick review of the discussions regarding eel sampling from the January 6, 2006 conference call with the agencies (see meeting notes on the Saluda relicensing website). Specifically, it was noted that USFWS recommended use of an eel ramp to sample for elvers due to the ineffectiveness of the eel pot sampling. He added that the group had agreed to evaluate use of an eel ramp; however, due to time constraints (sampling was slated to being February 1), it was determined that eel pot sampling should continue in the interim until potential eel ramp sites/design can be evaluated. Amanda reiterated that USFWS still strongly recommends a ramp for sampling elvers.

<u>Freshwater Mussel Surveys</u>

Shane noted that he had talked to Jennifer Price with SCDNR and Lora Zimmerman with USFW, and unfortunately, data on historical distributions of mussels in SC is extremely limited. He added that no mussels are known to occur in the LSR; however, no surveys have been conducted. Amanda Hill reiterated that information on mussels in SC is extremely limited and that recent FERC relicensing efforts have provided a lot of what is known. Amanda noted a similar lack of known mussel populations at the beginning of the Santee-Cooper relicensing; however, a survey by John Alderman indicated presence of several species, includes species with conservation status. The group agreed that a potential mussel survey was deserving of further discussion in the technical committee.

<u>Benthic Macroinvertebrate Studies</u>

The group briefly discussed the status of the crayfish pilot survey that was conducted on the LSR in fall 2005. Alan noted that a significant number were captured, have been IDed, and are currently being verified by Arnie Eversol at Clemson. Hal Beard noted the crayfish populations may fluctuate over time due to the amount of vegetation available along the shoreline, which is directly related to flow regime. Gina Kirkland noted that, since she is likely not going to be on the TCW, she would like to ensure that the crayfish population is properly evaluated due to their importance as prey for trout in the LSR.

Gerrit noted that importance of considering sediment dynamics when evaluating potential impacts to the macroinvertebrate community. Shane noted that the sediment regime study request had been shifted to the Instream Flow/Aquatic Habitat TWC under the Fish and Wildlife RCG to ensure that such factors are taken into account. The group agreed to defer further discussion to the TWC meeting.

Instream Flow Studies

Alan Stuart specifically noted that instream flow evaluations are a standard request for most relicensing efforts. Alan pointed out an important role of the Instream Flow TWC will be to provide input and alternatives to the Operations TWC. Dick Christie clarified, the purpose of this committee would be to use another model to identify flows that will protect and potentially restore habitat on the LSR. Once flows have been identified, the operations group may be able to answer what else happens to the project if these specific flows proceed downstream. Ron Ahle noted that it may be important to examine the habitat needs of specific target species, and from this information, determine which flows are necessary to provide habitat for these particular species. Ron recommended using a Physical Habitat Model (PHABSIM). Ron noted that there was a previous IFIM study done on the LSR, but that it is outdated. Several group members noted the importance of including data from the previous IFIM study into the discussions of the Instream Flow TWC. Ron noted that he has the raw data and summary information on the IFIM study and would share the information with the group. The group decided to propose a date after information has been obtained from Ron.

Fish Community Surveys

Shane noted that numerous studies have been done through the years on the resident fish fauna and that consolidating this information might satisfy the request. Shane referenced specifically Steve Summer's quarterly electrofishing in the LSR, Hal Beard's spring sampling on the LSR, and the Lake Murray Management Reports (SCDNR). Hal noted that, while the management reports provide some valuable information, they are typically species specific and would not cover the full range of potential species. He added that his boat electrofishing in the LSR likely misses some of the smaller species. Dick Christie noted that a compilation of the studies conducted over the last approximately 40 years would likely provide a fairly comprehensive species list. Amanda Hill proposed, and the group agreed, that available studies should be compiled and distributed to the group for review to determine whether any further surveys are needed.

Evaluation of Potential for Self-Sustaining Trout Population in LSR

Malcolm Leaphart noted that USGS did a study of the LSR in 1985 and found that, based on temperature and flow, the LSR has potential to be a coldwater fishery year-round. He noted that, in his opinion, the river has been impaired for decades due to operations at Saluda, and as such, has not been able to function as year-round coldwater habitat. Malcolm requested that the potential for establishing a year-round coldwater fishery be at least considered and discussed in the relicensing and referenced the Smith River trout studies as an example of potential enhancements. Gina Kirkland noted that the LSR's designated use is as a Put-Grow-and-Take trout stream; thus the stream is not impaired for its current designated use. Dick Christie noted that there is obviously strong interest in this issue and proposed that it be discussed further in the technical committees. After some discussion, it was determined that the limiting factors for reproducing trout are primarily habitat-related; thus the study request was assigned to the Instream Flow/Aquatic Habitat TWC. Dick Christie noted that a special meeting, drawing from some several TWCs, may be in order.

<u>Rare, Threatened and Endangered (RT & E) Species</u>

Amanda Hill noted that the Ivorybill Woodpecker had recently been rediscovered in Arkansas and that the experts felt that the most likely place for additional Ivory-bills is Congaree Swamp. She added that, since we will be evaluating impacts of project operations on Congaree Swamp, the Ivorybill should be considered in the evaluation of RT &E species. She also noted that the Saluda Crayfish, a terrestrial species known from a single location near Silversreet, SC in Newberry Co., should also be considered.

<u>Fish Entrainment</u>

Shane noted there was a request to conduct a desktop study of potential entrainment using previous studies conducted at other similar facilities. Alan pointed out that this is a typical request for relicensing. He added that there is a fairly standard study plan that is used. The group agreed that Kleinschmidt should distribute the study plan for review, after which, a conference call can be scheduled to discuss how to proceed on this issue.

<u>Migratory Bird Survey</u>

Shane noted that there is a considerable amount of data available for Dreher Island State Park, as well as the Lower Saluda River, from Columbia Audubon and other sources. Bob Seibels added that the zoo has access to considerable amount of data for their site. The group agrees this request should be deferred to the terrestrial TWC for further discussion of existing data and to determine whether a study is needed. It was also proposed that the study request regarding waterfowl usage, habitat, and hunting areas be deferred to the terrestrial group for discussion along with the other migratory bird request.

Striped Bass Evaluations

The group agreed that many of the issue related to impacts to striped bass are water-quality-related and thus are being handled by the Water Quality TWC. Dick Christie noted, and the group acknowledged, that there will undoubtedly be a need to for the Water Quality TWC and Fish and Wildlife RCG to interface regarding this issue.

Hydrologic/Hydraulic Operations Model

After some discussion, it was noted that the scope of this request is being handled in the Operations TWC; however, several group members noted the need to ensure that information is shared between the Operations and Instream Flow/Aquatic habitat TWCs.

Low Inflow Protocol Study

The group likewise agreed that the scope of this request is being handled in the Operations TWC; group members also noted the need to ensure that information is shared between the Operations and Instream Flow/Aquatic habitat TWCs.

Other Relevant Studies in the LSR and Congaree River

Wade Bales briefly discussed two future studies that the SCDNR will be conducting downstream of Saluda Hydro. He explained the first study will be to evaluate trout mortality in the river. He noted there is very little historical information on which to base trout stocking strategies, and they would like to establish baseline data to further enhance management strategies. This study will assess estimated annual mortality based on the number of trout released. He added that, after the trout have been stocked in the river, SCDNR will sample by electrofishing methods quarterly. Hal added that they are also hoping to identify any mortality differences between brown and rainbow trout, including the potential for holdovers. He noted they recently stocked trout in the river on January 10th and would start sampling in about one week. He added sampling would also take place in June, September, and possibly December.

Wade also noted SCDNR is developing a striped bass telemetry project. The goal of this study will be to document striped bass spatial and temporal use on the river via receivers deployed as part of Steve Leach's Shortnose Sturgeon study. He noted 30 striped bass, with a size range over ten pounds, will be tagged with transmitters in the Lower Saluda, Congaree, and Wateree Rivers. He explained that SCDNR is interested in movements of mature spawning striped bass, as well as how stocked and reproducing populations intermingle.

Dates and of Upcoming RCG and TWC Meetings

THE RCG meeting was closed at approximately 2:00 pm and the group agreed to use the remainder of the afternoon to convene the Diadromous Fish TWC (notes prepared separately). No date was set for the next Fish and Wildlife RCG meeting as the group determined it best that the TWC meet a few times and then propose a date to the RCG for its next meeting. The group also agreed to have the Terrestrial; Rare, Threatened and Endangered Species; and Freshwater Mussel/Benthic macroinvertebrate TWCs meet on March 8, 2006 at 9:00 am at the Lake Murray Training Center.

Fish and Wildlife

Study Requests:

- **Diadromous Fish Studies**: Study requests from the CCL/American Rivers focused on a more in depth analysis of habitat conditions, feasibility of hatchery operations for diadromous fish, impacts analysis of the Project on diad. fish stocks of the Santee-Cooper Basin, the feasibility and costs of fish passage at the Project. SCDNR requests that spawning and nursery habitat for diadromous fish species in the river and lake should be identified and quantified.

  Requested by: CCL/American Rivers, SCDNR, LSSRAC, National Marine Fisheries Service, USFWS

- **Mussel Surveys**: It was requested that the present status of mussels in the project area should be evaluated, their habitat needs assessed, and any project impacts on habitat be identified. CCL requests an evaluation of the cumulative impact analysis that the Project has on mussel stocks in the Santee Cooper Basin.

  Requested by: CCL/American Rivers, SCDNR, LSSRAC, USFWS

- **Benthic Macroinvertebrate Study**: Requested in order to determine if invertebrate fauna have increased in either number or species diversity as a result of turbine venting. As well as how far downstream they are impacted.

  Requested by: SCDNR, LSSRAC, National Marine Fisheries Service, SC Council Trout Unlimited, USFWS

- **Fish Community Surveys:** It was requested that these surveys be performed and include small non-game species in the Saluda River above and below the reservoir as well as in Lake Murray, to supplement existing fish community data and/or replace dated information. Specific sampling focused on determining presence or absence of the rare robust redhorse sucker, Carolina sucker, and the highfin carpsucker should be conducted in the lower Saluda River.

  Requested by: USFWS

- **Striped Bass Evaluations:** This study would involve an evaluation of project operations on the reservoir striped bass population, particularly regarding: (1) the effectiveness of current turbine operations, (2) potential additional enhancements in association with the summer thermocline near the powerhouse; and (3) determine if striped bass migrate upstream of the project within the Saluda River during the spring spawning season, and if and where spawning activities occur.

Requested by: USFWS

- **Migratory Bird Surveys**: This survey would evaluate the effects of the project on migratory bird use at Lake Murray and the Saluda River and riparian ecosystems. Surveys of migratory birds and their habitats to provide baseline information on populations. Aerial surveys for potential roosting, nesting, and foraging sites for the federally endangered woodstork should also continue.

  Requested by: USFWS

- **Hydrologic/Hydraulic Operations Model**:[2] Requested development of a computer simulation model that incorporates the operating characteristics of the Saluda Hydro Project. The model would be capable of simulating the Project's operations using specific hydraulic relationships based on inflows from all drainages to Lake Murray ending downstream in the Congaree River floodplain. The model would also include water flows in the Broad River above its confluence with the Saluda to accurately model combined flow conditions at the confluence and in the Congaree River.

  Requested by: LSSRAC

- **Low Inflow Protocol Study**:[1] Requested study to evaluate the effects of periods of low flow on elements such as reservoir levels, water availability, river flora and fauna habitat, etc. Study leading to the development of a low flow operations plan for the Project. According to the City of Columbia Parks and Recreation, this study should include the development of a "Hydrologic/Hydraulic Operations Model."

  Requested by: CCL/American Rivers, City of Columbia Parks and Recreation, LSSRAC

- **Floodplain Flow Evaluations**:[1] A study was requested in order to evaluate the flows necessary for incremental levels of floodplain inundation for the Lower Saluda, Congaree River, and Congaree National Park. It is requested that it include an inventory of floodplain vegetation as well, in order to classify and characterize the vegetative species composition and structure of the floodplain areas within the zone of operational influence of the river reaches.

[2]Not included as part of meeting handout; however, this study request was discussed in the meeting and thus is included in the meeting notes.

Requested by: CCL/American Rivers *(requested floodplain inundation study as well as floodplain vegetation component),* LSSRAC *(requested floodplain vegetation component only)* National Park Service

**In relation to this study, SCDNR requests that the hydrologic record associated with the operation of the project be compared to the unregulated hydrology that would have occurred under a natural flow regime over the life of the project. Including an estimate of the timing, duration and magnitude of flood events that occurred and that would have occurred in absence of the project*.

Requested by: SCDNR

- **Instream Flow Studies**:[1] Requested for the Saluda River and the Confluence area. An assessment on how Project operations affect stream flows, and which flow regimens would best meet the needs of the biota.

  Requested by: CCL/American Rivers, City of Columbia Parks and Recreation, SCDNR*, LSSRAC, National Marine Fisheries Service, SC Council Trout Unlimited, USFWS

  **[IFIM requested by SCDNR in lieu of implementing an instantaneous flow of at least 470 cfs needed to support one-way downstream navigation, and flows of 590 cfs (July – November), 1170 cfs (Jan-April), and 880 cfs (May, June and December) to provide seasonal aquatic habitat]*

- **Ecologically Sustainable Water Management (ESWM)**:[1] Described by the National Park Service as a "inclusive, collaborative, and consensus-based process to determine a scientifically based set of river flow prescriptions in order to protect downstream resources while balancing upstream benefits." The NPS notes that they believe this process can be readily adapted to the Saluda Project and have already began gathering information and developing an interactive GIS tool to provide information regarding the effect of various Saluda operational scenarios on the degree of inundation at the Congaree National Park. NPS seeks "partnership" with SCE&G as well as stakeholders in implementing this ESWM process.

  Requested by: National Park Service

[1] Not included as part of meeting handout; however, this study request was discussed in the meeting and thus is included in the meeting notes.

- **Sediment Regime and Sediment Transport Studies:**[1] A request has been made that a study be performed on the sediment regimen in the Project area as well as the Project effects on the sediment regimen of the lower Saluda River. Should include such things as sediment composition, bedload movement, gravel deposition, sediment storage behind dams, and bedload changes below the dam; and project effects on downstream geomorphometry, sediment availability and streambank erosion, and the possible addition of gravel to mitigate for project impacts. Also, the effects of the Project operations on habitat requirements for spawning fishes.

  Requested by: CCL/American Rivers, USFWS

Information Needs:

- **Comprehensive Habitat Assessment**: To provide quantitative and qualitative data in GIS format of available and potential spawning, rearing, and foraging habitats (i.e., riffles, shoals, open water, shallow coves, littoral zones) for diadromous and resident fishes in Lake Murray, the Saluda River and its major tributaries, and the Lower Saluda River below the Project.

  Requested by: National Marine Fisheries Service, USFWS

- **Fish Entrainment Desktop Study:** This study would include conducting a desktop study of potential entrainment using previous studies conducted at other similar facilities. The objectives of the study should be to (1) quantify the numbers and sizes of fish entrained, by species, (2) estimate mortality rates associated by species, and (3) provide recommendations for project design and operation that can reasonably be made to prevent or minimize fish entrainment and associated injury/mortality.

  Requested by: SCDNR, National Marine Fisheries Service, USFWS

- **A Study to Determine the Factors Needed for a Self Sustaining Trout Fishery**: The purpose of this study should be to determine the factors needed for a self sustaining trout fishery that can reproduce and thrive year round, and how the operation can be modified to meet the habitat needs. Dissolved oxygen, flows, spawning and rearing habitat, the aquatic food base, especially in the shallow, rocky foraging areas, and actual water chemistry should be key items in such an assessment.

[1] Not included as part of meeting handout; however, this study request was discussed in the meeting and thus is included in the meeting notes.

Requested by: SC Council Trout Unlimited

- **Rare Threatened and Endangered Species/Habitat Studies**: A study was requested to assess the condition of rare threatened and endangered species in the Project area, as well as how Project operations are affecting these species and how Project operations can be used to protect, restore, or enhance populations. Management plans be developed for species existing in the project area or under the influence of the project. Suggestions include Wood Stork and RSSL Surveys as well as SNS and American eel sampling.

  Requested by: CCL/American Rivers, SCDNR, LSSRAC, National Marine Fisheries Service, USFWS

- ***SCDNR*** requests a summary of emergency spill gate testing protocol to include the frequency, time of year, and any adaptive measures that are used to reduce fish mortality as a result of spill gate testing.

- Information on species composition, location, and acreage of aquatic plants in the project is needed to aide in the development of an aquatic plant management plan. ***SCDNR***

- Information be dispersed to lake users by SCE&G on aquatic weed control measures. ***County of Newberry***

- Please provide copies of the existing environmental studies conducted at the Saluda Hydroelectric Project by SCE&G contractors and the South Carolina Department of Natural Resources that are referenced in the literature cited section of the Initial Consultation Document. These may be provided as hard copies or via CD (preferable). **USFWS**

Requests for Potential Mitigation: None

Kacie Jensen

From: Gerrit Jobsis [gjobsis@americanrivers.org]
Sent: Wednesday, March 08, 2006 3:17 PM
To: Shane Boring
Cc: amanda_hill@fws.gov; gloverjb@dhec.sc.gov; EPPINK, THOMAS G; ahler@dnr.sc.gov; Jennifer Price; kirklagl@dhec.sc.gov
Subject: freshwater mussel DO information

Shane,

Here is the information I discussed in today's TWC meeting. The power point slides don't have much narrative. I'd be glad to provide some at a future TWC meeting if that is the group's interest.

Gerrit

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WITNESS STATEMENT OF M. CHRIS BARNHART, PH.D.

1. I, M. Chris Barnhart, submit this statement in anticipation of my testimony on behalf of Alabama Rivers Alliance and American Rivers in EMC Docket No. 05-14. My address is Department of Biology, Missouri State University, Springfield, Missouri 65897.

2. I am Professor of Biology at Missouri State University. I have studied the physiology and ecology of mollusks and other invertebrates for more than 25 years and I have authored or coauthored more than 50 scientific publications and reports dealing with these subjects. I have particular expertise in the biology of native freshwater mussels, and have conducted both field and laboratory studies of these animals for the past 12 years. This work has been funded by both state and federal resource agencies. I am currently conducting research on the effects of low oxygen on native mussels with support from the U.S. Environmental Protection Agency.

3. My curriculum vita, including publications, is attached as Attachment 4-A. I am willing to provide copies of publications upon request. I have not testified in any other cases in the past three years.

4. Alabama Rivers Alliance and American Rivers have called me to testify as to the adequacy of the water quality certifications to protect and restore native freshwater mussel species found in the affected waters of the Coosa and Black Warrior Rivers. The Coosa River system has suffered what may be largest mass extinction in U.S. history. Apparently at least 12 species of mussels and 25 species of freshwater gastropods were lost when the river was dammed and modified. Eleven mussel species currently or formerly found in the Coosa basin are currently listed or proposed for listing as federally endangered or threatened. In preparation for my testimony I have reviewed Alabama Power Company's (APC) applications for water

quality certification for the Coosa River, Jordan, Mitchell, and Black Warrior River Projects, as well as the certifications issued by the Alabama Department of Environmental Management (ADEM). I have also reviewed document index provided by the ADEM on September 23, 2005. Based on my review of the applications for certification and the certifications, I do not understand the basis for ADEM's implicit finding that 4.0 mg/l dissolved oxygen limitation would restore and protect freshwater mussels present in the affected waters. Further, I do not understand the basis for the ADEM's implicit finding that minimum flow schedules are not necessary to restore and protect the freshwater mussels present.

A. <u>Dissolved Oxygen Limitation</u>

5. The water quality certifications issued by the ADEM require APC to manage the hydroelectric developments "such that no less than 4.0 mg/l of dissolved oxygen (DO) shall be maintained at all times" at the specified monitoring locations. I have addressed the effects of low dissolved oxygen on freshwater animals in several studies (Hoback and Barnhart 1996, Mills and Barnhart 1999, Mills and Barnhart 2001) and have worked extensively with native mussels in the field and laboratory. I recently reviewed the literature regarding hypoxia and native mussels, and I am currently conducting research on the effects of low oxygen on survival and reproduction of native mussels with funding from USEPA. In my opinion 4.0 mg/l is not adequate to protect or restore native freshwater mussels.

6. There are several factors which affect DO concentrations in rivers and streams, including: (1) temperature, there is an inverse relationship between temperature and DO; (2) sources of oxygen, e.g., aquatic photosynthesis or reaeration; (3) sinks for oxygen, i.e., metabolism and chemical oxidation in water (BOD) and in sediment (SOD); (4) groundwater/surface water mixing; (5) hypolimnetic release from reservoirs, (6) instream flow,

which affects both the input of oxygen by mixing with surface water, and the conveyance of oxygenated water into and through the stream substrate or sediments, where freshwater mussels reside.

7. DO is generally measured in the water column. However, adult and juvenile mussels are potentially affected by both water column DO and DO in interstitial water in sediments. Mussels burrow in the stream sediments. Although adults generally keep siphons at the sediment surface, they may at times bury up to 5-10 centimeters (cm) below the surface. Young juvenile mussels are tiny (from 0.25 mm) and generally burrow 1 to several cm deep. DO in interstitial waters is generally lower and more variable than DO in the water column, and is affected by both water column DO and flow. There is ample precedent for regulating a higher water column DO in order to be protective of organisms that dwell in interstitial water, for example salmonid eggs. USEPA criteria for salmonid spawning habitat generally assume a 3 mg/L differential.

8. Low DO, or hypoxia, has significant negative effects on freshwater mussels, including limitation of aerobic metabolism (MO_2), reduced growth rate, behavioral responses, and mortality.

9. Oxygen is necessary to support chemical processes that provide energy in organisms for survival and growth (aerobic metabolism). Oxygen supply is particularly critical for aquatic organisms because water contains only about 1/30 the amount of oxygen as does air. Therefore, factors which reduced the dissolved oxygen concentration (DO) or which interfere with water flow (oxygen deliver) can limit metabolic rate. Those species of stream-dwelling mussels that have been investigated show measurable reduction of metabolic rate at DO well above 4 mg/L (Chen et al. 2001).

10. The effect of low DO in limiting metabolism is a particular problem if water temperature is high. The "cost of living" and metabolic demand for oxygen by ectothermic ("cold-blooded") organisms such as fish and mussels increases with increasing temperature, roughly doubling for each 10 degree C increase in temperature. Therefore, the negative effects of limiting metabolic energy supply are exacerbated because demand is exacerbated at high temperature.

11. In other animals such as fish, oxygen limitation of metabolic rate is associated with reduced rates of feeding, growth, and reproduction. We are currently conducting experiments to measure the effects of low DO on growth of freshwater mussels.

12. Freshwater bivalves are typically not killed by acute exposure (hours) to fairly severe hypoxia. Moreover, adult mussels typically have long lifespan (decades). Therefore it is not surprising to find that mussels may persist for decades even in waters that are occasionally hypoxic for brief periods. However, recent evidence indicates that reproduction and recruitment of mussels can be impaired by hypoxia that does not kill the adults outright.

13. Female mussels brood their developing eggs and mature larvae within specialized marsupial gills. Mussel species generally fall into two patterns of brooding- long term and short-term. Long-term brooders generally carry embryos and larvae from early fall until spring or early summer of the following year. Short-term brooders generally brood from late spring to late summer. Large numbers of eggs are densely packed into the marsupia, so that delivery of oxygen to the brood may be relatively inefficient. Recent experiments with a stream-dwelling mussel species in my lab have shown that the brood can be killed by relatively moderate hypoxia, with significant mortality at 4 mg/L (but not at 5 mg/L) at 20 C. Thus *these results indicate that intermittent hypoxia below 5 mg/L could interfere with mussel reproduction without*

killing the adults. Thus populations would show poor recruitment and dwindle over time, whi is a common pattern in regulated rivers.

B. Minimum Flow Schedules

14. The certifications do not require minimum flow schedules for the Weiss, Logan Martin, and Neely Henry developments. In my opinion minimum flow schedules below these developments are necessary in order restore and protect freshwater mussels in the affected reaches. Episodic interruption of flow will impact mussels in two major ways. First, standing water will become depleted of dissolved oxygen and elevated in temperature. These effects wi stress adults and may kill brooded larvae (13). Second, flow interruptions will limit the habita by periodically exposing portions of the stream bed, rendering these areas uninhabitable.

C. Monitoring

15. The certifications require APC to maintain 4.0 mg/l DO concentrations at specified monitoring locations, which do not appear to include interstitial waters. As discusse in paragraph 7, adult and juvenile mussels are exposed to both interstitial and water column D Interstitial DO is often lower than DO in the water column. Thus a 4 mg/l DO concentration i the water column may mean interstitial DO is 1 mg/l. In my opinion certifications which do n require monitoring of interstitial DO are inadequate to protect freshwater mussels.

CONCLUSION

Based on my review of the applications for certification and the certifications, and my knowledge of the biology of native mussels, I disagree with ADEM's implicit finding that 4.0 mg/l dissolved oxygen limitation would restore and protect freshwater mussels present in the affected rivers. I further disagree with ADEM's implicit finding that minimum flow schedules are not necessary to restore and protect the freshwater mussels present, including federally endangered species. I would like to add that very encouraging evidence has developed in the past few years indicating that responsible management of DO and flow below hydropower dams can result in dramatic recovery of mussel populations in rivers. Such a recovery has occurred in the Duck River in Tennessee, following implementation of oxygenation procedures and increased spring and summer flows below TVA's Normandy Dam. There is simply no further excuse for "business as usual" given these results and the threat of further losses of irreplaceable and frankly wonderful organisms.

Dated: October 4, 2005

Respectfully submitted,

M. C. Barnhart

M. Chris Barnhart, Ph.D.
Professor of Biology

DR. M.C. BARNHART'S LIST OF PUBLICATIONS

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Seymour, R.S., G.A. Bartholomew and M.C. Barnhart. 1983. Respiration and heat production by the inflorescence of *Philodendron selloum* Koch. Planta 157:336-343.

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Barnhart, M.C. and E.C. Powell. 1979. *Lissorchis kritskyi* sp. n. (Digenea, Lissorchidae) from the River Carpsucker, *Carpiodes carpio* (Rafinesque). Proceedings of the Helminthological Society of Washington 46:47-51.

Barnhart, M.C. 1979. Notes on the winter epiphragm of *Pupoides albilabris.* Veliger 21:400-401.

Barnhart, M.C. 1978. Three introduced gastropods in Iowa. Nautilus 92:107-108.

Barnhart, M.C., G.W. Calderwood and E.C. Powell. 1976. Helminth parasites of some Iowa fishes. Proceedings of the Iowa Academy of Science 83:64-66.

Recent presentations

Barnhart, M.C. and B. Roston. 2005. Host infection strategy of the snuffbox mussel, *Epioblasma triquetra*. 2005. Platform, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN.

Kaiser, B.E. and M.C. Barnhart. 2005. The effects of glochidiosis on fish respiration. Platform, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN.

Dodd, B.J., M.C. Barnhart, C. Rogers-Lowery, T. Fobian, R.V. Dimock 2005. Persistence of acquired resistance of largemouth bass to glochidia of a unionid mussel. Poster, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN. ***BEST STUDENT POSTER AWARD.***

Dodd, B.J., M.C. Barnhart, C. Rogers-Lowery, T. Fobian, R.V. Dimock 2005. Cross-resistance of largemouth bass to glochidia of unionid mussels. Platform, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN

Serb, J.M., M. C. Barnhart, and J.L. Harris. 2005. Identifying new populations of the endangered winged mapleleaf *Quadrula fragosa* using molecules and morphology. Platform, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN

Bringolf, R. B., M.C. Barnhart et al. 2005. Assessing the hazards of current use pesticides to early life stages of native freshwater mussels. Platform, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN.

Wang, N., T. Augsberger, C. Barnhart et al. 2005. Developing standardized guidance for conducting toxicity tests with the early life-stages of freshwater mussels. Platform, Biennial Symposium of the Freshwater Mollusc Conservation Society, St. Paul MN.

Barnhart, M. C. 2005. Culture methods for native freshwater mussels: How to make buckets of muckets. Joint meeting, Mid-Continent Warmwater Fish Culture Workshop and Missouri Aquaculture Association. Blue Springs, MO.

Barnhart, Chris, Kenda Flores, and Rob Pulliam. 2005. Buried treasure: the conservation significance of native mussels. Platform presentation, Missouri Natural Resources Conference, Lake Ozark, MO.

Kaiser, Brianna, and Chris Barnhart. 2005. The effects of glochidiosis on fish respiration. Platform presentation, Missouri Natural Resources Conference, Lake Ozark, MO. BEST STUDENT PRESENTATION AWARD, MO Chapter, American Fisheries Society.

Fobian, Todd, Ben Dodd, and Chris Barnhart. 2005. Cross-resistance of host fish to several species of mussel glochidia. Platform presentation, Missouri Natural Resources Conference, Lake Ozark, MO.

Barnhart, M. C. 2004. The intertwined interests of native mussels, fish, and fisheries professionals. American Fisheries Society 134th Annual Meeting, Madison, WI. Invited.

Barnhart, M. C. 2004. Artificial propagation as a management tool. U.S. Army Corps of Engineers, Memphis District, Mussel Workshop. Memphis, TN Invited presentation. 4/2/04

Barnhart, M. C. 2004. Conservation biology of native freshwater mussels. Invited seminar. University of Nebraska, Kearney, NE 2/27/04.

Barnhart, M. C. 2004. Why fisheries professionals should care about native freshwater mussels. Invited presentation at American Fisheries Society Annual Meeting, Emporia KS. 2/21/04

Eckert, N. E. and M. C. Barnhart. 2004. Diversity among Western fanshell mussel populations. Platform presentation at American Fisheries Society Annual Meeting, Emporia KS. 2/21/04. BEST STUDENT PAPER AWARD.

Benjamin J. Dodd and M. C. Barnhart. 2004. The development, persistence and mechanism of acquired immunity of largemouth bass to mussel glochidia. Poster presentation at American Fisheries Society Annual Meeting, Emporia KS. 2/21/04. BEST POSTER AWARD.

Serb, J M, N L Eckert, M C Barnhart. 2003. Congruence between molecular and reproductive characters as evidence for cryptic species within the western fanshell, *Cyprogenia aberti* (Bivalvia: Unionidae). Evolution 2003, California State University, Chico.

Wang N, Ingersoll CG, Greer IE, Whites DW, Dwyer FJ, Roberts AD, Augspurger T, Kane C, Tibbott C, Neves RJ, Barnhart MC. 2003. Developing standardized guidance for conducting toxicity tests with glochidia of freshwater mussels. Presented at the 24th meeting of SETAC, Austin, TX, November 9-13,.

Barnhart, M. C. 2003. Progress in the propagation of endangered native mussels. Kansas Pearly Mussel Meeting, Pittsburg State, KS. Invited

Eckert, N. and M. C. Barnhart. 2003. Reproductive biology and host requirement differences among isolated populations of Cyprogenia aberti (Conrad 1850). Kansas Pearly Mussel Meeting, Pittsburg State, KS.

Dodd, B. and M. C. Barnhart. 2003. Susceptibility of channel catfish to Ich and glochidia: Implications for artificial propagation of freshwater mussels. Kansas Pearly Mussel Meeting, Pittsburg State, KS.

Barnhart, M. C. and M. A. Shiver. 2003. Progress in the reproductive biology, propagation, and stocking of the Neosho mucket, Lampsilis rafinesqueana. Freshwater Mollusc Conservation Society Symposium, Durham NC.

Eckert, N. E. and M. C. Barnhart 2003. Comparison of host compatibility in two populations of Western fanshell, Cyprogenia aberti . Freshwater Mollusc Conservation Society Symposium, Durham NC.

Barnhart, M. C. 2003. Reproductive biology of native freshwater mussels. Seminar lecture at USGS Columbia Environmental Research Laboratory. Invited

Hutson, C. A. and M. C. Barnhart. 2003. Survey of unionoids in regulated rivers in Southwestern Missouri. Freshwater Mollusc Conservation Society Symposium, Durham NC.

Barnhart, M. C., Sue Bruenderman and Christian Hutson. 2003. Mussel Conservation update. Fisheries Division Training Conference, Missouri Department of Conservation, Lake Ozark, MO.

Eckert, N. E. and M. C. Barnhart. 2003. Reproductive biology of Western fanshell mussels in Kansas and Missouri. Missouri Natural Resources Conference, Lake Ozark, MO.

Eckert, N.E. and M. C. Barnhart. 2002. Reproductive biology of fanshell mussels from Kansas and Missouri. Kansas Pearly Mussel Meeting, Fort Scott, KS.

Barnhart, M. C. 2002. Recovery of propagated Neosho muckets from Fall and Verdigris rivers. Kansas Pearly Mussel Meeting, Fort Scott, KS. Invited

Barnhart, M. C. 2002. An introduction to reproduction in Unionoid mussels. Freshwater Mollusc Conservation Society Mussel Propagation Workshop. National Conservation Training Center, Shepherdstown, WV. March 14.

Barnhart, M. C. 2002. Mussel propagation in Missouri. Freshwater Mollusc Conservation Society Mussel Propagation Workshop. National Conservation Training Center, Shepherdstown, WV. March 15.

Shiver, Melissa A. and M. Christopher Barnhart. 2002. Reproduction and Propagation of the Neosho mucket, *Lampsilis rafinesqueana.* Missouri Natural Resources Conference, Osage Beach.

Hutson, Christian, Bryan Simmons and M. Christopher Barnhart. 2002. A survey of native freshwater mussels in the Sac river system, Missouri. Missouri Natural Resources Conference, Osage Beach.

Barnhart, M. C. and Michael S. Baird. 2001. Population age structure of the spectaclecase, *Cumberlandia monodonta*. Annual meeting of the North American Benthological Society, LaCrosse, WI.

Barnhart, M. C. and F. R. Riusech. 2001. Age and growth of *Venustaconcha*: Effects of the 1993 flood. Platform presentation at national meeting of the Freshwater Mollusc Conservation Society, Pittsburg, PA.

Barnhart, M. C. 2001. Reproductive biology of Unionoida. Invited briefing for U.S. Fish and Wildlife Service, Region 3 Management Team. Minneapolis, MN. 4/9/01.

Barnhart, M. C. 2000. Reproduction in freshwater mussels. Kansas Pearly Mussel Meetings, Independence, KS. 8/10/00.

Barnhart, M. C. and Michael S. Baird. 2000. Age, growth, reproduction and demography of *Cumberlandia monodonta*. Kansas Pearly Mussel Meetings, Independence, KS. 8/10/00.

Barnhart, M. C. 2000. Conservation biology of unionid mussels. U. S. Fish and Wildlife Service, Ozark Regional Ecosystem Meeting, Van Buren, MO.

Barnhart, M. Christopher, and Frank A. Riusech. 2000. Age and growth of freshwater mussels inferred from shell annuli: effects of the 1993 flood. Missouri Natural Resources Conference, Lake of the Ozarks.

Baird, Michael S., and M. Christopher Barnhart. 2000. Population age structure of the spectaclecase mussel, *Cumberlandia monodonta.* Missouri Natural Resources Conference, Lake of the Ozarks.

Barnhart, M. C. 1999. Pearls and Perils in Ozark Streams. Showcase on Faculty Research. Missouri State Office of Academic Affairs. Invited

Baird, M. S., and M. C. Barnhart. 1999. Population age structure of the spectaclecase mussel, *Cumberlandia monodonta*. Great Plains Limnology Meeting, Columbia, MO.

Barnhart, M. C. and A. R. Roberts. 1999. Life history of the flat floater mussel *Anodonta suborbiculata.* Great Plains Limnology Meeting, Columbia, MO.

Barnhart, M. C. 1999. Potential hosts and reproductive characteristics of some unusual unionoids. Symposium of the Freshwater Mollusk Conservation Society, March 17-19, Chattanooga, TN. Platform presentation.

Barnhart, M. C. 1999. Unio Gallery. Symposium of the Freshwater Mollusk Conservation Society, March 17-19, Chattanooga, TN. Platform presentation.

Barnhart, M. C. and F. A. Riusech. 1999. Host utilization and suitability among *Venustaconcha* populations in different river drainages. Symposium of the Freshwater Mollusk Conservation Society, March 17-19, Chattanooga, TN. Platform presentation.

Baird, M. S. and Barnhart, M. C. 1999. Survival and growth of *Lampsilis* species in a recirculating rearing system. Symposium of the Freshwater Mollusk Conservation Society, March 17-19, Chattanooga, TN. Platform presentation.

Barnhart, M.C. 1999. Ecology and conservation of freshwater molluscs. Invited lecture. Tri-Beta National Biological Honor Society, Northcentral District II Convention. Lay Field Station, St. Louis University. April 10.

Barnhart, M.C. 1999. Captive rearing of native mussels: last chance for endangered species in Missouri? Platform presentation, Missouri Natural Resources Conference, Lake of the Ozarks, MO.

Baird, M.S. and M.C. Barnhart. 1999. Life history of the freshwater bivalve, *Cumberlandia monodonta.* Missouri Natural Resources Conference, Lake of the Ozarks, MO. Platform presentation.

Barnhart, M.C. 1998. Reproduction in freshwater mussels. Invited presentation at Tri-State meeting of the American Fisheries Society, Fayetteville, Arkansas. February 10, 1998.

Ruisech, F.A. and M. C. Barnhart. 1998. Host suitability differences among V*enustaconcha ellipsiformis* (Bivalvia: Unionidae) from different river drainages. Poster presentation at 46th Annual Meeting of the North American Benthological Society, Charlottetown, PEI, Canada. June 4.

Hansen, D. and M. C. Barnhart. 1998. Hypoxia in the marsupium of the amphipod, *Gammarus pseudolimnaeus.* Oral presentation, 46th Annual Meeting of the North American Benthological Society, Charlottetown, PEI, Canada. June 3.

Barnhart, M.C. and A.D. Roberts. 1998. Effects of temperature, pH, and CO_2 on transformation of glochidia of the flat floater mussel, *Anodonta suborbiculata.* Presentation at symposium: Conservation, captive care and propagation of freshwater mussels. Columbus, Ohio.

Riusech, F. and M.C. Barnhart. 1998. Host suitability differences among populations of *Venustaconcha ellipsiformis* (Bivalvia, Unionidae) from different river drainages. Presentation at symposium: Conservation, captive care and propagation of freshwater mussels. Columbus, Ohio.

Barnhart, M.C. 1998. Unionid mussels in the St. John's Basin and New Madrid Floodway. Presentation at inter-agency planning meeting, January 9, Cape Girardeau, Missouri.

Barnhart, M.C. 1997. Sterile eggs in unionid mussels and their roles in conglutinate function. Annual Meeting, North American Benthological Society. San Marcos Texas, 6/97.

Roberts, A.D., A.P. Farnsworth, J. Sternburg and M. C. Barnhart. 1997. Freshwater mussels in Missouri's Bootheel: rediscovery of the fat pocketbook mussel in Missouri. Oral presentation at Missouri Forest, Fish and Wildlife Conference, Lake of the Ozarks, Missouri, February 7, 1997.

Barnhart, M.C. and A.D. Roberts. 1997. Reproduction and fish hosts of the federally endangered fat pocketbook mussel, *Potamilus capax*. Oral presentation at Missouri Forest, Fish and Wildlife Conference, Lake of the Ozarks, Missouri, February 7, 1997.

Barnhart, M.C. 1997. Reproductive biology of freshwater mussels. Invited lecture. Zoology Department and Oklahoma State Biological Survey, University of Oklahoma, Norman, Oklahoma. February 12, 1997.

Mills, N. E. and M.C. Barnhart. 1997. Effects of dissolved oxygen on embryo development in two *Ambystoma* and two *Rana* species. Interdisciplinary forum Missouri State. April 19, 1997.

Mills, N. E. and M.C. Barnhart. 1997. Effects on hypoxia on embryonic development in amphibians. Prairie States Ecology Conclave. Pittsburg, KS. Prairie State Park. April 26, 1997.

Kacie Jensen

Subject:	Saluda (Lake Murray) Relicensing: Terrestrial; Freshwater Mussel/Benthic Inverts; and Rare, Threatened and Endangered Species Technical Working Committee Meetings
Location:	Lake Murray Training Center
Start:	Wed 3/8/2006 9:00 AM
End:	Wed 3/8/2006 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Amanda Hill (amanda_hill@fws.gov); Jennifer Price; Ron Ahle (ahler@dnr.sc.gov); EPPINK, THOMAS G; Bob Seibels; Dick Christie; Gerrit Jobsis (American Rivers); Gerrit Jobsis (CCL); Steve Summer; Alan Stuart; Alison Guth; Bill Argentieri; Randy Mahan; BakerB@dnr.sc.gov; bstutts@scana.com

Hello Folks:

As discussed in the Fish and Wildlife Resource Conservation Group (RCG) meeting last week, the inaugural meetings of the Terrestrial, Freshwater Mussel/Benthic Invert, and Rare, Threatened and Endangered Species Technical Working Committees (TWCs) will be held on Wednesday March 8 at the Lake Murray Training Center. Throughout the relicensing process, similar efforts will be made to combine meeting to a single day to ease the travel burden on involved stakeholders and agency staff. A draft agenda is provided below for those who only want to attend the committees for which they are a member. Finally, please RSVP so that we can make the proper arrangements for lunch.

Thanks for you continued participation in the Saluda Relicensing.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

Fish and Wildlife
TWC Agenda 3...

Saluda Hydro Relicensing
Fisheries and Wildlife Technical Working Committees:
Terrestrial, Freshwater Mussels & RTE

Meeting Agenda

March 8, 2006
9:00 AM
Lake Murray Training Center

- **9:00 to 10:30** **Freshwater Mussels/Benthic Macroinvertebrates TWC**

  Members: Shane Boring, Ron Ahle, Amanda Hill, Jennifer Price, SCDHEC Representative

  Discussion Items: Mussel Surveys, Benthic Macroinvertebrate Study

- **10:30 to 12:00** **Terrestrial TWC**

  Members: Shane Boring, Dick Christie, Ron Ahle, Buddy Baker, Amanda Hill, Brandon Stutts

  Discussion Items: habitat, botanical, waterfowl hunting, Migratory Bird Surveys

- **12:00 to 12:30** Lunch

- **12:30 to 3:00** **RT&E TWC**

  Members: Shane Boring, Gerrit Jobsis, Ron Ahle, Bob Seibels, Amanda Hill, Tom Eppink

  Discussion Items: Rare Threatened and Endangered Species/Habitat Studies – Including Wood Stork, Saluda Crayfish, Carolina Darter

- **3:00** **Adjourn**

Saluda HYDRO RELICENSING

Kacie Jensen

From: Shane Boring
Sent: Friday, February 10, 2006 2:37 PM
To: Shane Boring; 'Amanda Hill (amanda_hill@fws.gov)'; 'Hal Beard (BeardH@scdnr.state.sc.us)'; 'Prescott Brownell (prescott.brownell@NOAA.gov)'; 'Steve Summer (ssummer@scana.com)'; 'dchristie@infoave.net'; 'Mark A. Cantrell (mark_a_cantrell@fws.gov)'; 'Steve Leach'; Alan Stuart; Alison Guth; BARGENTIERI@scana.com
Cc: RMAHAN@scana.com
Subject: RE: Saluda Hydro Relicense: Draft Diadromous Fish Conferece Call Meeting Notes and 2006 Study Plan

Hello folks:

Attached are the final meeting notes from our January 9th diadromous fish conference call, as well as an updated study plan reflecting the changes agreed to during the meeting (i.e. relocation of the Congaree sampling site to the vicinity of the I-77 bridge, etc.). Thanks to all who provided comments.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2006 Saluda Diadromous Fish St... 2005-01-09 adromous fish mee.

Alison,

Could you please post these documents to the Saluda Relicensing Website.

-----Original Message-----
From: Shane Boring
Sent: Friday, January 13, 2006 12:12 PM
To: Shane Boring; 'Amanda Hill (amanda_hill@fws.gov)'; 'Hal Beard (BeardH@scdnr.state.sc.us)'; 'Prescott Brownell (prescott.brownell@NOAA.gov)'; 'Steve Summer (ssummer@scana.com)'; 'dchristie@infoave.net'; 'Mark A. Cantrell (mark_a_cantrell@fws.gov)'; 'Steve Leach'; Alan Stuart; Alison Guth; Argentieri, Bill
Cc: MAHAN, RANDOLPH R
Subject: Saluda Hydro Relicense: Draft Diadromous Fish Conferece Call Meeting Notes and 2006 Study Plan

Hello All:

Attached for your review are the draft meeting notes from our conference call on Monday. As promised, I have made the agreed-to changes to the study plan and an updated 2006 Study Plan is also attached. To facilitate a quick review of the study plan, changes have been highlighted in the draft. It should be noted that the map of sampling sites is not included as it is being updated by our GIS staff to reflect the movement of the Congaree site to the I-77 Bridge. It should also be noted that the 2005 Study Plan included as a task review of the historical records of target diadromous species in the study area. Since my library research resulted in no additional records beyond what is present in the 2 reviews that are summarized in the study plan (Welch 2000, Newcomb and Fuller 2001), this task has been eliminated from the 2006 plan. If possible, please have your comments on these 2 documents back to me by Wednesday, January 25th. I apologize for the short turnaround time; however, sampling is salted to begin on February 1. I thank you all for your input on this issue.

C. Shane Boring
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West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

<< File: 2006 Saluda Diadromous Fish Study Plan (DRAFT;01132005;CSB).doc >> << File: 2005-01-09 Diadromous fish meeting notes (draft;01112005;CSB).doc >>

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
DIADROMOUS FISH CONFERENCE CALL

January 9, 2006

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Steve Summer, SCANA Services
Prescott Brownell, NOAA Fisheries
Mark Cantrell, USFWS
Jeff Isely, Clemson Univ.
Alison Guth, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Amanda Hill, USFWS
Steve Leach, SCDNR

ACTION ITEMS :

- Incorporate agreed-upon changes into study plan and distribute for review S. Boring
- Prepare meeting notes and distribute for review S. Boring

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting with a brief review of the 2005 diadromous fish sampling results, a final report of which was distributed to the group via e-mail on January 4, 2006. Specifically it was noted that 78 fish of 14 species were encountered during the study; however, none of the target diadromous species (American shad, hickory shad, and blueback herring) were captured.

Several group members expressed concern that target species may not have been detected due to difficulties encountered with sampling gear (i.e., inability to sample and/or blown out nets due to high flows, clogging of nets with *Elodea*, etc.). Jeff Isely noted that despite the fact that sites were not sampled in some instances due to high flows, these instances were made up for by adding additional samples. Jeff added that he felt his crews were able to effectively sample the upper 3 (Saluda River) sites, and as such, the lack of diadromous species in these samples were reflective of actual conditions in the Saluda during the sampling period. He added that the Congaree site (Rosewood Landing) was more problematic due to high flows and that results from the site may be less reflective of actual conditions. He noted that nets at the Congaree site often drifted or were blown out by the current.

Jeff noted that the Congaree could likely be more effectively sampled if the site were moved to the vicinity of the I-77 bridge, but that he had not relocated due to concerns about encountering shortnose sturgeon. Prescott Brownell noted that numerous researchers and commercial fishermen were gillnetting in sturgeon waters, and it was his understanding that this was acceptable as long as they were not targeting sturgeon specifically. The group subsequently agreed to move the Congaree

sampling site to the I-77 location, with the understanding that sampling would cease there in the event that a sturgeon is encountered. Shane Boring agreed to incorporate this change in the 2006 study plan.

Alan Stuart enquired as to the number of fish documented as passing at Pinopolis this year, and noted that the lack of target species in the sample may be indicative of lower-than-average movement of diadromous species in the Santee Basin during the 2005 migration. Steve Leach noted that approximately 200,000 American shad were passed at Pinopolis, and that these numbers were about average over the long-term. He added that several fishermen had noted encountering shad on the Congaree during the period as well. Jeff Isely noted that temperatures in the Saluda were between 12 and 14º C during most of the sampling period, while temperatures in the Broad and Congaree were as high as 18º C, and that this may have contributed to reduced numbers of diadromous species at the Saluda sampling sites.

The group briefly discussed how to address the issue of nets clogging with *Elodea* and other debris. Jeff Isely indicated that fishing nets parallel to the current, rather than perpendicular, might be beneficial. He also noted that he might use a lighter test monofilament for nets in the Saluda to reduce visibility of the nets. The group agreed that these modifications were acceptable. Amanda Hill noted that having more, shorter net sets might reduce the amount of debris trapped in the nets; thus increasing their capture efficiency. The group briefly discussed this and agreed to change from a single 4-hour net set per day at each site to three 2-hour net sets. Shane Boring was tasked with incorporating this change into the study plan.

Several agency staff recommended incorporating night or crepuscular net sets in an effort to increase capture efficiency. Steve Summer noted that the Saluda can be very difficult to navigate safely even during the day, and that he had apprehensions about the safety of crews netting at night. Jeff Isely noted that a few sites (Radio Tower, Saluda Shoals, and I-77) could potentially be fished safely at night, and that he would attempt to periodically sample some of these sites if, based on field observations at the time, it appeared feasible and safe. It was agreed that Jeff should use his best judgment regarding this matter, but that crew safety should be top priority.

The group briefly discussed the effectiveness of the current eel sampling methodology. Specifically, USFWS staff noted that use of traps similar those being used on the Saluda have proven generally ineffective at other projects (Roanoke Rapids, Catawba-Wateree). Further, it was recommended that an eel ramp with attached capture chamber and attraction flow pump might be more effective. Mark Cantrell noted that Duke has had considerable success capturing eels with this method and suggested that a similar approach might be feasible at the Saluda Spillway. Mark agreed to distribute some literature on design /effectiveness of this approach to the group via e-mail. Shane Boring noted that evaluating the feasibility of this approach for Saluda would likely require more in-depth discussion, but that in the short-term, a decision needs to be made regarding whether

or not continue the current trapping. The group agreed that further discussion of the ramp methodology is warranted, but that for the time being, eel trapping should continue as outlined in the study plan. USFWS staff also noted that trapping at Roanoke Rapids had greatest success when water temperatures approach 15ºC and that sampling should attempt to focus on this period.

The group closed the meeting with a brief review of the status of SCE&G's request for a scientific research permit from NOO Fisheries for shortnose sturgeon. Specifically, Shane Boring noted that he had spoken with Shane Guan from NOAA Fisheries via phone during December and several times since via e-mail. Shane Guan indicated that he had completed a draft Environmental Assessment for the application that concluded No Significant Impact to the species, and that the application had been passed on to the NOAA Fisheries Endangered Species section on approximately October 7 for Section 7 consultation under the Endangered Species Act. He also noted that, upon following-up with the Endangered Species Section, he was surprised to learn that they were still in the pre-consultation stage and had not yet begun formal consultation. Shane Boring noted that it remains unclear at this time whether a permit will be obtained in time to begin sampling on February 1; however, he added that they planned on having field equipment ready in the event a permit is granted.

Saluda Hydroelectric Project (FERC No. 516)

Study Plan

Study Plan Name: 2006 Diadromous Fish Studies
Applicable Hydro Projects: Saluda Hydro FERC No. 516

I. Study Objective

The objectives of this study are: (1) to document presence / absence of target diadromous fish species in the Lower Saluda River (LSR) and the upper Congaree River during the spring migratory period; (2) to determine the relative abundance and spatial and temporal distributions of species found to be present in the reach; and (3) to document spawning of these species in the Saluda River relative to the Congaree River. Target anadromous species for the study include American shad (*Alosa sappadissima*), hickory shad (*Alosa mediocris*), and blueback herring (*Alosa aestivalis*). One catadromous species, the American eel (*Anguila rostrata*), will also be targeted. Sampling of the LSR and upper Congaree River for target diadromous species during the spring spawning season will be necessary to meet this objective.

II. Basis

Restoration of anadromous clupeids to South Carolina waters has become an important objective of resource agencies. Each spring, efforts to pass migrating American shad and blueback herring are undertaken at the first barriers to migration in the Santee - Cooper system. Once passed, these fish have several migration pathways from which to choose. One such pathway results in these fish entering the Saluda River near Columbia. The relative abundance and potential spawning of this segment of the population is of particular interest to managers.

The FERC licensing process requires an assessment of potential impacts to fish and wildlife resources by the project and its operations (18CFR4.51). The United States Fish and Wildlife Service (USFWS) has mandatory conditioning authority for fishway prescriptions at all FERC licensed hydro projects; and the National Oceanographic and Atmospheric Administration – National Marine Fisheries Service (NOAA Fisheries) has similar mandatory conditioning authority where anadromous and/or catadromous species are involved.

III. Geographic and Temporal Scope

Diadromous fish studies will focus on the Lower Saluda River (LSR), from downstream of Saluda Hydro Dam to its confluence with the Broad River, and the upper Congaree River, from its origin at the confluence of the Saluda and Broad rivers to approximately the Interstate-77 Bridge. Studies are scheduled to begin in February 2006, with a final report issued by December 31, 2006.

IV. Summary of Existing Data

The South Carolina Department of Natural Resources (SCDNR), USFWS, and NOAA Fisheries have collaborated to develop the Santee Cooper Basin Diadromous Fish Passage Restoration Plan (USFWS et al. 2001), which has been submitted to and accepted by FERC as a Comprehensive Plan under Section 10(a)(2)(a) of the Federal Power Act. The plan identifies the Saluda River as being less than optimal for diadromous fish restoration efforts for a variety of reasons including: the large number of dams in the basin (approximately 13); the limited number of river miles available to upstream migrating fish prior to reaching the Saluda Hydro Dam (approximately 10); and the cost and potential biological limitation (i.e., pressure-related impacts to outmigrating fish) of establishing fish passage at the Saluda Hydro Dam. In addition, cold hypolimnetic water released from the Saluda Hydro Dam may cause migrating fish to select the warmer water of the Broad River and not enter the Saluda (USFWS et al. 2001).

According to two recent reviews (Welch 2000, Newcomb and Fuller 2001), the target species noted above (American shad, hickory shad, blueback herring, and American eel) are among the diadromous fish species that occurred historically in Saluda-Congaree sub-basin. Shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus*) also occurred historically in the sub-basin; however, these species have not been recently documented in the study area upstream of old Granby Lock and Dam. While some limited fish passage above old Granby Lock and Dam may be possible through the abandoned lock or during high flows, passage may be hindered for bottom-oriented species (USFWS et al. 2001) such as sturgeons.

V. Methodology

Gillnetting

Adult American shad, hickory shad, and blueback herring will be sampled using gillnetting methods during the 2006 spawning season. Sampling for target species will occur at the following four locations (Figure 1):

1. The LSR at Hope Ferry Landing;
2. The LSR upstream of the Gardendale Canoe Landing;
3. The LSR adjacent to Riverbanks Zoo; and
4. The Congaree River in the vicinity of the Interstate-77 Bridge.

The above sites will be sampled a minimum of one day per week from approximately February 1 through March 1 or until notification from the SCDNR that significant numbers of anadromous alosids have begun to move through the St. Stephens Fish Lift; sites will be sampled two days per week thereafter through April. Beginning on or around May 1, sampling will again be reduced to a minimum of one day per week and will continue until approximately June 1. At each location, sampling will occur during daylight hours and will employ 3 net sets, each of 2 hour duration. If deemed safe and feasible by the sampling crew, additional nighttime and/or crepuscular net sets may also be employed.

Gillnetting will utilize two 100 ft-long (30.5 m) monofilament gill nets at each sampling location: (1) one – 30 m x 2 m, 2.5 in (6.4 cm) stretch mesh; and (2) one – 30 m x 2 m, 5 in (12.7 cm) stretch mesh. Each net will be set perpendicular, parallel, or at an angle to the shore, with the larger mesh net set downstream of the smaller. All fish collected in the gill nets will be identified to species, weighed (0.1 kg), measured for total length (mm), sexed (if possible without sacrificing), and released alive when possible. A measurement of water temperature (ºC) and dissolved oxygen (mg/L) will also be taken at each location.

Survey data will be evaluated for presence or absence of diadromous species known to have occurred historically in this reach of the Saluda/Congaree sub-basin. In addition, a species list will be compiled of all species encountered during the study. Catch per Unit Effort (number of fish/net hours fished) will be determined and presented in the final report. Data will be compared by date and location.

Ichthyoplankton Sampling

Ichthyoplankton nets will be fished in conjunction with gillnets, whenever possible. Specifically, one plankton net (0.5 m x 1 m, 1.0 mm mesh; surface and bottom), equipped with flowmeter, will be fished in the general vicinity of each gillnetting location. Nets will be anchored facing upstream in sufficient flow to sample effectively. Nets will be deployed after the first gillnet is set at each location and allowed to fish for four hours. If no ichthyoplankton are collected, or if clogging of the net proves to be problematic, the length of time that the nets are fished may need to be adjusted in consultation with the resource agencies.

Ichthyoplankton samples will be preserved in Buffered Neutral Formalin (BNF) and returned to the laboratory for identification. All alosid larvae and eggs will be measured for standard length (0.1 mm) and identified to the lowest possible taxon. Larval densities (number / cm^3) will be calculated, compared by date and location, and presented in the final report.

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Eel Traps will be baited and allowed to fish undisturbed for two days each week from February through May. Traps will also be deployed at the following locations to document presence/absence and relative abundance of adult and juvenile Amercan eels:

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2. The mouth of Rawls Creek adjacent to Saluda Shoals Park;
3. The mouth of Twelvemile Mile Creek or the base of Corley Mill Dam, depending on suitable access; and
4. The LSR downstream of Interstate 26 near the USGS gaging station.

All captured eels will be identified, measured for total length (0.1 mm), examined and released and the location of capture will be noted.

VI. <u>Schedule and Required Conditions</u>

Sampling for target diadromous species below the Saluda Hydro Dam will be conducted from February through May during 2006. A draft report summarizing the 2006 sampling results will be issued by November 1, 2006, with a final report issued by December 31, 2006. The final report will include all sampling results and conclusions regarding presence and population status of diadromous species, as well as a summary of historical distributions in the area.

VII. <u>Use of Study Results</u>

Results of the diadromous fish study will be used as an information resource during discussion of relicensing issues with the SCDNR, USFWS, relicensing issue working groups and other relicensing stakeholders.

VIII. Study Participants

	NAME	ORGANIZATION	PHONE	E-MAIL
Applicant Leads	Stephen E. Summer	SCANA Services	(803)217-7357	ssummer@scana.com
	Alan W. Stuart	Kleinschmidt	(803)822-3177	alan.stuart@kleinschmidtusa.com
	Shane Boring	Kleinschmidt	(803)822-3177	shane.boring@kleinschmidtusa.com
Agency Leads	Dick Christie	SCDNR	(803)289-7022	dchristie@infoave.net
	Amanda Hill	USFWS	(843)727-4707, x303	Amanda_hill@fws.gov
	Prescott Brownell	NOAA Fisheries	(843)953-7204	Prescott.brownell@noaa.gov
Other Participants	William Argentieri	SCE&G	(803)217-9162	bargentieri@scana.com
	Randy Mahan	SCANA Services	(803)217-9538	rmahan@scana.com

IX. List of Attachments

ATTACHMENT A: Map of Diadromous Fish Sampling Locations on the Lower Saluda and Upper Congaree Rivers

ATTACHMENT B: Meeting Notes from January 9, 2006, Diadromous Fish Study Conference Call

X. List of References

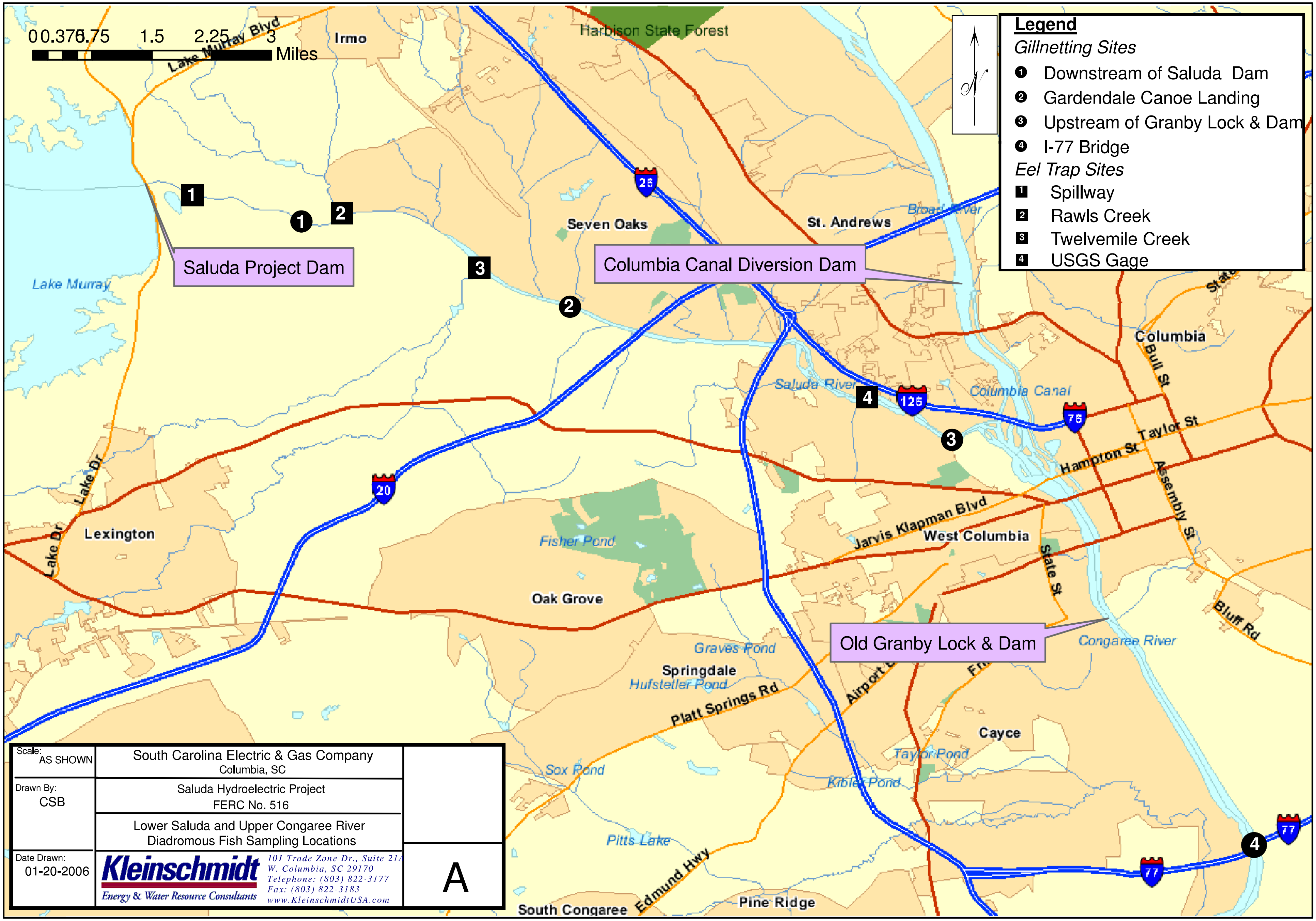
Newcomb, T.J. and J.S. Fuller. 2001. Anadromous and catadromous fish survey of Santee/Cooper Basin in North Carolina and South Carolina. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. Final Report, Prepared for Duke Power, June 25, 2001. 25 pp.

United States Fish and Wildlife Service, National Marine Fisheries Service, and South Carolina Department of Natural Resources. 2001. Santee-Cooper Basin diadromous fish passage restoration plan.

Welch, S.M. 2000. A report on the historical inland migrations of several diadromous fishes in South Carolina Rivers. Department of Aquaculture, Fisheries and Wildlife, Clemson University, Clemson, SC. Report prepared for Mr. Douglas W. Cook, South Carolina Department of Natural Resources. December 4, 2000. 19 pp.

ATTACHMENT A

Map of Diadromous Fish Sampling Locations on the Lower Saluda and Upper Congaree Rivers



Scale: AS SHOWN	South Carolina Electric & Gas Company Columbia, SC	
Drawn By: CSB	Saluda Hydroelectric Project FERC No. 516	
	Lower Saluda and Upper Congaree River Diadromous Fish Sampling Locations	
Date Drawn: 01-20-2006	Kleinschmidt Energy & Water Resource Consultants 101 Trade Zone Dr., Suite 21A W. Columbia, SC 29170 Telephone: (803) 822-3177 Fax: (803) 822-3183 www.KleinschmidtUSA.com	A

ATTACHMENT B

Meeting Notes from January 9, 2006, Diadromous Fish Conference Call

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
DIADROMOUS FISH CONFERENCE CALL

January 9, 2006

ATTENDEES:

Alan Stuart, Kleinschmidt Associates
Steve Summer, SCANA Services
Prescott Brownell, NOAA Fisheries
Mark Cantrell, USFWS
Jeff Isely, Clemson Univ.
Alison Guth, Kleinschmidt Associates
Shane Boring, Kleinschmidt Associates
Amanda Hill, USFWS
Steve Leach, SCDNR

ACTION ITEMS :

- Incorporate agreed-upon changes into study plan and distribute for review — S. Boring
- Prepare meeting notes and distribute for review — S. Boring

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting with a brief review of the 2005 diadromous fish sampling results, a final report of which was distributed to the group via e-mail on January 4, 2006. Specifically it was noted that 78 fish of 14 species were encountered during the study; however, none of the target diadromous species (American shad, hickory shad, and blueback herring) were captured.

Several group members expressed concern that target species may not have been detected due to difficulties encountered with sampling gear (i.e., inability to sample and/or blown out nets due to high flows, clogging of nets with *Elodea*, etc.). Jeff Isely noted that despite the fact that sites were not sampled in some instances due to high flows, these instances were made up for by adding additional samples. Jeff added that he felt his crews were able to effectively sample the upper 3 (Saluda River) sites, and as such, the lack of diadromous species in these samples were reflective of actual conditions in the Saluda during the sampling period. He added that the Congaree site (Rosewood Landing) was more problematic due to high flows and that results from the site may be less reflective of actual conditions. He noted that nets at the Congaree site often drifted or were blown out by the current.

Jeff noted that the Congaree could likely be more effectively sampled if the site were moved to the vicinity of the I-77 bridge, but that he had not relocated due to concerns about encountering shortnose sturgeon. Prescott Brownell noted that numerous researchers and commercial fishermen were gillnetting in sturgeon waters, and it was his understanding that this was acceptable as long as they were not targeting sturgeon specifically. The group subsequently agreed to move the Congaree

sampling site to the I-77 location, with the understanding that sampling would cease there in the event that a sturgeon is encountered. Shane Boring agreed to incorporate this change in the 2006 study plan.

Alan Stuart enquired as to the number of fish documented as passing at Pinopolis this year, and noted that the lack of target species in the sample may be indicative of lower-than-average movement of diadromous species in the Santee Basin during the 2005 migration. Steve Leach noted that approximately 200,000 American shad were passed at Pinopolis, and that these numbers were about average over the long-term. He added that several fishermen had noted encountering shad on the Congaree during the period as well. Jeff Isely noted that temperatures in the Saluda were between 12 and 14º C during most of the sampling period, while temperatures in the Broad and Congaree were as high as 18º C, and that this may have contributed to reduced numbers of diadromous species at the Saluda sampling sites.

The group briefly discussed how to address the issue of nets clogging with *Elodea* and other debris. Jeff Isely indicated that fishing nets parallel to the current, rather than perpendicular, might be beneficial. He also noted that he might use a lighter test monofilament for nets in the Saluda to reduce visibility of the nets. The group agreed that these modifications were acceptable. Amanda Hill noted that having more, shorter net sets might reduce the amount of debris trapped in the nets; thus increasing their capture efficiency. The group briefly discussed this and agreed to change from a single 4-hour net set per day at each site to three 2-hour net sets. Shane Boring was tasked with incorporating this change into the study plan.

Several agency staff recommended incorporating night or crepuscular net sets in an effort to increase capture efficiency. Steve Summer noted that the Saluda can be very difficult to navigate safely even during the day, and that he had apprehensions about the safety of crews netting at night. Jeff Isely noted that a few sites (Radio Tower, Saluda Shoals, and I-77) could potentially be fished safely at night, and that he would attempt to periodically sample some of these sites if, based on field observations at the time, it appeared feasible and safe. It was agreed that Jeff should use his best judgment regarding this matter, but that crew safety should be top priority.

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Kacie Jensen

From: Shane Boring
Sent: Friday, January 13, 2006 12:12 PM
To: Shane Boring; 'Amanda Hill (amanda_hill@fws.gov)'; 'Hal Beard (BeardH@scdnr.state.sc.us)'; 'Prescott Brownell (prescott.brownell@NOAA.gov)'; 'Steve Summer (ssummer@scana.com)'; 'dchristie@infoave.net'; 'Mark A. Cantrell (mark_a_cantrell@fws.gov)'; 'Steve Leach'; Alan Stuart; Alison Guth; BARGENTIERI@scana.com
Cc: RMAHAN@scana.com
Subject: Saluda Hydro Relicense: Draft Diadromous Fish Conferece Call Meeting Notes and 2006 Study Plan

Hello All:

Attached for your review are the draft meeting notes from our conference call on Monday. As promised, I have made the agreed-to changes to the study plan and an updated 2006 Study Plan is also attached. To facilitate a quick review of the study plan, changes have been highlighted in the draft. It should be noted that the map of sampling sites is not included as it is being updated by our GIS staff to reflect the movement of the Congaree site to the I-77 Bridge. It should also be noted that the 2005 Study Plan included as a task review of the historical records of target diadromous species in the study area. Since my library research resulted in no additional records beyond what is present in the 2 reviews that are summarized in the study plan (Welch 2000, Newcomb and Fuller 2001), this task has been eliminated from the 2006 plan. If possible, please have your comments on these 2 documents back to me by Wednesday, January 25th. I apologize for the short turnaround time; however, sampling is salted to begin on February 1. I thank you all for your input on this issue.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2006 Saluda Diadromous Fish St..

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MEETING NOTES

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SALUDA HYDRO PROJECT RELICENSING
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January 9, 2006

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Saluda Hydroelectric Project (FERC No. 516)

Study Plan

Study Plan Name: 2006 Diadromous Fish Studies
Applicable Hydro Projects: Saluda Hydro FERC No. 516

I. Study Objective

The objectives of this study are: (1) to document presence / absence of target diadromous fish species in the Lower Saluda River (LSR) and the upper Congaree River during the spring migratory period; (2) to determine the relative abundance and spatial and temporal distributions of species found to be present in the reach; and (3) to document spawning of these species in the Saluda River relative to the Congaree River. Target anadromous species for the study include American shad (*Alosa sappadissima*), hickory shad (*Alosa mediocris*), and blueback herring (*Alosa aestivalis*). One catadromous species, the American eel (*Anguila rostrata*), will also be targeted. Sampling of the LSR and upper Congaree River for target diadromous species during the spring spawning season will be necessary to meet this objective.

II. Basis

Restoration of anadromous clupeids to South Carolina waters has become an important objective of resource agencies. Each spring, efforts to pass migrating American shad and blueback herring are undertaken at the first barriers to migration in the Santee - Cooper system. Once passed, these fish have several migration pathways from which to choose. One such pathway results in these fish entering the Saluda River near Columbia. The relative abundance and potential spawning of this segment of the population is of particular interest to managers.

The FERC licensing process requires an assessment of potential impacts to fish and wildlife resources by the project and its operations (18CFR4.51). The United States Fish and Wildlife Service (USFWS) has mandatory conditioning authority for fishway prescriptions at all FERC licensed hydro projects; and the National Oceanographic and Atmospheric Administration – National Marine Fisheries Service (NOAA Fisheries) has similar mandatory conditioning authority where anadromous and/or catadromous species are involved.

III. Geographic and Temporal Scope

Diadromous fish studies will focus on the Lower Saluda River (LSR), from downstream of Saluda Hydro Dam to its confluence with the Broad River, and the upper Congaree River, from its origin at the confluence of the Saluda and Broad rivers to approximately the Interstate-77 Bridge. Studies are scheduled to begin in February 2006, with a final report issued by December 31, 2006.

IV. Summary of Existing Data

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Results of the diadromous fish study will be used as an information resource during discussion of relicensing issues with the SCDNR, USFWS, relicensing issue working groups and other relicensing stakeholders.

VIII. Study Participants

	NAME	ORGANIZATION	PHONE	E-MAIL
Applicant Leads	Stephen E. Summer Alan W. Stuart Shane Boring	SCANA Services Kleinschmidt Kleinschmidt	(803)217-7357 (803)822-3177 (803)822-3177	ssummer@scana.com alan.stuart@kleinschmidtusa.com shane.boring@kleinschmidtusa.com
Agency Leads	Dick Christie Amanda Hill Prescott Brownell	SCDNR USFWS NOAA Fisheries	(803)289-7022 (843)727-4707, x303 (843)953-7204	dchristie@infoave.net Amanda_hill@fws.gov Prescott.brownell@noaa.gov
Other Participants	William Argentieri Randy Mahan	SCE&G SCANA Services	(803)217-9162 (803)217-9538	bargentieri@scana.com rmahan@scana.com

IX. List of Attachments

ATTACHMENT A: Map of Diadromous Fish Sampling Locations on the Lower Saluda and Upper Congaree Rivers

ATTACHMENT B: Meeting Notes from January 9, 2006, Diadromous Fish Study Conference Call

X. List of References

Newcomb, T.J. and J.S. Fuller. 2001. Anadromous and catadromous fish survey of Santee/Cooper Basin in North Carolina and South Carolina. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. Final Report, Prepared for Duke Power, June 25, 2001. 25 pp.

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ATTACHMENT A

Map of Diadromous Fish Sampling Locations on the Lower Saluda and Upper Congaree Rivers

ATTACHMENT B

Meeting Notes from January 9, 2006, Diadromous Fish Conference Call

Kacie Jensen

From: Ed Diebold [ediebold@riverbanks.org]

Sent: Friday, January 06, 2006 12:00 PM

To: Alison Guth

Cc: Amanda_Hill@fws.gov; bill_hulslander@nps.gov; Bob Seibels; cheetahtrk@yahoo.com; dchristie@infoave.net; kayakduke@bellsouth.net; gjobsis@americanrivers.org; KIRKLAGL@dhec.sc.gov; Jeff_Duncan@NPS.gov; wildlife@sc.rr.com; Malcolml@mailbox.sc.edu; mark_Leao@fws.gov; lucky8lady@aol.com; Norm@sc.rr.com; PatrickM@scccl.org; Prescott.Brownell@noaa.gov; crafton@usit.net; ahler@dnr.sc.gov; samnancydrake@aol.com; Shane Boring; bellsteve9339@bellsouth.net; leachs@dnr.sc.gov; ssummer@scana.com; suzrhodes@juno.com; BeardH@dnr.sc.gov; BalesW@dnr.sc.gov; dianlog8@aol.com; marshallb@dnr.sc.gov; billeast@sc.rr.com; RLavisky@BBandT.com; Elymay2@aol.com

Subject: RE: Draft Fish and Wildlife Mission Statement

Hi Alison,

Here are suggestions from Bob Seibels and me.

Best Wishes,

Ed Diebold, Director of Animal Collections
Riverbanks Zoo & Botanical Garden
P.O. Box 1060
Columbia, SC 29202-1060
Phone: 803-779-8717, extension 1135
FAX: 803-253-6381
E-mail: ediebold@riverbanks.org

-----Original Message-----
From: Alison Guth [mailto:Alison.Guth@KleinschmidtUSA.com]
Sent: Thursday, January 05, 2006 4:45 PM
To: 'Amanda_Hill@fws.gov'; 'bill_hulslander@nps.gov'; Bob Seibels; 'cheetahtrk@yahoo.com'; 'dchristie@infoave.net'; Ed Diebold; 'kayakduke@bellsouth.net'; 'gjobsis@americanrivers.org'; 'KIRKLAGL@dhec.sc.gov'; 'Jeff_Duncan@NPS.gov'; 'wildlife@sc.rr.com'; 'Malcolml@mailbox.sc.edu'; 'mark_Leao@fws.gov'; 'lucky8lady@aol.com'; 'Norm@sc.rr.com'; 'PatrickM@scccl.org'; 'Prescott.Brownell@noaa.gov'; 'crafton@usit.net'; 'ahler@dnr.sc.gov'; 'samnancydrake@aol.com'; Shane Boring; 'bellsteve9339@bellsouth.net'; 'leachs@dnr.sc.gov'; 'ssummer@scana.com'; 'suzrhodes@juno.com'; 'BeardH@dnr.sc.gov'; 'BalesW@dnr.sc.gov'; 'dianlog8@aol.com'; 'marshallb@dnr.sc.gov'; 'billeast@sc.rr.com'; 'RLavisky@BBandT.com'; 'Elymay2@aol.com'
Subject: Draft Fish and Wildlife Mission Statement

Hello All,

In our first Fish and Wildlife RCG meeting we discussed some of the components that the group felt should be included in a mission statement. Taking those components, the group tasked Randy with the job of developing a draft statement. Please look over the draft mission statement and let me know of any comments that you may have by January 19th. Thanks for your participation and let me know if you have any questions. ~ Alison

<<Fish and Wildlife RCG Mission Statement doc.doc>>

Alison Guth
Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
P: (803) 822-3177
F: (803) 822-3183

Fish and Wildlife Resource Conservation Group
Mission Statement

The mission of the Fish and Wildlife RCG is to develop a Protection, Mitigation, and Enhancement Agreement (PM&E Agreement) relative to fisheries and wildlife management for inclusion within the Saluda Hydroelectric Project license application. The objective of the PM&E Agreement shall be to assure the development and implementation of a level of integrated management best adapted to serve the public interests and to preserve the unique [array] inventory? reservoir? of natural resources associated with the Saluda Hydroelectric Project. To achieve this mission, the Fish and Wildlife RCG shall identify the need for, define the scope of, and manage or influence as appropriate, data collection and/or studies relative to impacted fish, wildlife, and plant species and ecological communities, eco-systems and/or habitat within the Saluda Hydroelectric Project.

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Fish and Wildlife RCG Mission ...

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Kacie Jensen

From: Shane Boring
Sent: Tuesday, May 22, 2007 8:40 AM
To: Shane Boring; 'Theresa Thom'; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Bud Badr'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Mike Waddell'; 'Milton Quattlebaum (mquattlebaum@scana.com)'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
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Subject: Saluda Hydro Relicense: April 10 Instream Flow TWC Meeting Notes

All:

Attached for your records are the final meeting notes from the April 10 Instream Flow/Aquatic Habitat TWC conference call, at which we discussed Habitat Suitability Criteria for the upcoming Lower Saluda IFIM Study. Thanks to all who contributed to what was a very productive session, and please don't hesitate to call if you have questions. As always, the notes will be posted on the Saluda relicensing website.

Shane Boring

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Phone: (803)822-3177
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2007-04-10
ıstream Flow-Aquat.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Final CSB 05-22-07

ATTENDEES:

Dick Christie, SCDNR
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Mike Waddell, Trout Unlimited
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR

ACTION ITEMS

- Gather and distribute substrate HSC plots and legends from Catawba-Wateree study for brown trout fry/spawning/juveniles to TWC

  Dick Christie / Shane Boring

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  Shane Boring/Brandon Kulik

NEXT MEETING

TBD

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:00 AM. Shane noted that, at the January 22nd meeting of the Instream Flow/Aquatic Habitat Technical Working Committee (TWC), the TWC had agreed upon Habitat Suitability Criteria (HSC) for depth and velocity for several target species (smallmouth bass, brown trout, and rainbow trout adults). Shane added that the purpose of today's meeting would be to finalize the HSC selection process by selecting substrate criteria for these species.

Shane enquired as to whether there was any follow-up discussion regarding the depth/velocity criteria selection process or other TWC housekeeping items in need of attention. Hal Beard noted that, at the previous meeting, there was an action item assigned to determine whether HSC curves were available for gizzard shad in riverine systems. Hal added that, after discussing this issue with colleagues at SCDNR, he did not think this species was as much of a priority as he had once thought.

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The group then turned their attention to the memo prepared by Shane Boring and Brandon Kulik (Attachment A), which summarized potential source HSC for substrate from a number of regional studies. After reviewing the source HSC plots for applicability to the lower Saluda, TWC members agreed on substrate HSC for the following species and lifestages:

Species	Life Stage	Curve Source	Modifications
brown trout	adult	Deerfield	Change 'Ledge' to 'Irregular Bedrock' and change SI of this category to 1.0
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	Fry	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
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smallmouth bass	Adult	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	Juvenile	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	YOY	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	spawning	Deerfield	Change 'Ledge' to 'Irregular Bedrock'

The group was not able to reach consensus on an acceptable substrate HSC for rainbow trout juveniles, fry or spawning due to limited source information (i.e., only the Raleigh et al. "Blue Book" value were presented). Mike Waddell, expressed interest in evaluating the curves used in the Catawba-Wateree IFIM Study before making a final selection for these lifestages. Dick Christie noted that these curves were presented in the Catawba-Wateree Final IFIM Report, but added that the legends needed to interpret the plots were not included. Dick agreed to contact the authors regarding the legends. Shane agreed to distribute the curves to the TWC once all of the information is gathered.

The meeting adjourned at approximately 11:00 AM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Substrate for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized "Bluebook" criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized "Bluebook" criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized "Bluebook" criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

LITERATURE CITED

Edwards, E.A., G. Gebhart, and O.E. Maughan. 1983. Habitat suitability information: smallmouth bass. U.S. Dept. Int., Fish Wildl. Serv. FWS/oES-32/10.36 47 pp.

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Newcomb, T.J., S.A. Perry and W.B. Perry. 1995. Comparison of habitat suitability criteria for smallmouth bass (*Micropterus dolomieu*) from three West Virginia rivers. Rivers 5(3):170-183.

Perry, S.A., W.B. Perry, D.L. Graham and N.H. Sagalkin. 1993. Verification and transferability studies for smallmouth bass in West Virginia streams. West Virginia Coop. Fish and Wildl. Res. unit, West Virginia Univ., Morgantown, WV.WVCFRUWRU Cooperative Agreement 14-16-0009-1563. 25 pp. plus appendices.

Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish and Wildl. Serv. FWS/OBS-82(10.124). 65 pp..

Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

Strakosh, T.R., R.M. Neumann, and R.A. Jacobsen. 2003. Development and assessment of habitat suitability criteria for adult brown trout in southern New England rivers. Ecology of Freshwater Fish 12:265-274. Blackwell Munksgaards, 2003.

Appendix A
Brown Trout Substrate Habitat Suitability Criteria

Kacie Jensen

From: Shane Boring
Sent: Tuesday, May 22, 2007 8:40 AM
To: Shane Boring; 'Theresa Thom'; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Bud Badr'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Mike Waddell'; 'Milton Quattlebaum (mquattlebaum@scana.com)'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
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2007-04-10
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MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Final CSB 05-22-07

ATTENDEES:

Dick Christie, SCDNR
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Mike Waddell, Trout Unlimited
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	YOY	Deerfield	Change 'Ledge' to 'Irregular Bedrock'
	spawning	Deerfield	Change 'Ledge' to 'Irregular Bedrock'

The group was not able to reach consensus on an acceptable substrate HSC for rainbow trout juveniles, fry or spawning due to limited source information (i.e., only the Raleigh et al. "Blue Book" value were presented). Mike Waddell, expressed interest in evaluating the curves used in the Catawba-Wateree IFIM Study before making a final selection for these lifestages. Dick Christie noted that these curves were presented in the Catawba-Wateree Final IFIM Report, but added that the legends needed to interpret the plots were not included. Dick agreed to contact the authors regarding the legends. Shane agreed to distribute the curves to the TWC once all of the information is gathered.

The meeting adjourned at approximately 11:00 AM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Substrate for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized "Bluebook" criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized "Bluebook" criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized "Bluebook" criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

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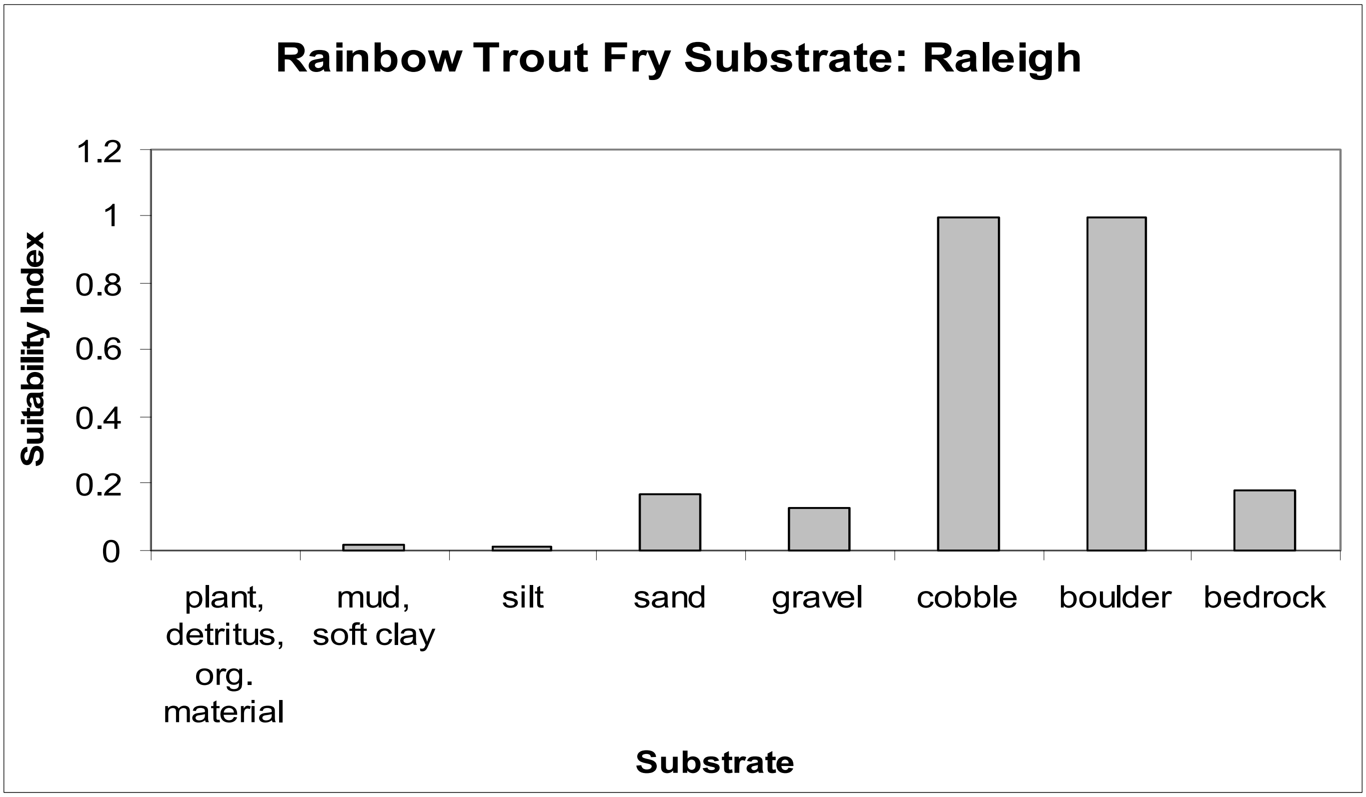
Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish and Wildl. Serv. FWS/OBS-82(10.124). 65 pp..

Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

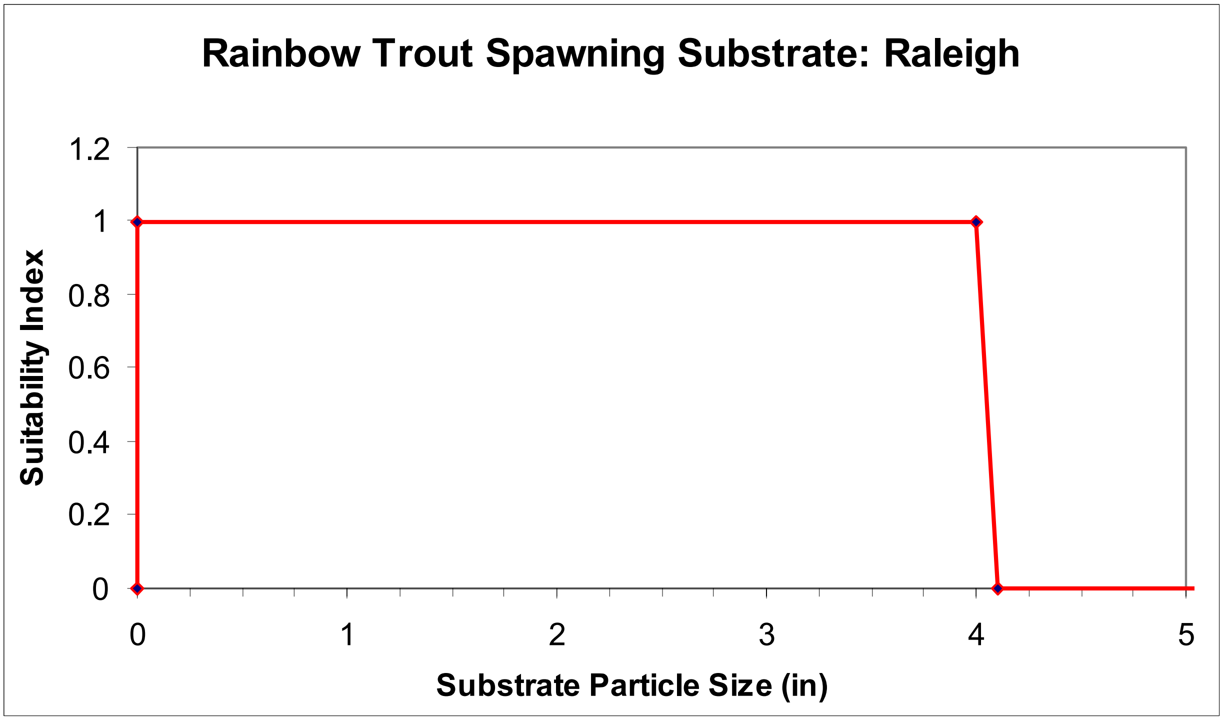
Strakosh, T.R., R.M. Neumann, and R.A. Jacobsen. 2003. Development and assessment of habitat suitability criteria for adult brown trout in southern New England rivers. Ecology of Freshwater Fish 12:265-274. Blackwell Munksgaards, 2003.

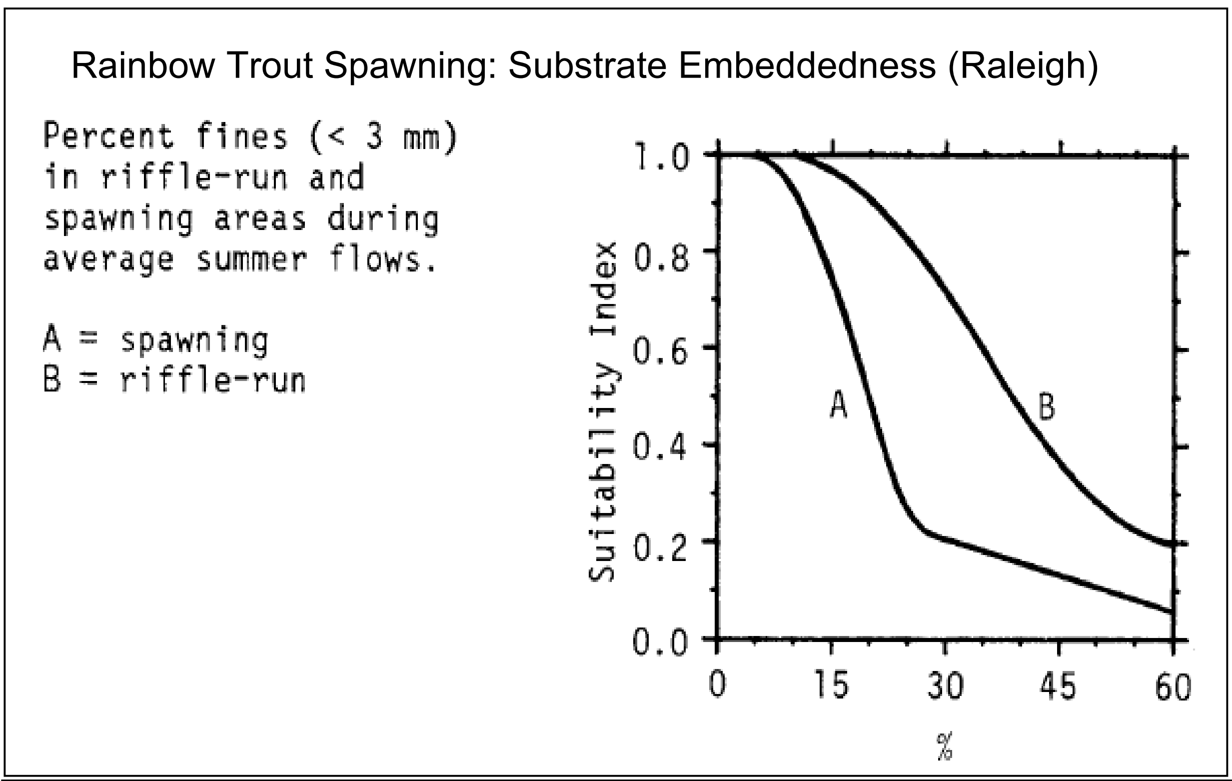
Appendix A
Brown Trout Substrate Habitat Suitability Criteria

Rainbow Trout Fry



Rainbow Trout Spawning





Appendix C
Smallmouth Bass Substrate Habitat Suitability Criteria

Appendix C, Table 1: Substrate Classification Codes - Bain

Code	Description	Size (mm)	Size (in)
	Silt		
	Sand		
	Gravel	4-75	< 3 in. diam,
	Rubble	75-300	3-12 in. diam.
	Boulder	300-600	1-3 ft. diam.
	Bedrock		

Appendix C, Table 2: Substrate Classification Codes - Deerfield

Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

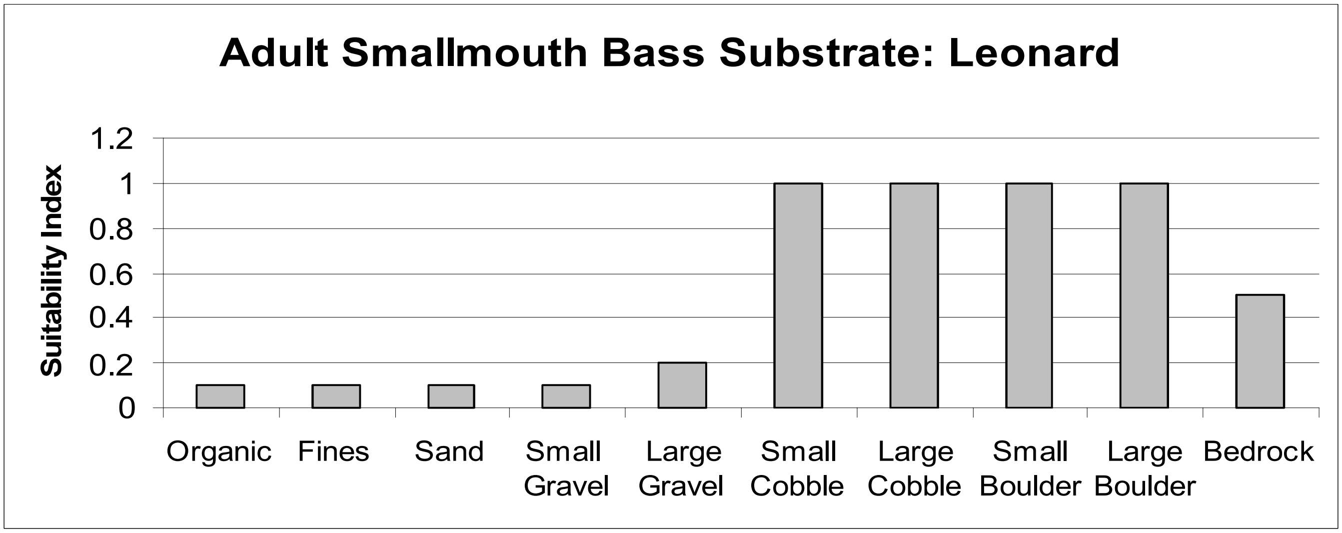
Appendix C, Table 3: Substrate Classification Codes - Leonard

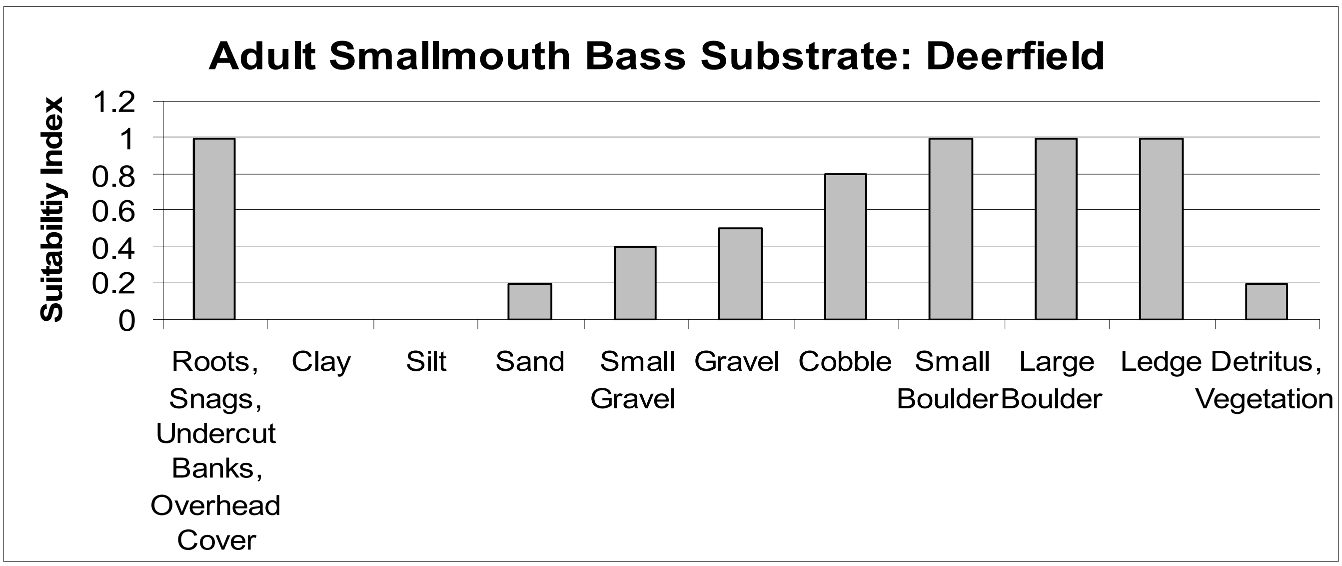
Code	Description	Size (mm)	Size (in)
1	Organic		
2	Fines		
3	Sand		
4	Small Gravel		<2 inches diam.
5	Large Gravel		2-4 inches diam.
6	Small Cobble		4-7 inches diam.
7	Large Cobble		8-10 inches diam.
8	Small Boulder		10-24inches diam.
9	Large Boulder		> 2 ft diameter
10	Bedrock		

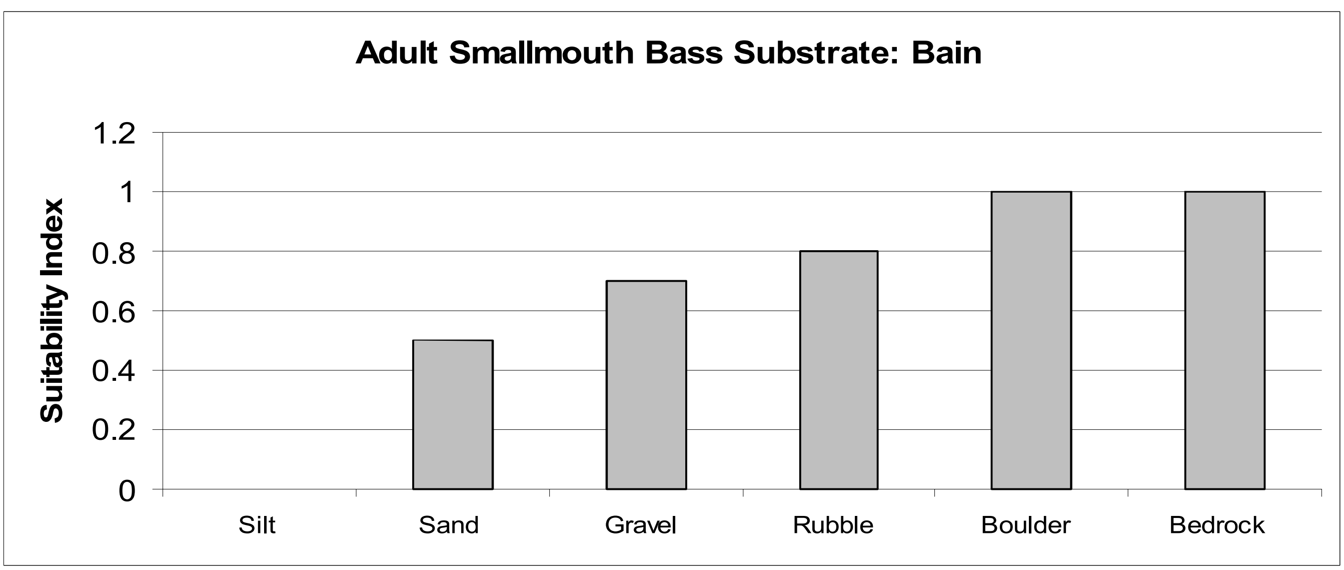
Appendix C, Table 4: Substrate Classification Codes - Lockhart

Code	Description	Size (mm)	Size (in)
1	mud	<1	< 0.4
2	sand	1 - 2	0.4 - 0.8
3	small gravel	2 - 16	0.8 - 6.3
4	large gravel	16 - 64	6.3 - 25.2
5	small cobble	64 - 128	25.2 - 50.4
6	large cobble	128 - 256	50.4 - 100.8
7	small boulder	256 - 512	100.8 - 201.6
8	large boudler	> 512	> 201.6
9	bedrock	-	

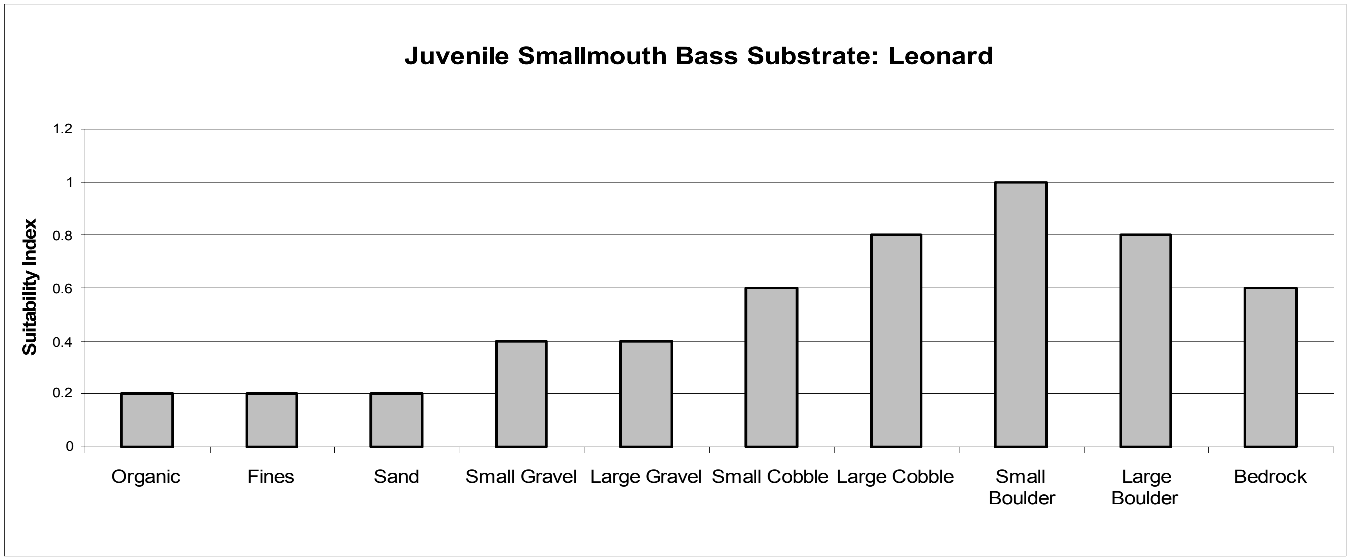
Adult Smallmouth Bass

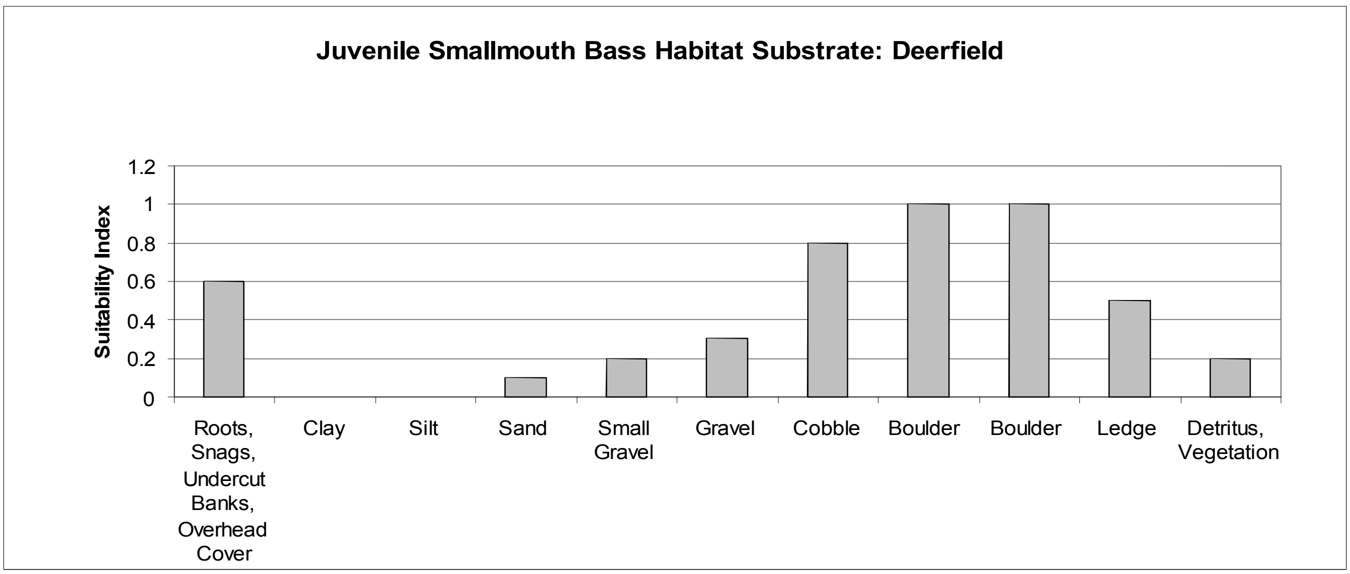


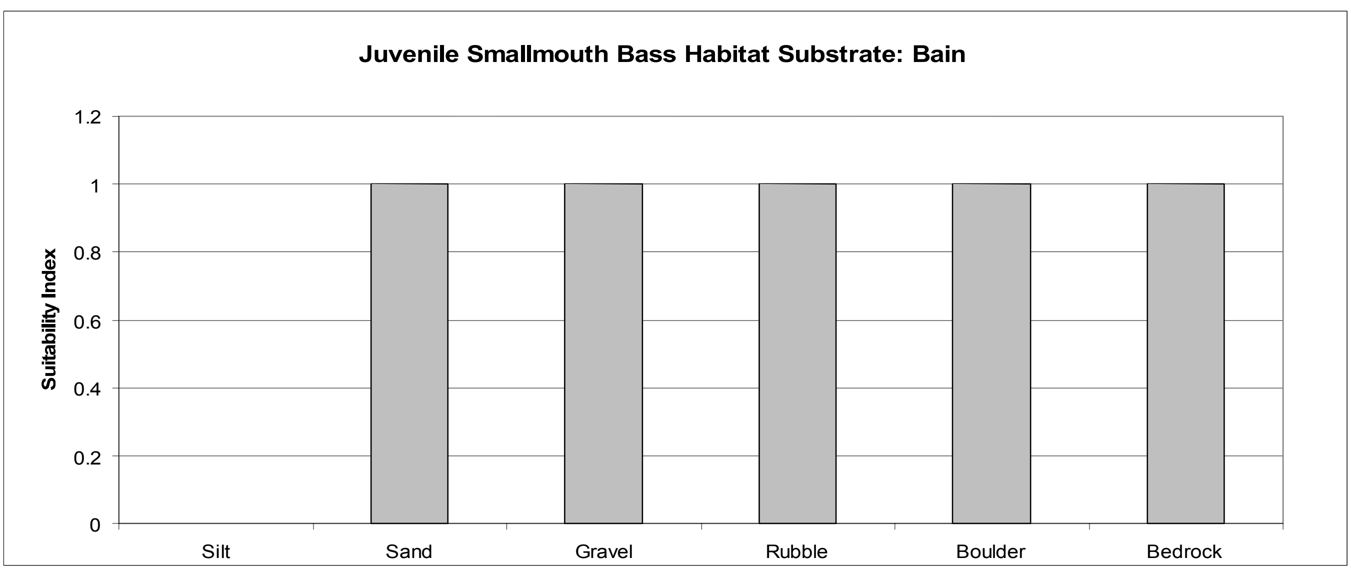




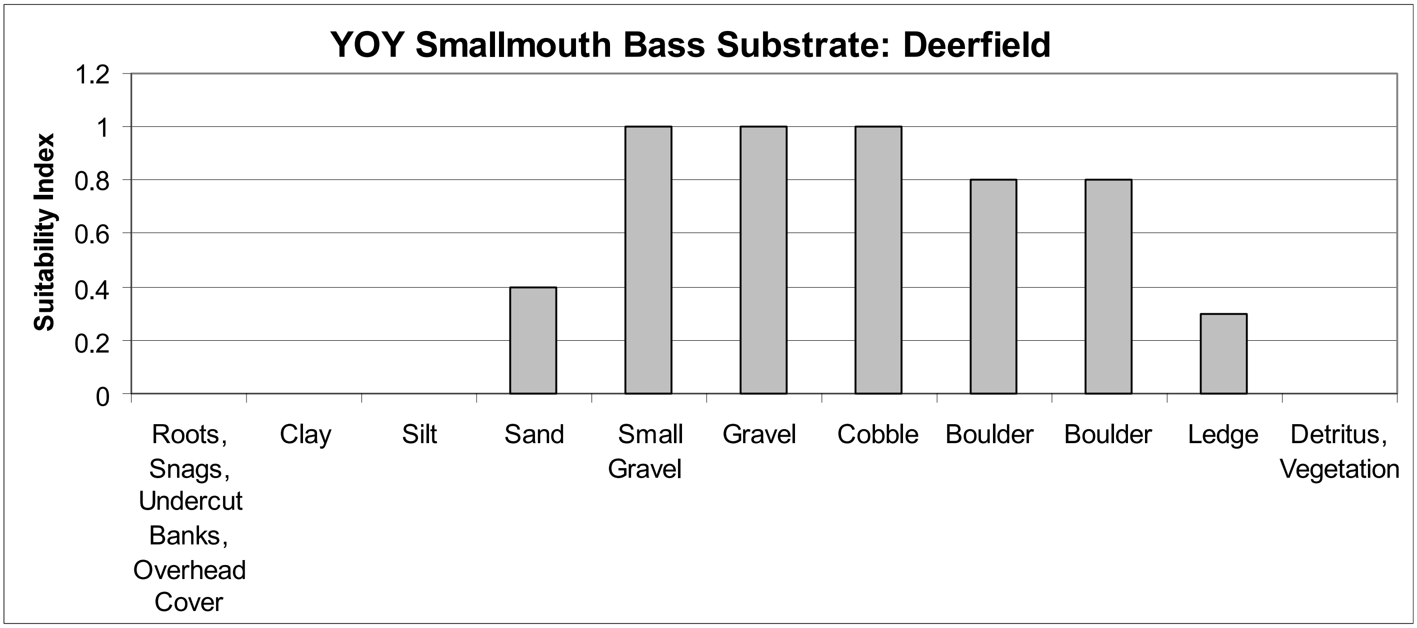
Juvenile Smallmouth Bass

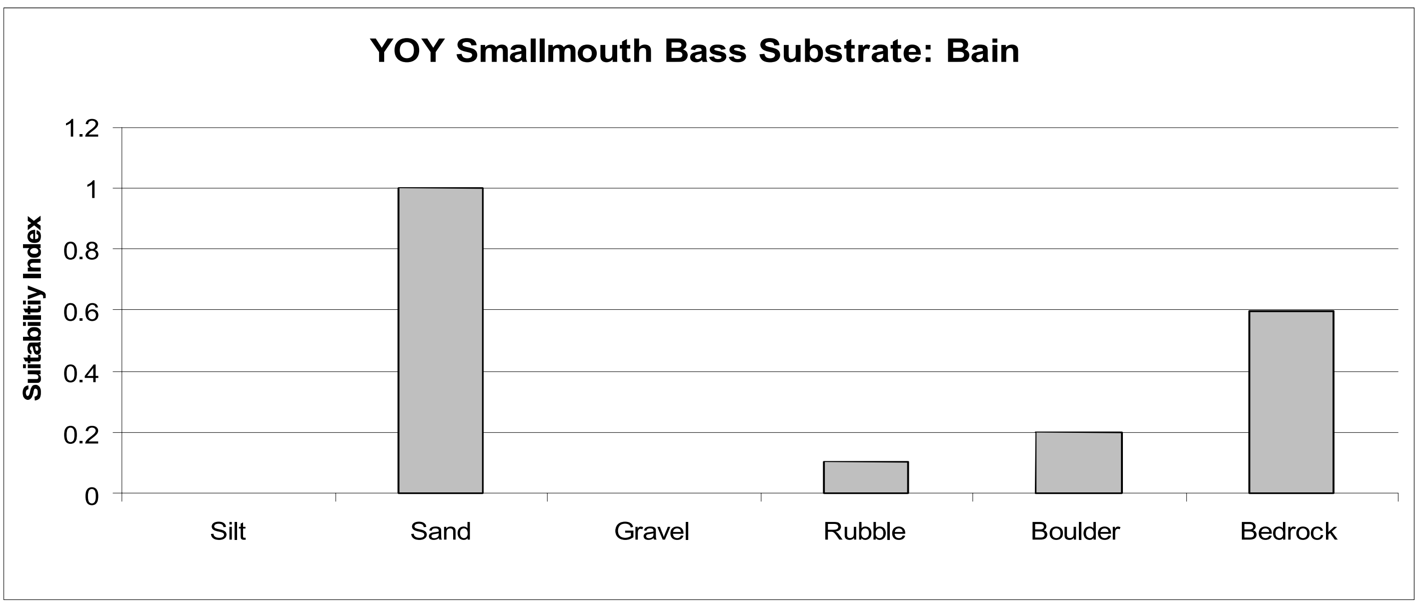




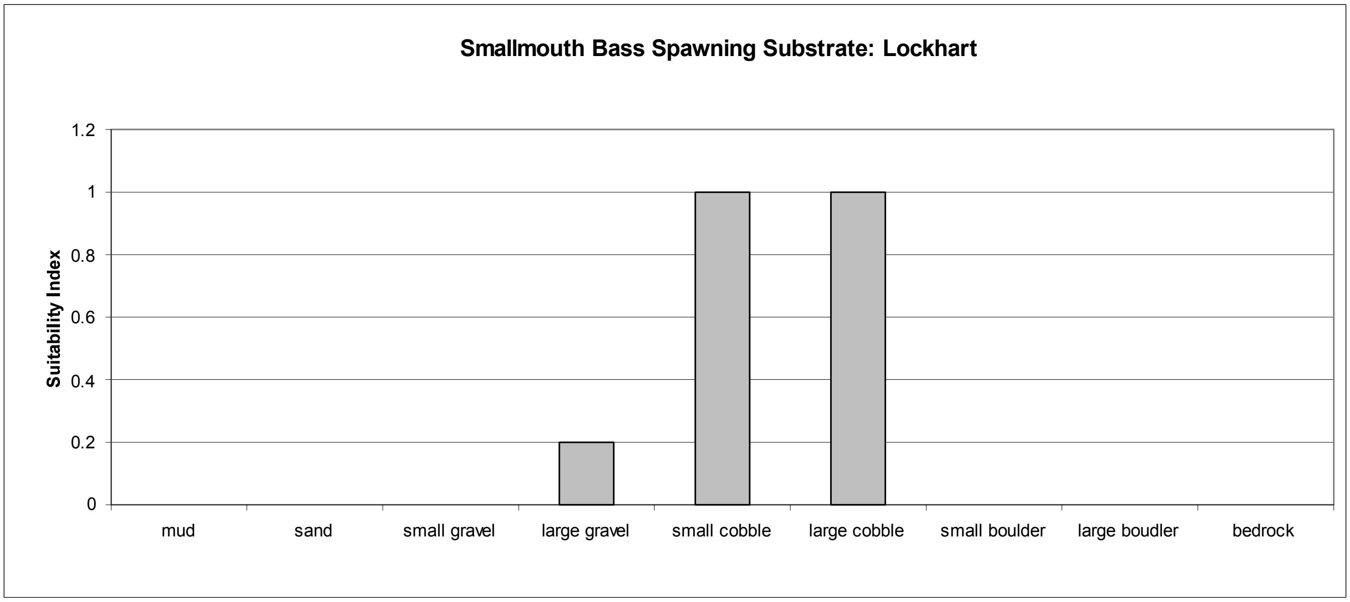


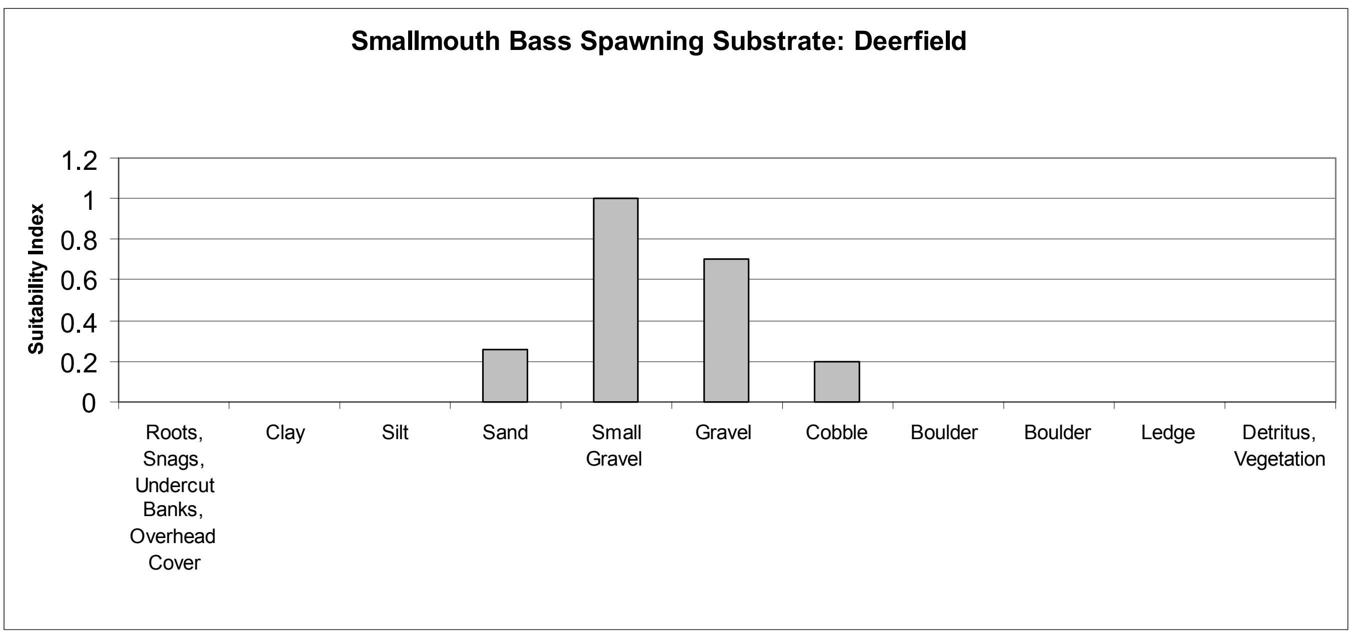
Smallmouth Bass YOY





Smallmouth Bass Spawning





01/16/07 – CLB
0455029.00-93-03
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Kacie Jensen

From: Alison Guth
Sent: Thursday, May 03, 2007 3:13 PM
To: Alison Guth; 'Amanda_Hill@fws.gov'; 'Bill Argentieri'; Alan Stuart; 'Dick Christie'; 'Prescott Brownell'; 'Steve Summer'
Subject: April 25th Fisheries Studies Conference Call Notes

Hello All,

Attached is a brief set of notes that I drafted from the conference call that was held on April 25th to discuss Columbia fishway monitoring and the American shad telemetry study. Thanks, Alison

2007-4-25 draft
Meeting Minute...

Alison Guth
Licensing Coordinator
Kleinschmidt Associates
101 Trade Zone Drive
Suite 21A
West Columbia, SC 29170
P: (803) 822-3177
F: (803) 822-3183

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
FISHERIES STUDIES CONFERENCE CALL

April 25, 2007

acg 5-3-07

ATTENDEES:

Alison Guth, Kleinschmidt Associates
Alan Stuart - Kleinschmidt Associates
Dick Christie, SCDNR
Steve Summer, SCANA Services
Bill Argentieri, SCE&G
Amanda Hill, USFWS
Prescott Brownell, NOAA

NEXT MEETING DATE: May 16, 2007 at 9:00 am – Conference Call

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Alan Stuart opened the conference call and noted there were several items to discuss during the call regarding the Columbia fishway monitoring and the American shad telemetry study. With regards to the Columbia fishway monitoring, Alan noted that the study plan stated that monitoring would conclude by on May 15th or at the end of the season as informed by the agencies. Alan explained that they have received notification from St. Stephens that it is getting towards the end of the passage season and asked the group to what date they envisioned monitoring efforts extending until. Amanda Hill asked how many American shad were currently being seen at St. Stephens at and Dick Christie replied that the numbers were way down as of the previous week.

The group continued to discuss the passage season and Amanda pointed out that it has appeared to be a bad year for monitoring. Dick added that he believed that the passage did not reflect the run. He continued to explain that passage effectiveness appears to be low this year due to a number of problems at St. Stephens (a flood, the lift was down). Dick noted that he would contact Al Crosby to obtain information on when St. Stephens completes passing fish. Prescott Brownell and Amanda suggested discontinuing fishway monitoring at Columbia 1 to 2 weeks after fish passage completes at St. Stephens. Dick concurred and noted that since it was the first year of monitoring it was probably best to continue until May 15th. Dick continued to explain that they may be more comfortable with stopping early during subsequent monitoring years.

Bill Argentieri noted that he understood the agencies concerns and asked the agencies if there was a situation under which they would consider stopping later than May 15th. Amanda noted that if for some reason 50 or more American shad passed through the Columbia fishway then she would want to continue a little longer. The group concurred and Bill noted that Alison Guth will continue to send out weekly updates on the monitoring and the group would re-convene by conference call on May 16th at 9 am.

The second issue that the group discussed was the American shad telemetry study that was scheduled for this spring. Alan explained that they have made numerous trips in order to locate shad without much success. He continued to explain that there was still interest on SCE&G's part to perform this study, however the shad movement has not allowed them to successfully get the numbers of fish needed to perform the study. The group agreed that this year may not be the best for the study. Alan noted that it may be best to perform this study next year and asked the group if there were any recommendations on potential ways to, or places to, capture the needed amounts of fish.

Steve Summer asked what the water temperatures were when Jeff Isley came upon the school of American shad in June of 2006. Shane noted that he would look into this. Amanda noted that if the water temperatures are similar it may be good to check for fish again. Prescott also noted that Joe Hightower had experience with locating shad and he would check with him on his techniques. Dick suggested that in the event that this study does not occur this year, the tags could be pooled with next years tags and the efforts could be combined with the Accord activities. Dick added that this may be an option if SCE&G feels that there isn't any crucial information that they will obtain by tagging at Santee Cooper versus the study plan that was developed for the Saluda relicensing. Subsequently, Bill asked the group if they still wanted to make an attempt to tag next year, or if they wanted to forgo it all together and participate in this study under the Accord. Amanda noted that they could still potentially do the study next year and obtain the information needed for the license application. The group noted that they would make this particular decision at a later date. Depending on what information was obtained on temperatures at which Isley caught fish, and what information was obtained from Joe Hightower, SCE&G noted that they may attempt to locate shad one more time this year by 601 bridge

Alan noted that they would finish out the sampling year and convene in October to discuss next years efforts. Bill also added that this week is the last for sturgeon sampling. The group will continue discussions when they convene again on May 16th by conference call.

Kacie Jensen

From: Shane Boring
Sent: Tuesday, April 24, 2007 9:43 AM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Cc: Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; 'Ralph Crafton'; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: April 10 Instream Flow TWC Meeting Notes - Draft

Dear Instream Flow/Aquatic Habitat TWC Members:

Attached for your review are the draft meeting notes from the April 10th TWC conference call, at which Habitat Suitability Criteria for substrate were selected for some target species (smallmouth bass, brown and rainbow trout). **Please provide comments on the draft notes by Friday, April 4th**.

The memo that served as visual aid during the conference call will be included as an appendix to the notes and is also attached. Please note that the typo on Table 1, Appendix A (substrate particle size/codes from Bovee 1982) has been corrected.

Thanks to all who contributed to a very productive session.

Shane

C. Shane Boring
Environmental Scientist
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West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2007-04-10 ıstream Flow-Aquat.

ìaluda IFIM Study - Habitat Su...

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Draft CSB 04-23-07

ATTENDEES:

Dick Christie, SCDNR	Gerrit Jobsis, AR/CCL
Alan Stuart, Kleinschmidt Associates	Shane Boring, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services	Brandon Kulik, Kleinschmidt Associates
Jeni Summerlin, Kleinschmidt Associates	Hal Beard, SCDNR
Mike Waddell, Trout Unlimited	

ACTION ITEMS

- Gather and distribute substrate HSC plots and legends from Catawba-Wateree study for brown trout fry/spawning/juveniles to TWC

Dick Christie / Shane Boring

- Finalize HSC curves based on TWC input and incorporate as an appendix to the Saluda IFIM Study Plan

Shane Boring/Brandon Kulik

NEXT MEETING

TBD

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Draft CSB 04-23-07

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:00 AM. Shane noted that, at the January 22nd meeting of the Instream Flow/Aquatic Habitat Technical Working Committee (TWC), the TWC had agreed upon Habitat Suitability Criteria (HSC) for depth and velocity for several target species (smallmouth bass, brown trout, and rainbow trout adults). Shane added that the purpose of today's meeting would be to finalize the HSC selection process by selecting substrate criteria for these species.

Shane enquired as to whether there was any follow-up discussion regarding the depth/velocity criteria selection process or other TWC housekeeping items in need of attention. Hal Beard noted that, at the previous meeting, there was an action item assigned to determine whether HSC curves were available for gizzard shad in riverine systems. Hal added that, after discussing this issue with colleagues at SCDNR, he did not think this species was as much of a priority as he had once thought.

Dick Christie reminded the group that DNR manages the lower Saluda as a put-grow-take trout fishery, and as such, he and other DNR staffers had requested at previous TWC meetings that the habitat modeling for trout focus on adult lifestages (i.e. not include spawning, juvenile, fry). He added that, while DNR certainly welcomes any improvements to water quality or habitat that might benefit these early-lifestages, flow recommendations resulting from the IFIM process should not come at the detriment of providing quality growing conditions for stocked adult and sub-adult trout. Dick added that, while looking at early lifestages in the modeling might be good to have for informational purposes, these lifestages were not within the DNR's management strategy for the lower Saluda. Mike Waddell noted that Trout Unlimited does not agree with DNR's strategy of managing only for adult lifestages.

The group then turned their attention to the memo prepared by Shane Boring and Brandon Kulik (Attachment A), which summarized potential source HSC for substrate from a number of regional studies. After reviewing the source HSC plots for applicability to the lower Saluda, TWC members agreed on substrate HSC for the following species and lifestages:

Species	Life Stage	Curve Source	Modifications
brown trout	adult	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’ and change SI of this category to 1.0
	juvenile	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’ and change SI of this category to 1.0
	Fry	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	Spawning	Deerfield	
rainbow trout	Adult	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’ and change SI of this category to 1.0; Lower SI for ‘Roots, Snags, Undercut banks, Overhead Cover’ to 0.2
smallmouth bass	Adult	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	Juvenile	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	YOY	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	spawning	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’

The group was not able to reach consensus on an acceptable substrate HSC for rainbow trout juveniles, fry or spawning due to limited source information (i.e., only the Raleigh et al. “Blue Book” value were presented). Mike Waddell, expressed interest in evaluating the curves used in the Catawba-Wateree IFIM Study before making a final selection for these lifestages. Dick Christie noted that these curves were presented in the Catawba-Wateree Final IFIM Report, but added that the legends needed to interpret the plots were not included. Dick agreed to contact the authors regarding the legends. Shane agreed to distribute the curves to the TWC once all of the information is gathered.

The meeting adjourned at approximately 11:00 AM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Substrate for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized "Bluebook" criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized "Bluebook" criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized "Bluebook" criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

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Connecticut Dept. of Environmental Protection. (unpublished data). Housatonic River IFIM SI criteria. Peter Aarestad, CTDEP, personal communication.

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Strakosh, T.R., R.M. Neumann, and R.A. Jacobsen. 2003. Development and assessment of habitat suitability criteria for adult brown trout in southern New England rivers. Ecology of Freshwater Fish 12:265-274. Blackwell Munksgaards, 2003.

Appendix A
Brown Trout Substrate Habitat Suitability Criteria

Appendix A, Table 1: Substrate Classification Codes - Raleigh

Substrate Codes from Bovee (1982)			
Code	**Description**	**Size (mm)**	**Size (in)**
1	plant/detritus/organic material		
2	mud/soft clay		
3	silt	<0.062	
4	sand	0.062 – 2.0	
5	gravel	2.0 - 64	
6	cobble	64 - 250	
7	boulder	250 – 4000	
8	bedrock	solid	

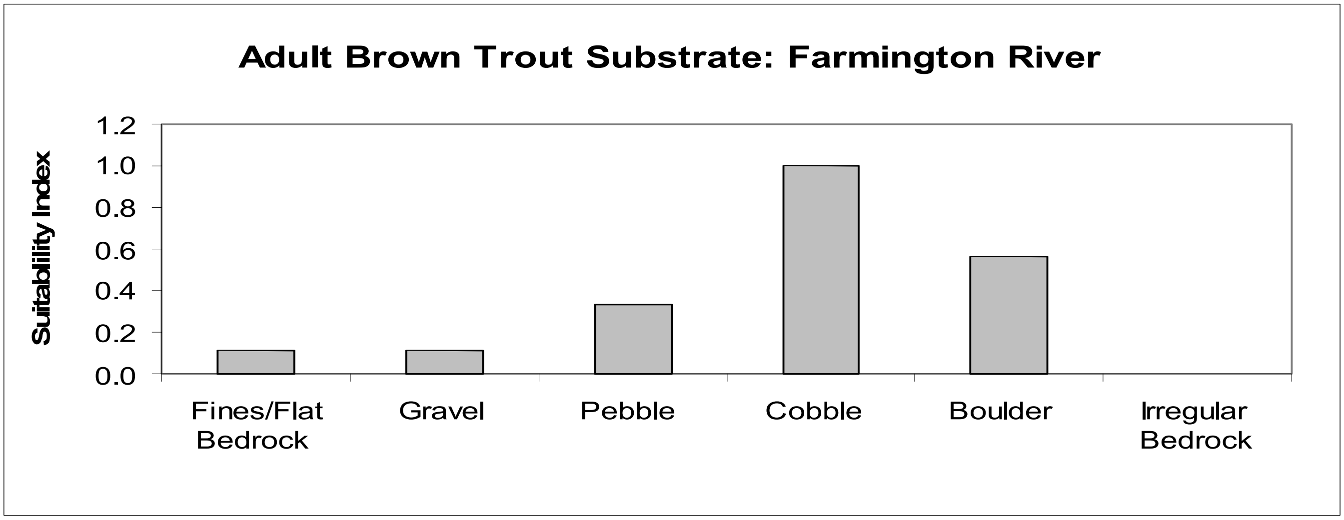
Appendix A, Table 2: Substrate Classification Codes - Deerfield & Housatonic

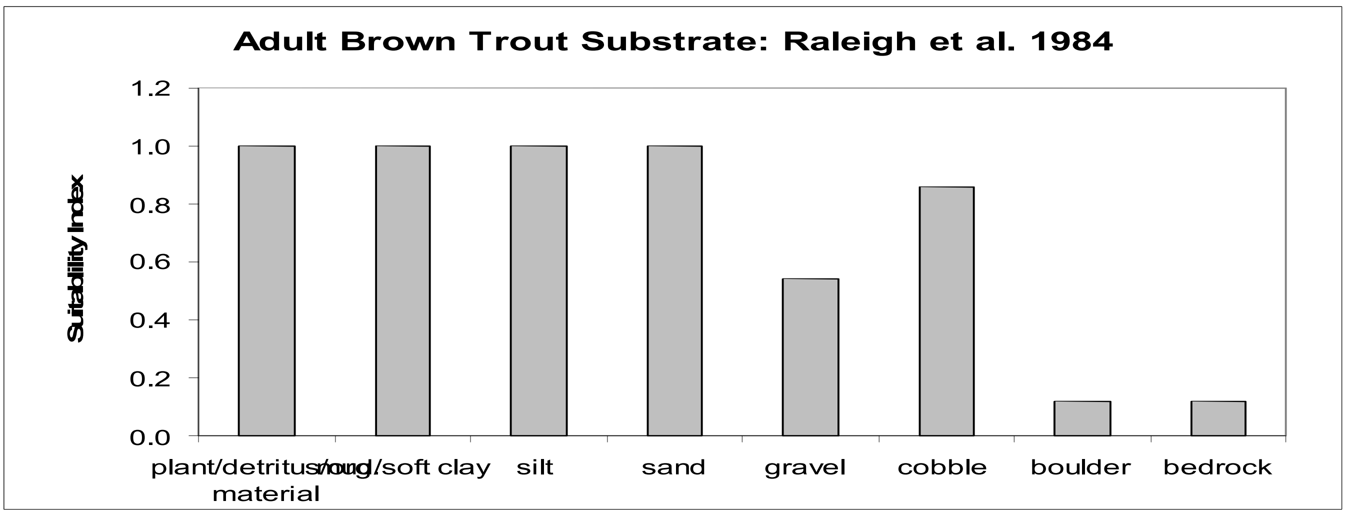
Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

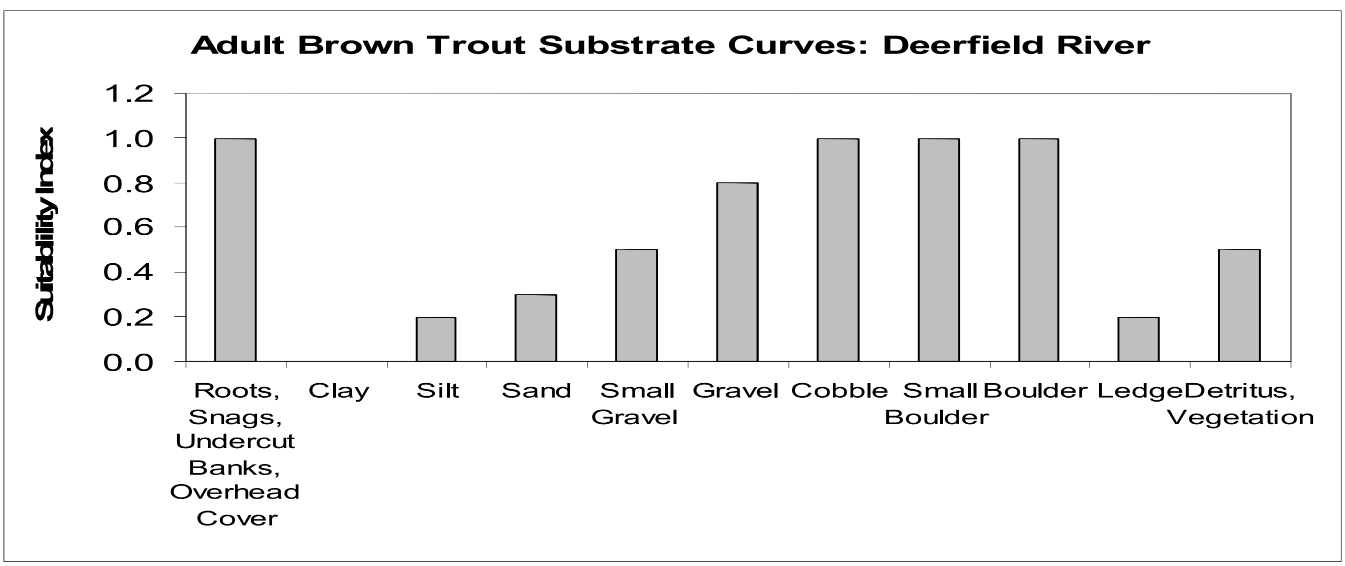
Appendix A, Table 3: Substrate Classification Codes - Farmington

Code	Description	Size (mm)	Size (in)
1	Fines/Flat Bedrock	< 2	< .08
2	Gravel	2 - 16	0.08 - 0.63
3	Pebble	16 - 64	0.63 - 2.52
4	Cobble	64 - 256	2.52 - 10.08
5	Boulder	> 256	> 10.08
6	Irregular Bedrock		

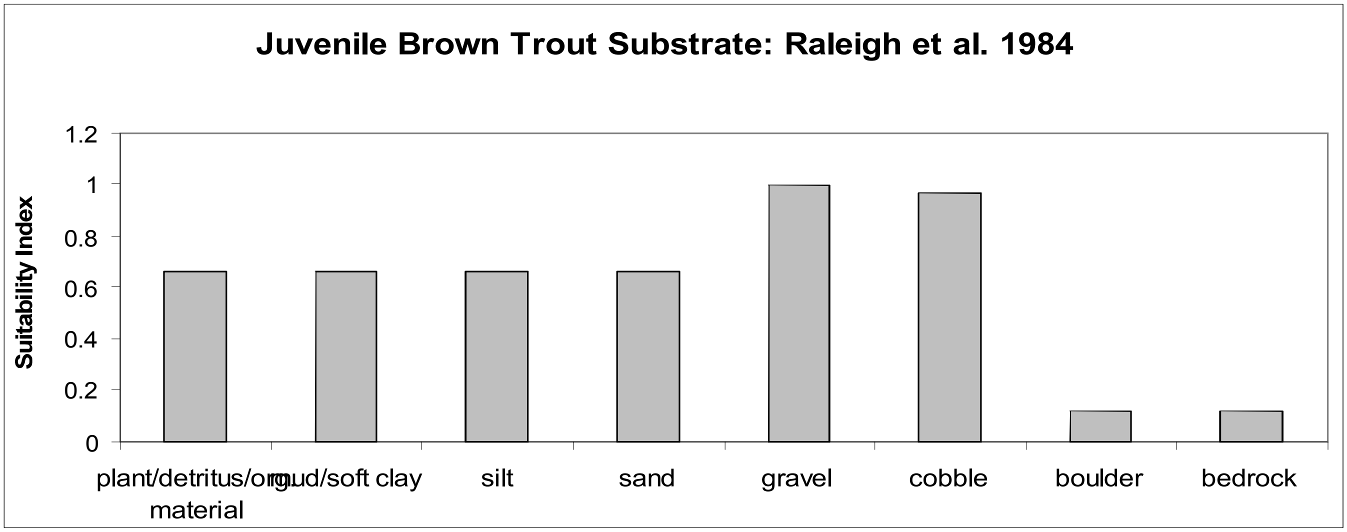
Adult Brown Trout

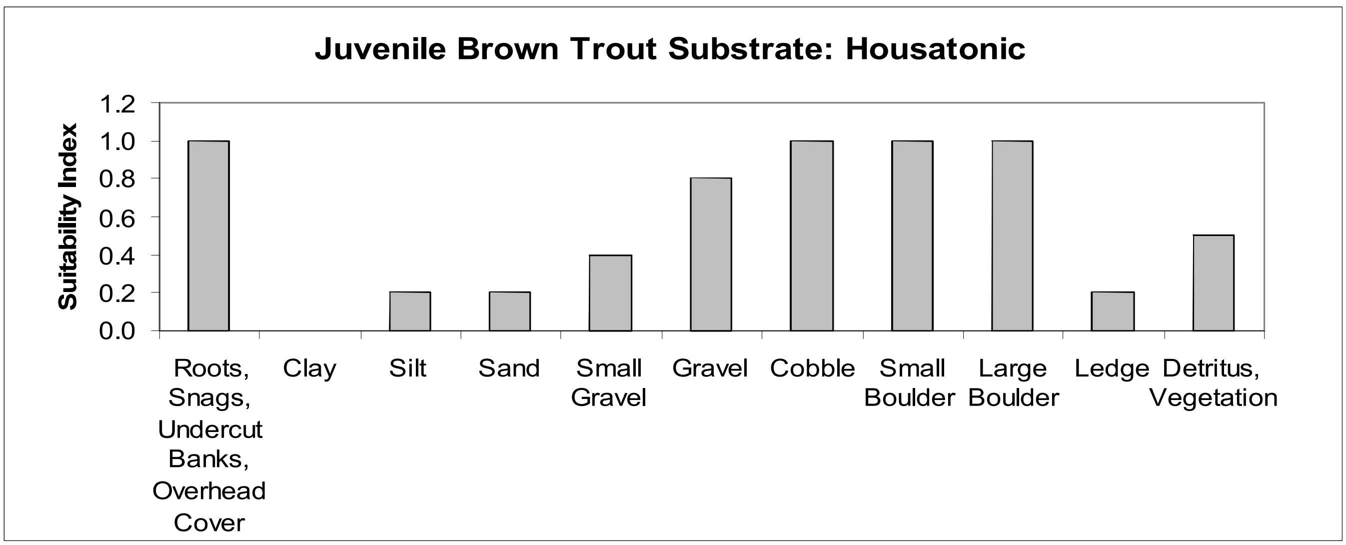


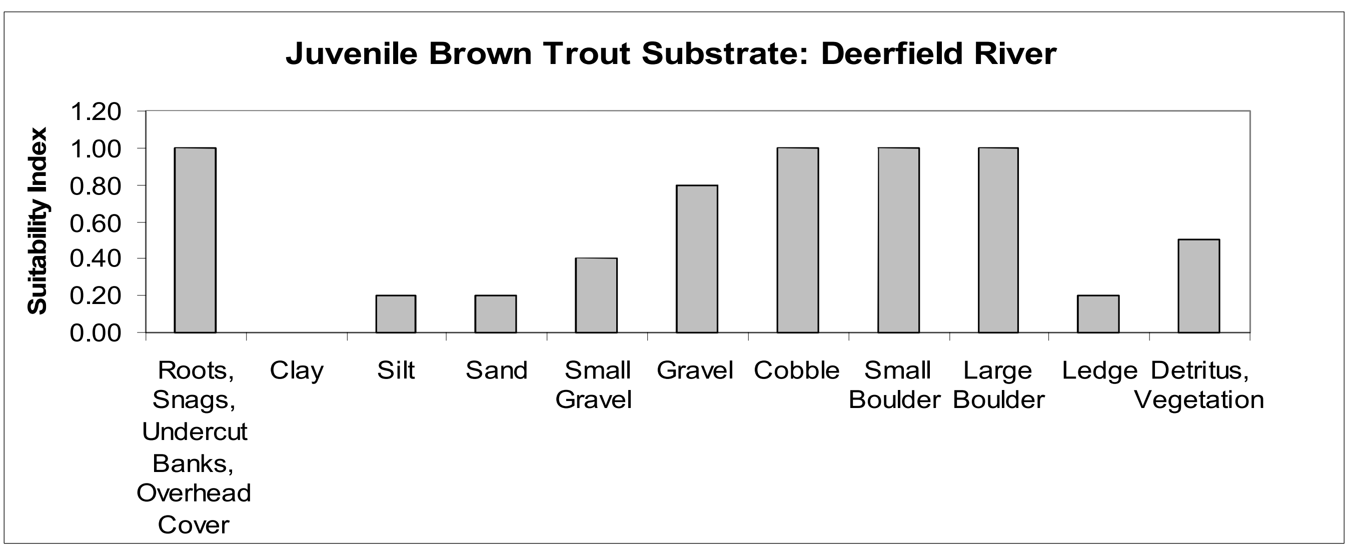




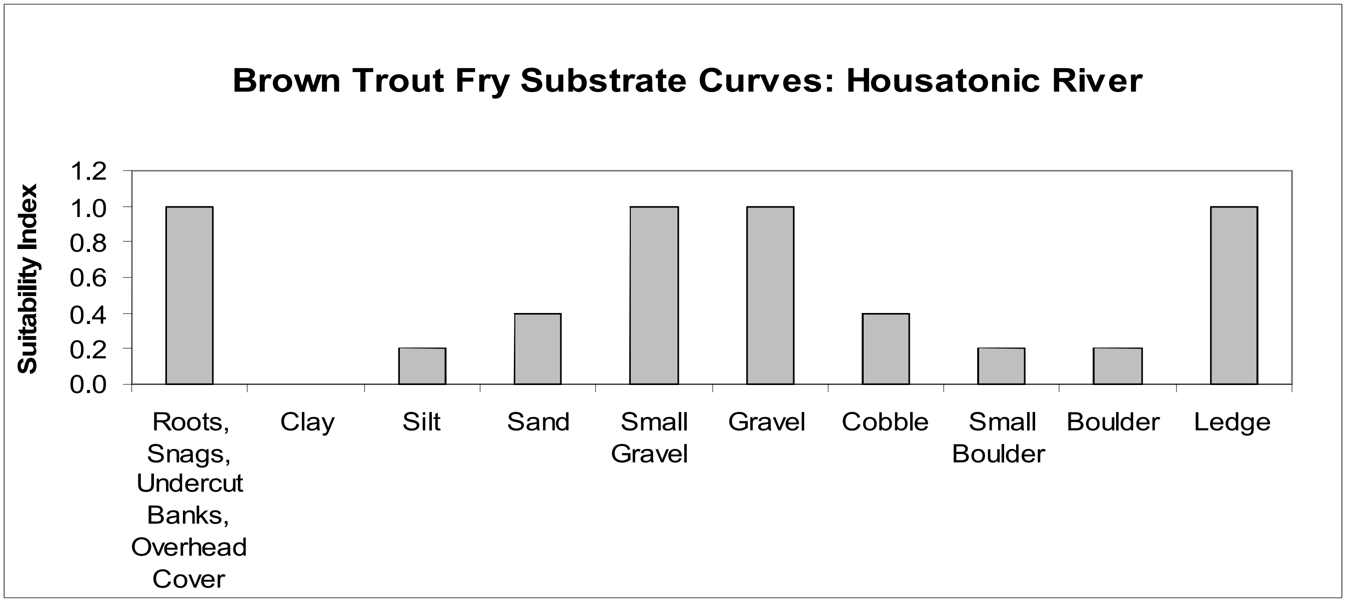
Juvenile Brown Trout

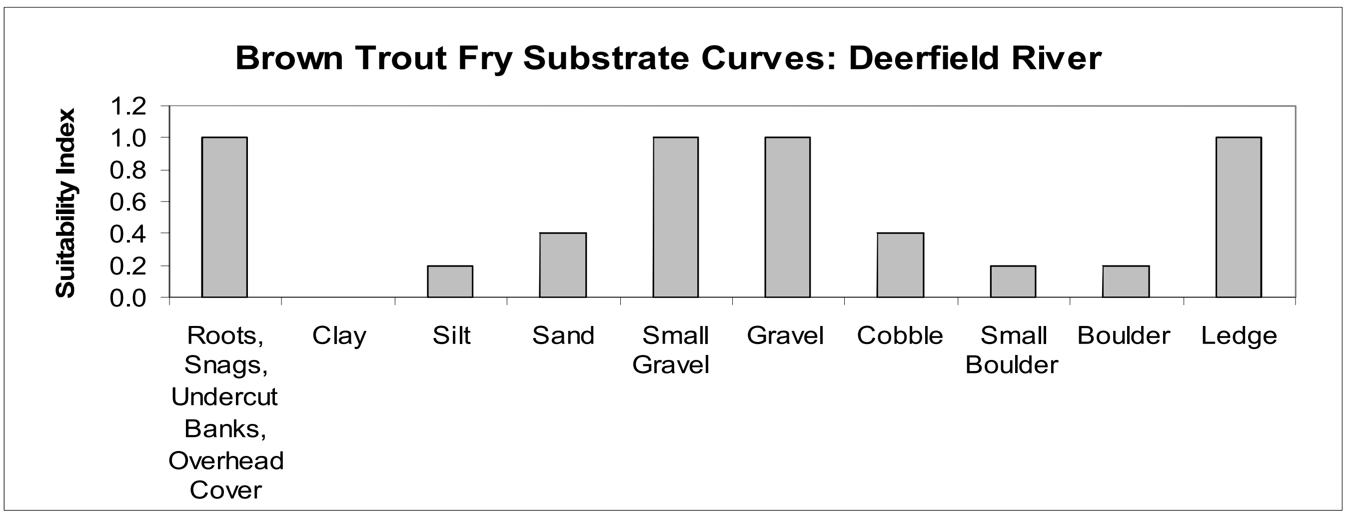


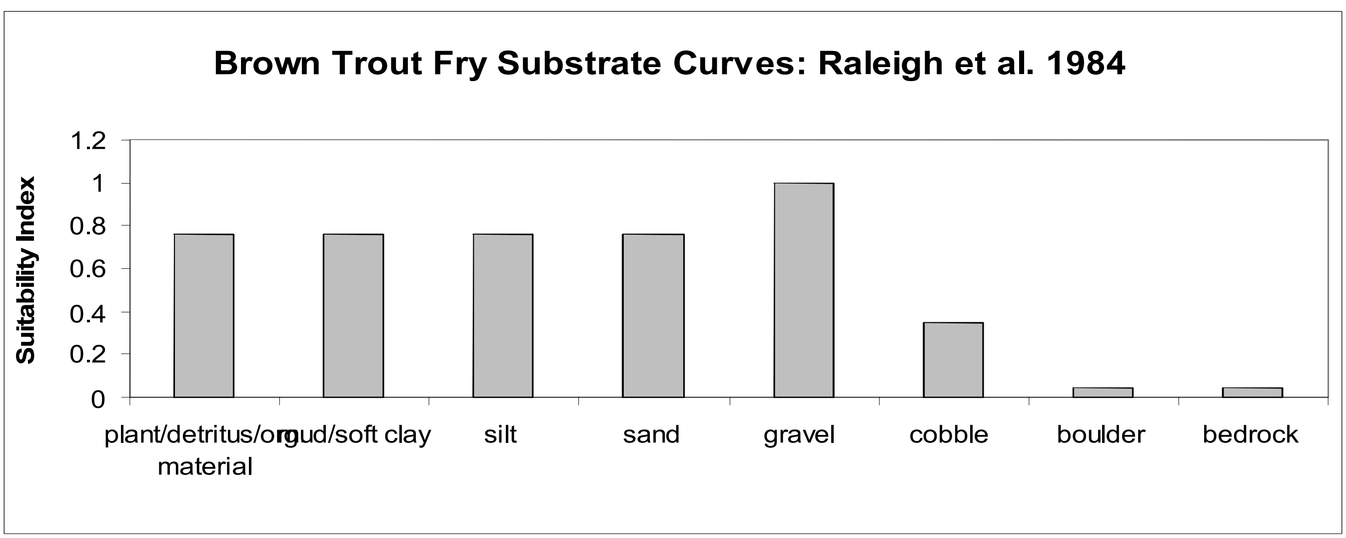




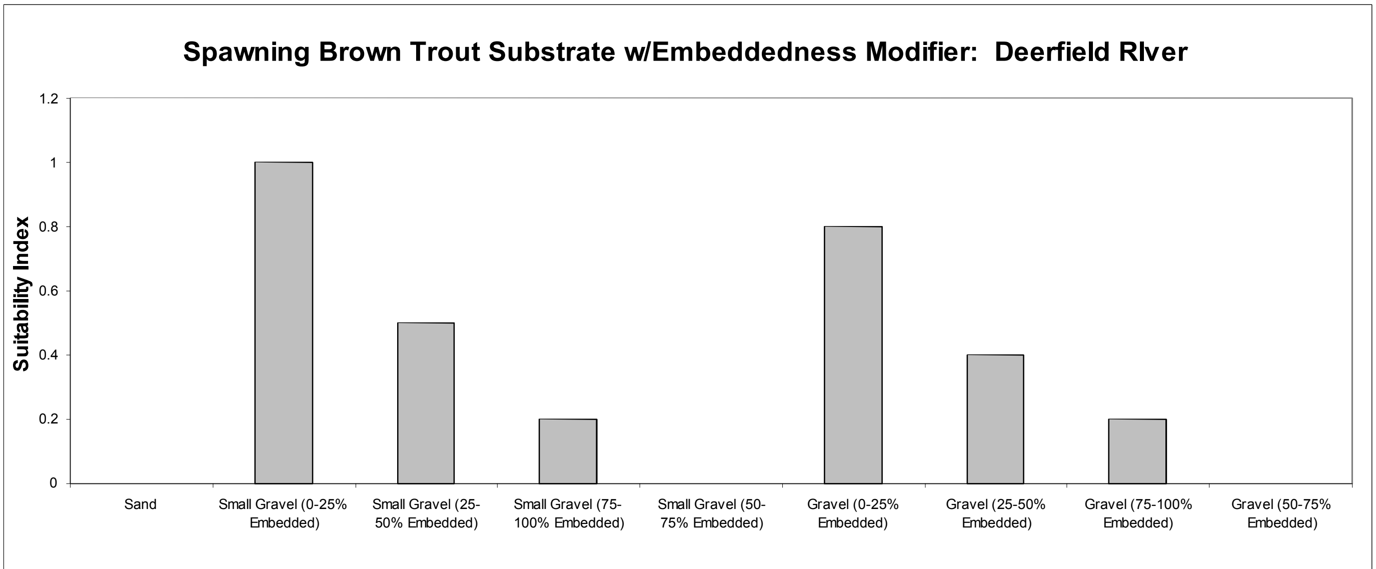
Brown Trout Fry

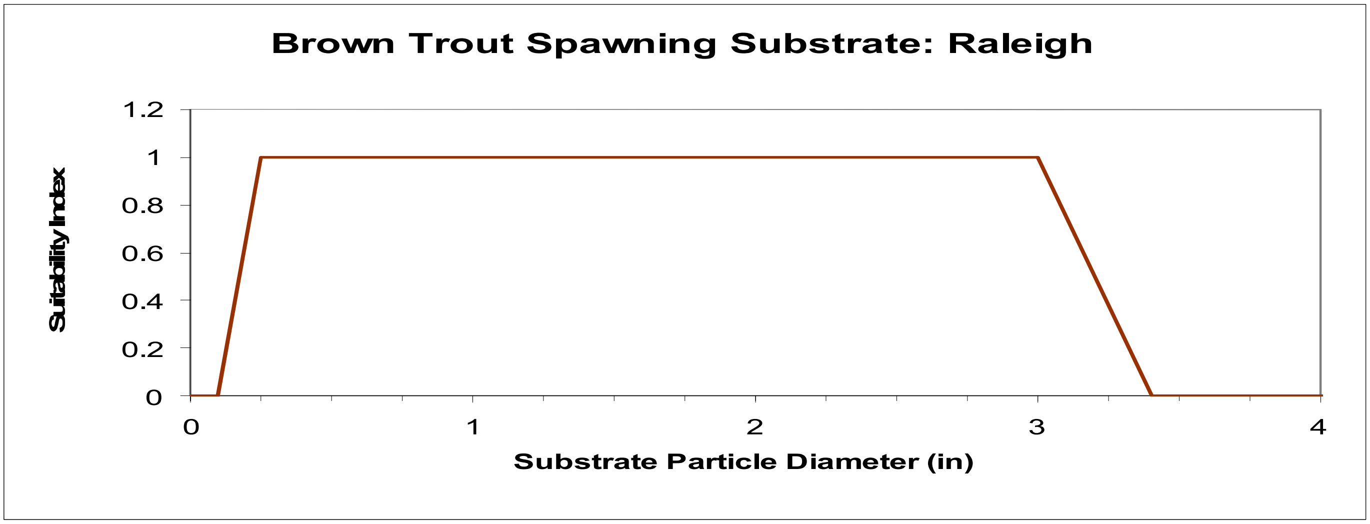




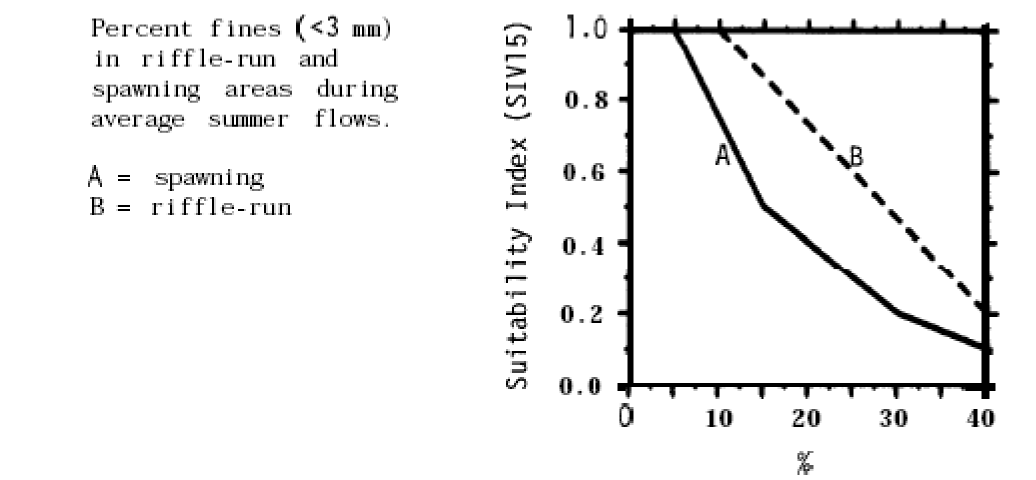


Spawning Brown Trout



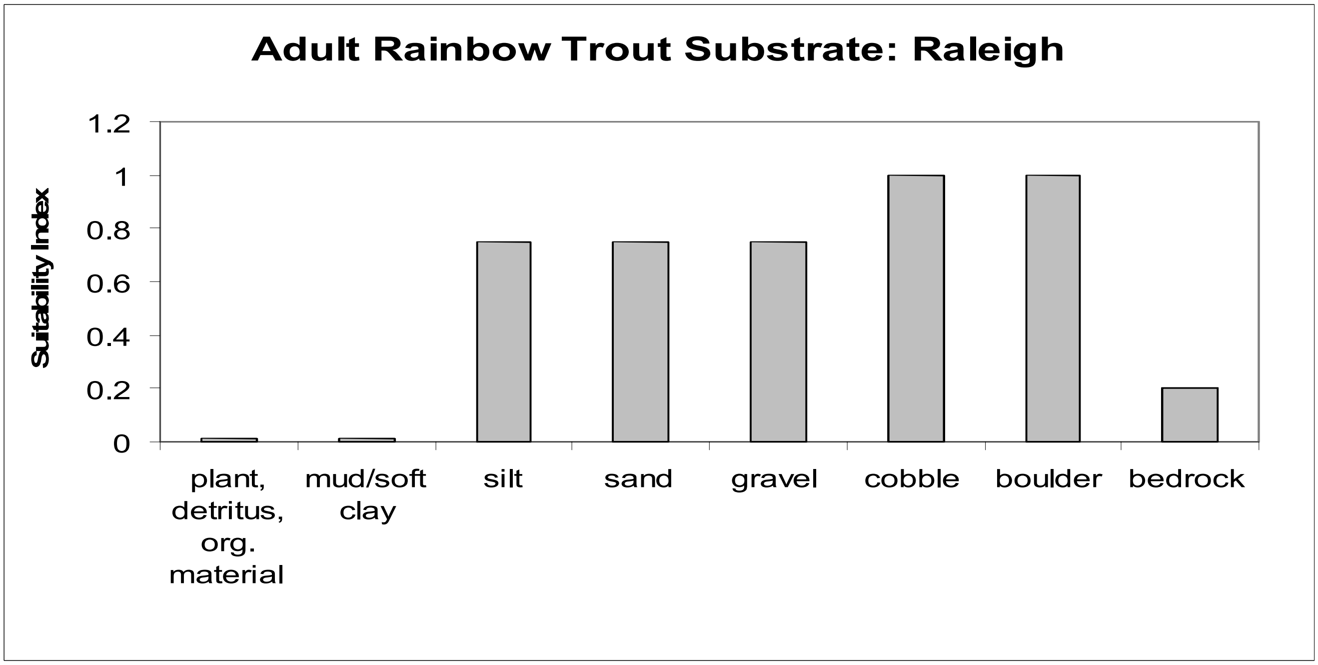


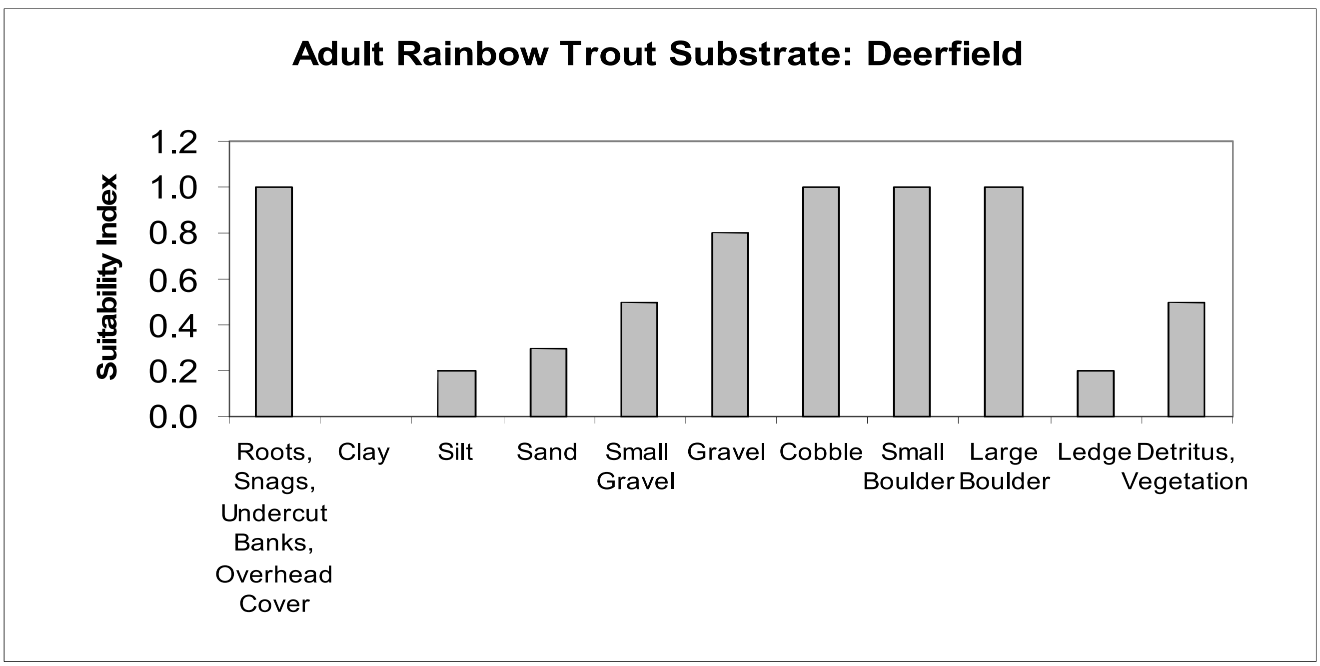
Brown Trout Spawning: Substrate Embeddedness (Raleigh)



Appendix B
Rainbow Trout Substrate Habitat Suitability Criteria

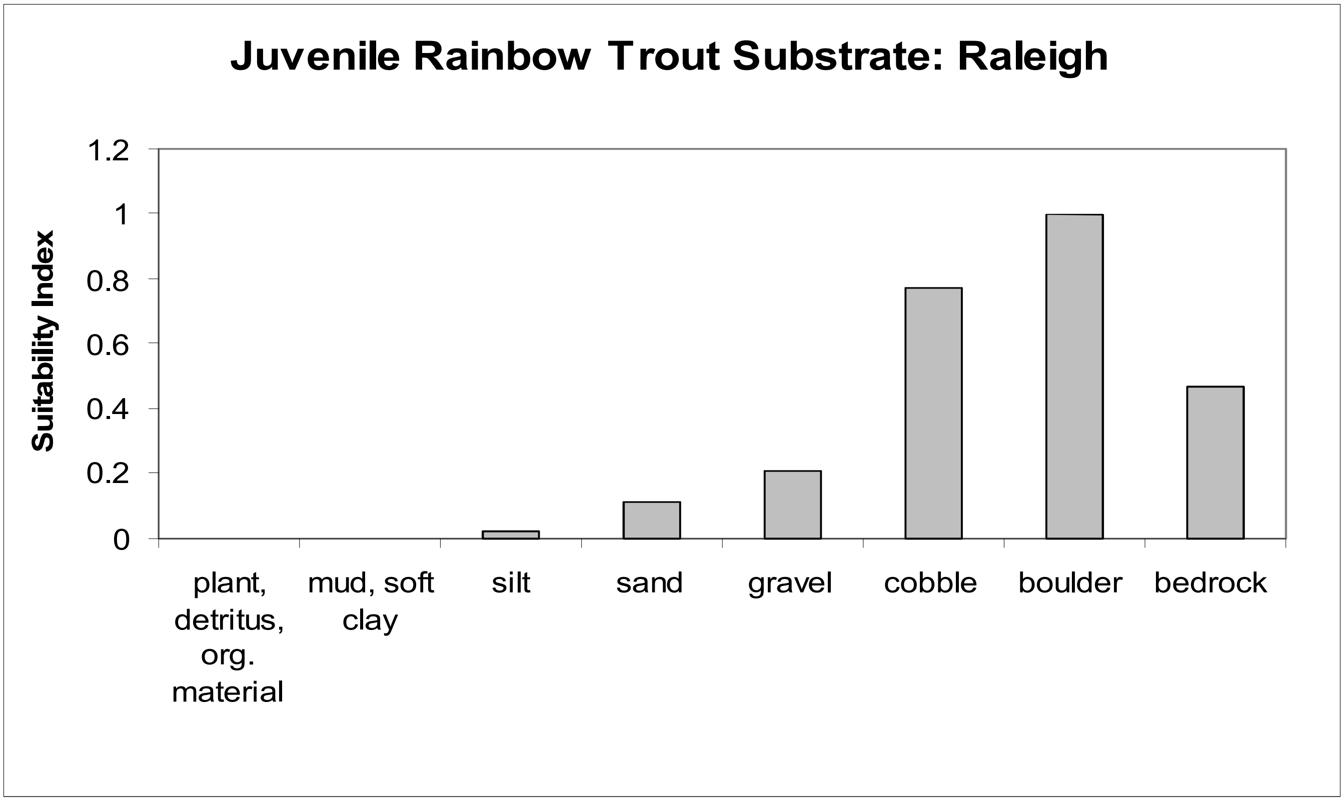
Adult Rainbow Trout[1]



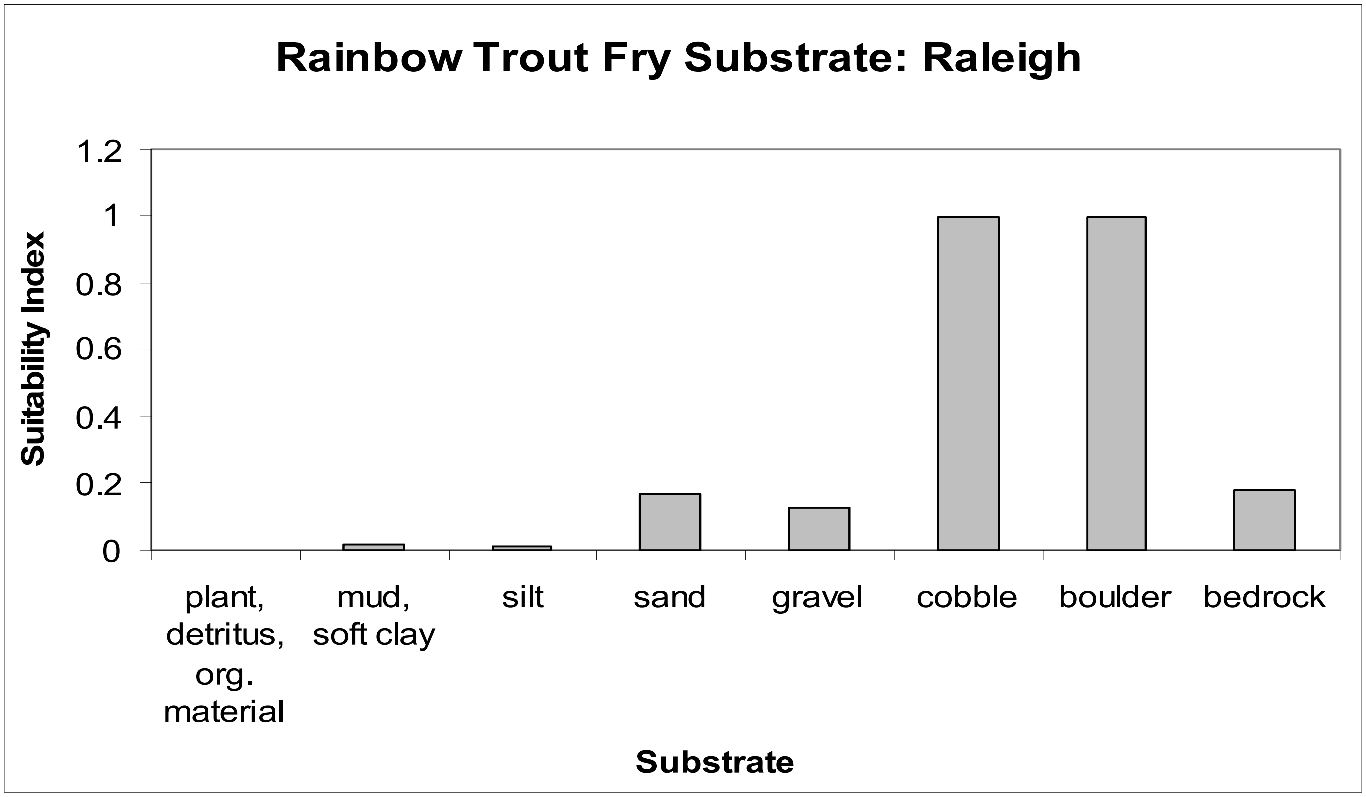


[1] See Appendix A for substrate codes and descriptions.

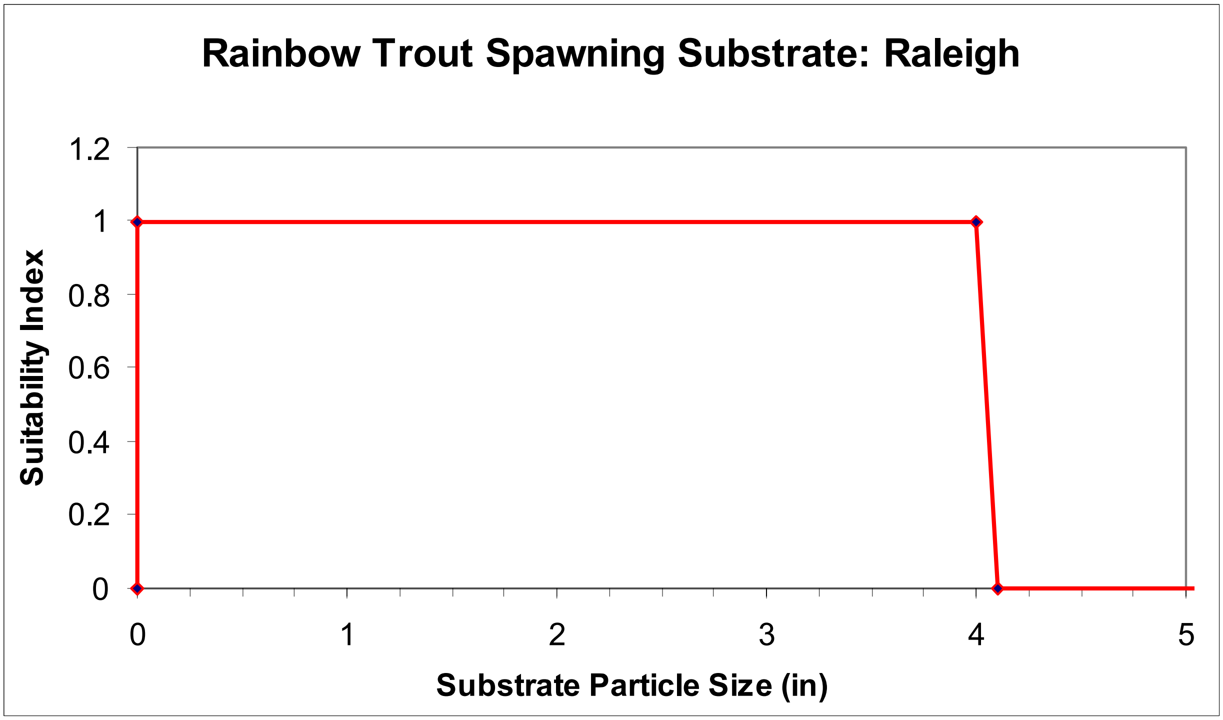
Juvenile Rainbow Trout

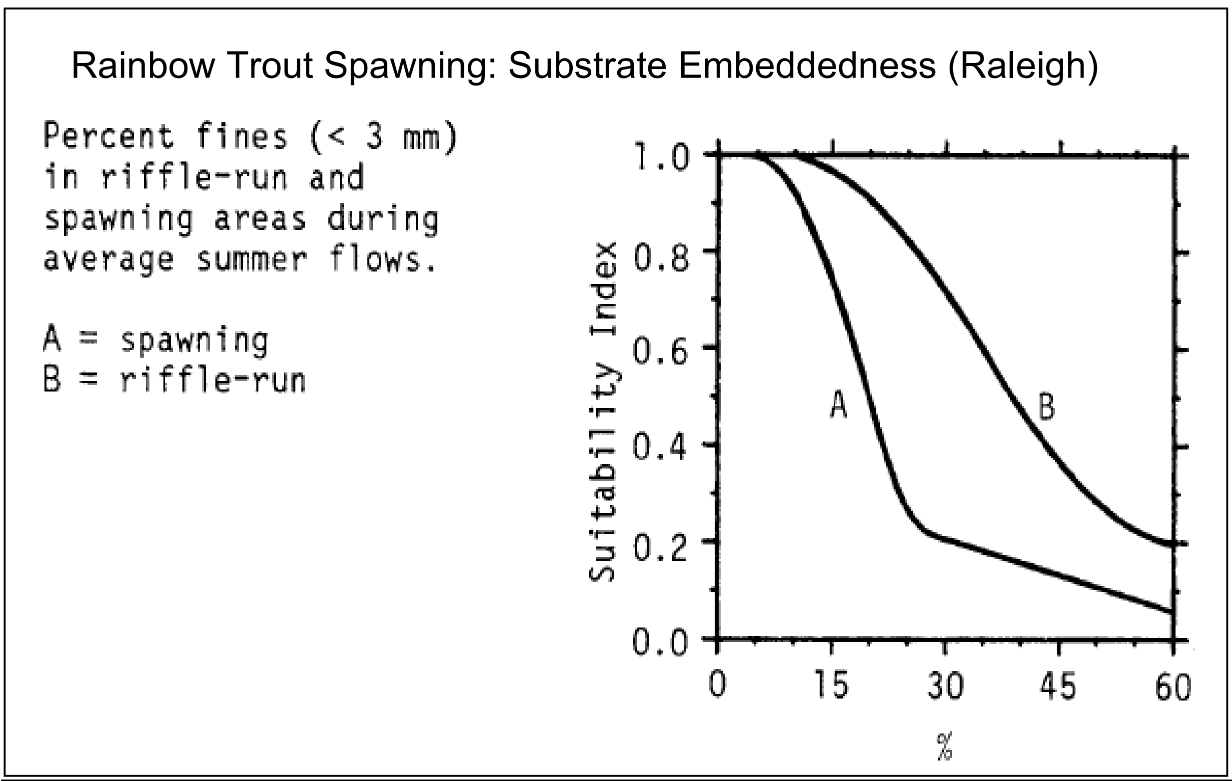


Rainbow Trout Fry



Rainbow Trout Spawning





Appendix C
Smallmouth Bass Substrate Habitat Suitability Criteria

Appendix C, Table 1: Substrate Classification Codes - Bain

Code	Description	Size (mm)	Size (in)
	Silt		
	Sand		
	Gravel	4-75	< 3 in. diam,
	Rubble	75-300	3-12 in. diam.
	Boulder	300-600	1-3 ft. diam.
	Bedrock		

Appendix C, Table 2: Substrate Classification Codes - Deerfield

Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

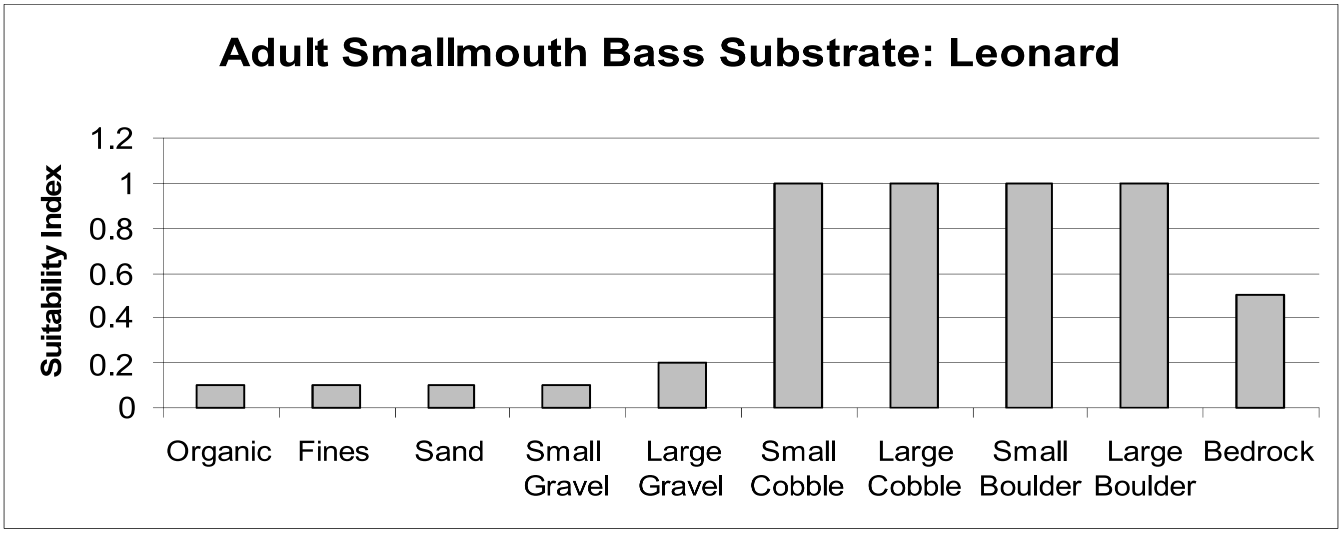
Appendix C, Table 3: Substrate Classification Codes - Leonard

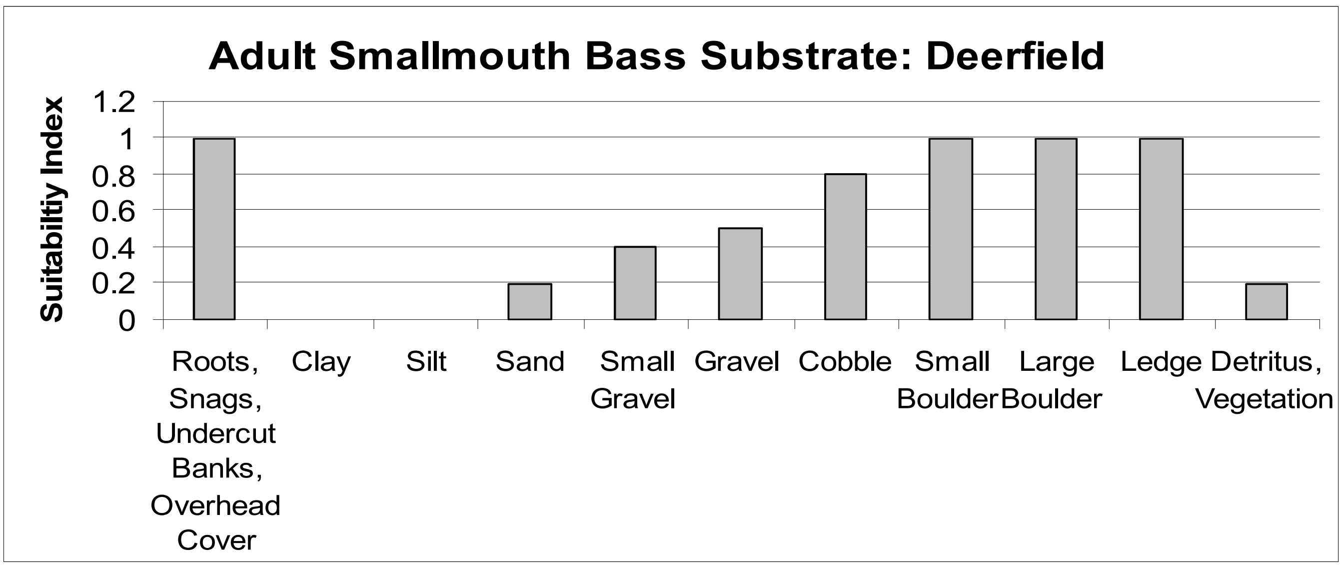
Code	Description	Size (mm)	Size (in)
1	Organic		
2	Fines		
3	Sand		
4	Small Gravel		<2 inches diam.
5	Large Gravel		2-4 inches diam.
6	Small Cobble		4-7 inches diam.
7	Large Cobble		8-10 inches diam.
8	Small Boulder		10-24inches diam.
9	Large Boulder		> 2 ft diameter
10	Bedrock		

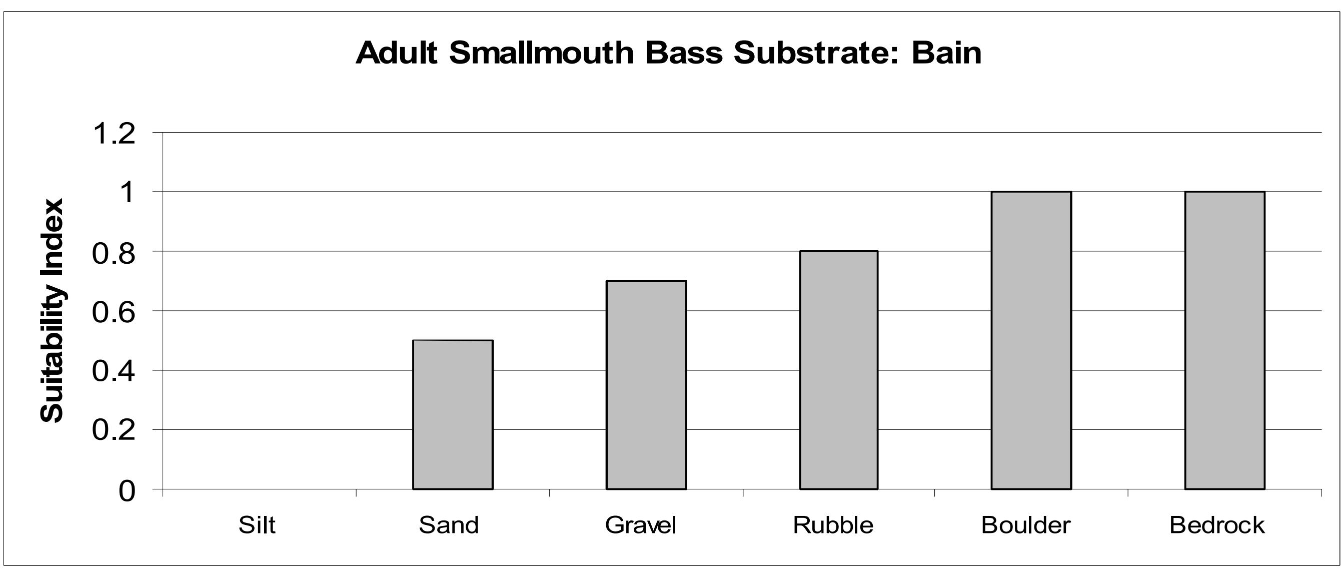
Appendix C, Table 4: Substrate Classification Codes - Lockhart

Code	Description	Size (mm)	Size (in)
1	mud	<1	< 0.4
2	sand	1 - 2	0.4 - 0.8
3	small gravel	2 - 16	0.8 - 6.3
4	large gravel	16 - 64	6.3 - 25.2
5	small cobble	64 - 128	25.2 - 50.4
6	large cobble	128 - 256	50.4 - 100.8
7	small boulder	256 - 512	100.8 - 201.6
8	large boudler	> 512	> 201.6
9	bedrock	-	

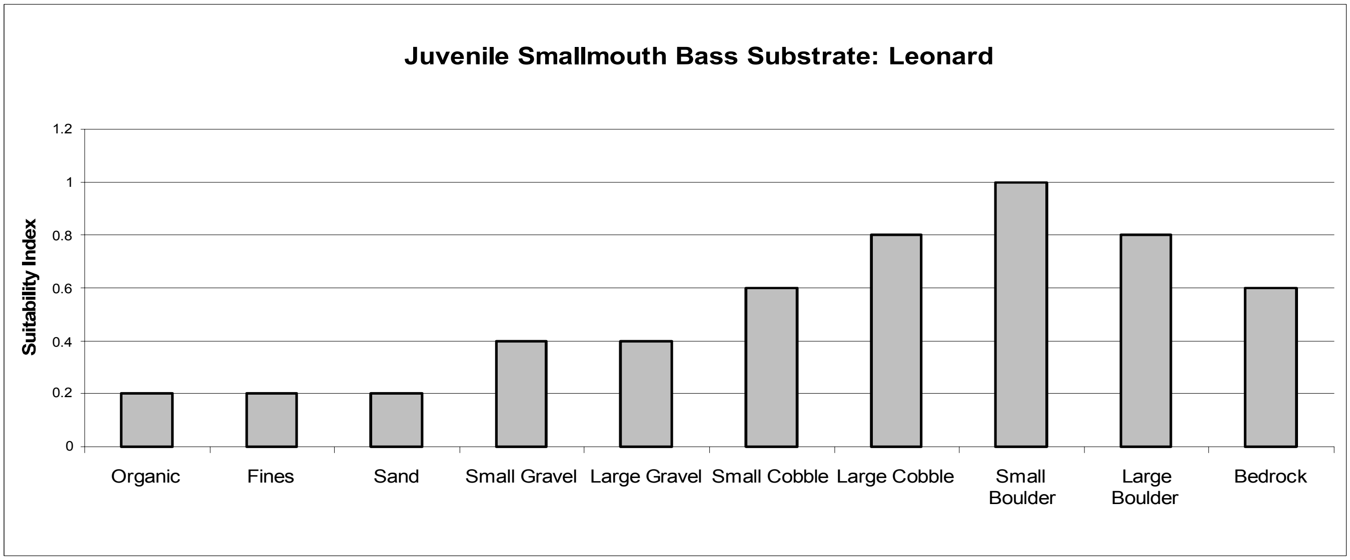
Adult Smallmouth Bass

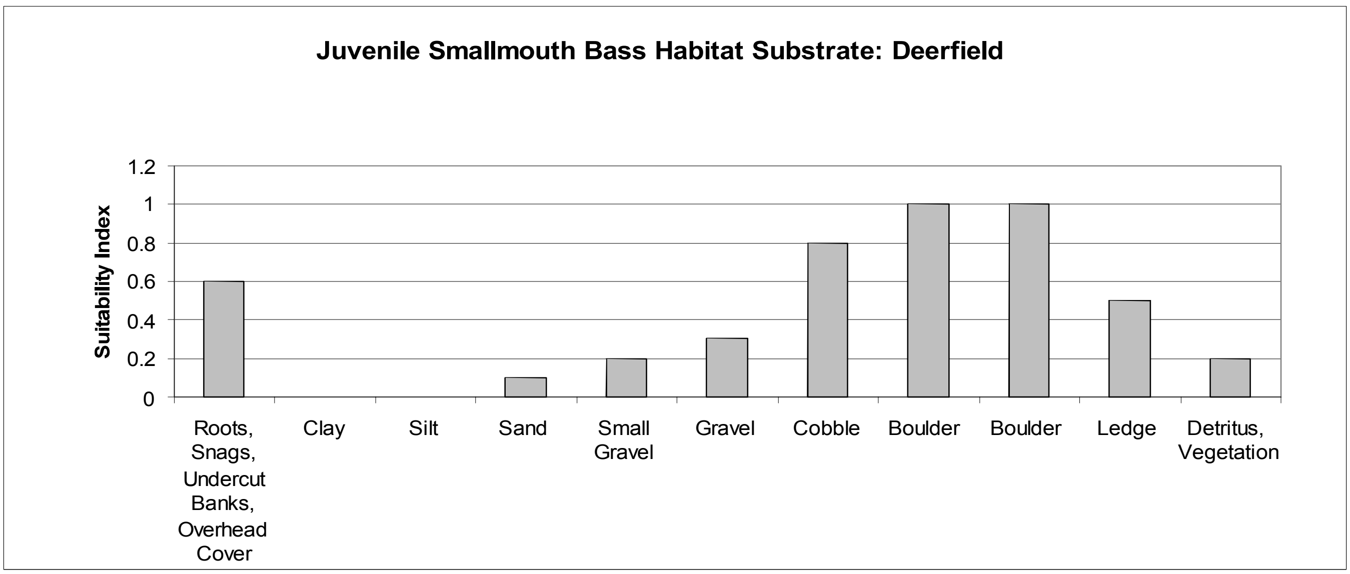


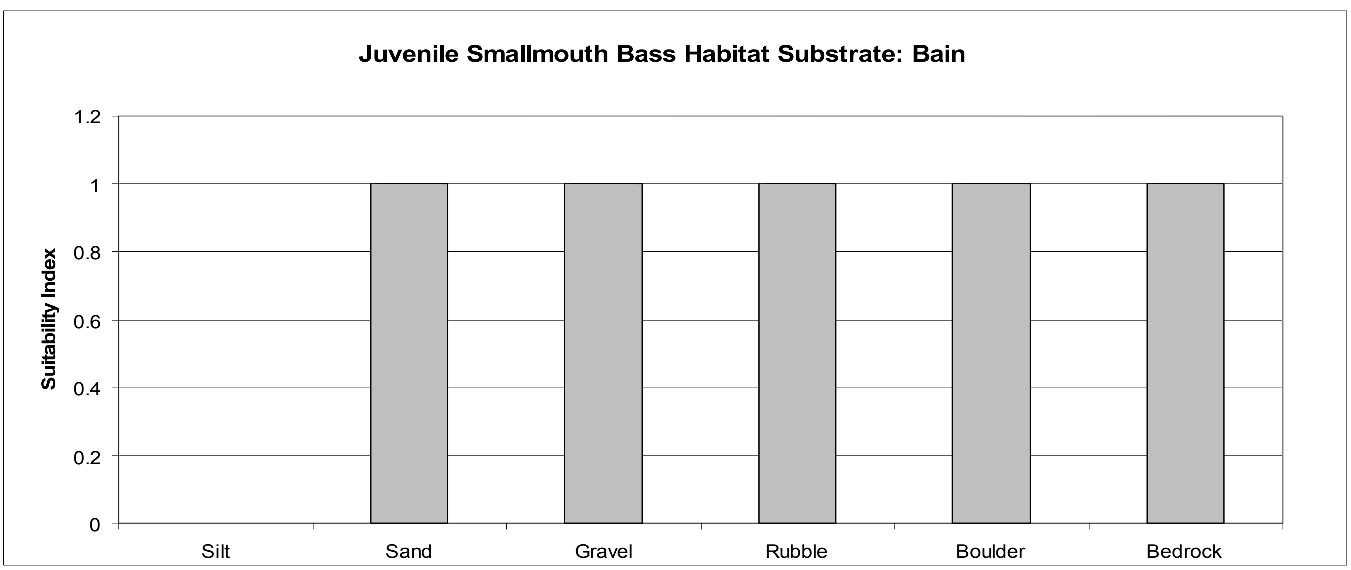




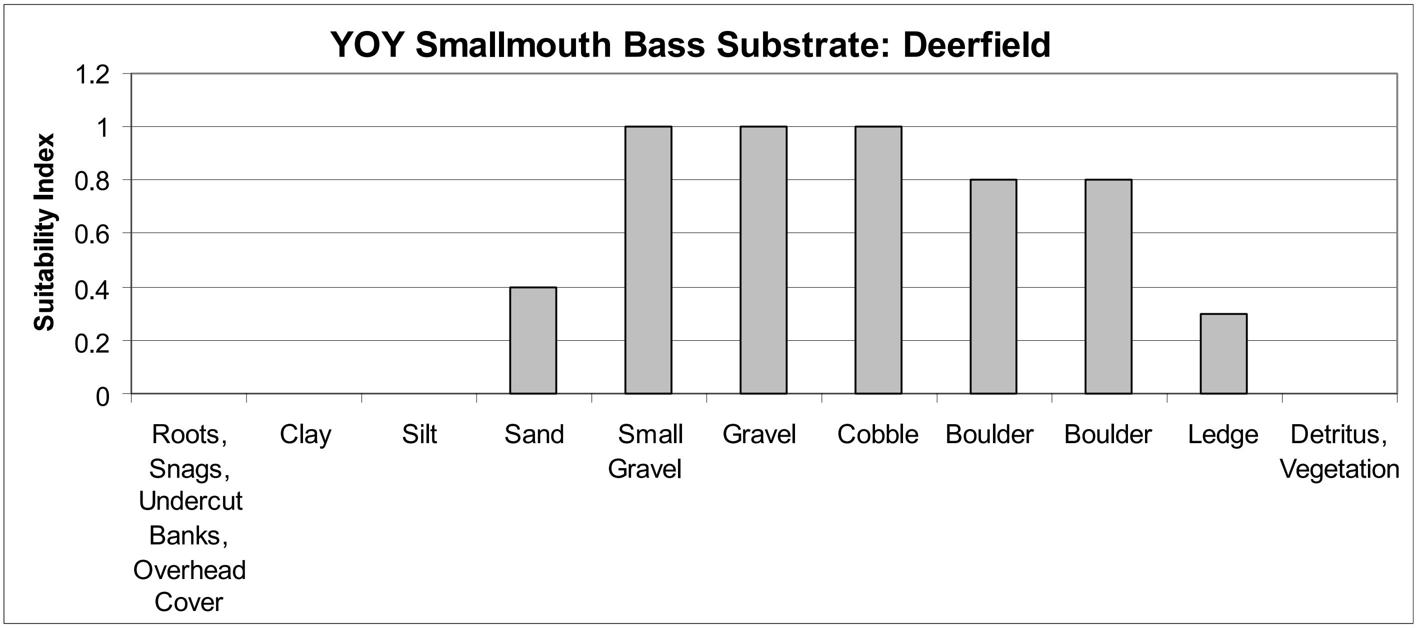
Juvenile Smallmouth Bass

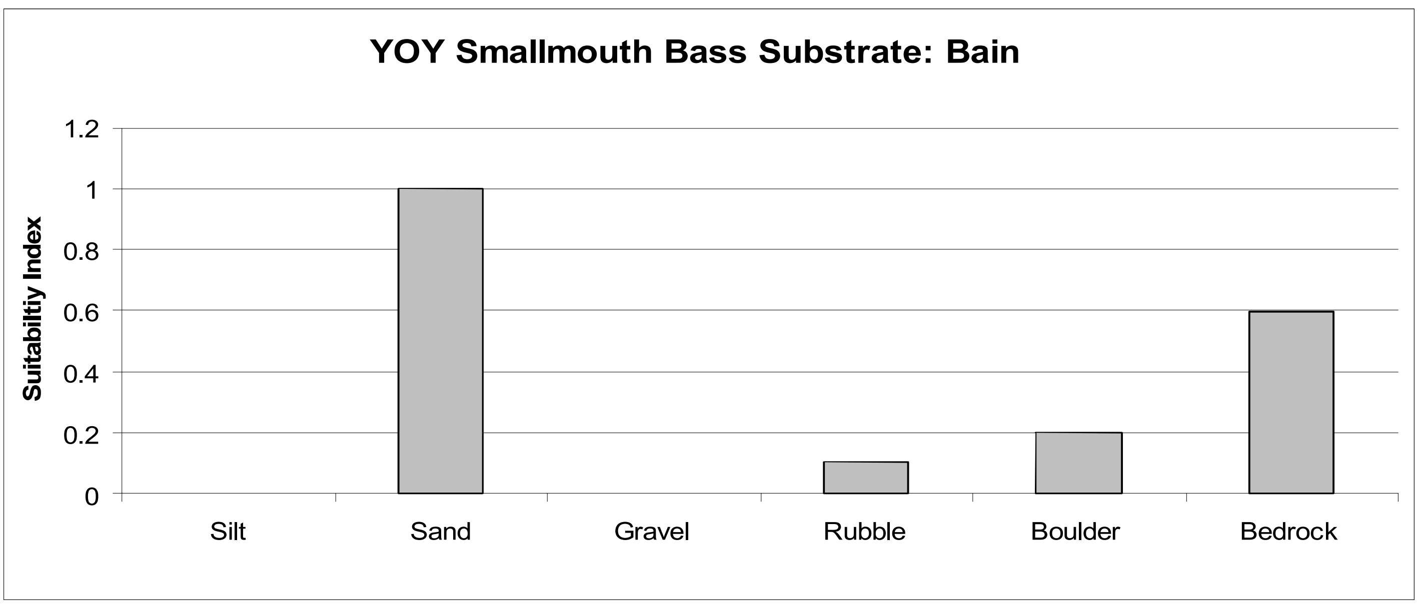




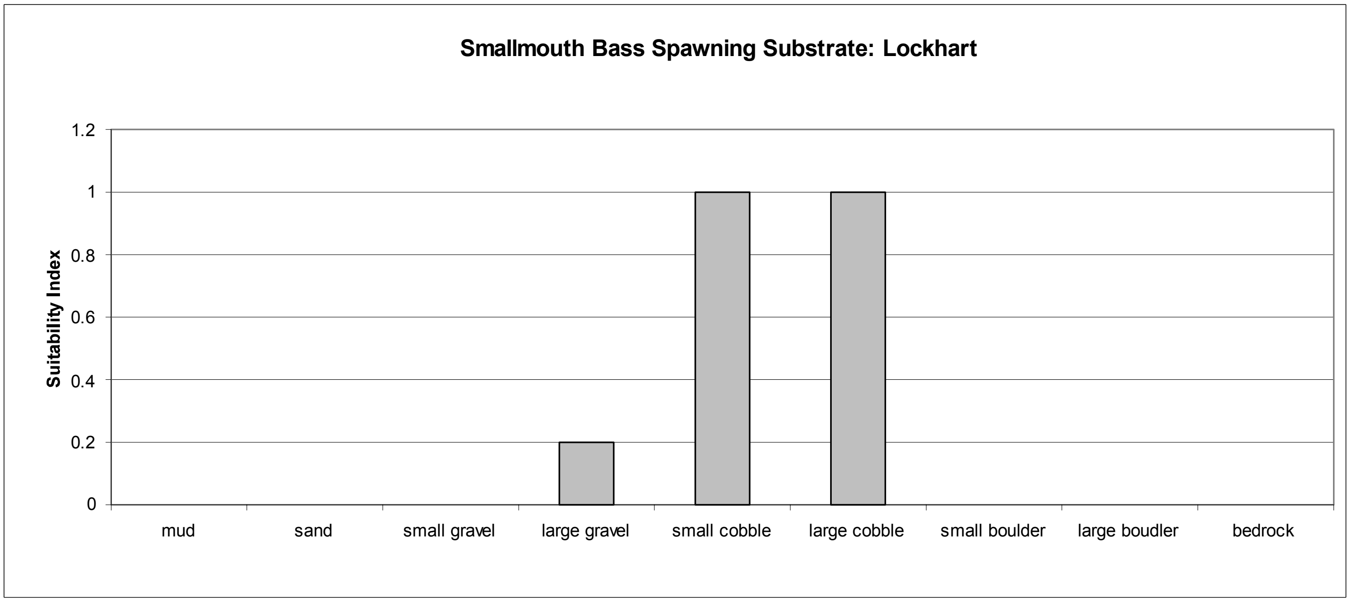


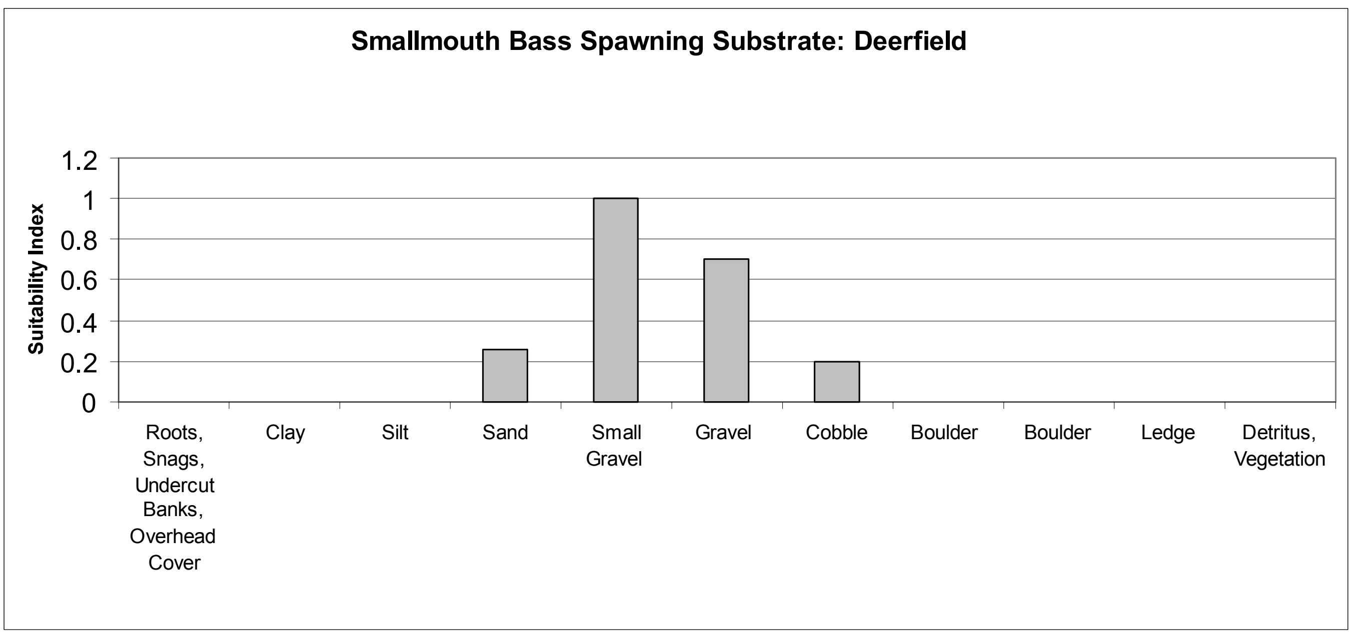
Smallmouth Bass YOY





Smallmouth Bass Spawning





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Z:\SCO\455\029\2007-01-16 Saluda Instream Flow Study - Habitat Suitability Criteria.doc

Kacie Jensen

From: Alison Guth
Sent: Monday, April 09, 2007 11:46 AM
To: Alison Guth; 'Theresa Thom'; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Bud Badr'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Mike Waddell'; 'Milton Quattlebaum (mquattlebaum@scana.com)'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
Subject: IFIM Conference Call Info

Hello All,

In light of our IFIM conference call tomorrow, attached is the memo that was originally sent out on March 30. This memo will serve as both the agenda and visual for tomorrow's meeting. Thanks and feel free to email Shane or I with any questions that you may have. Alison

Saluda IFIM Study - Habitat Su...

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC)) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized "Bluebook" criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized "Bluebook" criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized "Bluebook" criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

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Appendix A
Brown Trout Substrate Habitat Suitability Criteria

Kacie Jensen

From: Alison Guth
Sent: Monday, April 09, 2007 11:46 AM
To: Alison Guth; 'Theresa Thom'; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Bud Badr'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Mike Waddell'; 'Milton Quattlebaum (mquattlebaum@scana.com)'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; Brandon Kulik; Alan Stuart
Subject: IFIM Conference Call Info

Hello All,

In light of our IFIM conference call tomorrow, attached is the memo that was originally sent out on March 30. This memo will serve as both the agenda and visual for tomorrow's meeting. Thanks and feel free to email Shane or I with any questions that you may have. Alison

Saluda IFIM Study - Habitat Su...

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC)) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized "Bluebook" criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized "Bluebook" criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized "Bluebook" criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

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Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

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Appendix A

Brown Trout Substrate Habitat Suitability Criteria

Appendix A, Table 1: Substrate Classification Codes - Raleigh

Substrate Codes from Bovee (1982)			
Code	**Description**	**Size (mm)**	**Size (in)**
1	plant/detritus/organic material		
2	mud/soft clay		
3	silt	<.08	<.03
4	sand	0.8 - 4.8	0.3 - 1.9
5	gravel	4.8 - 75	1.9 -29.5
6	cobble	75 - 300	29.5 - 118
7	boulder	> 300 mm	> 118
8	bedrock		

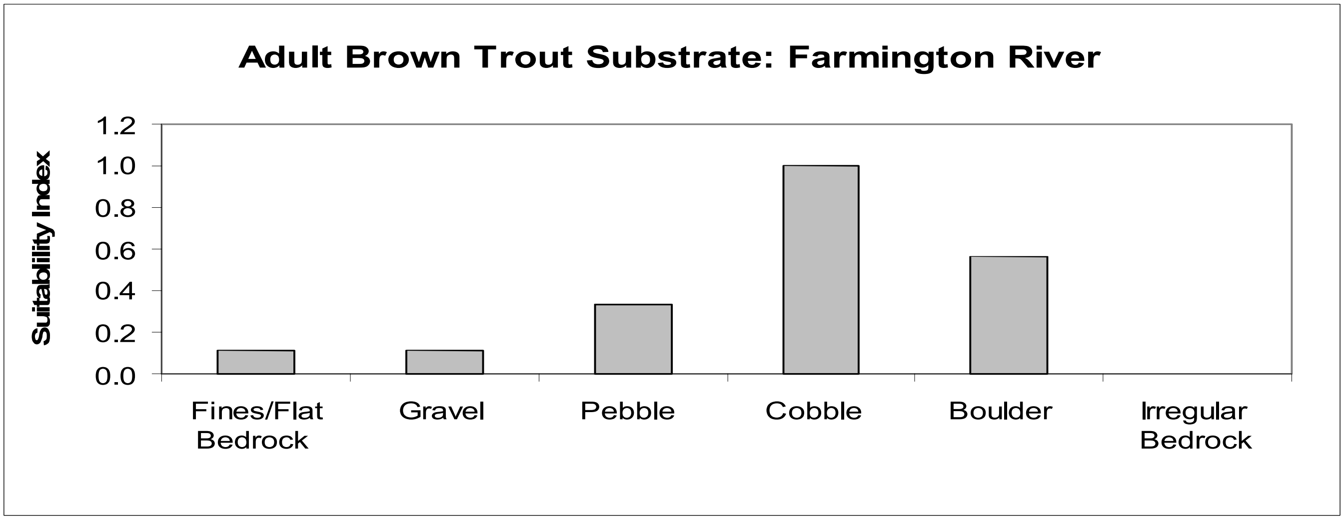
Appendix A, Table 2: Substrate Classification Codes - Deerfield & Housatonic

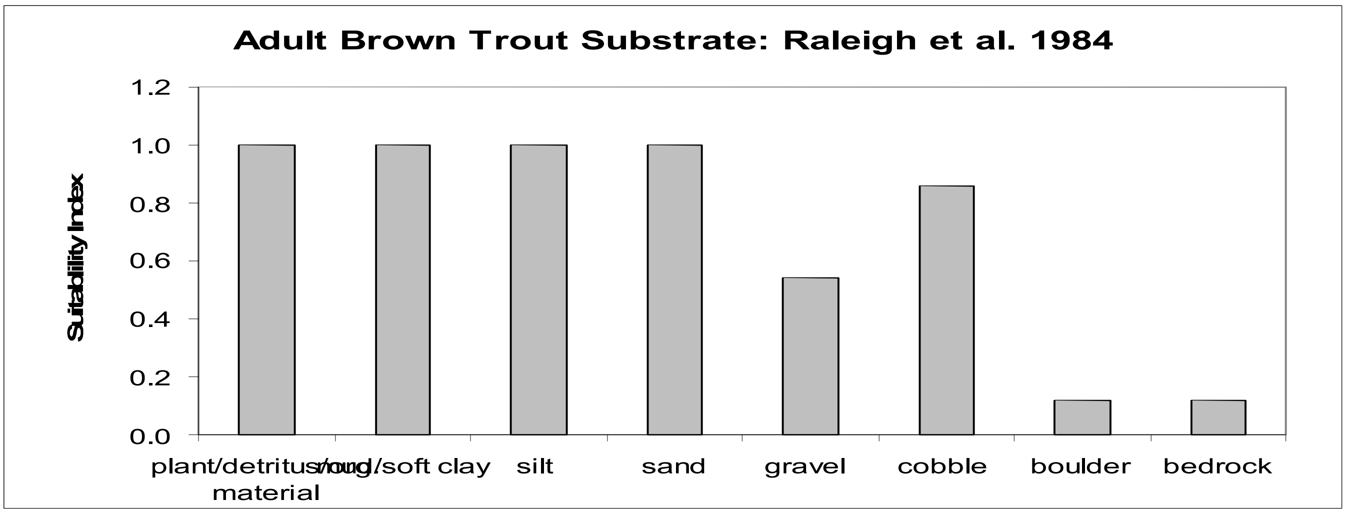
Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

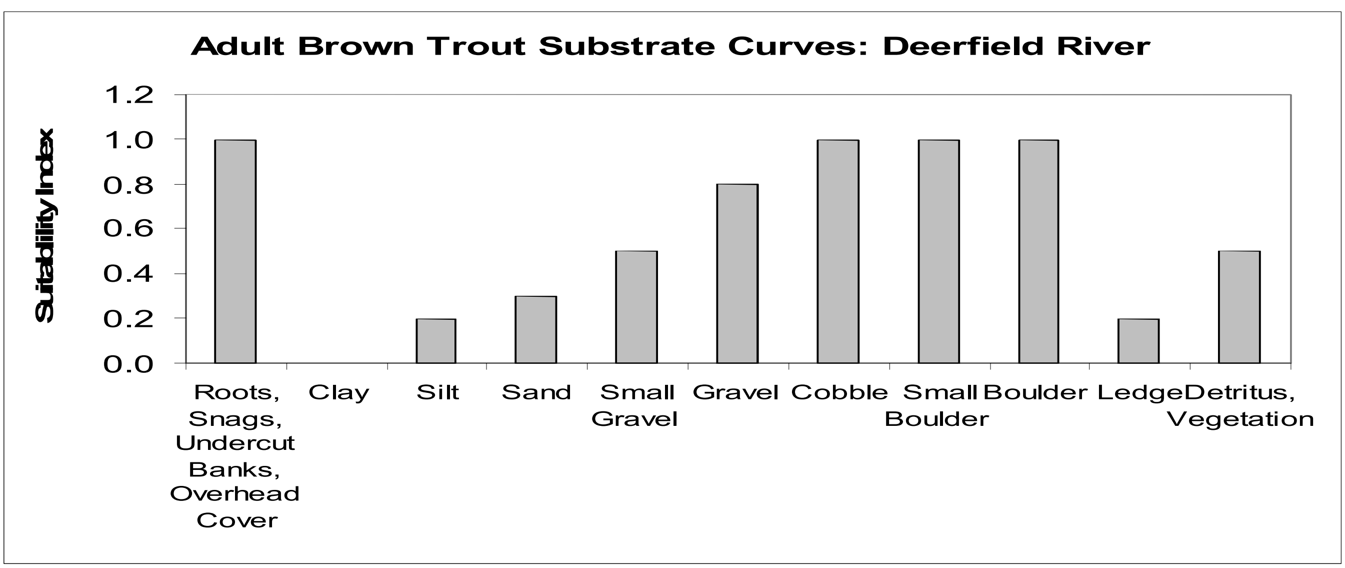
Appendix A, Table 3: Substrate Classification Codes - Farmington

Code	Description	Size (mm)	Size (in)
1	Fines/Flat Bedrock	< 2	< .08
2	Gravel	2 - 16	0.08 - 0.63
3	Pebble	16 - 64	0.63 - 2.52
4	Cobble	64 - 256	2.52 - 10.08
5	Boulder	> 256	> 10.08
6	Irregular Bedrock		

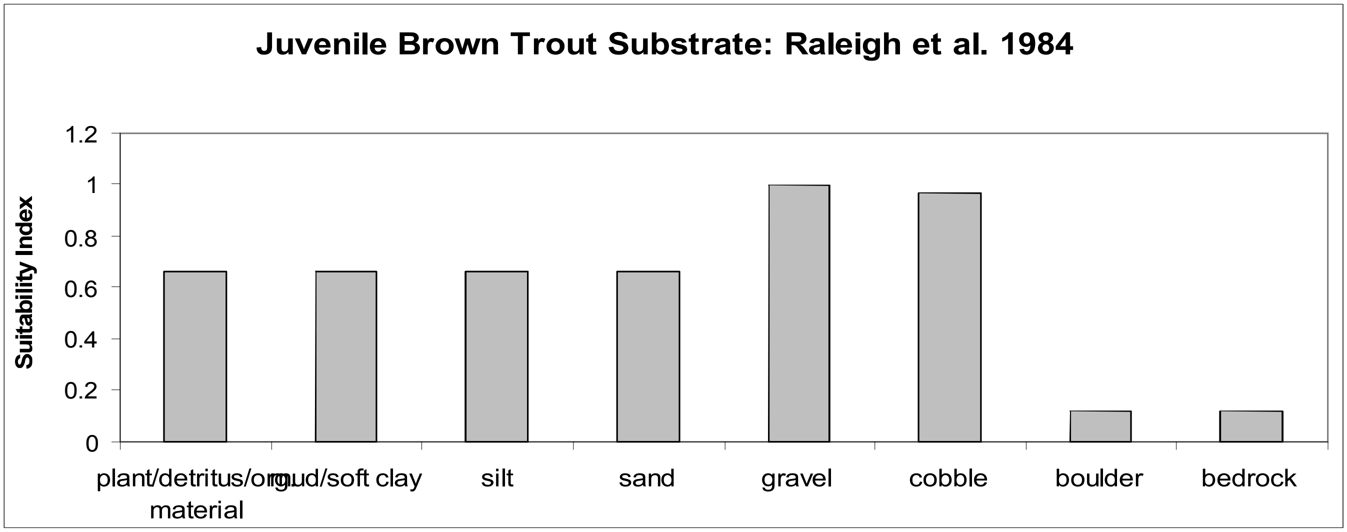
Adult Brown Trout

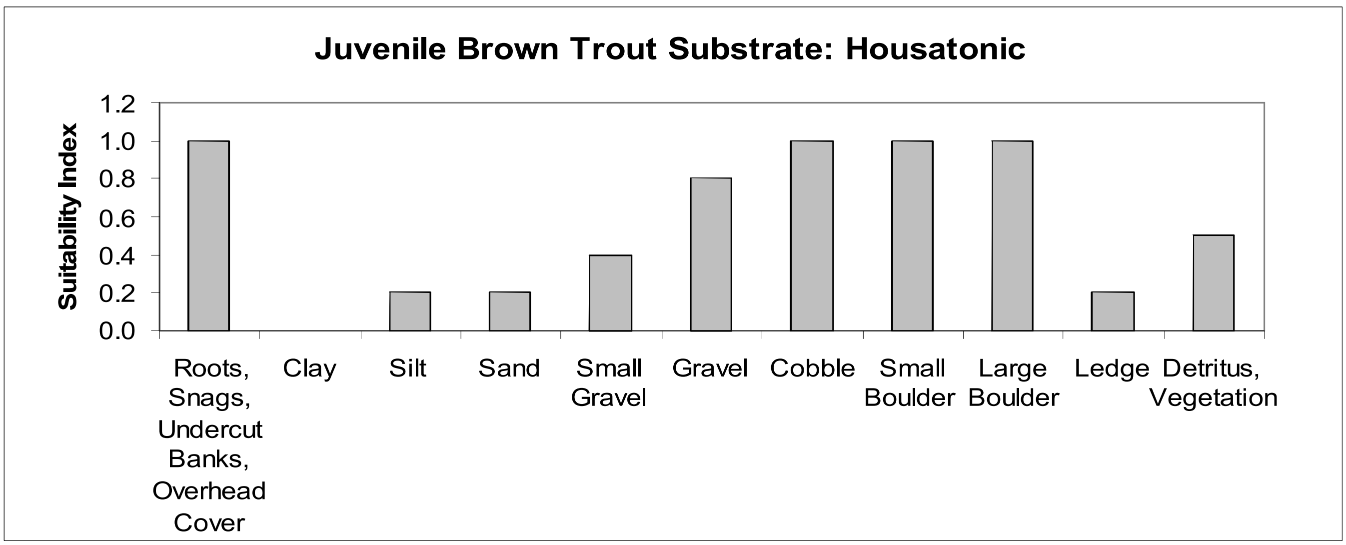


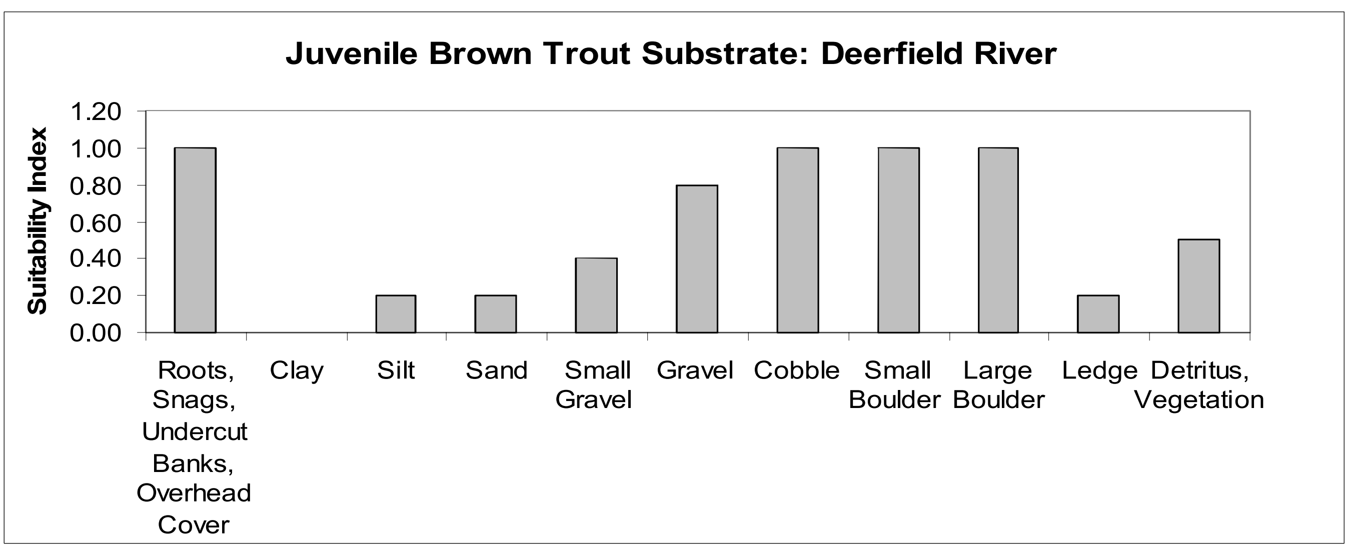




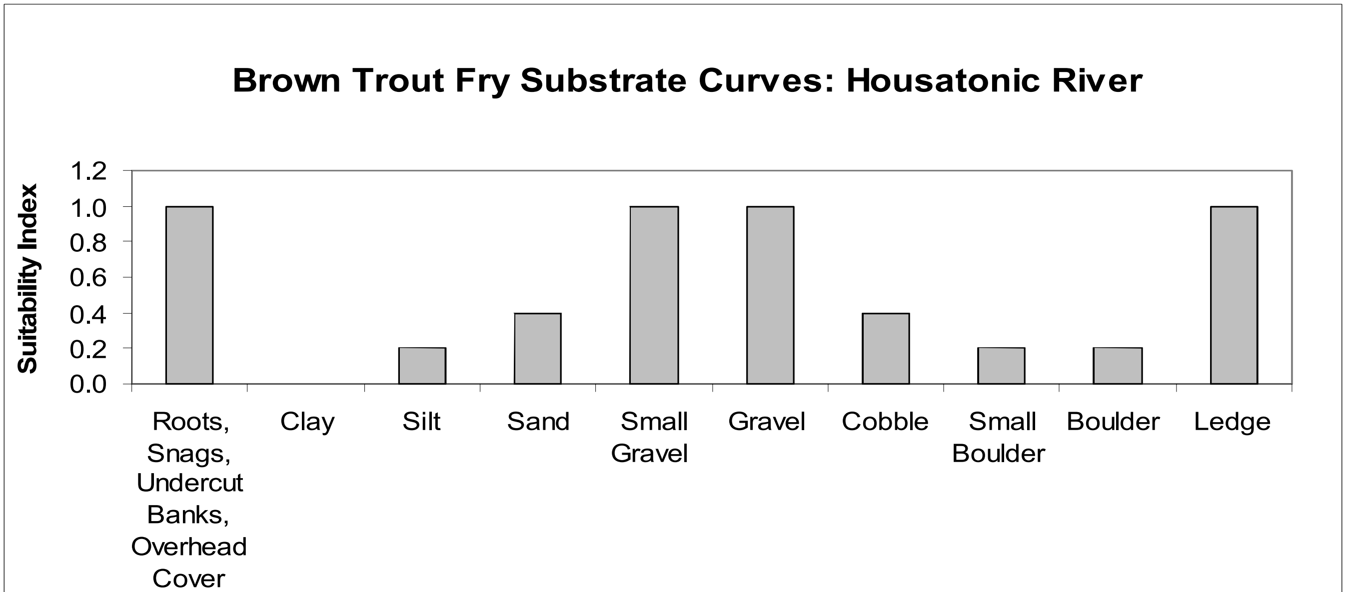
Juvenile Brown Trout

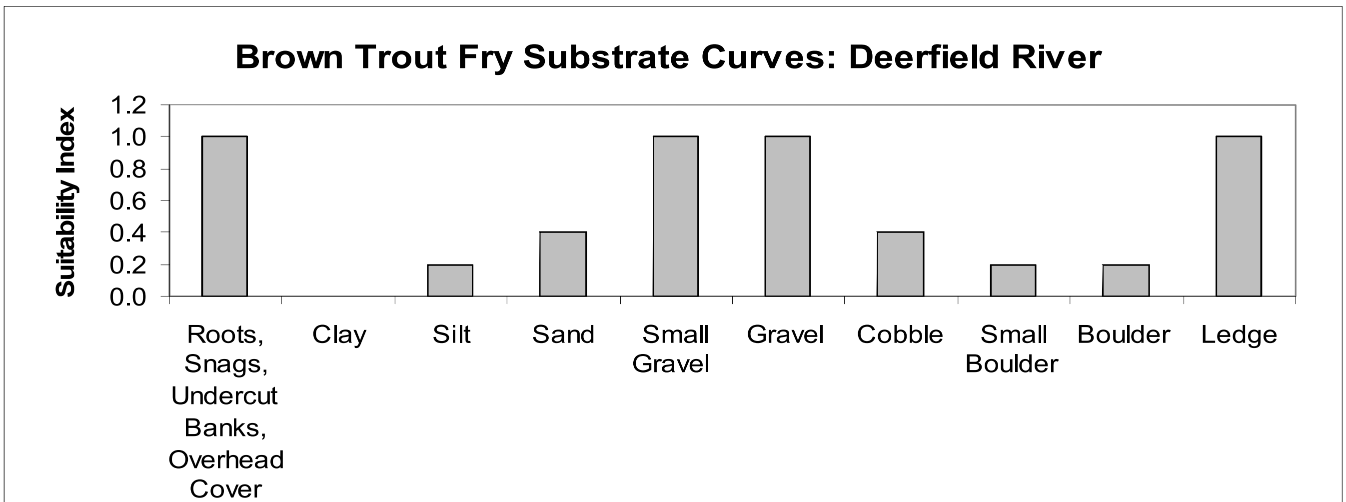


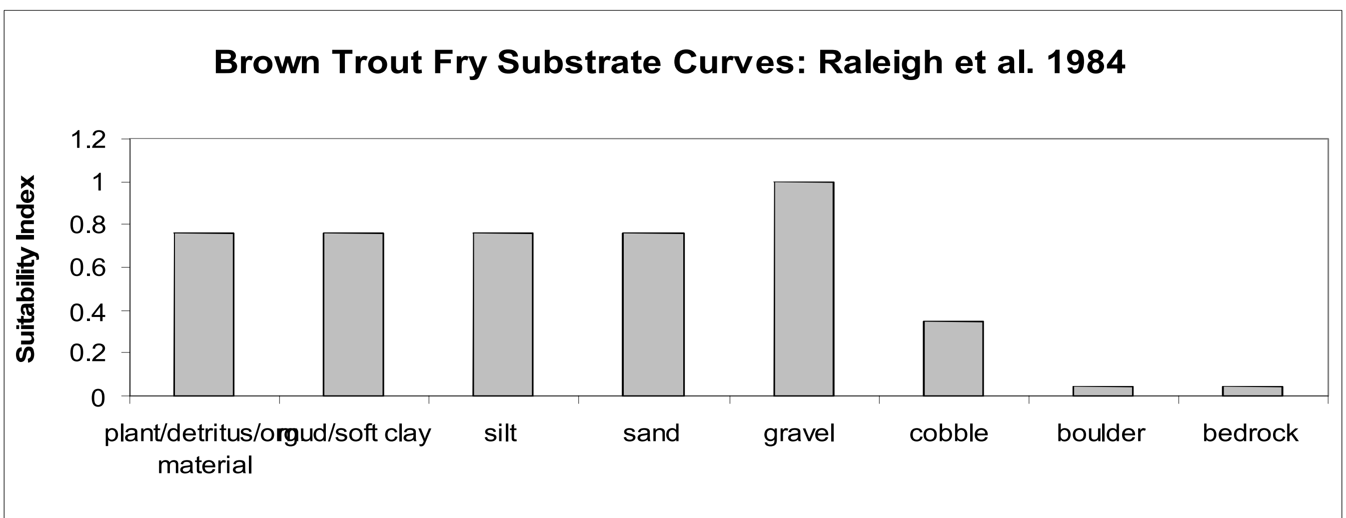




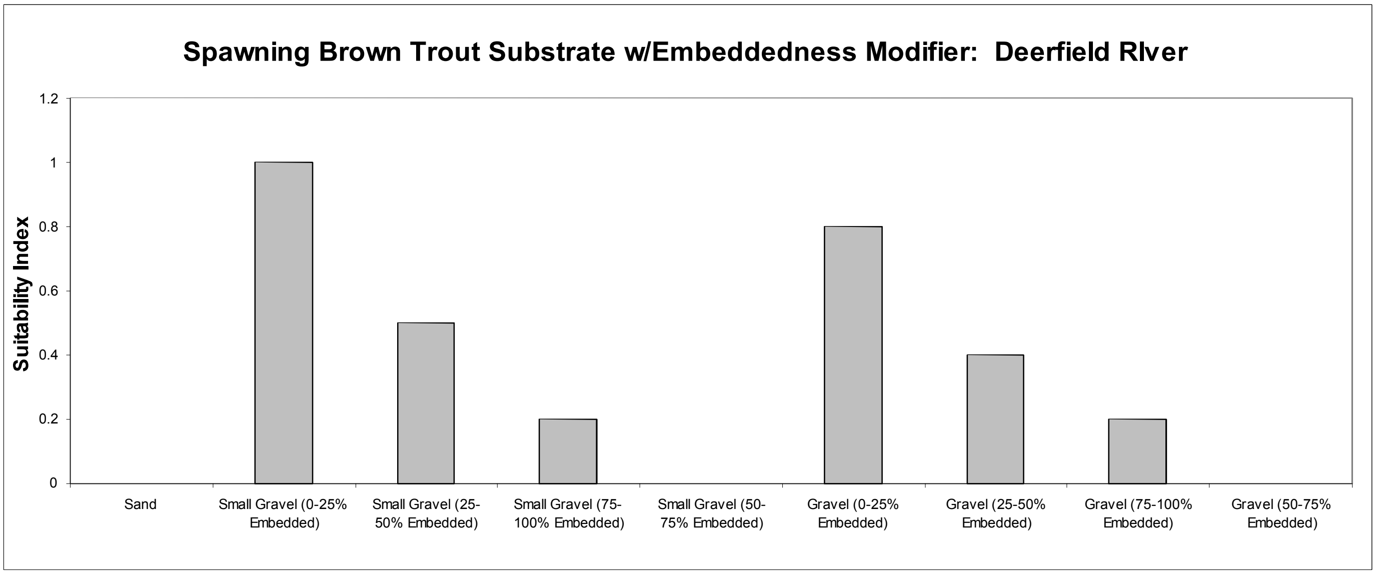
Brown Trout Fry

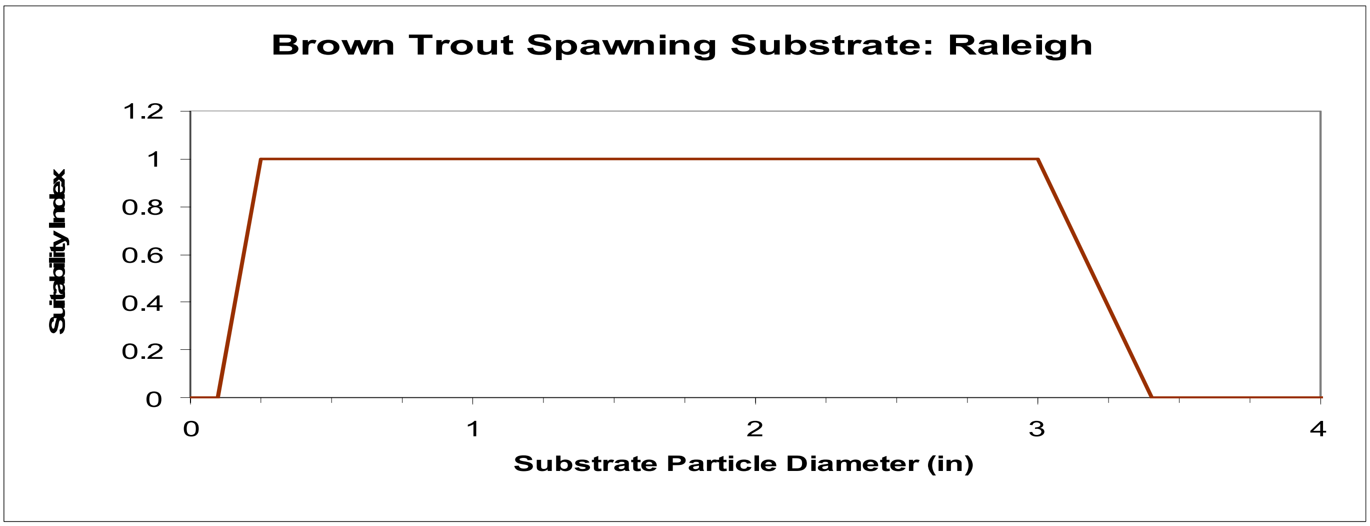


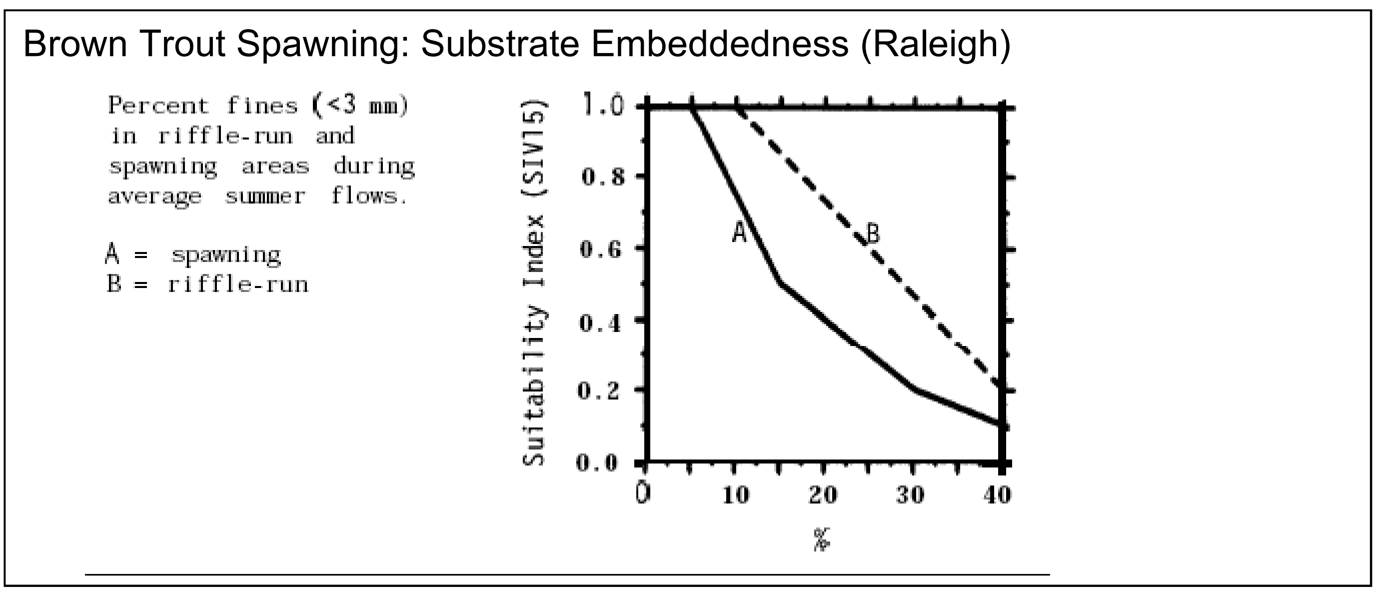




Spawning Brown Trout

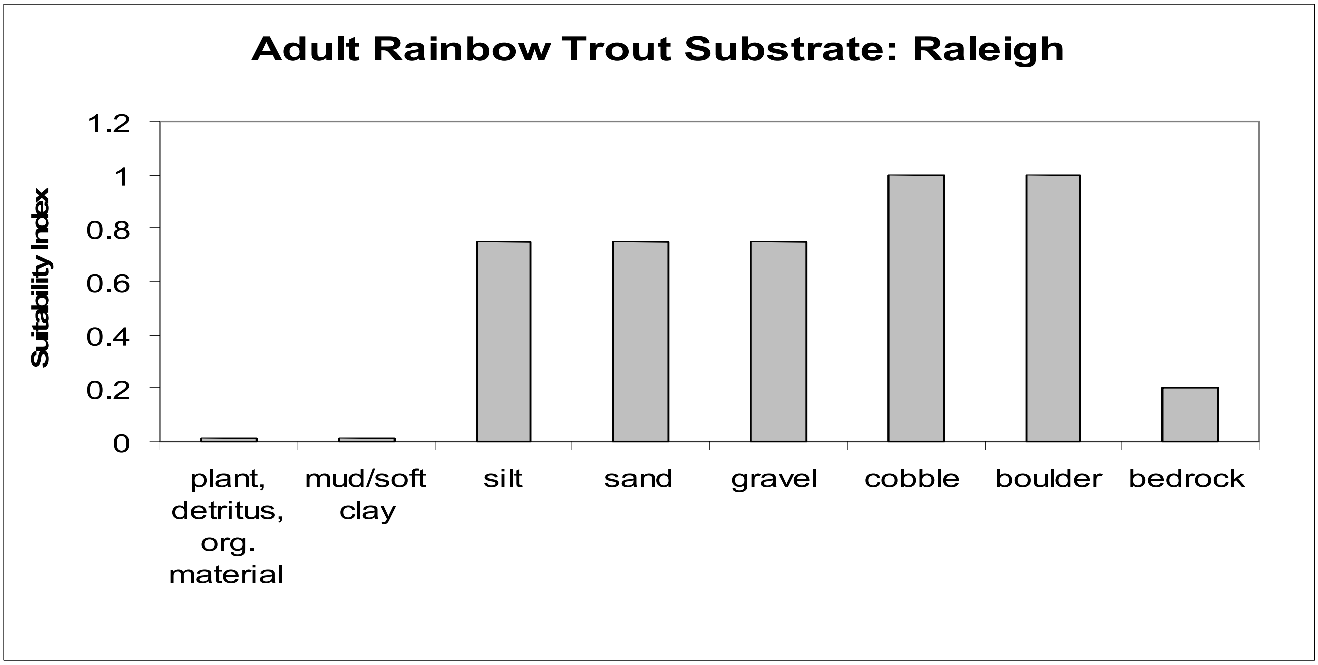


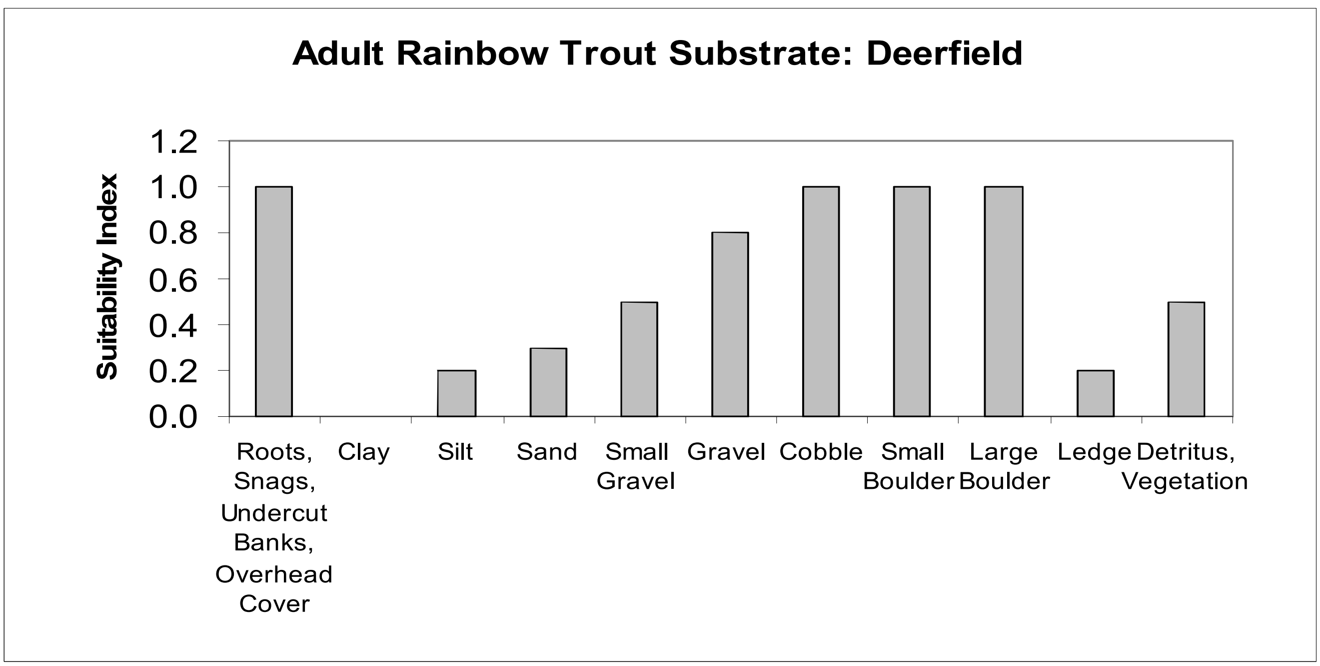




Appendix B
Rainbow Trout Substrate Habitat Suitability Criteria

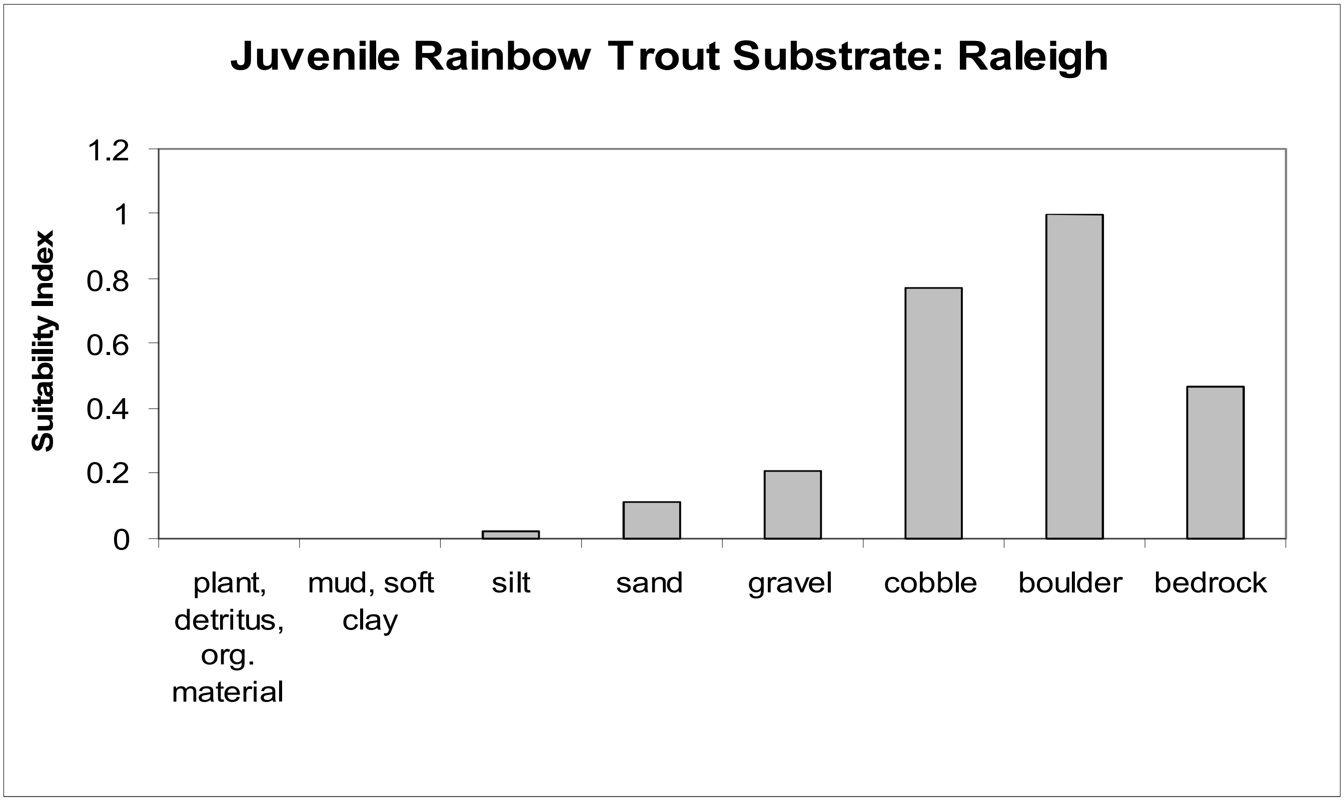
Adult Rainbow Trout[1]



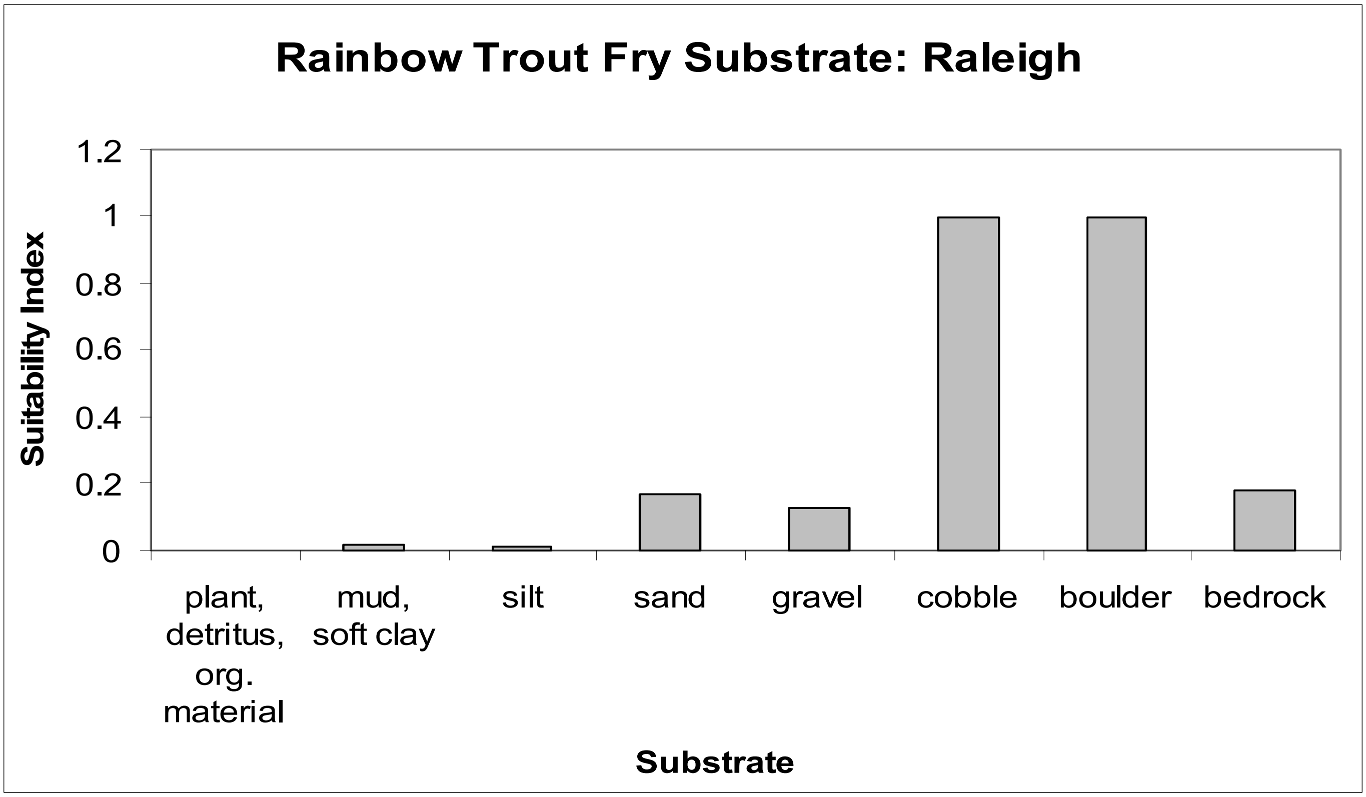


[1] See Appendix A for substrate codes and descriptions.

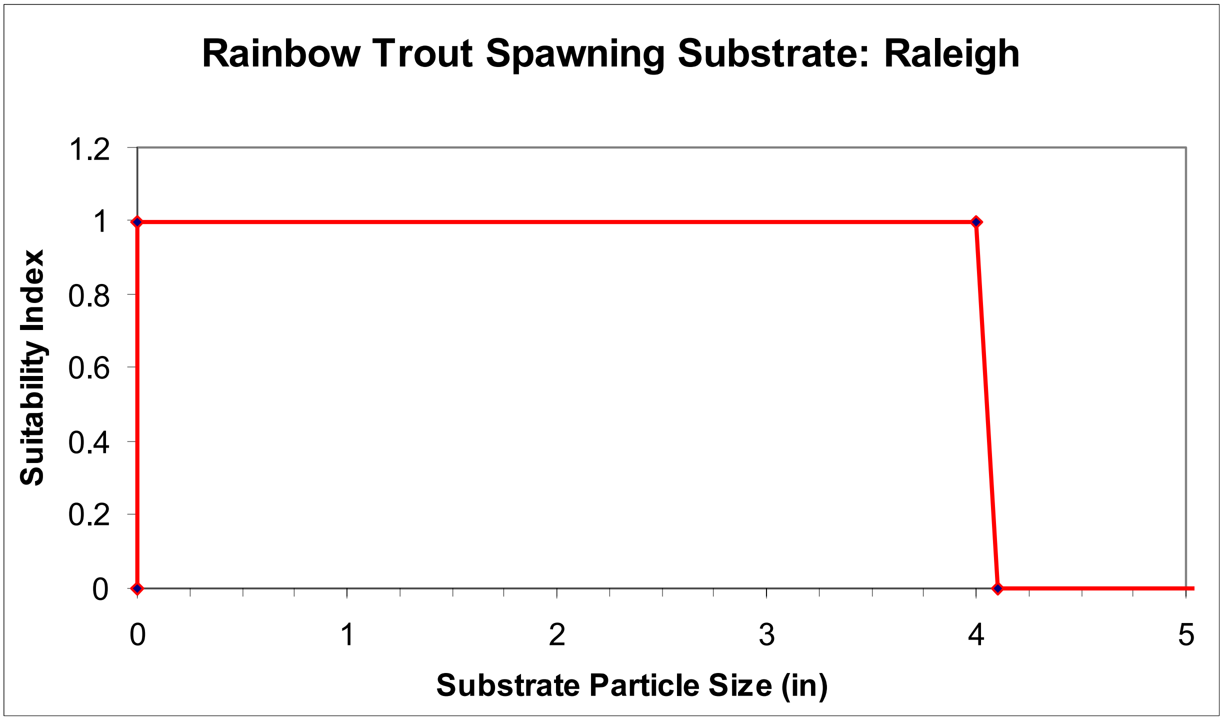
Juvenile Rainbow Trout

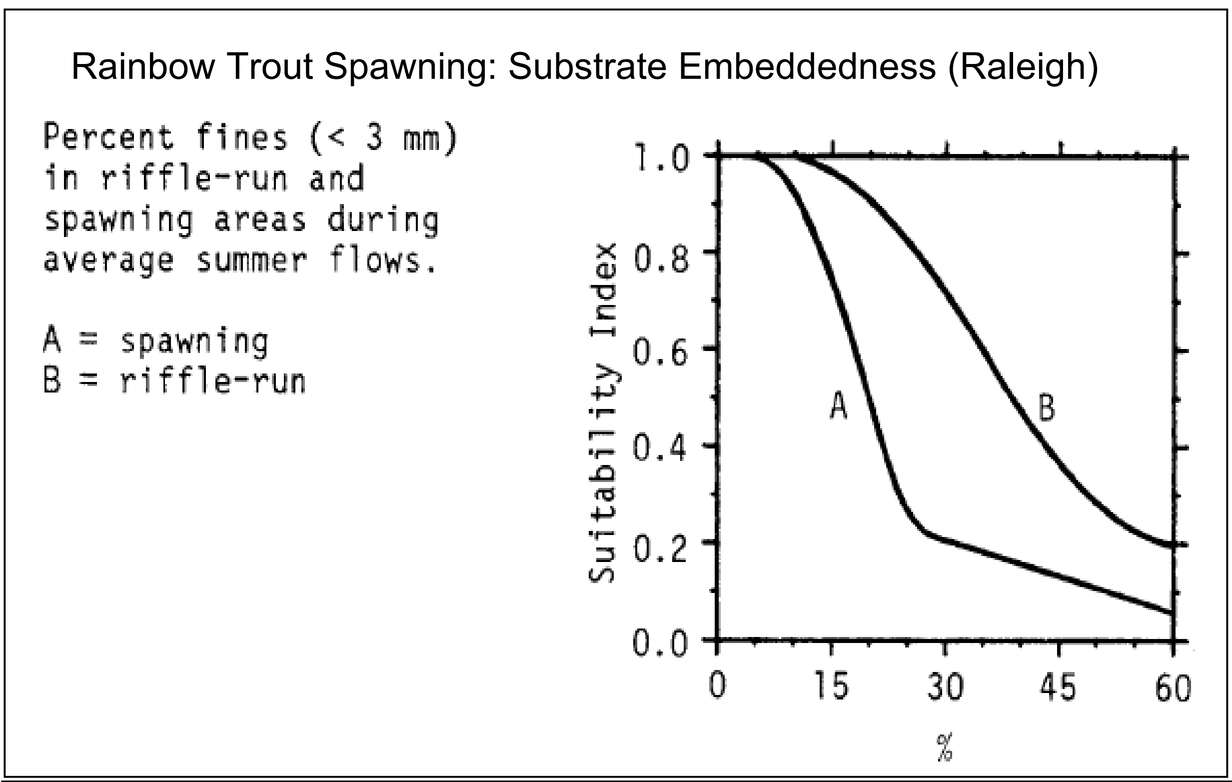


Rainbow Trout Fry



Rainbow Trout Spawning





Appendix C
Smallmouth Bass Substrate Habitat Suitability Criteria

Appendix C, Table 1: Substrate Classification Codes - Bain

Code	Description	Size (mm)	Size (in)
	Silt		
	Sand		
	Gravel	4-75	< 3 in. diam,
	Rubble	75-300	3-12 in. diam.
	Boulder	300-600	1-3 ft. diam.
	Bedrock		

Appendix C, Table 2: Substrate Classification Codes - Deerfield

Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

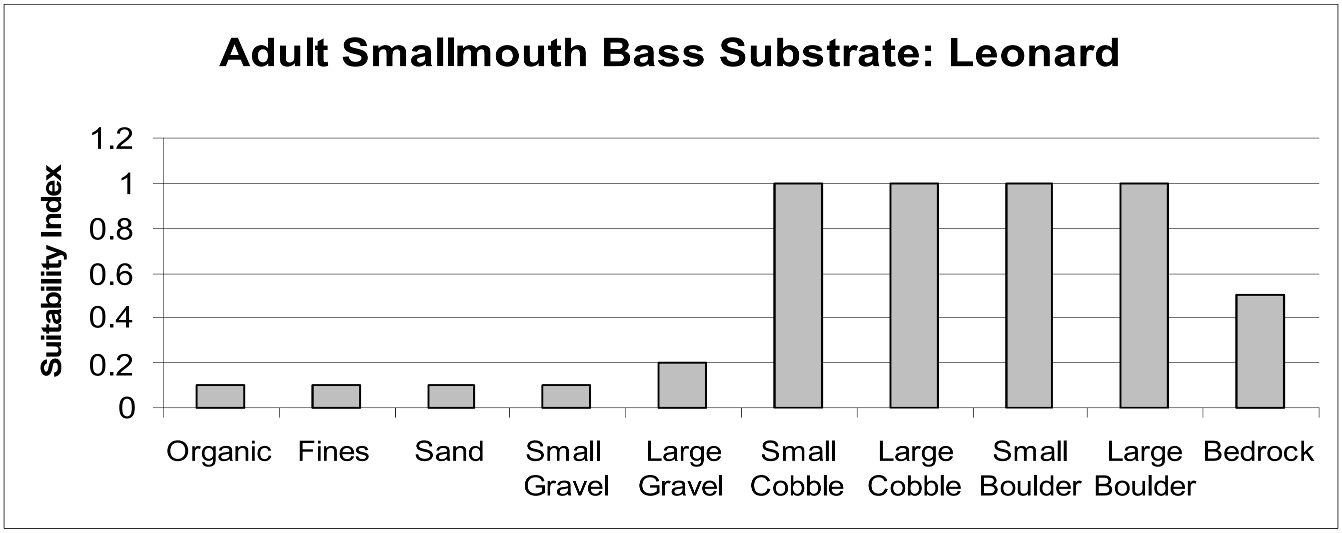
Appendix C, Table 3: Substrate Classification Codes - Leonard

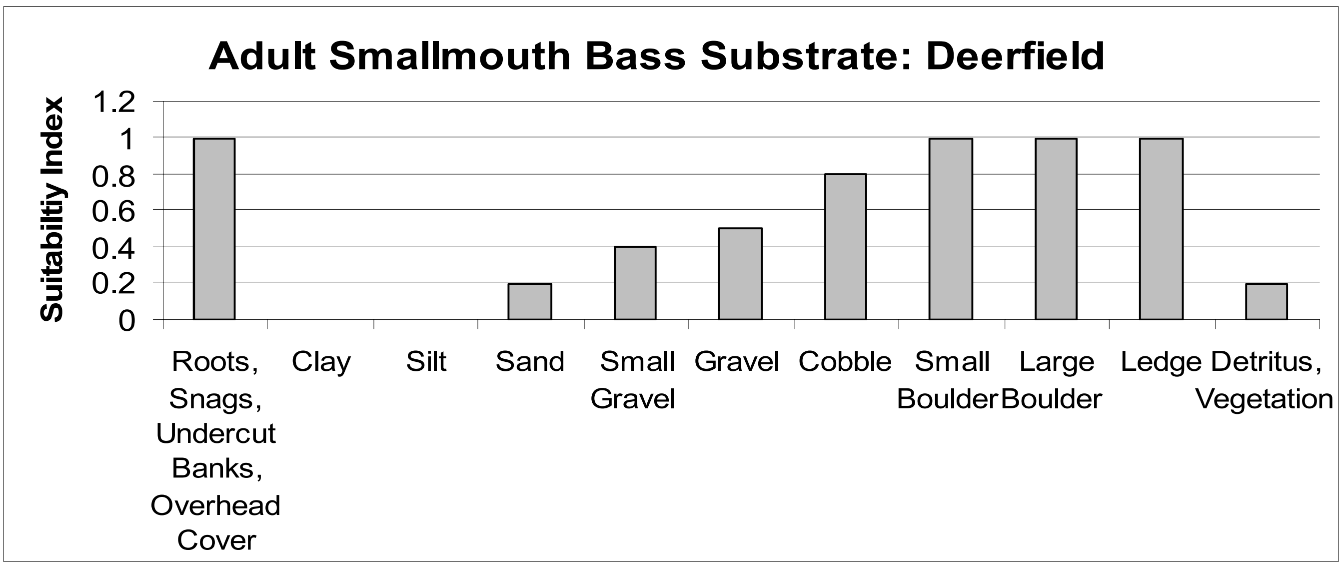
Code	Description	Size (mm)	Size (in)
1	Organic		
2	Fines		
3	Sand		
4	Small Gravel		<2 inches diam.
5	Large Gravel		2-4 inches diam.
6	Small Cobble		4-7 inches diam.
7	Large Cobble		8-10 inches diam.
8	Small Boulder		10-24inches diam.
9	Large Boulder		> 2 ft diameter
10	Bedrock		

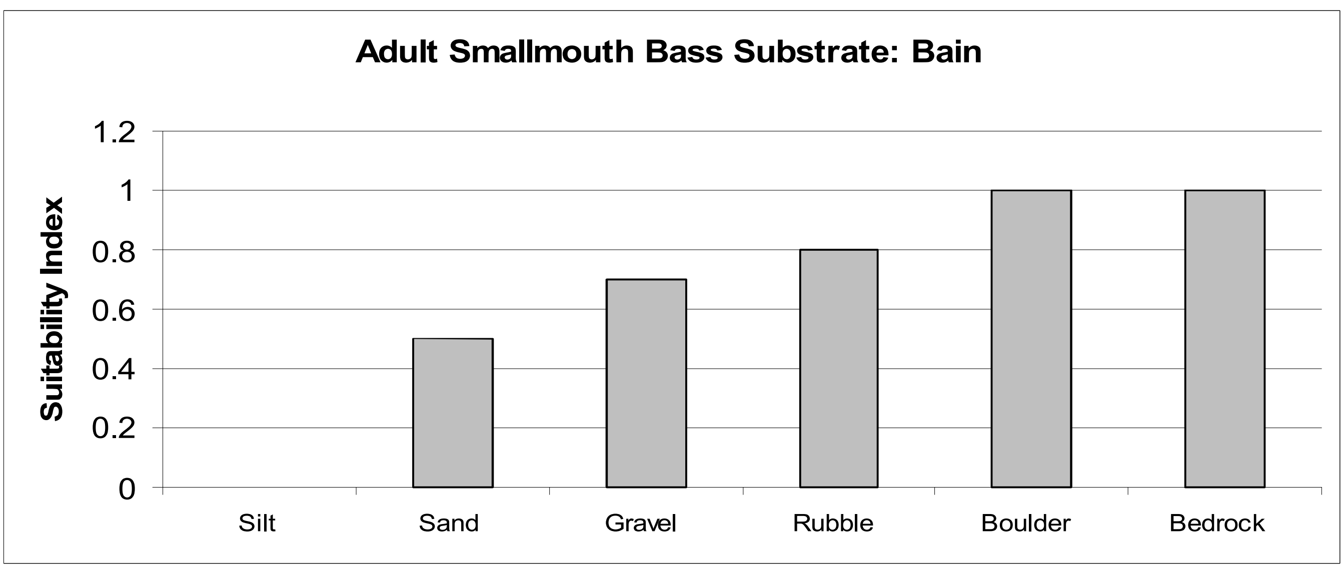
Appendix C, Table 4: Substrate Classification Codes - Lockhart

Code	Description	Size (mm)	Size (in)
1	mud	<1	< 0.4
2	sand	1 - 2	0.4 - 0.8
3	small gravel	2 - 16	0.8 - 6.3
4	large gravel	16 - 64	6.3 - 25.2
5	small cobble	64 - 128	25.2 - 50.4
6	large cobble	128 - 256	50.4 - 100.8
7	small boulder	256 - 512	100.8 - 201.6
8	large boudler	> 512	> 201.6
9	bedrock	-	

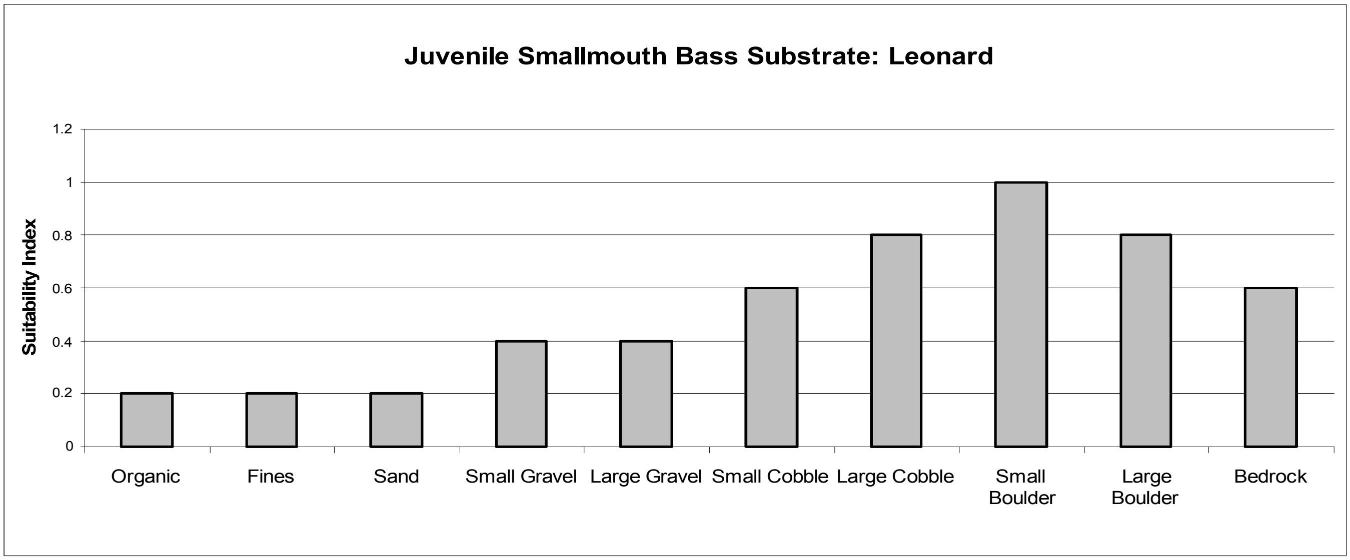
Adult Smallmouth Bass

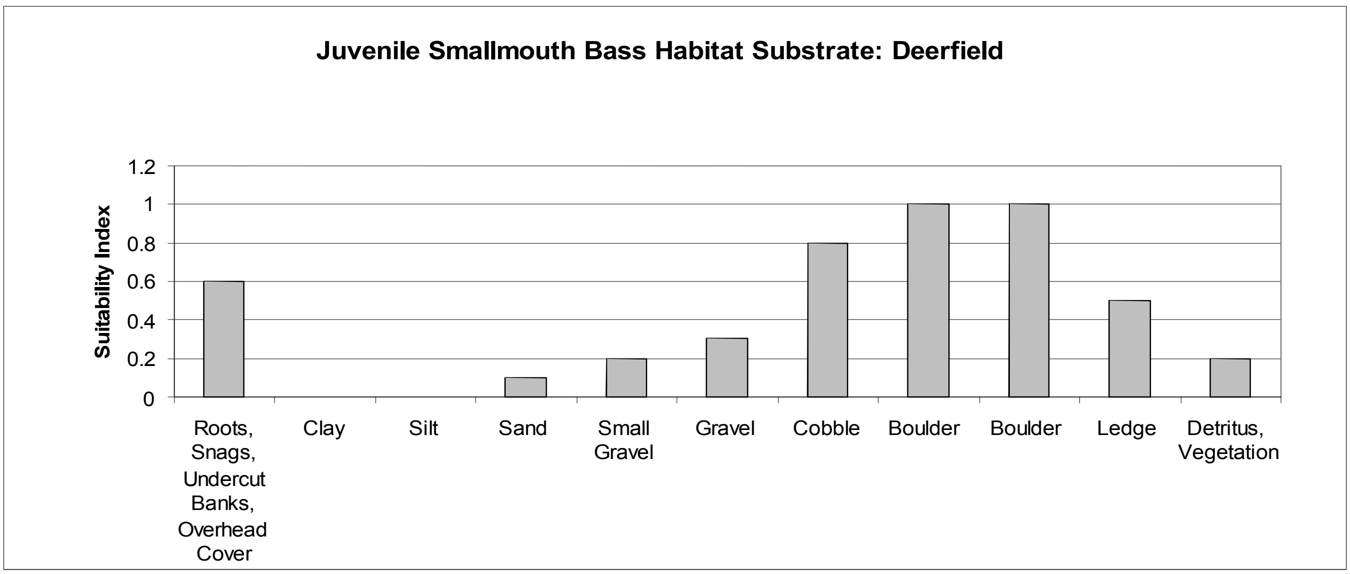


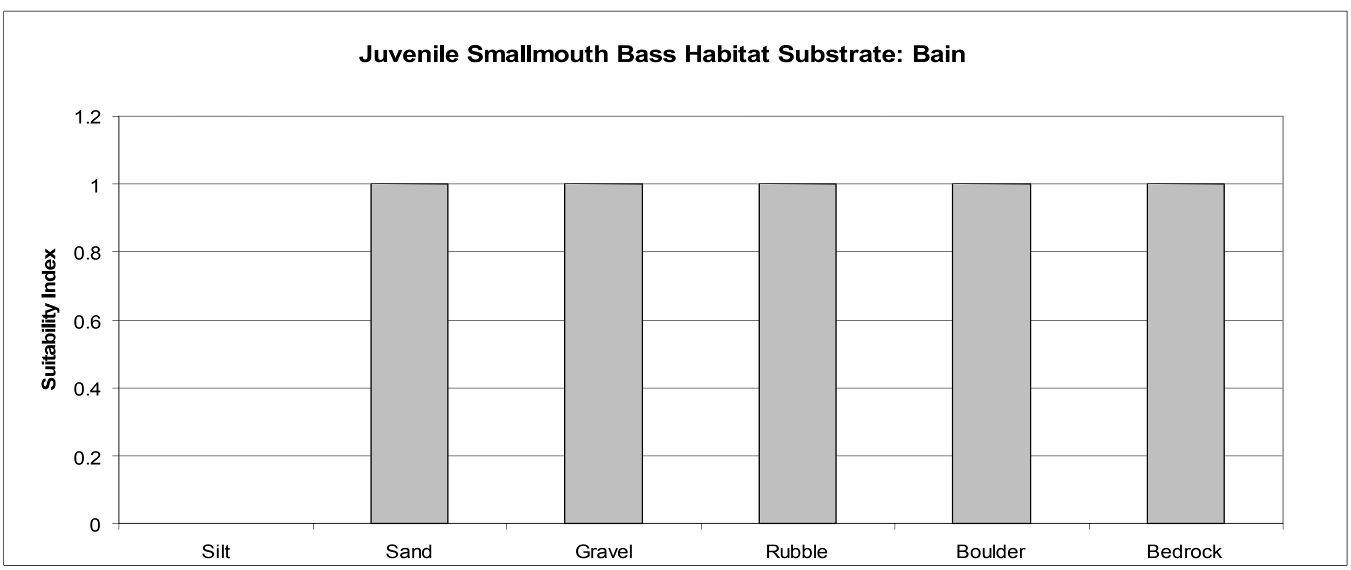




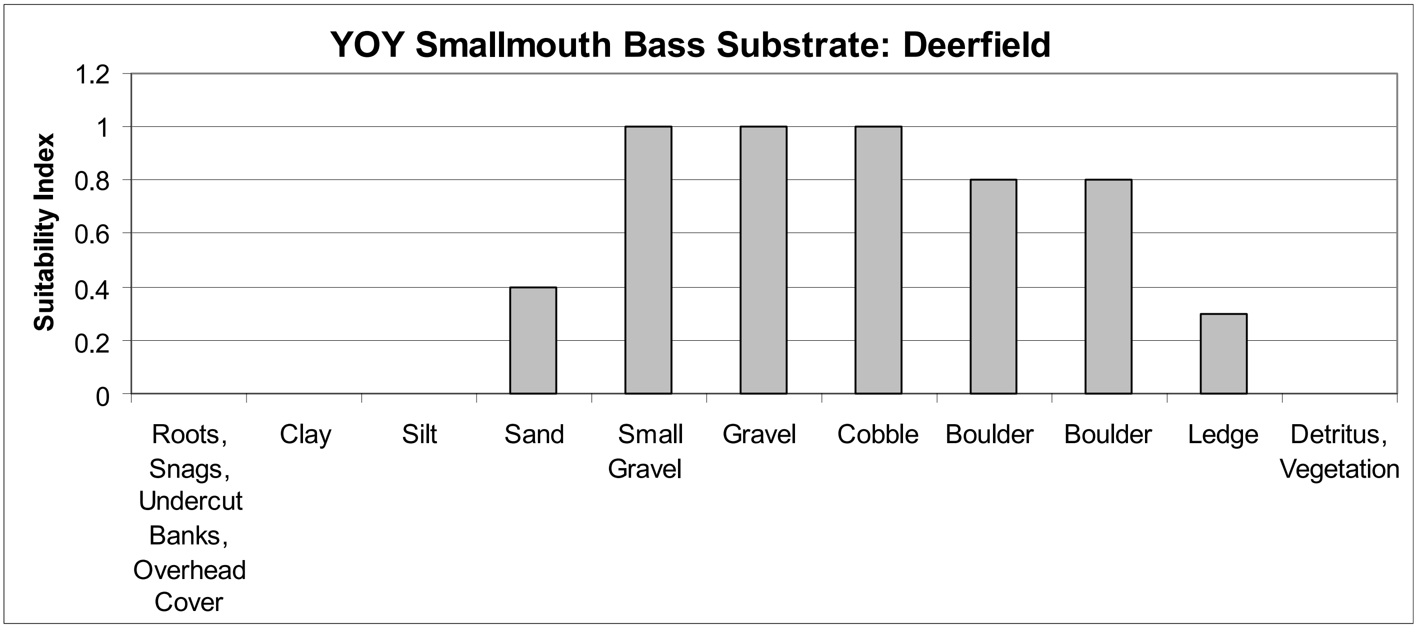
Juvenile Smallmouth Bass

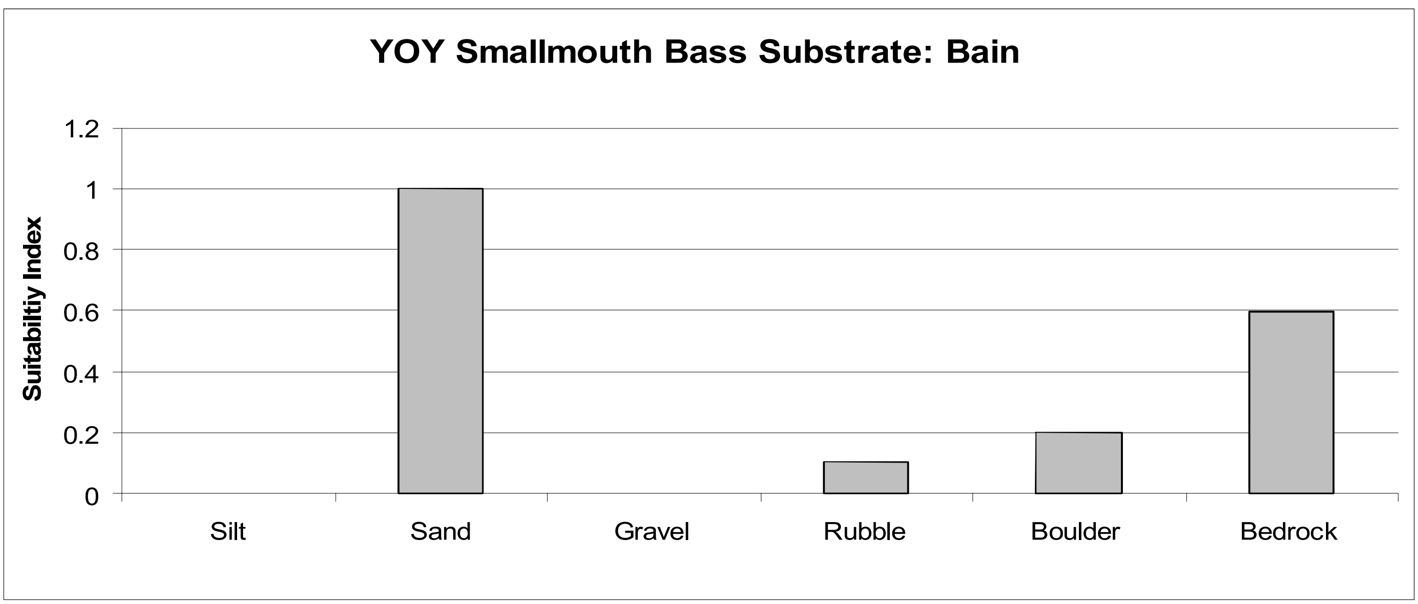




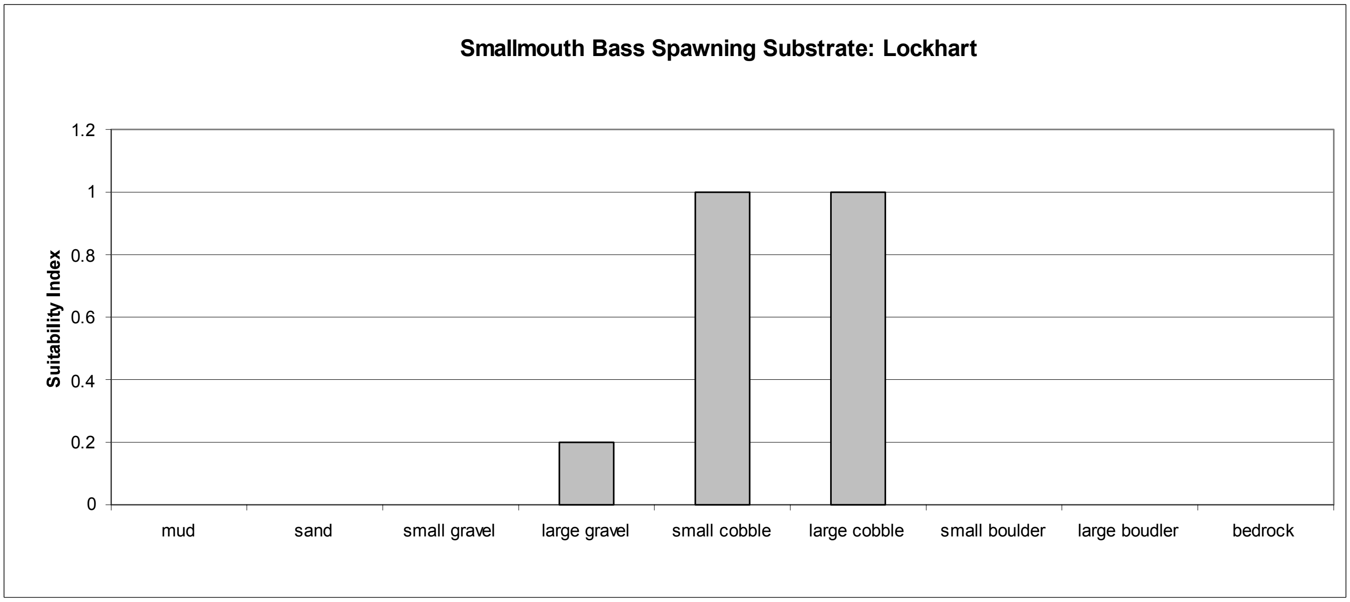


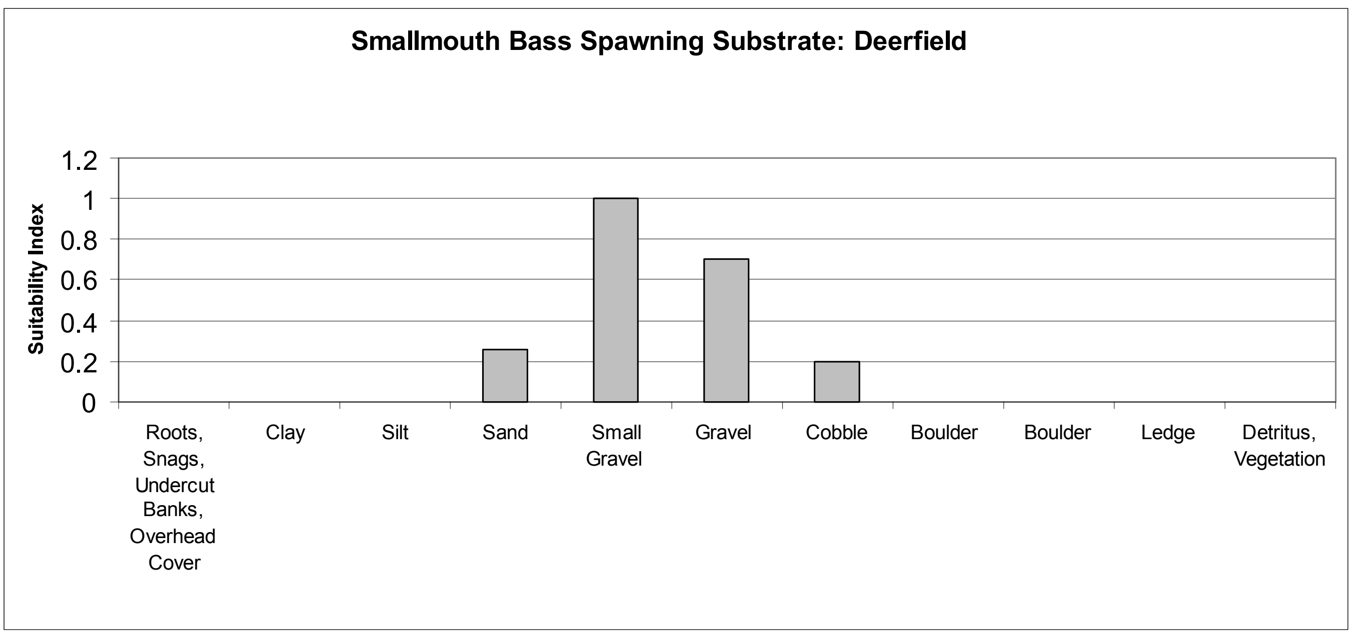
Smallmouth Bass YOY





Smallmouth Bass Spawning





Kacie Jensen

From: Prescott Brownell [Prescott.Brownell@noaa.gov]
Sent: Monday, April 02, 2007 11:08 AM
To: Shane Boring
Cc: Theresa Thom; Alison Guth; Amanda Hill; BARGENTIERI@scana.com; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; mquattlebaum@scana.com; RMAHAN@scana.com; Ron Ahle; Scott Harder; Steve Summer; Brandon Kulik; Alan Stuart; Cheryl Balitz; balesw@dnr.sc.gov; Bill East; Bill Hulslander; Bill Marshall; Bob Perry; bseibels@yahoo.com; Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; turnerle@dhec.sc.gov; laura.mccary@gmail.com; Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; Ralph Crafton; rbull@davisfloyd.com; Robert Lavisky; Sam Drake; Steve Bell; Steve Leach; Suzanne Rhodes; tbowles@scana.com
Subject: Re: Saluda Hydro Relicense: 1/22/2007 Instream flow/Aquatic Habitat TWC Final Meeting Notes

Sturgeon Model Draft March 03....
Atlantic Sturgeon Model.xls (2...
Revised SNS Model.xls (27 KB)
prescott.brownell.vcf (401 B)

Hello Shane and team,
The notes state that you had been unable to contact me regarding shortnose sturgeon model curves and their applicability to the Saluda. I sent a copy of the most recent shortnose and Atlantic sturgeon model in February, and a draft earlier version with the same curves in October ??. The curves should be well adapted for use in the Saluda River. Attached is another copy of the sturgeon model just in case.

Call if you have questions..

PB

Shane Boring wrote:
>
> All:
>
> Attached for your records are the final meeting notes from the January
> 22nd, 2007, meeting of the Instream Flow / Aquatic Habitat TWC.
> Thanks to all who provided comments. As always, the notes will be
> posted to the relicensing website.
>
> Have a good weekend,
> Shane Boring
>
>
> <<2007-01-22 Instream Flow TWC meeting notes(final).pdf>>
>
> Cheryl:
>
> Could you please post these to the website under Fish and Wildlife
> RCG, Instream Flow TWC. Thanks.
>

Spawning Habitat Suitability Index Models
And Instream Flow Suitability Curves

Model I: Shortnose Sturgeon
Model II: Atlantic Sturgeon

Southeastern Atlantic Coast River Basins

Draft
March 12, 2003

Edited by:

Prescott H. Brownell

Fishery Biologist

National Marine Fisheries Service

Charleston, South Carolina

Acknowledgements

The draft models have been prepared in coordination with Joe Hightower, North Carolina Cooperative Fish and Wildlife Research Unit, N.C. State University; Mark Collins, South Carolina Division of Marine Resources, Charleston, SC; Boyd Kynard and Micah Kieffer, Silvio Conte Anadromous Fish Laboratory, Turners Falls, Massachusetts; Steve Gilbert, U.S. Fish & Wildlife Service, Charleston, SC Field Office, and Wilson Laney, U.S. Fish & Wildlife Service, Fishery Resources Office, Raleigh, N.C. Their assistance is greatly appreciated. The current draft model has been circulated to a wider audience of biologists, and their recommendations will be included in preparation of final models for publication.

PREFACE

The information and suitability curves presented in this draft model are intended for use in evaluating instream habitat conditions, employing Habitat Evaluation Procedures (HEP) and/or the Instream Flow Incremental Methodology (IFIM). The IFIM curves for Atlantic sturgeon and shortnose sturgeon presented are project team modifications of the original model for shortnose sturgeon that was prepared by Crance (1986)[1.] As noted by Crance in the original documentation, the SI curves were intended as starting points for users of HEP or IFIM to develop their own curves and relationships, in response to project-specific conditions and needs. Since publication of the original model in 1986 considerable research has been conducted on shortnose sturgeon, and to a lesser degree Atlantic sturgeon behavior and habitat preferences, as well as historic distribution and habitat use in northeastern and southeastern habitats. The information and curves presented are hypotheses of species-habitat relationships, not statements of proven cause and effect relationships. Further, the model relationships and outputs are intended to aid in the assessment of impacts, and design of potential instream flow mitigation features and recommendations. The fishery biologists using these relationships will need to make project specific recommendations whether or not an IFIM model is available. It is hoped that this model will aid their efforts and promote consensus in management decisionmaking.

SHORTNOSE AND ATLANTIC STURGEON SPAWNING HABITAT MODELS

HABITAT USE INFORMATION, Southeastern Rivers

General

Sturgeon are known to have ascended major southeastern river basins such as the St. Johns, St. Mary's, Altamaha, Ogeechee, Savannah, Edisto, Santee, Pee Dee, Neuse, and Roanoke to riverine habitats well past the limit of the coastal plain, based on historic accounts (Goode, 1887[2], and Bowers, 1896[3]). Because of the fact that sturgeon data in historic accounts did not distinguish between shortnose and Atlantic sturgeon, it is impossible to acertain if there were differences in distribution (river ascent) between the species. The assumption is made that sturgeon of both species were capable of moving upstream as far as hydraulic conditions would allow, and in all probability did migrate upstream well into the piedmont in larger river systems. Sturgeon stocks have declined drastically since the mid 19th century due to overfishing, habitat degradation, and to blockage of access to primary spawning habitats by dams on many rivers. An additional factor contributing to the decline of sturgeon species may be alteration of natural instream flows due to water diversions, hydropower operations, and related impacts on sturgeon spawning behavior due to non-natural fluctuations in flows during spawning periods. Based on the consensus opinion of the model development team, optimal spawning habitat conditions were generally present in rocky shoal and rock outcrop habitats in major rivers of the east. These shoal habitats are generally present at the moderate to high gradient transition between coastal plain and piedmont physiographic provinces, and at other locations well into the piedmont sections of these rivers. In nearly all cases, such habitats have been blocked by major hydropower and navigation dams and are no longer accessible to spawning sturgeon. Limited spawning and recruitment may be possible in other riverine habitats, possibly accounting for the presence of small remnant populations of sturgeon in some rivers such as the Altamaha, Savannah, Santee, Pee Dee, and Neuse.

MODEL I: SHORTNOSE STURGEON *(Acipenser brevirostrum)*

Modified IFIM Spawning Habitat Suitability Curves for Shortnose Sturgeon

The following variables and relationships are considered important for assessment of shortnose sturgeon spawning habitat quality, and related evaluation of impacts due to changes in substrate, water velocity, temperature, and depth. The overall habitat suitability value expressed in this model is simply the lowest of the four individual Suitability Index (SI) values. Figures identified below are the attached excel files.

V1. Water Velocity, spawning and incubation. Measured as mean water column velocity in Meters per second. Figure 1 displays a table of data values and corresponding SI value relationships.

V2. Depth, spawning, incubation. Figure 2 displays a table of data values and SI relationships. The depth vs. SI values are estimated to represent minimum suitable depths for spawning adults assuming that access to these depths is not obstructed by habitat features further downstream.

V3. Substrate, spawning and incubation. This habitat variable is intended to capture behavioral preferences of spawning adults and habitat conditions for eggs during the incubation period prior to the first downstream migration of larvae. Factors such as oxygenation, substrte embeddedness, available egg attachment sites, and protection of eggs from other predators are hypothesized to be available in gravel, and cobble gravel substrates. Bedrock typically is interspersed with pockets of cobble and gravel, and may also contain fissures and microhabitat features that provide cover and well oxygenated sites for egg maturation. Figure 3 displays a table of data values and SI relationships

V4. Temperature, spawning. The SI values and relationships to temperature are based on literature and consensus of the model review team. Figure 4 displays a table of values and SI relationships.

The overall SI value for shortnose sturgeon spawning habitat is represented by the lowest individual variable si value.

SI = the lowest of: V1 si, V2 si, V3 si, V4 si.

MODEL II: ATLANTIC STURGEON *(Acipenser oxyrinchus)*

<u>IFIM Habitat Suitability Curves for Spawning Atlantic Sturgeon</u>

The following variables and relationships are considered important for assessment of Atlantic sturgeon spawning habitat quality, and related evaluation of impacts due to changes in substrate, water velocity, temperature, and depth. Figures referenced below are the attached excel files.

V1. Water Velocity, spawning and incubation. Measured as mean water column velocity in meters per second. Figure 1 presents a table of data values and SI relationships

V2. Depth, spawning, incubation. The depth vs. SI values are estimated to represent minimum suitable depths for spawning adults assuming that access to these depths is not obstructed by habitat features further downstream. The depth relationships are based on the hypothesized minimum depths for spawning age Atlantic sturgeon. Figure 2 displays variable relationships.

V3. Substrate, spawning and early incubation. This habitat variable is intended to capture behavioral preferences of spawning adults and habitat conditions for eggs during the incubation period prior to the first downstream migration of larvae. The curve and data values for Atlantic sturgeon are based on the model for shortnose sturgeon, assuming similar habitat preferences and conditions are required. Factors such as oxygenation, substrate embeddedness, available egg attachment sites, protection of eggs from other predators, light intensity, solar warming…are hypothesized to be available in gravel, boulder, and cobble gravel substrates. Bedrock typically is interspersed with pockets of cobble and gravel, and may also contain fissures and microhabitat features that provide cover and well oxygenated sites for egg maturation. Figure 3 displays a table of data values and SI relationships

V4. Temperature, spawning. The SI values and relationships to temperature are based on the generally later upstream spawning movement of Atlantic sturgeon, compared with the shortnose sturgeon. Figure 4 displays a table of values and SI relationships.

The overall SI value for Atlantic sturgeon spawning habitat is represented by the lowest individual variable si value.

SI = the lowest of: V1si, V2 si, V3 si, V4 si

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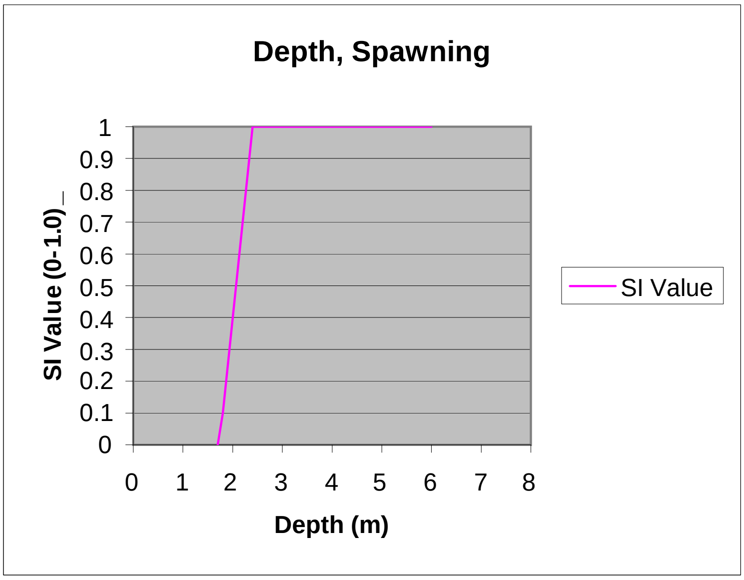
Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, *Acipenser brevirostrum*. Env. Biol. Fish: 48:319-334.

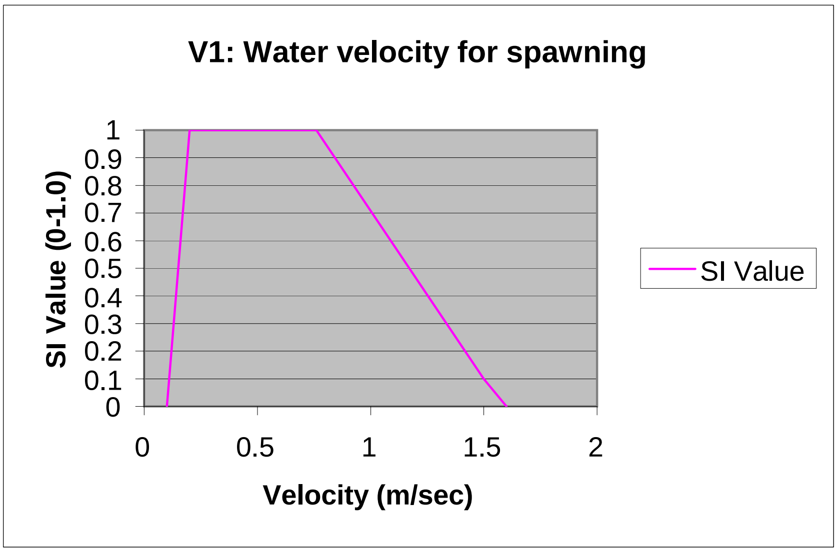
Atlantic Sturgeon
V2: Depth, spawning and incubation.

Depth (m)	Depth (ft)	SI Value
1.7	0	0
1.8		0.1
2.4		1
3		1
4		1
5		1
6		1
7		1
8		1



Shortnose Sturgeon IFIM Curves
Revised Shortnose Sturgeon Spawning Habitat Model
V1: Water velocity, spawning and incubation. Measured as mean water column velocity in meters per s

Velocity	SI Value
0.1	0
0.2	1
0.76	1
1.5	0.1
1.6	0



second.

Kacie Jensen

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Kacie Jensen

From: Shane Boring
Sent: Friday, March 30, 2007 4:36 PM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Subject: Saluda IFIM Study: Proposed Conference Call to Discuss Substrate Habitat Suitability Criteria

All:

As you may remember, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) met on January 22nd, 2007 and agreed upon Habitat Suitability Criteria (HSC) for depth and velocity for target species and lifestages for the upcoming Saluda IFIM study. To close out the HSC selection process, we would like to propose a conference call for Tuesday April 10th at 10:00 am to discuss HSC information for substrate. An alternative would be Wednesday April 11th. Please let us know of your availability, and after we receive input from the TWC, we will send out a formal meeting invitation with the final date, time, and conference call access numbers.

To facilitate our substrate discussion, Brandon Kulik and I have prepared a memo that summarizes substrate habitat suitability from a number of potential source studies (attached). We thought it would be good get the memo to everyone in advance to make our discussion more productive.

Have a good weekend,
Shane

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

Saluda IFIM Study - Habitat Su...

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC)) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized "Bluebook" criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized "Bluebook" criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized "Bluebook" criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

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Leonard, P.M., D.J. Orth, and C.J. Goodreau.1986. Development of a method for recommending instream flows for fishes in the upper James River, Virginia. VA poly Inst. and State Univ., Blacksburg, VA. Bull. 152, 109 pp.

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Strakosh, T.R., R.M. Neumann, and R.A. Jacobsen. 2003. Development and assessment of habitat suitability criteria for adult brown trout in southern New England rivers. Ecology of Freshwater Fish 12:265-274. Blackwell Munksgaards, 2003.

Kacie Jensen

From: Shane Boring
Sent: Friday, March 30, 2007 2:14 PM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Cc: Cheryl Balitz; Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; 'Ralph Crafton'; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: 1/22/2007 Instream flow/Aquatic Habitat TWC Final Meeting Notes

All:

Attached for your records are the final meeting notes from the January 22nd, 2007, meeting of the Instream Flow / Aquatic Habitat TWC. Thanks to all who provided comments. As always, the notes will be posted to the relicensing website.

Have a good weekend,
Shane Boring

2007-01-22
stream Flow TWC m

Cheryl:

Could you please post these to the website under Fish and Wildlife RCG, Instream Flow TWC. Thanks.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Final CSB 03-30-07

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Ron Ahle, SCDNR
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR
Scott Harder, SCDNR

ACTION ITEMS

- Incorporate comments into the Instream Flow Study Plan and send out to all committee members for review

Shane Boring

- Determine whether HSI curves are available for gizzard shad in riverine systems, and if so, distribute to TWC

Shane Boring/Brandon Kulik

- Email Prescott Brownell about whether it would be applicable to use the Catawba-Wateree shortnose sturgeon HSI curves for the Saluda IFIM study

Amanda Hill

- Compile potential source HSI substrate curves and distribute to TWC prior to Feb. 21 meeting

Shane Boring/Brandon Kulik

- Construct plots of finalized HSI curves (Depth/Velocity for smallmouth bass, rainbow trout, brown trout)

Shane Boring/Brandon Kulik

NEXT MEETING

February 21, 2007 at 9:30am
Location: Lake Murray Training Center[1]

[1] This meeting date was later cancelled.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Final CSB 03-30-07

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 10:00 AM and noted that the purpose of today's meeting will be to discuss: (1) HSI criteria for guilds, (2) HSI criteria for stand-alone species, and (3) the next steps that need to be taken for the IFIM study. He briefly reviewed the action items from the previous meeting. Shane noted that he was currently incorporating comments made on the IFIM study plan and would send it back out to committee members within the next week for comments.

Review of HSI Criteria for Guilds

Shane noted that the species guild matrix had been revised based on comments from the previous IFIM meeting and distributed a revised matrix. The group then reviewed the updated matrix, and after several additional revisions, agreed that the following guild approach was acceptable:

Deep Slow Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
blueback herring	spawning	
blueback herring	YOY	
Norrthern hogsucker	adult	
redbreast sunfish	adult	
robust redhorse	juvenile	
robust redhorse	adult	
spotted sucker	juvenile	
spotted sucker	adult	

Deep Fast Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
American shad	spawning	
Norrthern hogsucker	spawning	
Norrthern hogsucker	fry/YOY	
Norrthern hogsucker	juvenile	
shorthead redhorse	adult	

spottail shiner	adult	

Deep Fast Guild

species	**life stage**	**SI curve source**
benthic macroinver.	juvenile	Catawba-Wateree
robust redhorse	spawning	
saluda darter	adult	
spottail shiner	spawning	
spotted sucker	spawning	

Deep Fast Guild

species	**life stage**	**SI curve source**
redbreast sunfish	spawning	Catawba-Wateree
robust redhorse	fry/YOY	
spotted sucker	juvenile	
spotted sucker	fry/YOY	

There was a brief discussion about whether to add threadfin shad to the list of target species. It was noted that HSI curves were not available for threadfin shad, but that gizzard shad could potentially serve as a surrogate. Alan Stuart and others noted that the existing gizzard shad HSI curves were developed for reservoir habitats, not riverine systems. After some discussion, it was determined that availability of appropriate riverine HSI curves for gizzard shad should be evaluated prior to determining whether this species can serve as an appropriate surrogate for threadfin shad. The group agreed to withhold a determination on whether or not threadfin shad should be included until after this information is evaluated.

Review of Habitat Suitability Criteria (HSC) for Stand-Alone Species

Brandon Kulik noted that a memorandum regarding HSC for stand-alone species was sent out on January 16, 2007 to all committee members (Attachment A). He noted that this memorandum summarized HSC curves for smallmouth bass, rainbow trout, and brown trout from a number of potential source studies for purposes of evaluating transferability to the lower Saluda study. He noted that TWC members should consider their field experience/observations regarding the target species and the lower Saluda River in evaluating applicability of the potential source curves. The group examined the HSC curves for each species and lifestage for both depth and velocity. The group agreed to use the following HSC curves for the following species:

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

Zone of Passage for Striped Bass

Brandon suggested that the minimal flow limiting passage requirement for a fish would be an adequate amount of water so that the body of the fish is submerged. A maximum flow limiting factor for passage would be a high velocity that exceeds the fish's sustained swimming strength. Gerrit noted that there are striped bass passage standards for South Carolina. He explained that according to the standard, river must be 18 inches in depth for a 20 pound striped bass, with a 10 ft width, covering 10 % of the channel. Hal Beard noted that he thinks there may only be one year in

which striped bass were not able to make it up the lower Saluda River past Millrace Rapids. Hal noted that it may have occurred in the months of May/April of 1991. This was because Saluda Hydro was not releasing. Brandon presented a spreadsheet model from the USGS Conte Lab paper (Attachment B) that described limiting velocities for striped bass passage based on fish size and ambient water temperature.

Next Steps

Brandon noted that the group would need to also agree upon appropriate substrate HSC curves. The group agreed that discussion of potential source curves for substrate would be appropriate for the February 21st TWC meeting. Brandon and Shane agreed to draft and similar memo summarizing potential source curves and distribute to the group prior to the meeting.

Brandon noted that Shane will be going out in the field to characterize mesohabitats on the lower Saluda River. Shane added that they hope to have the mesohabitat characterization completed and available for review by the TWC by late March.

Brandon mentioned that they have not yet been able to contact Prescott Brownell regarding HSC curves for shortnose sturgeon. After some discussion, the group agreed that the Catawba-Wateree IFIM study would be the most likely source for shortnose sturgeon curves. Amanda Hill noted that she would e-mail Prescott regarding transferability of the Catawba-Wateree curves; she recommended contacting Pace Wilbur at NOAA-Fisheries if we were not able to contact Prescott.

Next Meeting

The group noted that the next TWC meeting had been scheduled for February 21st, 2007 at Lake Murray Training Center. The meeting adjourned at approximately 3:10 PM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Depth and Velocity for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: January 16, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

The Saluda River instream flow study plan requires that habitat suitability of a range of flows will be rated using existing Habitat Suitability Criteria (HSC). Specific criteria will be selected in consultation with SCDNR, USFWS and NMFS fishery agencies participating in the Saluda relicensing IFIM Technical Working Committee (TWC). The TWC agreed to model most instream habitat uses with representative guild surrogates, but also desired more detailed modeling of individual fish species of particular resource management interest.

At the November 28, 2006 TWC meeting, it was agreed that additional research was required to obtain HSC that can be adequately transferred to the Saluda River for these individual species. The purpose of this memo is to summarize a cross-section of HSC for the following species and lifestages so that the TWC can evaluate the transferability of candidate source curves. Individual species and lifestages for which source studies were sought include:

SPECIES	LIFESTAGES
Smallmouth bass	Spawning, YOY, juvenile, adult
Rainbow trout	Spawning, YOY, juvenile, adult
Brown trout	Spawning, YOY, juvenile, adult
Striped bass	Zone of Passage

Habitat Suitability criteria transferability is commonly applied in instream flow models (Groshens and Orth, 1994). However some consideration must be given to the biotic and abiotic comparability between proposed source and study streams. According to Thomas and Bovee (1993), "*The transferability of HSC from a source stream to a destination stream probably depends on the overall similarity between the two and how important their differences are in causing changes in fish behavior*".

Differences in habitat use for species among rivers may result from real differences in habitat availability such as cover, geomorphology (Perry, *et al*., 1993), abiotic factors such as macrohabitat (*e.g.* thermal regime) or biotic factors such as intra- or inter-specific interactions, presence and/or absence of predators, competitors and prey (Newcomb, et al., 1995, Groshens and Orth, 1994). In some cases, source criteria may be flawed due to aberrant definitions of suitability used by source authors that are not applicable to the destination stream (Groshens and Orth, 1994). Perry *et al.* (1993) concluded that smallmouth bass HSC obtained from streams with relatively homogenous habitat and from a similar ecoregion transferred best to similar streams because the distribution of preferred habitat was similar and this would minimize behavioral differences expressed by target populations.

CANDIDATE CRITERIA

Smallmouth Bass

We obtained HSC that have been successfully applied in IFIM studies from the upper James (VA), Deerfield (MA), and the Broad rivers (SC); criteria developed for use in several rivers in the Appalachian highlands (VA and WVA), and generalized "Bluebook" criteria (Edwards, et al., 1983). Table 1 summarizes major river characteristics of each source study.

Table 1: Summary of Habitat Characteristics for Smallmouth Bass HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley	1.8	Cobble boulder gravel	95
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont	Approx. 1	Cobble, sand	
Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont	0.5- 1.5	Bedrock, cobble sand	82-113
Edwards, *et al* (1983)	Generic					
Monahan (1991)	Huron (MI)	Great Lakes	Central Lowland	N.A.	Sand gravel	115

There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable. Authors and modelers have likewise generally felt that there are few if any site-specific differences in suitability preferences among the spawning and YOY life stages, but instead have focused on differences among the juvenile and adult lifestages. According to Bovee (1990), there was:

> "*controversy regarding the velocity criteria historically applied to earlier smallmouth bass studies which relied on the old "blue book" HSI data …because standard applications of this criteria in studies…tended to make velocity appear more limiting in the PHABSIM model than it really is...because riverine bass tend to use localized low-velocity areas created by flow shelters but standard applications have not reflected that these shelters are often adjacent to velocity chutes which the fish use for feeding*".

This suggests that our current focus should be on:

- juvenile and adult lifestages;
- some consideration should be given to the relative preponderance of object cover such as boulders, logs, *etc.* in the study area vs. those characteristics found in the candidate source study rivers; and
- consider "cover conditional" velocity criteria that account for both "good" cover and "poor" cover conditions (for example, as in the Deerfield River curves).

It may be reasonable to accept general criteria such as Edwards, et al. (1983) in selecting velocity and depth criteria for spawning and YOY lifestages.

Appendix A contains graphic comparisons of depth and velocity criteria for juvenile and adult lifestages.

<u>Rainbow Trout</u>

We obtained HSC that have been successfully applied in IFIM studies from the Lackawaxen (PA) , Deerfield (MA), Housatonic (CT), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 2 summarizes major river characteristics of each source study. Life stages of interest in this study are adult and juvenile.

Table 2: Habitat Characteristics for Rainbow Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
TVA[1]	various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1986)	Generic "Blue Book" data					

HSC from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC. The original criteria were developed from field data collected in second and third-order streams (SRBC, 1998), and were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e*. fourth and fifth-order) rivers.

Rainbow trout HSC curves for Deerfield River adult lifestage provide cover-conditional velocity criteria. Appendix B provides graphic comparisons of HSC from the above studies.

[1] adopted data from Raleigh, et al. (1986) without modification

Brown Trout

We obtained HSC from the Lackawaxen (PA) , Deerfield (MA), Connecticut (various rivers), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al.*, 1986). Table 3 summarizes major river characteristics of each source study.

Table 3: Summary of Habitat Characteristics for Brown Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland	1.5-2.0	boulder gravel	100-200
CT DEP	Housatonic (CT)	New England	New England Upland	2.0	boulder cobble	150-200
TVA[2]	Various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1984)	Generic "Blue Book" data					

As discussed under rainbow trout, HSC for brown trout from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC criteria. The original criteria were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e.* fourth and fifth-order) rivers.

HS curves for Deerfield and Housatonic provides cover-conditional velocity criteria. Appendix C provides graphic comparisons of HSC from the above studies.

Striped Bass (Zone of Passage)

Adult striped bass originating downstream in the Congaree/Santee rivers may ascend the Lower Saluda River during summer months to seek forage and thermal refuge (D. Christie, SCDNR, Pers. Comm.). The TWC concluded that zone of passage through limiting steep gradient rapids found at Millrace Rapids, is the most applicable instream flow assessment issue for this species. For zone-of-passage assessment for striped bass, minimum passage criteria from Bovee (1982) are:

> *"The minimum recommended clearance requirement should probably be no less than two-thirds the body thickness of the fish…The Oregon State Game Commission (Thompson 1972) suggests that the total width of stream having the*

[2] adopted data from Raleigh, et al. (1986) without modification

specified passage depth should be at least 25% of the top width or that the longest continuous portion be at least 10% of the top width."

Table 29 in Bovee (1982) lists minimum depth criteria for various trout, as well as Chum, Chinook and Coho salmon ranging of 0.6 (large trout) to 0.8 (Chinook salmon). An estimate of available body depth data for indigenous Saluda River striped bass would be obtained or extrapolated, and applied to these criteria to determine limiting body depth. For example, Smith (1985) gives a ratio of body depth to total length as 27.9:123.5 for this species.

Criteria developed by Haro *et al.* (2004) provides guidance on limiting velocities that can affect the ability of anadromous fish (including striped bass) to ascend rapids against high flows. These criteria were developed through flume tests at the Conte Anadromous Fish Research Center (Turners Falls, MA), and take into account the ichthyomechanics and thermal metabolism of adult fish. Use of these criteria will depend on site-specific estimates of striped bass length and ambient water temperature. Haro *et al.* (2004) was previously distributed to the study team via email on December 4, 2006.

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Kacie Jensen

From: Shane Boring
Sent: Friday, March 30, 2007 2:14 PM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Cc: Cheryl Balitz; Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; 'Ralph Crafton'; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: 1/22/2007 Instream flow/Aquatic Habitat TWC Final Meeting Notes

All:

Attached for your records are the final meeting notes from the January 22nd, 2007, meeting of the Instream Flow / Aquatic Habitat TWC. Thanks to all who provided comments. As always, the notes will be posted to the relicensing website.

Have a good weekend,
Shane Boring

2007-01-22
stream Flow TWC m

Cheryl:

Could you please post these to the website under Fish and Wildlife RCG, Instream Flow TWC. Thanks.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Final CSB 03-30-07

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Ron Ahle, SCDNR
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR
Scott Harder, SCDNR

ACTION ITEMS

- Incorporate comments into the Instream Flow Study Plan and send out to all committee members for review

Shane Boring

- Determine whether HSI curves are available for gizzard shad in riverine systems, and if so, distribute to TWC

Shane Boring/Brandon Kulik

- Email Prescott Brownell about whether it would be applicable to use the Catawba-Wateree shortnose sturgeon HSI curves for the Saluda IFIM study

Amanda Hill

- Compile potential source HSI substrate curves and distribute to TWC prior to Feb. 21 meeting

Shane Boring/Brandon Kulik

- Construct plots of finalized HSI curves (Depth/Velocity for smallmouth bass, rainbow trout, brown trout)

Shane Boring/Brandon Kulik

NEXT MEETING

February 21, 2007 at 9:30am
Location: Lake Murray Training Center[1]

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[1] This meeting date was later cancelled.

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Final CSB 03-30-07

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 10:00 AM and noted that the purpose of today's meeting will be to discuss: (1) HSI criteria for guilds, (2) HSI criteria for stand-alone species, and (3) the next steps that need to be taken for the IFIM study. He briefly reviewed the action items from the previous meeting. Shane noted that he was currently incorporating comments made on the IFIM study plan and would send it back out to committee members within the next week for comments.

Review of HSI Criteria for Guilds

Shane noted that the species guild matrix had been revised based on comments from the previous IFIM meeting and distributed a revised matrix. The group then reviewed the updated matrix, and after several additional revisions, agreed that the following guild approach was acceptable:

Deep Slow Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
blueback herring	spawning	
blueback herring	YOY	
Norrthern hogsucker	adult	
redbreast sunfish	adult	
robust redhorse	juvenile	
robust redhorse	adult	
spotted sucker	juvenile	
spotted sucker	adult	

Deep Fast Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
American shad	spawning	
Norrthern hogsucker	spawning	
Norrthern hogsucker	fry/YOY	
Norrthern hogsucker	juvenile	
shorthead redhorse	adult	

spottail shiner	adult	

Deep Fast Guild

species	**life stage**	**SI curve source**
benthic macroinver.	juvenile	Catawba-Wateree
robust redhorse	spawning	
saluda darter	adult	
spottail shiner	spawning	
spotted sucker	spawning	

Deep Fast Guild

species	**life stage**	**SI curve source**
redbreast sunfish	spawning	Catawba-Wateree
robust redhorse	fry/YOY	
spotted sucker	juvenile	
spotted sucker	fry/YOY	

There was a brief discussion about whether to add threadfin shad to the list of target species. It was noted that HSI curves were not available for threadfin shad, but that gizzard shad could potentially serve as a surrogate. Alan Stuart and others noted that the existing gizzard shad HSI curves were developed for reservoir habitats, not riverine systems. After some discussion, it was determined that availability of appropriate riverine HSI curves for gizzard shad should be evaluated prior to determining whether this species can serve as an appropriate surrogate for threadfin shad. The group agreed to withhold a determination on whether or not threadfin shad should be included until after this information is evaluated.

Review of Habitat Suitability Criteria (HSC) for Stand-Alone Species

Brandon Kulik noted that a memorandum regarding HSC for stand-alone species was sent out on January 16, 2007 to all committee members (Attachment A). He noted that this memorandum summarized HSC curves for smallmouth bass, rainbow trout, and brown trout from a number of potential source studies for purposes of evaluating transferability to the lower Saluda study. He noted that TWC members should consider their field experience/observations regarding the target species and the lower Saluda River in evaluating applicability of the potential source curves. The group examined the HSC curves for each species and lifestage for both depth and velocity. The group agreed to use the following HSC curves for the following species:

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

Zone of Passage for Striped Bass

Brandon suggested that the minimal flow limiting passage requirement for a fish would be an adequate amount of water so that the body of the fish is submerged. A maximum flow limiting factor for passage would be a high velocity that exceeds the fish's sustained swimming strength. Gerrit noted that there are striped bass passage standards for South Carolina. He explained that according to the standard, river must be 18 inches in depth for a 20 pound striped bass, with a 10 ft width, covering 10 % of the channel. Hal Beard noted that he thinks there may only be one year in

which striped bass were not able to make it up the lower Saluda River past Millrace Rapids. Hal noted that it may have occurred in the months of May/April of 1991. This was because Saluda Hydro was not releasing. Brandon presented a spreadsheet model from the USGS Conte Lab paper (Attachment B) that described limiting velocities for striped bass passage based on fish size and ambient water temperature.

Next Steps

Brandon noted that the group would need to also agree upon appropriate substrate HSC curves. The group agreed that discussion of potential source curves for substrate would be appropriate for the February 21st TWC meeting. Brandon and Shane agreed to draft and similar memo summarizing potential source curves and distribute to the group prior to the meeting.

Brandon noted that Shane will be going out in the field to characterize mesohabitats on the lower Saluda River. Shane added that they hope to have the mesohabitat characterization completed and available for review by the TWC by late March.

Brandon mentioned that they have not yet been able to contact Prescott Brownell regarding HSC curves for shortnose sturgeon. After some discussion, the group agreed that the Catawba-Wateree IFIM study would be the most likely source for shortnose sturgeon curves. Amanda Hill noted that she would e-mail Prescott regarding transferability of the Catawba-Wateree curves; she recommended contacting Pace Wilbur at NOAA-Fisheries if we were not able to contact Prescott.

Next Meeting

The group noted that the next TWC meeting had been scheduled for February 21st, 2007 at Lake Murray Training Center. The meeting adjourned at approximately 3:10 PM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Depth and Velocity for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: January 16, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

The Saluda River instream flow study plan requires that habitat suitability of a range of flows will be rated using existing Habitat Suitability Criteria (HSC). Specific criteria will be selected in consultation with SCDNR, USFWS and NMFS fishery agencies participating in the Saluda relicensing IFIM Technical Working Committee (TWC). The TWC agreed to model most instream habitat uses with representative guild surrogates, but also desired more detailed modeling of individual fish species of particular resource management interest.

At the November 28, 2006 TWC meeting, it was agreed that additional research was required to obtain HSC that can be adequately transferred to the Saluda River for these individual species. The purpose of this memo is to summarize a cross-section of HSC for the following species and lifestages so that the TWC can evaluate the transferability of candidate source curves. Individual species and lifestages for which source studies were sought include:

SPECIES	LIFESTAGES
Smallmouth bass	Spawning, YOY, juvenile, adult
Rainbow trout	Spawning, YOY, juvenile, adult
Brown trout	Spawning, YOY, juvenile, adult
Striped bass	Zone of Passage

Habitat Suitability criteria transferability is commonly applied in instream flow models (Groshens and Orth, 1994). However some consideration must be given to the biotic and abiotic comparability between proposed source and study streams. According to Thomas and Bovee (1993), "*The transferability of HSC from a source stream to a destination stream probably depends on the overall similarity between the two and how important their differences are in causing changes in fish behavior*".

Differences in habitat use for species among rivers may result from real differences in habitat availability such as cover, geomorphology (Perry, *et al*., 1993), abiotic factors such as macrohabitat (*e.g.* thermal regime) or biotic factors such as intra- or inter-specific interactions, presence and/or absence of predators, competitors and prey (Newcomb, et al., 1995, Groshens and Orth, 1994). In some cases, source criteria may be flawed due to aberrant definitions of suitability used by source authors that are not applicable to the destination stream (Groshens and Orth, 1994). Perry *et al.* (1993) concluded that smallmouth bass HSC obtained from streams with relatively homogenous habitat and from a similar ecoregion transferred best to similar streams because the distribution of preferred habitat was similar and this would minimize behavioral differences expressed by target populations.

CANDIDATE CRITERIA

Smallmouth Bass

We obtained HSC that have been successfully applied in IFIM studies from the upper James (VA), Deerfield (MA), and the Broad rivers (SC); criteria developed for use in several rivers in the Appalachian highlands (VA and WVA), and generalized "Bluebook" criteria (Edwards, et al., 1983). Table 1 summarizes major river characteristics of each source study.

Table 1: Summary of Habitat Characteristics for Smallmouth Bass HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley	1.8	Cobble boulder gravel	95
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont	Approx. 1	Cobble, sand	
Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont	0.5- 1.5	Bedrock, cobble sand	82-113
Edwards, *et al* (1983)	Generic					
Monahan (1991)	Huron (MI)	Great Lakes	Central Lowland	N.A.	Sand gravel	115

There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable. Authors and modelers have likewise generally felt that there are few if any site-specific differences in suitability preferences among the spawning and YOY life stages, but instead have focused on differences among the juvenile and adult lifestages. According to Bovee (1990), there was:

> "*controversy regarding the velocity criteria historically applied to earlier smallmouth bass studies which relied on the old "blue book" HSI data …because standard applications of this criteria in studies…tended to make velocity appear more limiting in the PHABSIM model than it really is...because riverine bass tend to use localized low-velocity areas created by flow shelters but standard applications have not reflected that these shelters are often adjacent to velocity chutes which the fish use for feeding*".

This suggests that our current focus should be on:

- juvenile and adult lifestages;
- some consideration should be given to the relative preponderance of object cover such as boulders, logs, *etc.* in the study area vs. those characteristics found in the candidate source study rivers; and
- consider "cover conditional" velocity criteria that account for both "good" cover and "poor" cover conditions (for example, as in the Deerfield River curves).

It may be reasonable to accept general criteria such as Edwards, et al. (1983) in selecting velocity and depth criteria for spawning and YOY lifestages.

Appendix A contains graphic comparisons of depth and velocity criteria for juvenile and adult lifestages.

<u>Rainbow Trout</u>

We obtained HSC that have been successfully applied in IFIM studies from the Lackawaxen (PA) , Deerfield (MA), Housatonic (CT), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 2 summarizes major river characteristics of each source study. Life stages of interest in this study are adult and juvenile.

Table 2: Habitat Characteristics for Rainbow Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
TVA[1]	various	Southeastern	Appalachian Ridge and Valley			
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HSC from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC. The original criteria were developed from field data collected in second and third-order streams (SRBC, 1998), and were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e*. fourth and fifth-order) rivers.

Rainbow trout HSC curves for Deerfield River adult lifestage provide cover-conditional velocity criteria. Appendix B provides graphic comparisons of HSC from the above studies.

[1] adopted data from Raleigh, et al. (1986) without modification

Brown Trout

We obtained HSC from the Lackawaxen (PA) , Deerfield (MA), Connecticut (various rivers), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al.*, 1986). Table 3 summarizes major river characteristics of each source study.

Table 3: Summary of Habitat Characteristics for Brown Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
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TVA[2]	Various	Southeastern	Appalachian Ridge and Valley			
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As discussed under rainbow trout, HSC for brown trout from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC criteria. The original criteria were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e.* fourth and fifth-order) rivers.

HS curves for Deerfield and Housatonic provides cover-conditional velocity criteria. Appendix C provides graphic comparisons of HSC from the above studies.

Striped Bass (Zone of Passage)

Adult striped bass originating downstream in the Congaree/Santee rivers may ascend the Lower Saluda River during summer months to seek forage and thermal refuge (D. Christie, SCDNR, Pers. Comm.). The TWC concluded that zone of passage through limiting steep gradient rapids found at Millrace Rapids, is the most applicable instream flow assessment issue for this species. For zone-of-passage assessment for striped bass, minimum passage criteria from Bovee (1982) are:

> *"The minimum recommended clearance requirement should probably be no less than two-thirds the body thickness of the fish…The Oregon State Game Commission (Thompson 1972) suggests that the total width of stream having the*

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specified passage depth should be at least 25% of the top width or that the longest continuous portion be at least 10% of the top width."

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Criteria developed by Haro *et al.* (2004) provides guidance on limiting velocities that can affect the ability of anadromous fish (including striped bass) to ascend rapids against high flows. These criteria were developed through flume tests at the Conte Anadromous Fish Research Center (Turners Falls, MA), and take into account the ichthyomechanics and thermal metabolism of adult fish. Use of these criteria will depend on site-specific estimates of striped bass length and ambient water temperature. Haro *et al.* (2004) was previously distributed to the study team via email on December 4, 2006.

LITERATURE CITED

Bovee, K.D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream flow information paper No. 12 U.S.D.I. Fish and Wildl. Serv., Office of Biol. Serv. FWS/OBS-82/26. 248 pp.

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Kacie Jensen

From: Alison Guth
Sent: Wednesday, March 07, 2007 10:38 AM
To: Alison Guth; Shane Boring; Alan Stuart; 'ARGENTIERI, WILLIAM R'; 'MAHAN, RANDOLPH R'; 'dchristie@infoave.net'; 'Ed eudaly@fws.gov'
Cc: 'murphyt@dnr.sc.gov'
Subject: RE: Wood Stork Meeting Notes from 2-9 conf call

Hello All,

Attached are the final meeting notes from the February 9th wood stork conference call. I did not receive any suggested changes or additions to the notes. Thanks and take care, Alison

2007-2-9 Final Meeting Minute...

-----Original Message-----
From: Alison Guth
Sent: Tuesday, February 13, 2007 3:08 PM
To: Shane Boring; Alan Stuart; 'ARGENTIERI, WILLIAM R'; 'MAHAN, RANDOLPH R'; 'dchristie@infoave.net'; 'Ed_eudaly@fws.gov'
Cc: 'murphyt@dnr.sc.gov'
Subject: Wood Stork Meeting Notes from 2-9 conf call

Hello all,

Attached are the meeting notes that I have drafted up from our Feb 9th conference call regarding the wood storks. Please let me know of any corrections or additions to the notes by February 23. Thanks, Alison

<< File: 2007-2-9 draft Meeting Minutes - wood stork discussions.doc >>

Alison Guth
Licensing Coordinator
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West Columbia, SC 29170
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MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Wood Stork Discussions

Via Conference Call
February 9, 2007

Final ACG 3-7-07

ATTENDEES:

Alison Guth, Kleinschmidt Associates
Alan Stuart, Kleinschmidt Associates
Dick Christie, SCDNR
Ed Eudaly, USFWS
Bill Argentieri, SCE&G
Shane Boring, Kleinschmidt Associates
Randy Mahan, SCANA Services

HOMEWORK:

- Shane Boring– To revise the 2006 Wood Stork Survey Report based on what the group agreed to.

MEETING NOTES:

These notes serve to be a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

The group began the meeting by discussing the 2006 Wood Stork Survey Summary Report. Alan asked if the group had any questions on the report itself. The group indicated that they were satisfied with the information it entailed. Alan then noted that the next important point of discussion would be how they should proceed with the surveys at this point, and whether there is a need to continue the surveys. Randy Mahan noted that SCE&G is interested in discontinuing the surveys if the agencies feel that there is no real benefit to the information being gleaned from the surveys from this point forward.

Ed Eudaly noted that, based on the results of the surveys, they did not see any regular or extensive use of the Project area by the wood storks. He explained that they have observed sporadic use upstream of Lake Murray. Ed noted that based on this, he did not see much of a need to continue with the surveys. Dick Christie noted that he concurred with Ed that there was not a need to continue with the surveys. Dick further added that since the wood storks were documented in the Project area, even through their use appears to be sporadic and infrequent, it may be beneficial to give the birds some recognition in the relicensing. He explained that this could be accomplished by drafting a brief management plan, or by observing these species through informal surveys. Dick further noted that it may be best to be prepared to address some management needs if they arise in the future. Ed agreed that the group should address the wood storks in some manner during relicensing.

To follow up on the strategies that Dick had just discussed, Shane noted that any wood storks observed during the Waterfowl Surveys will be documented. Shane explained that this may give them the means to track wood storks around the project without performing formal wood stork surveys. Shane further explained to the group that their observations of wood storks have so far been limited to foraging and there has been no nesting behavior observed. Dick noted that if there is ever any evidence of nesting that they may want to consider establishing some protected areas.

Bill then explained that SCE&G had originally began these studies based on a 2004 order from the FERC. He further explained that this order noted that SCE&G needed to be in consultation with the USFWS and SCDNR on evaluating these areas. Bill explained that the order also stated that SCE&G should refrain from selling or developing these areas until further information is obtained. Bill asked the group for advice on how to word the response to FERC now that SCE&G and the agencies have agreed that the surveys could be discontinued. Ed noted that it would probably be best to tailor the language in the letter to note that the land restrictions are no longer warranted due to wood storks. Ed further reiterated that he believed that the wood storks were seen at the Project due to the prolonged drawdowns. Dick agreed. Bill noted that he would draft a letter to FERC and send it to the agencies for review.

Bill then asked how SCE&G should best address the agencies recommendation of recognition of the wood stork in relicensing. Dick noted that, as discussed above, the waterfowl surveys will continue to document wood stork observations. Shane noted that Tom Murphy may be able to keep watch for the wood storks during his eagle surveys. Dick continued to explain that the wood stork could be addressed during the RT&E component of relicensing through the 2006 Survey Report and the recommendations to follow. The group discussed the possibility of developing an RT&E species awareness program/brochure that highlighted those unique species that one was most likely to see at Lake Murray. This could include the Bald Eagle, the purple martin and the wood stork. Ed also suggested that it would be beneficial to have some mechanism for tracking reports on wood stork sightings. The group noted that there could be a means for tracking reports through the brochure the group discussed and through SCE&G's website.

The group concluded their meeting and Shane noted that he would revise the report and reference what the group agreed to. Group adjourned.

Kacie Jensen

From: Shane Boring
Sent: Friday, February 23, 2007 2:47 PM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Cc: Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; 'Ralph Crafton'; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: 1-22-2007 Instream Flow/Aquatic Habitat TWC Draft Meeting Notes

Dear Instream Flow/Aquatic Habitat TWC Members:

Attached for your review are the draft meeting notes from the January 22, 2007 meeting of the Instream Flow/Aquatic Habitat TWC. Please note that, due to file format, Attachments A&B are included as separate files. Please provide comment on the draft notes by March 9th. As always, thanks for your continued participation in the Saluda Hydro Relicensing.

Have a good weekend,
Shane Boring

2007-01-22 ıstream Flow-Aquat..

Attachment A -22-2007 IFIM TW..

Attachment B -22-2007 IFIM Me..

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Draft jms 01-30-07

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Ron Ahle, SCDNR
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR
Scott Harder, SCDNR

ACTION ITEMS

- Incorporate comments into the Instream Flow Study Plan and send out to all committee members for review

Shane Boring

- Determine whether HSI curves are available for gizzard shad in riverine systems, and if so, distribute to TWC

Shane Boring/Brandon Kulik

- Email Prescott Brownell about whether it would be applicable to use the Catawba-Wateree shortnose sturgeon HSI curves for the Saluda IFIM study

Amanda Hill

- Compile potential source HSI substrate curves and distribute to TWC prior to Feb. 21 meeting

Shane Boring/Brandon Kulik

- Construct plots of finalized HSI curves (Depth/Velocity for smallmouth bass, rainbow trout, brown trout)

Shane Boring/Brandon Kulik

NEXT MEETING

February 21, 2007 at 9:30am
Location: Lake Murray Training Center

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Draft jms 01-30-07

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 10:00 AM and noted that the purpose of today's meeting will be to discuss: (1) HSI criteria for guilds, (2) HSI criteria for stand-alone species, and (3) the next steps that need to be taken for the IFIM study. He briefly reviewed the action items from the previous meeting. Shane noted that he was currently incorporating comments made on the IFIM study plan and would send it back out to committee members within the next week for comments.

Review of HSI Criteria for Guilds

Shane noted that the species guild matrix had been revised based on comments from the previous IFIM meeting and distributed a revised matrix. The group then reviewed the updated matrix, and after several additional revisions, agreed that the following guild approach was acceptable:

Deep Slow Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
blueback herring	spawning	
blueback herring	YOY	
Norrthern hogsucker	adult	
redbreast sunfish	adult	
robust redhorse	juvenile	
robust redhorse	adult	
spotted sucker	juvenile	
spotted sucker	adult	

Deep Fast Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
American shad	spawning	
Norrthern hogsucker	spawning	
Norrthern hogsucker	fry/YOY	
Norrthern hogsucker	juvenile	
shorthead redhorse	adult	

spottail shiner	adult	

Deep Fast Guild

species	**life stage**	**SI curve source**
benthic macroinver.	juvenile	Catawba-Wateree
robust redhorse	spawning	
saluda darter	adult	
spottail shiner	spawning	
spotted sucker	spawning	

Deep Fast Guild

species	**life stage**	**SI curve source**
redbreast sunfish	spawning	Catawba-Wateree
robust redhorse	fry/YOY	
spotted sucker	juvenile	
spotted sucker	fry/YOY	

There was a brief discussion about whether to add threadfin shad to the list of target species. It was noted that HSI curves were not available for threadfin shad, but that gizzard shad could potentially serve as a surrogate. Alan Stuart and others noted that the existing gizzard shad HSI curves were developed for reservoir habitats, not riverine systems. After some discussion, it was determined that availability of appropriate riverine HSI curves for gizzard shad should be evaluated prior to determining whether this species can serve as an appropriate surrogate for threadfin shad. The group agreed to withhold a determination on whether or not threadfin shad should be included until after this information is evaluated.

Review of Habitat Suitability Criteria (HSC) for Stand-Alone Species

Brandon Kulik noted that a memorandum regarding HSC for stand-alone species was sent out on January 16, 2007 to all committee members (Attachment A). He noted that this memorandum summarized HSC curves for smallmouth bass, rainbow trout, and brown trout from a number of potential source studies for purposes of evaluating transferability to the lower Saluda study. He noted that TWC members should consider their field experience/observations regarding the target species and the lower Saluda River in evaluating applicability of the potential source curves. The group examined the HSC curves for each species and lifestage for both depth and velocity. The group agreed to use the following HSC curves for the following species:

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

Zone of Passage for Striped Bass

Brandon suggested that the minimal flow limiting passage requirement for a fish would be an adequate amount of water so that the body of the fish is submerged. A maximum flow limiting factor for passage would be a high velocity that exceeds the fish's sustained swimming strength. Gerrit noted that there are striped bass passage standards for South Carolina. He explained that according to the standard, river must be 18 inches in depth for a 20 pound striped bass, with a 10 ft width, covering 10 % of the channel. Hal Beard noted that he thinks there may only be one year in

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which striped bass were not able to make it up the lower Saluda River past Millrace Rapids. Hal noted that it may have occurred in the months of May/April of 1991. This was because Saluda Hydro was not releasing. Brandon presented a spreadsheet model from the USGS Conte Lab paper (Attachment B) that described limiting velocities for striped bass passage based on fish size and ambient water temperature.

Next Steps

Brandon noted that the group would need to also agree upon appropriate substrate HSC curves. The group agreed that discussion of potential source curves for substrate would be appropriate for the February 21st TWC meeting. Brandon and Shane agreed to draft and similar memo summarizing potential source curves and distribute to the group prior to the meeting.

Brandon noted that Shane will be going out in the field to characterize mesohabitats on the lower Saluda River. Shane added that they hope to have the mesohabitat characterization completed and available for review by the TWC by late March.

Brandon mentioned that they have not yet been able to contact Prescott Brownell regarding HSC curves for shortnose sturgeon. After some discussion, the group agreed that the Catawba-Wateree IFIM study would be the most likely source for shortnose sturgeon curves. Amanda Hill noted that she would e-mail Prescott regarding transferability of the Catawba-Wateree curves; she recommended contacting Pace Wilbur at NOAA-Fisheries if we were not able to contact Prescott.

Next Meeting

The group noted that the next TWC meeting had been scheduled for February 21st, 2007 at Lake Murray Training Center. The meeting adjourned at approximately 3:10 PM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Depth and Velocity for Smallmouth Bass and Rainbow and Brown Trout Lifestages

Attachment B

Spreadsheet Summarizing Limiting Velocities for Striped Bass Passage (Source: Conte Anadromous Fish Lab)

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: January 16, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

The Saluda River instream flow study plan requires that habitat suitability of a range of flows will be rated using existing Habitat Suitability Criteria (HSC). Specific criteria will be selected in consultation with SCDNR, USFWS and NMFS fishery agencies participating in the Saluda relicensing IFIM Technical Working Committee (TWC). The TWC agreed to model most instream habitat uses with representative guild surrogates, but also desired more detailed modeling of individual fish species of particular resource management interest.

At the November 28, 2006 TWC meeting, it was agreed that additional research was required to obtain HSC that can be adequately transferred to the Saluda River for these individual species. The purpose of this memo is to summarize a cross-section of HSC for the following species and lifestages so that the TWC can evaluate the transferability of candidate source curves. Individual species and lifestages for which source studies were sought include:

SPECIES	LIFESTAGES
Smallmouth bass	Spawning, YOY, juvenile, adult
Rainbow trout	Spawning, YOY, juvenile, adult
Brown trout	Spawning, YOY, juvenile, adult
Striped bass	Zone of Passage

Habitat Suitability criteria transferability is commonly applied in instream flow models (Groshens and Orth, 1994). However some consideration must be given to the biotic and abiotic comparability between proposed source and study streams. According to Thomas and Bovee (1993), "*The transferability of HSC from a source stream to a destination stream probably depends on the overall similarity between the two and how important their differences are in causing changes in fish behavior*".

Differences in habitat use for species among rivers may result from real differences in habitat availability such as cover, geomorphology (Perry, *et al*., 1993), abiotic factors such as macrohabitat (*e.g.* thermal regime) or biotic factors such as intra- or inter-specific interactions, presence and/or absence of predators, competitors and prey (Newcomb, et al., 1995, Groshens and Orth, 1994). In some cases, source criteria may be flawed due to aberrant definitions of suitability used by source authors that are not applicable to the destination stream (Groshens and Orth, 1994). Perry *et al.* (1993) concluded that smallmouth bass HSC obtained from streams with relatively homogenous habitat and from a similar ecoregion transferred best to similar streams because the distribution of preferred habitat was similar and this would minimize behavioral differences expressed by target populations.

CANDIDATE CRITERIA

Smallmouth Bass

We obtained HSC that have been successfully applied in IFIM studies from the upper James (VA), Deerfield (MA), and the Broad rivers (SC); criteria developed for use in several rivers in the Appalachian highlands (VA and WVA), and generalized "Bluebook" criteria (Edwards, et al., 1983). Table 1 summarizes major river characteristics of each source study.

Table 1: Summary of Habitat Characteristics for Smallmouth Bass HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley	1.8	Cobble boulder gravel	95
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont	Approx. 1	Cobble, sand	
Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont	0.5- 1.5	Bedrock, cobble sand	82-113
Edwards, *et al* (1983)	Generic					
Monahan (1991)	Huron (MI)	Great Lakes	Central Lowland	N.A.	Sand gravel	115

There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable. Authors and modelers have likewise generally felt that there are few if any site-specific differences in suitability preferences among the spawning and YOY life stages, but instead have focused on differences among the juvenile and adult lifestages. According to Bovee (1990), there was:

> "*controversy regarding the velocity criteria historically applied to earlier smallmouth bass studies which relied on the old "blue book" HSI data …because standard applications of this criteria in studies…tended to make velocity appear more limiting in the PHABSIM model than it really is...because riverine bass tend to use localized low-velocity areas created by flow shelters but standard applications have not reflected that these shelters are often adjacent to velocity chutes which the fish use for feeding*".

This suggests that our current focus should be on:

- juvenile and adult lifestages;
- some consideration should be given to the relative preponderance of object cover such as boulders, logs, *etc.* in the study area vs. those characteristics found in the candidate source study rivers; and
- consider "cover conditional" velocity criteria that account for both "good" cover and "poor" cover conditions (for example, as in the Deerfield River curves).

It may be reasonable to accept general criteria such as Edwards, et al. (1983) in selecting velocity and depth criteria for spawning and YOY lifestages.

Appendix A contains graphic comparisons of depth and velocity criteria for juvenile and adult lifestages.

<u>Rainbow Trout</u>

We obtained HSC that have been successfully applied in IFIM studies from the Lackawaxen (PA) , Deerfield (MA), Housatonic (CT), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 2 summarizes major river characteristics of each source study. Life stages of interest in this study are adult and juvenile.

Table 2: Habitat Characteristics for Rainbow Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
TVA[1]	various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1986)	Generic "Blue Book" data					

HSC from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC. The original criteria were developed from field data collected in second and third-order streams (SRBC, 1998), and were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e*. fourth and fifth-order) rivers.

Rainbow trout HSC curves for Deerfield River adult lifestage provide cover-conditional velocity criteria. Appendix B provides graphic comparisons of HSC from the above studies.

[1] adopted data from Raleigh, et al. (1986) without modification

Brown Trout

We obtained HSC from the Lackawaxen (PA) , Deerfield (MA), Connecticut (various rivers), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 3 summarizes major river characteristics of each source study.

Table 3: Summary of Habitat Characteristics for Brown Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland	1.5-2.0	boulder gravel	100-200
CT DEP	Housatonic (CT)	New England	New England Upland	2.0	boulder cobble	150-200
TVA[2]	Various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1984)	Generic "Blue Book" data					

As discussed under rainbow trout, HSC for brown trout from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC criteria. The original criteria were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e.* fourth and fifth-order) rivers.

HS curves for Deerfield and Housatonic provides cover-conditional velocity criteria. Appendix C provides graphic comparisons of HSC from the above studies.

Striped Bass (Zone of Passage)

Adult striped bass originating downstream in the Congaree/Santee rivers may ascend the Lower Saluda River during summer months to seek forage and thermal refuge (D. Christie, SCDNR, Pers. Comm.). The TWC concluded that zone of passage through limiting steep gradient rapids found at Millrace Rapids, is the most applicable instream flow assessment issue for this species. For zone-of-passage assessment for striped bass, minimum passage criteria from Bovee (1982) are:

> *"The minimum recommended clearance requirement should probably be no less than two-thirds the body thickness of the fish…The Oregon State Game Commission (Thompson 1972) suggests that the total width of stream having the*

[2] adopted data from Raleigh, et al. (1986) without modification

specified passage depth should be at least 25% of the top width or that the longest continuous portion be at least 10% of the top width."

Table 29 in Bovee (1982) lists minimum depth criteria for various trout, as well as Chum, Chinook and Coho salmon ranging of 0.6 (large trout) to 0.8 (Chinook salmon). An estimate of available body depth data for indigenous Saluda River striped bass would be obtained or extrapolated, and applied to these criteria to determine limiting body depth. For example, Smith (1985) gives a ratio of body depth to total length as 27.9:123.5 for this species.

Criteria developed by Haro *et al.* (2004) provides guidance on limiting velocities that can affect the ability of anadromous fish (including striped bass) to ascend rapids against high flows. These criteria were developed through flume tests at the Conte Anadromous Fish Research Center (Turners Falls, MA), and take into account the ichthyomechanics and thermal metabolism of adult fish. Use of these criteria will depend on site-specific estimates of striped bass length and ambient water temperature. Haro *et al.* (2004) was previously distributed to the study team via email on December 4, 2006.

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Perry, S.A., W.B. Perry, D.L. Graham and N.H. Sagalkin. 1993. Verification and transferability studies for smallmouth bass in West Virginia streams. West Virginia Coop. Fish and Wildl. Res. unit, West Virginia Univ., Morgantown, WV.WVCFRUWRU Cooperative Agreement 14-16-0009-1563. 25 pp. plus appendices.

Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish and Wildl. Serv. FWS/OBS-82(10.124). 65 pp..

Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

Appendix A
Smallmouth Bass Habitat Suitability Criteria Curves

Kacie Jensen

From: Alison Guth
Sent: Thursday, January 18, 2007 12:10 PM
To: Alison Guth; 'Steve Summer'; Alan Stuart; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Dee Bennett '; 'Dick Christie'; 'GibbonsJ@dnr.sc.gov'; 'Harold Moxley'; Jennifer Summerlin; 'Joey Jaco'; 'Prescott Brownell'; 'Ross Self'; Shane Boring
Subject: Agenda: Columbia Fishway Meeting/Saluda Diadromous Fish Meeting

Hello all,

Attached is the agenda for next Tuesday's meeting. If you have not RSVP'ed for lunch yet, please do so by tomorrow. Thanks, Alison

12307 columbia fishway, diadro...

-----Original Appointment-----
From: Alison Guth
Sent: Monday, January 15, 2007 8:54 AM
To: Steve Summer; Alan Stuart; Alison Guth; Amanda Hill; Bill Argentieri; Dee Bennett ; Dick Christie; GibbonsJ@dnr.sc.gov; Harold Moxley; Jennifer Summerlin; Joey Jaco; Prescott Brownell; Ross Self; Shane Boring
Subject: Updated: Columbia Fishway Meeting/Saluda Diadromous Fish Meeting
When: Tuesday, January 23, 2007 9:30 AM-3:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: Carolina Research Park

Good morning all,

It is time again to convene our meeting to discuss fishway monitoring at Columbia Hydro for the 2007 operation season and to discuss future diadromous fish sampling for Saluda Hydro relicensing. What we have planned is to dedicate the morning to discuss Columbia monitoring efforts, break for lunch (provided) and the afternoon to Saluda Hydro efforts. Please come prepared to discuss the draft fishway monitoring plan, sent out 12/29/06. The meeting will be held at SCE&G's office at Carolina Research Park off of Farrow Rd and begin promptly at 9:30 a.m. Please try to be on time as we have a good bit of material to discuss. We'll send out an agenda in the next few days and if any of you need directions of have questions please do not hesitate to give me a call. Please RSVP for lunch by Thursday.

We look forward to seeing everyone and thank you for your continuing efforts of the Columbia and Saluda Projects.

Alison

Columbia Fish Passage/Saluda Diadromous Fish Studies
Meeting Agenda

January 23, 2007
9:30 AM
SCE&G offices at Carolina Research Park

- **9:30 to 9:35** Welcome and Introductions
- **9:35 to 10:30** Discussion on Columbia Fishway O & M Manual
- **10:30 to 10:35** Break
- **10:35 to 11:45** Discussion on Fishway Compliance Monitoring Program including Minimum Flows
- **11:45 to 12:15** Lunch
- **12:15 to 1:00** Discussion on the 2007 Columbia Fishway Evaluation Plan
- **1:00 to 1:45** Discussion on the 2007 American Shad Telemetry Study Plan
- **1:45 to 2:00** Review of any Homework Assignments/Action Items

Adjourn

Saluda HYDRO RELICENSING

Kacie Jensen

From: Brandon Kulik
Sent: Wednesday, January 17, 2007 5:06 PM
To: Shane Boring; 'Wade Bales (balesw@dnr.sc.gov)'; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Bud Badr'; 'Dick Christie'; 'Gerrit Jobsis (American Rivers)'; 'Hal Beard'; Jennifer Summerlin; 'Jim Glover'; 'Malcolm Leaphart'; 'Milton Quattlebaum (mquattlebaum@scana.com)'; 'Prescott Brownell'; 'Randy Mahan'; 'Ron Ahle'; 'Scott Harder'; Shane Boring; 'Steve Summer'; 'Theresa Thom'; Alan Stuart
Subject: RE: Saluda Hydro IFIM TWC Meeting Reminder and Suitability Criteria Memo

I would just add to Shane's note that the attached memo focuses primarily on the SI variables of depth and velocity, which are the model parameters for these species that will require the most thought and discussion. We are also preparing information to bring to the meeting summarizing the parameter of substrate/cover, but wanted tog et the hydraulic criteria out to everyone ahead of the meeting for consideration.

Feel free to contact me ahead of the meeting should you have any questions or thoughts.

Right now it's -1 (F) outside here in Maine. Looking forward to spending time with you in some warm and balmy South Carolina weather.

Regards,

Brandon

Brandon H Kulik
Senior Fisheries Biologist
Kleinschmidt Energy & Water Resources
75 Main Street
Pittsfield, ME 04967
(207) 487-3328
Fax: 487-3124

-----Original Message-----
From: Shane Boring
Sent: Wednesday, January 17, 2007 4:57 PM
To: Wade Bales (balesw@dnr.sc.gov); Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart
Subject: Saluda Hydro IFIM TWC Meeting Reminder and Suitability Criteria Memo

Hello folks:

Just a reminder of our IFIM TWC meeting next Monday, January 22nd, at Lake Murray Training Center. As you may remember, this meeting will be aimed at finalizing the guilds and habitat suitability criteria for the upcoming study.

In an effort to make our time on Monday a bit more productive, Brandon and I have prepared a memo comparing candidate curves for several of the "stand-alone" species (see attached). Specifically, these curves and memo compare the potential curves identified for brown trout, rainbow trout and smallmouth bass, as well as the passage criteria for striped bass.

The meeting agenda is also attached.

Look forward to seeing you all on Monday.

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177

Fax: (803)822-3183
<< File: 2007-01-16 Saluda Instream Flow Study - Habitat Suitabilit..pdf >>

<< File: Instream Flow TWC Agenda 01-22-07.doc >>

Kacie Jensen

From: Shane Boring
Sent: Friday, February 23, 2007 2:47 PM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Cc: Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; 'Ralph Crafton'; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: 1-22-2007 Instream Flow/Aquatic Habitat TWC Draft Meeting Notes

Dear Instream Flow/Aquatic Habitat TWC Members:

Attached for your review are the draft meeting notes from the January 22, 2007 meeting of the Instream Flow/Aquatic Habitat TWC. Please note that, due to file format, Attachments A&B are included as separate files. Please provide comment on the draft notes by March 9th. As always, thanks for your continued participation in the Saluda Hydro Relicensing.

Have a good weekend,
Shane Boring

2007-01-22 Instream Flow-Aquat... | Attachment A 1-22-2007 IFIM TW... | Attachment B 1-22-2007 IFIM Me...

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Draft jms 01-30-07

ATTENDEES:

Bill Argentieri, SCE&G
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Amanda Hill, USFWS
Ron Ahle, SCDNR
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR
Scott Harder, SCDNR

ACTION ITEMS

- Incorporate comments into the Instream Flow Study Plan and send out to all committee members for review

Shane Boring

- Determine whether HSI curves are available for gizzard shad in riverine systems, and if so, distribute to TWC

Shane Boring/Brandon Kulik

- Email Prescott Brownell about whether it would be applicable to use the Catawba-Wateree shortnose sturgeon HSI curves for the Saluda IFIM study

Amanda Hill

- Compile potential source HSI substrate curves and distribute to TWC prior to Feb. 21 meeting

Shane Boring/Brandon Kulik

- Construct plots of finalized HSI curves (Depth/Velocity for smallmouth bass, rainbow trout, brown trout)

Shane Boring/Brandon Kulik

NEXT MEETING

February 21, 2007 at 9:30am
Location: Lake Murray Training Center

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
SCE&G's Lake Murray Training Center
January 22, 2007

Draft jms 01-30-07

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 10:00 AM and noted that the purpose of today's meeting will be to discuss: (1) HSI criteria for guilds, (2) HSI criteria for stand-alone species, and (3) the next steps that need to be taken for the IFIM study. He briefly reviewed the action items from the previous meeting. Shane noted that he was currently incorporating comments made on the IFIM study plan and would send it back out to committee members within the next week for comments.

Review of HSI Criteria for Guilds

Shane noted that the species guild matrix had been revised based on comments from the previous IFIM meeting and distributed a revised matrix. The group then reviewed the updated matrix, and after several additional revisions, agreed that the following guild approach was acceptable:

Deep Slow Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
blueback herring	spawning	
blueback herring	YOY	
Norrthern hogsucker	adult	
redbreast sunfish	adult	
robust redhorse	juvenile	
robust redhorse	adult	
spotted sucker	juvenile	
spotted sucker	adult	

Deep Fast Guild

species	life stage	SI curve source
American shad	YOY	Catawba-Wateree
American shad	spawning	
Norrthern hogsucker	spawning	
Norrthern hogsucker	fry/YOY	
Norrthern hogsucker	juvenile	
shorthead redhorse	adult	

spottail shiner	adult	

Deep Fast Guild

species	life stage	SI curve source
benthic macroinver.	juvenile	Catawba-Wateree
robust redhorse	spawning	
saluda darter	adult	
spottail shiner	spawning	
spotted sucker	spawning	

Deep Fast Guild

species	life stage	SI curve source
redbreast sunfish	spawning	Catawba-Wateree
robust redhorse	fry/YOY	
spotted sucker	juvenile	
spotted sucker	fry/YOY	

There was a brief discussion about whether to add threadfin shad to the list of target species. It was noted that HSI curves were not available for threadfin shad, but that gizzard shad could potentially serve as a surrogate. Alan Stuart and others noted that the existing gizzard shad HSI curves were developed for reservoir habitats, not riverine systems. After some discussion, it was determined that availability of appropriate riverine HSI curves for gizzard shad should be evaluated prior to determining whether this species can serve as an appropriate surrogate for threadfin shad. The group agreed to withhold a determination on whether or not threadfin shad should be included until after this information is evaluated.

Review of Habitat Suitability Criteria (HSC) for Stand-Alone Species

Brandon Kulik noted that a memorandum regarding HSC for stand-alone species was sent out on January 16, 2007 to all committee members (Attachment A). He noted that this memorandum summarized HSC curves for smallmouth bass, rainbow trout, and brown trout from a number of potential source studies for purposes of evaluating transferability to the lower Saluda study. He noted that TWC members should consider their field experience/observations regarding the target species and the lower Saluda River in evaluating applicability of the potential source curves. The group examined the HSC curves for each species and lifestage for both depth and velocity. The group agreed to use the following HSC curves for the following species:

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

Zone of Passage for Striped Bass

Brandon suggested that the minimal flow limiting passage requirement for a fish would be an adequate amount of water so that the body of the fish is submerged. A maximum flow limiting factor for passage would be a high velocity that exceeds the fish's sustained swimming strength. Gerrit noted that there are striped bass passage standards for South Carolina. He explained that according to the standard, river must be 18 inches in depth for a 20 pound striped bass, with a 10 ft width, covering 10 % of the channel. Hal Beard noted that he thinks there may only be one year in

which striped bass were not able to make it up the lower Saluda River past Millrace Rapids. Hal noted that it may have occurred in the months of May/April of 1991. This was because Saluda Hydro was not releasing. Brandon presented a spreadsheet model from the USGS Conte Lab paper (Attachment B) that described limiting velocities for striped bass passage based on fish size and ambient water temperature.

Next Steps

Brandon noted that the group would need to also agree upon appropriate substrate HSC curves. The group agreed that discussion of potential source curves for substrate would be appropriate for the February 21st TWC meeting. Brandon and Shane agreed to draft and similar memo summarizing potential source curves and distribute to the group prior to the meeting.

Brandon noted that Shane will be going out in the field to characterize mesohabitats on the lower Saluda River. Shane added that they hope to have the mesohabitat characterization completed and available for review by the TWC by late March.

Brandon mentioned that they have not yet been able to contact Prescott Brownell regarding HSC curves for shortnose sturgeon. After some discussion, the group agreed that the Catawba-Wateree IFIM study would be the most likely source for shortnose sturgeon curves. Amanda Hill noted that she would e-mail Prescott regarding transferability of the Catawba-Wateree curves; she recommended contacting Pace Wilbur at NOAA-Fisheries if we were not able to contact Prescott.

Next Meeting

The group noted that the next TWC meeting had been scheduled for February 21st, 2007 at Lake Murray Training Center. The meeting adjourned at approximately 3:10 PM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Depth and Velocity for Smallmouth Bass and Rainbow and Brown Trout Lifestages

Attachment B

Spreadsheet Summarizing Limiting Velocities for Striped Bass Passage (Source: Conte Anadromous Fish Lab)

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: January 16, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

The Saluda River instream flow study plan requires that habitat suitability of a range of flows will be rated using existing Habitat Suitability Criteria (HSC). Specific criteria will be selected in consultation with SCDNR, USFWS and NMFS fishery agencies participating in the Saluda relicensing IFIM Technical Working Committee (TWC). The TWC agreed to model most instream habitat uses with representative guild surrogates, but also desired more detailed modeling of individual fish species of particular resource management interest.

At the November 28, 2006 TWC meeting, it was agreed that additional research was required to obtain HSC that can be adequately transferred to the Saluda River for these individual species. The purpose of this memo is to summarize a cross-section of HSC for the following species and lifestages so that the TWC can evaluate the transferability of candidate source curves. Individual species and lifestages for which source studies were sought include:

SPECIES	LIFESTAGES
Smallmouth bass	Spawning, YOY, juvenile, adult
Rainbow trout	Spawning, YOY, juvenile, adult
Brown trout	Spawning, YOY, juvenile, adult
Striped bass	Zone of Passage

Habitat Suitability criteria transferability is commonly applied in instream flow models (Groshens and Orth, 1994). However some consideration must be given to the biotic and abiotic comparability between proposed source and study streams. According to Thomas and Bovee (1993), "*The transferability of HSC from a source stream to a destination stream probably depends on the overall similarity between the two and how important their differences are in causing changes in fish behavior*".

Differences in habitat use for species among rivers may result from real differences in habitat availability such as cover, geomorphology (Perry, *et al*., 1993), abiotic factors such as macrohabitat (*e.g.* thermal regime) or biotic factors such as intra- or inter-specific interactions, presence and/or absence of predators, competitors and prey (Newcomb, et al., 1995, Groshens and Orth, 1994). In some cases, source criteria may be flawed due to aberrant definitions of suitability used by source authors that are not applicable to the destination stream (Groshens and Orth, 1994). Perry *et al.* (1993) concluded that smallmouth bass HSC obtained from streams with relatively homogenous habitat and from a similar ecoregion transferred best to similar streams because the distribution of preferred habitat was similar and this would minimize behavioral differences expressed by target populations.

CANDIDATE CRITERIA

Smallmouth Bass

We obtained HSC that have been successfully applied in IFIM studies from the upper James (VA), Deerfield (MA), and the Broad rivers (SC); criteria developed for use in several rivers in the Appalachian highlands (VA and WVA), and generalized "Bluebook" criteria (Edwards, et al., 1983). Table 1 summarizes major river characteristics of each source study.

Table 1: Summary of Habitat Characteristics for Smallmouth Bass HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley	1.8	Cobble boulder gravel	95
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont	Approx. 1	Cobble, sand	
Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont	0.5- 1.5	Bedrock, cobble sand	82-113
Edwards, *et al* (1983)	Generic					
Monahan (1991)	Huron (MI)	Great Lakes	Central Lowland	N.A.	Sand gravel	115

There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable. Authors and modelers have likewise generally felt that there are few if any site-specific differences in suitability preferences among the spawning and YOY life stages, but instead have focused on differences among the juvenile and adult lifestages. According to Bovee (1990), there was:

> "*controversy regarding the velocity criteria historically applied to earlier smallmouth bass studies which relied on the old "blue book" HSI data …because standard applications of this criteria in studies…tended to make velocity appear more limiting in the PHABSIM model than it really is...because riverine bass tend to use localized low-velocity areas created by flow shelters but standard applications have not reflected that these shelters are often adjacent to velocity chutes which the fish use for feeding*".

This suggests that our current focus should be on:

- juvenile and adult lifestages;
- some consideration should be given to the relative preponderance of object cover such as boulders, logs, *etc.* in the study area vs. those characteristics found in the candidate source study rivers; and
- consider "cover conditional" velocity criteria that account for both "good" cover and "poor" cover conditions (for example, as in the Deerfield River curves).

It may be reasonable to accept general criteria such as Edwards, et al. (1983) in selecting velocity and depth criteria for spawning and YOY lifestages.

Appendix A contains graphic comparisons of depth and velocity criteria for juvenile and adult lifestages.

Rainbow Trout

We obtained HSC that have been successfully applied in IFIM studies from the Lackawaxen (PA) , Deerfield (MA), Housatonic (CT), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 2 summarizes major river characteristics of each source study. Life stages of interest in this study are adult and juvenile.

Table 2: Habitat Characteristics for Rainbow Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
TVA[1]	various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1986)	Generic "Blue Book" data					

HSC from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC. The original criteria were developed from field data collected in second and third-order streams (SRBC, 1998), and were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e*. fourth and fifth-order) rivers.

Rainbow trout HSC curves for Deerfield River adult lifestage provide cover-conditional velocity criteria. Appendix B provides graphic comparisons of HSC from the above studies.

[1] adopted data from Raleigh, et al. (1986) without modification

Brown Trout

We obtained HSC from the Lackawaxen (PA) , Deerfield (MA), Connecticut (various rivers), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 3 summarizes major river characteristics of each source study.

Table 3: Summary of Habitat Characteristics for Brown Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland	1.5-2.0	boulder gravel	100-200
CT DEP	Housatonic (CT)	New England	New England Upland	2.0	boulder cobble	150-200
TVA[2]	Various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1984)	Generic "Blue Book" data					

As discussed under rainbow trout, HSC for brown trout from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC criteria. The original criteria were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e.* fourth and fifth-order) rivers.

HS curves for Deerfield and Housatonic provides cover-conditional velocity criteria. Appendix C provides graphic comparisons of HSC from the above studies.

Striped Bass (Zone of Passage)

Adult striped bass originating downstream in the Congaree/Santee rivers may ascend the Lower Saluda River during summer months to seek forage and thermal refuge (D. Christie, SCDNR, Pers. Comm.). The TWC concluded that zone of passage through limiting steep gradient rapids found at Millrace Rapids, is the most applicable instream flow assessment issue for this species. For zone-of-passage assessment for striped bass, minimum passage criteria from Bovee (1982) are:

> *"The minimum recommended clearance requirement should probably be no less than two-thirds the body thickness of the fish…The Oregon State Game Commission (Thompson 1972) suggests that the total width of stream having the*

[2] adopted data from Raleigh, et al. (1986) without modification

specified passage depth should be at least 25% of the top width or that the longest continuous portion be at least 10% of the top width."

Table 29 in Bovee (1982) lists minimum depth criteria for various trout, as well as Chum, Chinook and Coho salmon ranging of 0.6 (large trout) to 0.8 (Chinook salmon). An estimate of available body depth data for indigenous Saluda River striped bass would be obtained or extrapolated, and applied to these criteria to determine limiting body depth. For example, Smith (1985) gives a ratio of body depth to total length as 27.9:123.5 for this species.

Criteria developed by Haro *et al.* (2004) provides guidance on limiting velocities that can affect the ability of anadromous fish (including striped bass) to ascend rapids against high flows. These criteria were developed through flume tests at the Conte Anadromous Fish Research Center (Turners Falls, MA), and take into account the ichthyomechanics and thermal metabolism of adult fish. Use of these criteria will depend on site-specific estimates of striped bass length and ambient water temperature. Haro *et al.* (2004) was previously distributed to the study team via email on December 4, 2006.

LITERATURE CITED

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Leonard, P.M., D.J. Orth, and C.J. Goodreau.1986. Development of a method for recommending instream flows for fishes in the upper James River, Virginia. VA poly Inst. and State Univ., Blacksburg, VA. Bull. 152, 109 pp.

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Perry, S.A., W.B. Perry, D.L. Graham and N.H. Sagalkin. 1993. Verification and transferability studies for smallmouth bass in West Virginia streams. West Virginia Coop. Fish and Wildl. Res. unit, West Virginia Univ., Morgantown, WV.WVCFRUWRU Cooperative Agreement 14-16-0009-1563. 25 pp. plus appendices.

Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish and Wildl. Serv. FWS/OBS-82(10.124). 65 pp..

Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

Appendix A
Smallmouth Bass Habitat Suitability Criteria Curves

Kacie Jensen

Subject: IFIM Meeting - Changed to Conference Call
Location: Via Conference Call

Start: Wed 2/21/2007 10:00 AM
End: Wed 2/21/2007 12:00 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Required Attendees: Fish & Wildlife TWC - IFIM/Aquatic Habitat

Hello All,

As many of your are aware, we have an IFIM meeting scheduled for next Wednesday, February 21st. However, the meeting agenda has been substantially shortened due to the unavailability of the speakers and presentations that were planned. Therefore, **we will be holding this meeting as a conference call.** We will be reviewing the HSI curves for substrate, and we will be emailing those out to you before the meeting for your review. The conference call will begin at 10:00 am. In order to join the conference call, please call 207-487-3328 and request conference bridge 206. Thanks, and we will talk to you on Wednesday. Alison

Kacie Jensen

Subject: Saluda Relicensing: Fish Entrainment Meeting
Location: Conference call

Start: Thu 2/22/2007 1:30 PM
End: Thu 2/22/2007 3:00 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Required Attendees: Jennifer Summerlin; Fish & Wildlife TWC - Fish Entrainment
Optional Attendees: Alison Guth

Hello Everyone,

There have been some questions regarding the Saluda Fish Entrainment/Mortality Report. The meeting discussion will include: stratification in Lake Murray, fish entrainment for units 1-4 and 5, and mitigation. I would like to have a conference call on February 22, 2007 at 1:30 PM to discuss these questions. Please let me know if you plan to attend the meeting.

Thanks,

Jennifer Summerlin
Scientist Technician
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Kacie Jensen

From: Prescott Brownell [Prescott.Brownell@noaa.gov]
Sent: Thursday, February 08, 2007 3:55 PM
To: Alison Guth
Subject: January 23 Meeting Notes and documents

prescott.brownell.vcf (401 B)

Hi Alison,
I have reviewed all the documents and do not have any additional comments before you finalize them. Thank you for keeping up with all these things.

P. Brownell

Hello All,

Attached are the draft meeting notes from the January 23 Columbia Fishway/Saluda Diadromous Fish Committee meeting. Please have any comments or edits on these notes back to me by February 15th for finalization. I have also attached the Columbia Fishway Evaluation Study Plan with the group edits in track changes and with the group edits accepted. Likewise, I have attached the American Shad Telemetry Study with the group edits shown in track changes and the finalized document. Thanks, Alison

<<2007-1-23 Columbia Fishway-Saluda Relicensing draft meeting notes.doc>> <<Draft Columbia Fishway Evaluation Plan 12-06 acg changes.doc>> <<Draft Columbia Fishway Evaluation Plan 12-06 acg accepted changes.doc>> <<American Shad Telemetry Study Plan 01-8-2007 (jms_csb_aws)2.doc>> <<Final American Shad Telemetry Study Plan 01-23-2007.doc>>

Alison Guth
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Good afternoon,

It appears from the responses I've received Friday February 9th is the day of choice to convene the conference call. Bill A. was kind enough to secure us a conference call in number and you'll find that information below.

If you have questions before hand please give me a call. Otherwise we'll talk to you at 2:00 pm on Friday.

Wood Stork conference call numbers are ext. 76565 for SCE&G participants and 1-888-500-7717 for all other participants. Access code is 9345. Call is scheduled for 2:00 PM on Friday, February 9.

Thanks for the quick responses !
Alan

Kacie Jensen

From: Alison Guth
Sent: Thursday, January 18, 2007 12:10 PM
To: Alison Guth; 'Steve Summer'; Alan Stuart; Alison Guth; 'Amanda Hill'; 'Bill Argentieri'; 'Dee Bennett '; 'Dick Christie'; 'GibbonsJ@dnr.sc.gov'; 'Harold Moxley'; Jennifer Summerlin; 'Joey Jaco'; 'Prescott Brownell'; 'Ross Self'; Shane Boring
Subject: Agenda: Columbia Fishway Meeting/Saluda Diadromous Fish Meeting

Hello all,

Attached is the agenda for next Tuesday's meeting. If you have not RSVP'ed for lunch yet, please do so by tomorrow.
Thanks, Alison

12307 columbia fishway, diadro...

-----Original Appointment-----
From: Alison Guth
Sent: Monday, January 15, 2007 8:54 AM
To: Steve Summer; Alan Stuart; Alison Guth; Amanda Hill; Bill Argentieri; Dee Bennett ; Dick Christie; GibbonsJ@dnr.sc.gov; Harold Moxley; Jennifer Summerlin; Joey Jaco; Prescott Brownell; Ross Self; Shane Boring
Subject: Updated: Columbia Fishway Meeting/Saluda Diadromous Fish Meeting
When: Tuesday, January 23, 2007 9:30 AM-3:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: Carolina Research Park

Good morning all,

It is time again to convene our meeting to discuss fishway monitoring at Columbia Hydro for the 2007 operation season and to discuss future diadromous fish sampling for Saluda Hydro relicensing. What we have planned is to dedicate the morning to discuss Columbia monitoring efforts, break for lunch (provided) and the afternoon to Saluda Hydro efforts. Please come prepared to discuss the draft fishway monitoring plan, sent out 12/29/06. The meeting will be held at SCE&G's office at Carolina Research Park off of Farrow Rd and begin promptly at 9:30 a.m. Please try to be on time as we have a good bit of material to discuss. We'll send out an agenda in the next few days and if any of you need directions of have questions please do not hesitate to give me a call. Please RSVP for lunch by Thursday.

We look forward to seeing everyone and thank you for your continuing efforts of the Columbia and Saluda Projects.

Alison

Columbia Fish Passage/Saluda Diadromous Fish Studies
Meeting Agenda

January 23, 2007
9:30 AM
SCE&G offices at Carolina Research Park

- **9:30 to 9:35** Welcome and Introductions
- **9:35 to 10:30** Discussion on Columbia Fishway O & M Manual
- **10:30 to 10:35** Break
- **10:35 to 11:45** Discussion on Fishway Compliance Monitoring Program including Minimum Flows
- **11:45 to 12:15** Lunch
- **12:15 to 1:00** Discussion on the 2007 Columbia Fishway Evaluation Plan
- **1:00 to 1:45** Discussion on the 2007 American Shad Telemetry Study Plan
- **1:45 to 2:00** Review of any Homework Assignments/Action Items

Adjourn

Saluda HYDRO RELICENSING

Kacie Jensen

From: Shane Boring
Sent: Wednesday, January 17, 2007 4:57 PM
To: Wade Bales (balesw@dnr.sc.gov); Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Theresa Thom; Brandon Kulik; Alan Stuart
Subject: Saluda Hydro IFIM TWC Meeting Reminder and Suitability Criteria Memo

Hello folks:

Just a reminder of our IFIM TWC meeting next Monday, January 22nd, at Lake Murray Training Center. As you may remember, this meeting will be aimed at finalizing the guilds and habitat suitability criteria for the upcoming study.

In an effort to make our time on Monday a bit more productive, Brandon and I have prepared a memo comparing candidate curves for several of the "stand-alone" species (see attached). Specifically, these curves and memo compare the potential curves identified for brown trout, rainbow trout and smallmouth bass, as well as the passage criteria for striped bass.

The meeting agenda is also attached.

Look forward to seeing you all on Monday.

C. Shane Boring
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2007-01-16 Saluda Instream Flo...

Instream Flow TWC Agenda 01-22...

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: January 16, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

The Saluda River instream flow study plan requires that habitat suitability of a range of flows will be rated using existing Habitat Suitability Criteria (HSC). Specific criteria will be selected in consultation with SCDNR, USFWS and NMFS fishery agencies participating in the Saluda relicensing IFIM Technical Working Committee (TWC). The TWC agreed to model most instream habitat uses with representative guild surrogates, but also desired more detailed modeling of individual fish species of particular resource management interest.

At the November 28, 2006 TWC meeting, it was agreed that additional research was required to obtain HSC that can be adequately transferred to the Saluda River for these individual species. The purpose of this memo is to summarize a cross-section of HSC for the following species and lifestages so that the TWC can evaluate the transferability of candidate source curves. Individual species and lifestages for which source studies were sought include:

SPECIES	LIFESTAGES
Smallmouth bass	Spawning, YOY, juvenile, adult
Rainbow trout	Spawning, YOY, juvenile, adult
Brown trout	Spawning, YOY, juvenile, adult
Striped bass	Zone of Passage

Habitat Suitability criteria transferability is commonly applied in instream flow models (Groshens and Orth, 1994). However some consideration must be given to the biotic and abiotic comparability between proposed source and study streams. According to Thomas and Bovee (1993), "*The transferability of HSC from a source stream to a destination stream probably depends on the overall similarity between the two and how important their differences are in causing changes in fish behavior*".

Differences in habitat use for species among rivers may result from real differences in habitat availability such as cover, geomorphology (Perry, *et al*., 1993), abiotic factors such as macrohabitat (*e.g.* thermal regime) or biotic factors such as intra- or inter-specific interactions, presence and/or absence of predators, competitors and prey (Newcomb, et al., 1995, Groshens and Orth, 1994). In some cases, source criteria may be flawed due to aberrant definitions of suitability used by source authors that are not applicable to the destination stream (Groshens and Orth, 1994). Perry *et al.* (1993) concluded that smallmouth bass HSC obtained from streams with relatively homogenous habitat and from a similar ecoregion transferred best to similar streams because the distribution of preferred habitat was similar and this would minimize behavioral differences expressed by target populations.

CANDIDATE CRITERIA

Smallmouth Bass

We obtained HSC that have been successfully applied in IFIM studies from the upper James (VA), Deerfield (MA), and the Broad rivers (SC); criteria developed for use in several rivers in the Appalachian highlands (VA and WVA), and generalized "Bluebook" criteria (Edwards, et al., 1983). Table 1 summarizes major river characteristics of each source study.

Table 1: Summary of Habitat Characteristics for Smallmouth Bass HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley	1.8	Cobble boulder gravel	95
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont	Approx. 1	Cobble, sand	
Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont	0.5- 1.5	Bedrock, cobble sand	82-113
Edwards, *et al* (1983)	Generic					
Monahan (1991)	Huron (MI)	Great Lakes	Central Lowland	N.A.	Sand gravel	115

There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable. Authors and modelers have likewise generally felt that there are few if any site-specific differences in suitability preferences among the spawning and YOY life stages, but instead have focused on differences among the juvenile and adult lifestages. According to Bovee (1990), there was:

> "*controversy regarding the velocity criteria historically applied to earlier smallmouth bass studies which relied on the old "blue book" HSI data …because standard applications of this criteria in studies…tended to make velocity appear more limiting in the PHABSIM model than it really is...because riverine bass tend to use localized low-velocity areas created by flow shelters but standard applications have not reflected that these shelters are often adjacent to velocity chutes which the fish use for feeding*".

This suggests that our current focus should be on:

- juvenile and adult lifestages;
- some consideration should be given to the relative preponderance of object cover such as boulders, logs, *etc.* in the study area vs. those characteristics found in the candidate source study rivers; and
- consider "cover conditional" velocity criteria that account for both "good" cover and "poor" cover conditions (for example, as in the Deerfield River curves).

It may be reasonable to accept general criteria such as Edwards, et al. (1983) in selecting velocity and depth criteria for spawning and YOY lifestages.

Appendix A contains graphic comparisons of depth and velocity criteria for juvenile and adult lifestages.

Rainbow Trout

We obtained HSC that have been successfully applied in IFIM studies from the Lackawaxen (PA) , Deerfield (MA), Housatonic (CT), and the TVA (miscellaneous rivers); and generalized "Bluebook" criteria (Raleigh, *et al*., 1986). Table 2 summarizes major river characteristics of each source study. Life stages of interest in this study are adult and juvenile.

Table 2: Habitat Characteristics for Rainbow Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
TVA[1]	various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1986)	Generic "Blue Book" data					

HSC from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC. The original criteria were developed from field data collected in second and third-order streams (SRBC, 1998), and were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e*. fourth and fifth-order) rivers.

Rainbow trout HSC curves for Deerfield River adult lifestage provide cover-conditional velocity criteria. Appendix B provides graphic comparisons of HSC from the above studies.

[1] adopted data from Raleigh, et al. (1986) without modification

Brown Trout

We obtained HSC from the Lackawaxen (PA) , Deerfield (MA), Connecticut (various rivers), and the TVA (miscellaneous rivers); and generalized “Bluebook” criteria (Raleigh, *et al.*, 1986). Table 3 summarizes major river characteristics of each source study.

Table 3: Summary of Habitat Characteristics for Brown Trout HSC Reported in Source Studies

SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION	APPROX. GRADIENT (%)	DOMINANT SUBSTRATE	MEAN WIDTH (FT)
KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau	1.5	Cobble boulder gravel	150-180
NEP (1990)	Deerfield (MA)	New England	New England Upland	1.5-2.0	boulder gravel	150
Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland	1.5-2.0	boulder gravel	100-200
CT DEP	Housatonic (CT)	New England	New England Upland	2.0	boulder cobble	150-200
TVA[2]	Various	Southeastern	Appalachian Ridge and Valley			
Raleigh, *et al* (1984)	Generic “Blue Book” data					

As discussed under rainbow trout, HSC for brown trout from the Lackawaxen River were adapted by the Pennsylvania Fish and Boat Commission from Susquehanna River Basin Commission (1998) category III HSC criteria. The original criteria were adjusted to better reflect habitat preference for greater depths and velocities found in larger (*i.e.* fourth and fifth-order) rivers.

HS curves for Deerfield and Housatonic provides cover-conditional velocity criteria. Appendix C provides graphic comparisons of HSC from the above studies.

Striped Bass (Zone of Passage)

Adult striped bass originating downstream in the Congaree/Santee rivers may ascend the Lower Saluda River during summer months to seek forage and thermal refuge (D. Christie, SCDNR, Pers. Comm.). The TWC concluded that zone of passage through limiting steep gradient rapids found at Millrace Rapids, is the most applicable instream flow assessment issue for this species. For zone-of-passage assessment for striped bass, minimum passage criteria from Bovee (1982) are:

> *“The minimum recommended clearance requirement should probably be no less than two-thirds the body thickness of the fish…The Oregon State Game Commission (Thompson 1972) suggests that the total width of stream having the*

[2] adopted data from Raleigh, et al. (1986) without modification

specified passage depth should be at least 25% of the top width or that the longest continuous portion be at least 10% of the top width."

Table 29 in Bovee (1982) lists minimum depth criteria for various trout, as well as Chum, Chinook and Coho salmon ranging of 0.6 (large trout) to 0.8 (Chinook salmon). An estimate of available body depth data for indigenous Saluda River striped bass would be obtained or extrapolated, and applied to these criteria to determine limiting body depth. For example, Smith (1985) gives a ratio of body depth to total length as 27.9:123.5 for this species.

Criteria developed by Haro *et al.* (2004) provides guidance on limiting velocities that can affect the ability of anadromous fish (including striped bass) to ascend rapids against high flows. These criteria were developed through flume tests at the Conte Anadromous Fish Research Center (Turners Falls, MA), and take into account the ichthyomechanics and thermal metabolism of adult fish. Use of these criteria will depend on site-specific estimates of striped bass length and ambient water temperature. Haro *et al.* (2004) was previously distributed to the study team via email on December 4, 2006.

LITERATURE CITED

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Newcomb, T.J., S.A. Perry and W.B. Perry. 1995. Comparison of habitat suitability criteria for smallmouth bass (*Micropterus dolomieu*) from three West Virginia rivers. Rivers 5(3):170-183.

Perry, S.A., W.B. Perry, D.L. Graham and N.H. Sagalkin. 1993. Verification and transferability studies for smallmouth bass in West Virginia streams. West Virginia Coop. Fish and Wildl. Res. unit, West Virginia Univ., Morgantown, WV.WVCFRUWRU Cooperative Agreement 14-16-0009-1563. 25 pp. plus appendices.

Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish and Wildl. Serv. FWS/OBS-82(10.124). 65 pp..

Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

Saluda Hydro Relicensing
Instream Flow/Aquatic Habitat and Technical Working Committee

Meeting Agenda

January 21, 2007
10:00 AM
Lake Murray Training Center

- **10:00 – 10:45** Housekeeping Items
  - Review of Action Items
  - Species Guild Matrix
  - Study Plan Updates
- **10:45 – 11:15** Review of HSI Criteria for Guilds
- **11:15 – 12:00** Review of HSI Criteria for stand-alone species
  - Rainbow Trout
  - Brown trout
  - Striped bass (zone of passage)
  - Shortnose Sturgeon
- **12:00 – 1:00** Lunch
- **1:00 - 2:45** Review of HSI Criteria for stand-alone species (continued)
- **2:45 to 3:00** Next steps
- **3:00** Adjourn

Saluda HYDRO RELICENSING

Kacie Jensen

From: Alison Guth
Sent: Tuesday, January 16, 2007 1:45 PM
To: Tony Bebber; Alan Stuart; Alison Guth; Amanda Hill; Bill Argentieri; David Hancock; Dick Christie; Joy Downs; Ron Ahle; Steve Bell
Subject: RT&E tracking tool

Hello Folks,

I had a homework item at the last meeting to acquire from Shane what has been accomplished so far for RT&E species. Attached below is the tracking tool that has been developed to track RT&E species with their preferred habitat. I will bring a copy of this tomorrow and we can discuss it more then. Thanks! Alison

Section 7 Saluda
Hydro Trackin...

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Section 7 Species Tracking Tool: Saluda Relicensing Project

Common Name	*Scientific Name*	Federal Status[1]	Population Status[2]	Critical Habitat Designated
Southern Dusky Salamander	*Desmognathus auriculatus*	SC		N/A
American kestrel	*Falco sparverius*	SC		N/A
Bachman's sparrow	*Aimophia aestivalis*	SC		N/A
Bald eagle	*Haliaeetus leucocephalus*	T		No
Henslow's sparrow	*Ammodramus henslowii*	SC		N/A
Ivory-billed woodpecker	*Campephilus principalis*	E		No
Loggerhead shrike	*Lanius ludovicianus*	SC		N/A
Painted bunting	*Passerina ciris ciris*	SC		N/A
Red-cockaded woodpecker	*Picoides borealis*	E		No
Wood stork	*Mycteria americana*	E		No

Carolina darter	*Etheostoma collis*	SC	N/A
Robust Redhorse Sucker	*Moxostoma robustum*	SC	N/A
Saluda darter	*Etheostoma saludae*	SC	N/A
Shortnose sturgeon	*Acipenser brevirostrum**	E	No
Carolina heelsplitter	*Lasmigona decorata*	E	Yes, but not listed in project boundaries
Saluda crayfish	*Distocambarus youngineri*	SC	N/A
Savannah lilliput	*Toxolasma pullus*	SC	N/A
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	SC	N/A
Algae-like pondweed	*Potamogeton confervoides*	SC	N/A
Awned meadowbeauty	*Rhexia aristosa*	SC	N/A
Biltmore green briar	*Smilax biltmoreana*	SC	N/A
Bog spicebush	*Lindera subcoriacea*	SC	N/A
Butternut	*Juglans cinerea*	SC	N/A

Canby's dropwort	*Oxypolis canbyi*	E	
Carolina bogmint	*Macbridea caroliniana*	SC	N/A
Creeping St. John's wort	*Hypericum adpressum*	SC	N/A
Dwarf aster	*Aster mirabilis*	SC	N/A
Dwarf burhead	*Echinodorus parvulus*	SC	N/A
False coco	*Pteroglossaspis ecristata*	SC	N/A
Georgia aster	*Aster georgianus*	C	
Little amphianthus	*Amphianthus pusillus*	T	
Pickering's morning-glory	*Stylisma pickeringii var. pickeringii*	SC	N/A
Piedmont bishop-weed	*Ptilimnium nodosum*	E	
Piedmont cowbane	*Oxypolis ternata*	SC	N/A
Prairie birdsfoot-trefoil	*Lotus purshianus var. helleri*	SC	N/A
Purple balduina	*Balduina atropurpurea*	SC	N/A
Rayner's blueberry	*Vaccinium crassifolium ssp sempervirens*	SC	N/A
Reclined meadow-rue	*Thalictrum subrotundum*	SC	N/A
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E	
Sandhills milk-vetch	*Astragalus michauxii*	SC	N/A

Schweinitz's sunflower	*Helianthus schweinitzii*	E	
Shoal's spider-lily	*Hymenocallis coronaria*	SC	N/A
Smooth coneflower	*Echinacea laevigata*	E	
Sweet pinesap	*Monotropsis odorata*	SC	N/A
White false-asphodel	*Tofieldia glabra*	SC	N/A
Wire-leaved dropseed	*Sporobolus teretifolius*	SC	N/A
Southern hognose snake	*Heterodon simus*	SC	N/A

[1] E – Federally Listed as Endangered
T - Federally Listed as Threatened
SC - species is a Candidate for Federal Listing as Threatened or Endangered (species of concern)
EDCH - Federally Listed as Endangered and has Designated Critical Habitat in the counties surrounding the project.
TPDH - Federally Listed as Threatened and has Designated Critical Habitat in the counties surrounding the project.
PE - Presumed extinct/no current status

[2] N - No recent records
E - Extant; occurs within project boundaries
EO - Extant; occurs outside project boundaries
RD - Recently discovered

[3] NE - No Effect
NL - Not likely to adversely affect
LA - Likely to adversely affect

Existing Restoration Plan (FWS or Other)	Counties	Habitat	Determination of effect
Amphibians			
N/A	Lexington (possible), Richland (possible)	Mucky areas near swamps, cypress heads, floodplain pools, and ravine streams where pockets of organic debris collect	
Birds			
N/A	Lexington (possible), Newberry (possible), Richland, Saluda (possible)	Cliff, cropland/hedgerow, desert, grassland/herbaceous, old field, savanna, woodlands	
N/A	Newberry, Saluda, Richland, Lexington	Old field, savanna, coniferous and hardwood woodlands	
FWS (Southeastern States)	Lexington, Newberry, Richland, Saluda	Cliff, woodlands, forest	
N/A	Newberry, Saluda, Richland, Lexington	Grassland, herbaceous	
N/A		Swampy forests, especially large bottomland river swamps of coastal plain and Mississippi Delta and cypress swamps of Florida	
N/A	Lexington (possible), Newberry (possible), Richland, Saluda (possible)	Cropland/hedgerow, desert, grassland/herbaceous, old field, savanna, shrubland/chaparral	
N/A	Lexington (possible), Richland (possible)	Old field, savanna, shrubland/chaparral, suburban/orchard, hardwood woodland	
FWS	Lexington, Richland, Saluda	Coniferous woodlands	
FWS	Newberry	estuarine-lagoon, scrub-shrub wetland, lacustrine- shallow water, palustrine-forested wetland, herbaceous wetland, scrub-shrub wetland, temporary pool	

Fish			
	N/A	Richland	Creek, low-moderate gradient, pool
	N/A	Lexington (possible)	Creek, medium river
	N/A	Lexington, Richland, Saluda, Newberry	Sluggish to calm areas in clear to slightly turbid small streams with substrate of mud, sand, gravel or bedrock
		Lexington (possible), Richland	Marine- near shore, estuarine- bay/ sound, lagoon, river mouth, riverine- big river with low gradient, medium river with moderate gradient, lacustrine- deep/ shallow water, palustrine- forested wetland
Invertebrates			
	FWS	Lexington (possible), Newberry (possible), Richland (possible),	Creek, low gradient, medium river, pool
	N/A	Newberry	Forested wetlands
	N/A	Saluda	Riverine- creek, lacustrine- shallow water
Mammals			
	N/A	Richland	Hardwood forest, suburban/orchard, urban/edificarian, hardwood woodlands
Plants			
	N/A	Richland	
	N/A	Richland	Grass-sedge dominated Carolina Bays, vernal ponds, wet pinelands, acid bogs, pond-cypress savanna, dried soil of cypress bottoms
	N/A	Newberry	
	N/A	Richland	Permanently moist to wet shrub-dominated seepage wetlands
	N/A	Newberry (possible)	Rich mesophytic forests, lower slopes, ravines and various types of bottomland

	Richland	Cypress ponds, grass-sedge dominated Carolina bays, wet pine savannahs, shallow pineland ponds, and cypress-pine swamps or sloughs
N/A	Richland	Wet longleaf pine or pond pine savannas and acidic swamp forests
N/A	Richland, Saluda	
N/A	Lexington (possible)	Moist stream bluffs and slopes and nutrient-rich, somewhat acidic bottomland
N/A	Saluda	
N/A	Richland	Scrub oak lands, pine rocklands, pine-palmetto flatwoods, and dry-mesic pine savannah
FWS	Richland	Dry open woods, roadsides, and other openings
FWS	Saluda	Vernal pools on granite outcrops of the Southeastern Piedmont
N/A	Lexington	
	Saluda	Rocky or gravelly shoals of clear, swift-flowing streams, the edges of intermittent pineland ponds, or low, wet savannah meadows on the Coastal Plain
N/A	Lexington	
N/A	Lexington (possible), Newberry (possible), Richland (Possible),	
N/A	Richland	Wet pine savannahs and peaty hillside seepage bogs
N/A	Lexington, Richland	Open seepage slopes in association with Atlantic White Cedar
N/A	Richland	
FWS	Richland	
N/A	Richland	

FWS	Lexington	
N/A	Lexington, Richland	
FWS	Lexington (possible), Richland	Openings in woods, along roadsides and utility line rights-of-way, dry limestone bluffs
N/A	Newberry	
N/A	Richland	
N/A	Lexington	Permanently moist to wet savannahs on essentially flat terrain underlain by a clay layer
Reptiles		
N/A	Lexington (possible), Richland, Saluda	Grassland/herbaceous, old field, savanna, woodlands

Data Needs/Comments

Kacie Jensen

Subject: Updated: Columbia Fishway Meeting/Saluda Diadromous Fish Meeting
Location: Carolina Research Park

Start: Tue 1/23/2007 9:30 AM
End: Tue 1/23/2007 3:00 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Required Attendees: Columbia Fish Passage Committee

Good morning all,

It is time again to convene our meeting to discuss fishway monitoring at Columbia Hydro for the 2007 operation season and to discuss future diadromous fish sampling for Saluda Hydro relicensing. What we have planned is to dedicate the morning to discuss Columbia monitoring efforts, break for lunch (provided) and the afternoon to Saluda Hydro efforts. Please come prepared to discuss the draft fishway monitoring plan, sent out 12/29/06. The meeting will be held at SCE&G's office at Carolina Research Park off of Farrow Rd and begin promptly at 9:30 a.m. Please try to be on time as we have a good bit of material to discuss. We'll send out an agenda in the next few days and if any of you need directions of have questions please do not hesitate to give me a call. Please RSVP for lunch by Thursday.

We look forward to seeing everyone and thank you for your continuing efforts of the Columbia and Saluda Projects.

Alison

Kacie Jensen

Subject:	Updated: Instream Flow/Aquatic habitat TWC Meeting - Habitat Suitability Curve/Guilding Session
Location:	Lake Murray Training Center
Start:	Mon 1/22/2007 10:00 AM
End:	Mon 1/22/2007 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Fish & Wildlife TWC - IFIM/Aquatic Habitat
Optional Attendees:	Alan Stuart; 'Gerrit Jobsis'; ARGENTIERI, WILLIAM R
Importance:	High

I MADE A MISTAKE ON THE PREVIOUS INVITATION. THE MEETING WILL NE HELD AT LAKE MURRAY TRAINING CENTER, NOT CAROLINA RESEARCH PARK. MY APOLOGIES FOR THE CONFUSION. PLEASE CLICK ACCEPT AGAIN TO UPDATE THE MEETING LOCATION IN YOUR OUTLOOK CALENDAR.

As discussed at our last IFIM TWC meeting, this session will focus on finalizing the species guilding and HSI curves for the upcoming Saluda IFIM study. **Please note that the meeting will begin at 10:00 AM, rather than 9:30;** since it is a Monday, we're trying to allow folks a little more travel time.

Kacie Jensen

Subject:	Instream Flow/Aquatic habitat TWC Meeting - Habitat Suitability Curve/Guilding Session
Location:	SCE&G Offices at Carolina Research Park
Start:	Mon 1/22/2007 10:00 AM
End:	Mon 1/22/2007 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Required Attendees:	Fish & Wildlife TWC - IFIM/Aquatic Habitat

As discussed at our last IFIM TWC meeting, this session will focus on finalizing the species guilding and HSI curves for the upcoming Saluda IFIM study. **Please note that the meeting will begin at 10:00 AM, rather than 9:30;** since it is a Monday, we're trying to allow folks a little more travel time.

Kacie Jensen

From: Shane Boring
Sent: Tuesday, April 24, 2007 9:43 AM
To: Theresa Thom; Alison Guth; Amanda Hill; Bill Argentieri; Bud Badr; Dick Christie; Gerrit Jobsis (American Rivers); Hal Beard; Jennifer Summerlin; Jim Glover; Malcolm Leaphart; Mike Waddell; Milton Quattlebaum (mquattlebaum@scana.com); Prescott Brownell; Randy Mahan; Ron Ahle; Scott Harder; Shane Boring; Steve Summer; Brandon Kulik; Alan Stuart
Cc: Wade Bales (balesw@dnr.sc.gov); Alan Stuart; Bill East; Bill Hulslander; Bill Marshall; Bob Perry ; Bob Seibels (bseibels@yahoo.com); Charlene Coleman; Daniel Tufford; Ed Diebold; George Duke; Gina Kirkland; Jeff Duncan; Jennifer O'Rourke; Jim Goller; Joe Logan; Joy Downs; Larry Turner (turnerle@dhec.sc.gov); Laura Boos (laura.mccary@gmail.com); Mark Leao; Mike Sloan; Norman Ferris; Patrick Moore; 'Ralph Crafton'; Reed Bull (rbull@davisfloyd.com); Robert Lavisky; 'Sam Drake'; Steve Bell; Steve Leach; Suzanne Rhodes; Tom Bowles (tbowles@scana.com)
Subject: Saluda Hydro Relicense: April 10 Instream Flow TWC Meeting Notes - Draft

Dear Instream Flow/Aquatic Habitat TWC Members:

Attached for your review are the draft meeting notes from the April 10th TWC conference call, at which Habitat Suitability Criteria for substrate were selected for some target species (smallmouth bass, brown and rainbow trout). **Please provide comments on the draft notes by Friday, April 4th**.

The memo that served as visual aid during the conference call will be included as an appendix to the notes and is also attached. Please note that the typo on Table 1, Appendix A (substrate particle size/codes from Bovee 1982) has been corrected.

Thanks to all who contributed to a very productive session.

Shane

C. Shane Boring
Environmental Scientist
Kleinschmidt Associates
101 Trade Zone Dr., Suite-21A
West Columbia, SC 29170
Phone: (803)822-3177
Fax: (803)822-3183

2007-04-10 ıstream Flow-Aquat.

Ѕaluda IFIM Study - Habitat Su...

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Draft CSB 04-23-07

ATTENDEES:

Dick Christie, SCDNR
Alan Stuart, Kleinschmidt Associates
Milton Quattlebaum, SCANA Services
Jeni Summerlin, Kleinschmidt Associates
Mike Waddell, Trout Unlimited
Gerrit Jobsis, AR/CCL
Shane Boring, Kleinschmidt Associates
Brandon Kulik, Kleinschmidt Associates
Hal Beard, SCDNR

ACTION ITEMS

- Gather and distribute substrate HSC plots and legends from Catawba-Wateree study for brown trout fry/spawning/juveniles to TWC

  Dick Christie / Shane Boring
- Finalize HSC curves based on TWC input and incorporate as an appendix to the Saluda IFIM Study Plan

  Shane Boring/Brandon Kulik

NEXT MEETING

TBD

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
SALUDA HYDRO PROJECT RELICENSING
Instream Flow/Aquatic Habitat Technical Working Committee
Via Conference Call
April 10, 2007

Draft CSB 04-23-07

MEETING NOTES:

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Shane Boring opened the meeting at approximately 9:00 AM. Shane noted that, at the January 22nd meeting of the Instream Flow/Aquatic Habitat Technical Working Committee (TWC), the TWC had agreed upon Habitat Suitability Criteria (HSC) for depth and velocity for several target species (smallmouth bass, brown trout, and rainbow trout adults). Shane added that the purpose of today's meeting would be to finalize the HSC selection process by selecting substrate criteria for these species.

Shane enquired as to whether there was any follow-up discussion regarding the depth/velocity criteria selection process or other TWC housekeeping items in need of attention. Hal Beard noted that, at the previous meeting, there was an action item assigned to determine whether HSC curves were available for gizzard shad in riverine systems. Hal added that, after discussing this issue with colleagues at SCDNR, he did not think this species was as much of a priority as he had once thought.

Dick Christie reminded the group that DNR manages the lower Saluda as a put-grow-take trout fishery, and as such, he and other DNR staffers had requested at previous TWC meetings that the habitat modeling for trout focus on adult lifestages (i.e. not include spawning, juvenile, fry). He added that, while DNR certainly welcomes any improvements to water quality or habitat that might benefit these early-lifestages, flow recommendations resulting from the IFIM process should not come at the detriment of providing quality growing conditions for stocked adult and sub-adult trout. Dick added that, while looking at early lifestages in the modeling might be good to have for informational purposes, these lifestages were not within the DNR's management strategy for the lower Saluda. Mike Waddell noted that Trout Unlimited does not agree with DNR's strategy of managing only for adult lifestages.

The group then turned their attention to the memo prepared by Shane Boring and Brandon Kulik (Attachment A), which summarized potential source HSC for substrate from a number of regional studies. After reviewing the source HSC plots for applicability to the lower Saluda, TWC members agreed on substrate HSC for the following species and lifestages:

Species	Life Stage	Curve Source	Modifications
brown trout	adult	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’ and change SI of this category to 1.0
	juvenile	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’ and change SI of this category to 1.0
	Fry	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	Spawning	Deerfield	
rainbow trout	Adult	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’ and change SI of this category to 1.0; Lower SI for ‘Roots, Snags, Undercut banks, Overhead Cover’ to 0.2
smallmouth bass	Adult	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	Juvenile	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	YOY	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’
	spawning	Deerfield	Change ‘Ledge’ to ‘Irregular Bedrock’

The group was not able to reach consensus on an acceptable substrate HSC for rainbow trout juveniles, fry or spawning due to limited source information (i.e., only the Raleigh et al. “Blue Book” value were presented). Mike Waddell, expressed interest in evaluating the curves used in the Catawba-Wateree IFIM Study before making a final selection for these lifestages. Dick Christie noted that these curves were presented in the Catawba-Wateree Final IFIM Report, but added that the legends needed to interpret the plots were not included. Dick agreed to contact the authors regarding the legends. Shane agreed to distribute the curves to the TWC once all of the information is gathered.

The meeting adjourned at approximately 11:00 AM.

Attachment A

Memo Summarizing Potential Source Habitat Suitability Curves for Substrate for Smallmouth Bass and Rainbow and Brown Trout Lifestages

MEMORANDUM

TO: Saluda Hydro: Instream Flow/Aquatic Habitat TWC

FROM: Shane Boring, Brandon Kulik

DATE: March 30, 2007

RE: **INSTREAM FLOW STUDY: HABITAT SUITABILITY CRITERIA**

On January 22nd, 2007, the Instream Flow/Aquatic Habitat Technical Working Committee (TWC) agreed upon Habitat Suitability Criteria (HSC) depth and velocity criteria for target species and lifestages (smallmouth bass, brown trout, and rainbow trout adults, juveniles, young-of-year, and spawning). Criteria from various source studies were evaluated based on transferability to the lower Saluda River (Table 1);

Although depth and velocity HSC were adapted for adult, juvenile, fry/young-of-year, and spawning smallmouth bass, as well as brown and rainbow trout (Table 2), the TWC did not time to completely evaluate substrate suitability. The purpose of this memo is to build upon the decisions made at the January 22nd 2007 TWC meeting by summarizing HSC for substrate and embeddedness for rainbow and brown trout, and smallmouth bass.

Table 1: Summary of Source Studies Evaluated for Depth and Velocity Habitat Suitability Criteria

SPECIES	SOURCE	RIVER	ECO-REGION	PHYSIOGRAPHIC REGION
Smallmouth bass	Leonard *et al*. (1986)	Upper James (VA)	Mid-Atlantic	Appalachian Ridge and Valley
Smallmouth bass	NEP (1990)	Deerfield (MA)	New England	New England Upland
Smallmouth bass	Lockhart IFIM study	Broad (SC)	Southeastern	Piedmont
Smallmouth bass	Groshens and Orth (1994)	N. Anna and Craig Creek	Southeastern Plains	Appalachian Ridge and Valley and Piedmont
Smallmouth bass	Edwards, *et al* (1983)	Generic		
Rainbow trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau
Rainbow trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Rainbow trout	Raleigh, *et al* (1986)	Generic "Blue Book" data		
Brown trout	KA (2001)	Lackawaxen, (PA)	Mid-Atlantic	Appalachian Plateau

Brown trout	NEP (1990)	Deerfield (MA)	New England	New England Upland
Brown trout	Strakosh, *et al.* 2003	Farmington (CT)	New England	New England Upland
Brown trout	CT DEP	Housatonic (CT)	New England	New England Upland
Brown trout	Raleigh, *et al* (1984)	Generic "Blue Book" data		

Table 2. Summary of Acceptable HSC Curves as Identified By The TWC

Species	Life Stage	Parameter	SI Curve Source
brown trout	adult	Depth	Combination: Housatonic (poor cover), Deerfield
	adult	Velocity	Lackawaxen, w/modifications
brown trout	fry/YOY	Depth	Deerfield
	fry/YOY	Velocity	Deerfield
brown trout	juvenile	Depth	Combination: Deerfield, Raleigh
	juvenile	Velocity	Combination: Lackawaxen, Deerfield
brown trout	spawning	Depth	Raleigh
	spawning	Velocity	Raleigh w/modifications
rainbow trout	adult	Depth	Deerfield
		Velocity	Deerfield (abundant)
rainbow trout	fry/YOY	Depth	Raleigh
		Velocity	Raleigh
rainbow trout	juvenile	Depth	Lackawaxen
		Velocity	Lackawaxen
rainbow trout	spawning	Depth	Raleigh
		Velocity	Raleigh
smallmouth bass	adult	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Groshens & Orth, Deerfield (abundant velocity refuge)
smallmouth bass	juvenile	Depth	Combination: Bain, Deerfield w/modifications
		Velocity	Deerfield (abundant velocity refuge)
smallmouth bass	spawning	Depth	Lockhart
		Velocity	Lockhart
smallmouth bass	YOY	Depth	Combination: Groshens & Orth, Bain
		Velocity	Combination: Deerfield, Bain

SUBSTRATE CRITERIA OPTIONS

Brown Trout

We obtained HSC successfully applied in IFIM studies from the Farmington (CT) (Strakosh, et al. 2003), Deerfield (MA) (NEP, 1990), and Housatonic (CT) (CT DEP) rivers, as well as the generalized “Bluebook” criteria (Raleigh, *et al*., 1986) that have been employed in several regional PHABSIM studies. Appendix A contains graphical representations of substrate criteria for juvenile and adult lifestages. For brown trout juveniles and adults, substrates ranging from gravel/pebble to cobble/small boulder were generally found to be the most suitable, along with undercut banks and vegetation for some studies. The degree of substrate embeddedness is also a sub-criterion.

Rainbow Trout

HSC criteria developed for the Deerfield River (MA) and generalized “Bluebook” criteria (Raleigh, *et al*., 1984) are presented in Appendix B. Although the studies varied in how some substrate sizes were classified, habitat suitability was generally similar between studies, with gravel, cobble and boulder substrates being more suitable than silt, sand and mud. This was particularly true of the early lifestages, i.e. spawning, fry, juvenile. The degree of substrate embeddedness is also a sub-criterion.

Smallmouth Bass

Substrate HSC criteria developed for the Deerfield River (MA), James (VA) (Leonard, et al., 1986) and generalized “Bluebook” criteria (Edwards, *et al*., 1993) are presented in Appendix C. There is relatively good general agreement among all curves relative to substrate and cover suitability, with large cobble/boulder tending to be optimal, and silt/sand/organics being less suitable.

LITERATURE CITED

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Leonard, P.M., D.J. Orth, and C.J. Goodreau.1986. Development of a method for recommending instream flows for fishes in the upper James River, Virginia. VA poly Inst. and State Univ., Blacksburg, VA. Bull. 152, 109 pp.

New England Power Company. 1990. New England Power Company, Deerfield River Project IFIM Study. Stetson-Harza, Weare, NH.

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Perry, S.A., W.B. Perry, D.L. Graham and N.H. Sagalkin. 1993. Verification and transferability studies for smallmouth bass in West Virginia streams. West Virginia Coop. Fish and Wildl. Res. unit, West Virginia Univ., Morgantown, WV.WVCFRUWRU Cooperative Agreement 14-16-0009-1563. 25 pp. plus appendices.

Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish and Wildl. Serv. FWS/OBS-82(10.124). 65 pp..

Raleigh, R.F., T Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60 64 pp.

Strakosh, T.R., R.M. Neumann, and R.A. Jacobsen. 2003. Development and assessment of habitat suitability criteria for adult brown trout in southern New England rivers. Ecology of Freshwater Fish 12:265-274. Blackwell Munksgaards, 2003.

Appendix A
Brown Trout Substrate Habitat Suitability Criteria

Appendix A, Table 1: Substrate Classification Codes - Raleigh

Substrate Codes from Bovee (1982)			
Code	**Description**	**Size (mm)**	**Size (in)**
1	plant/detritus/organic material		
2	mud/soft clay		
3	silt	<0.062	
4	sand	0.062 – 2.0	
5	gravel	2.0 - 64	
6	cobble	64 - 250	
7	boulder	250 – 4000	
8	bedrock	solid	

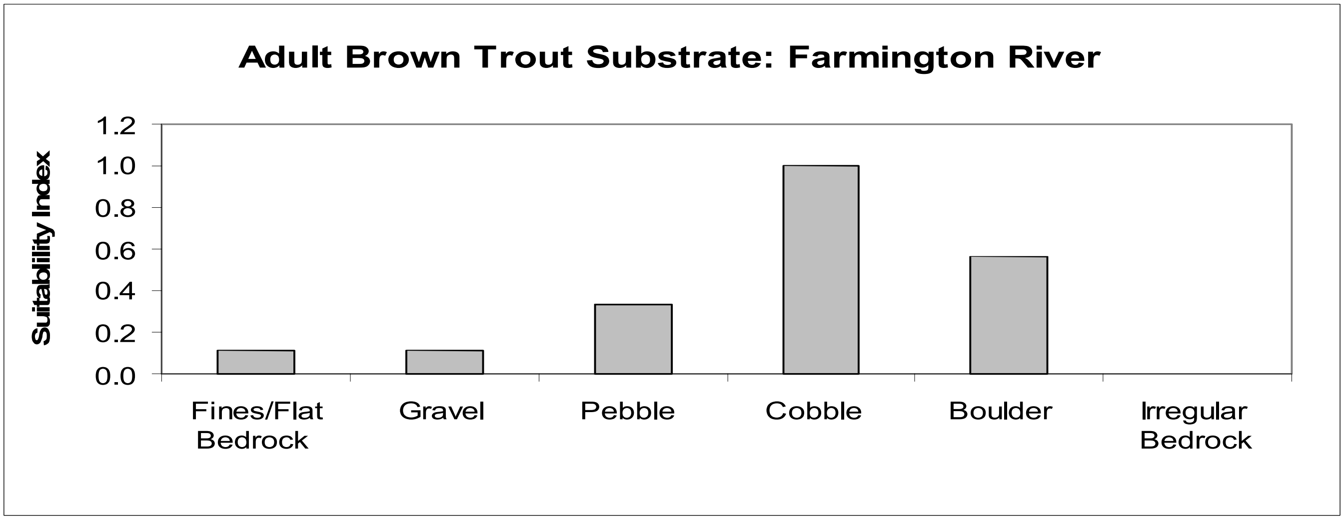
Appendix A, Table 2: Substrate Classification Codes - Deerfield & Housatonic

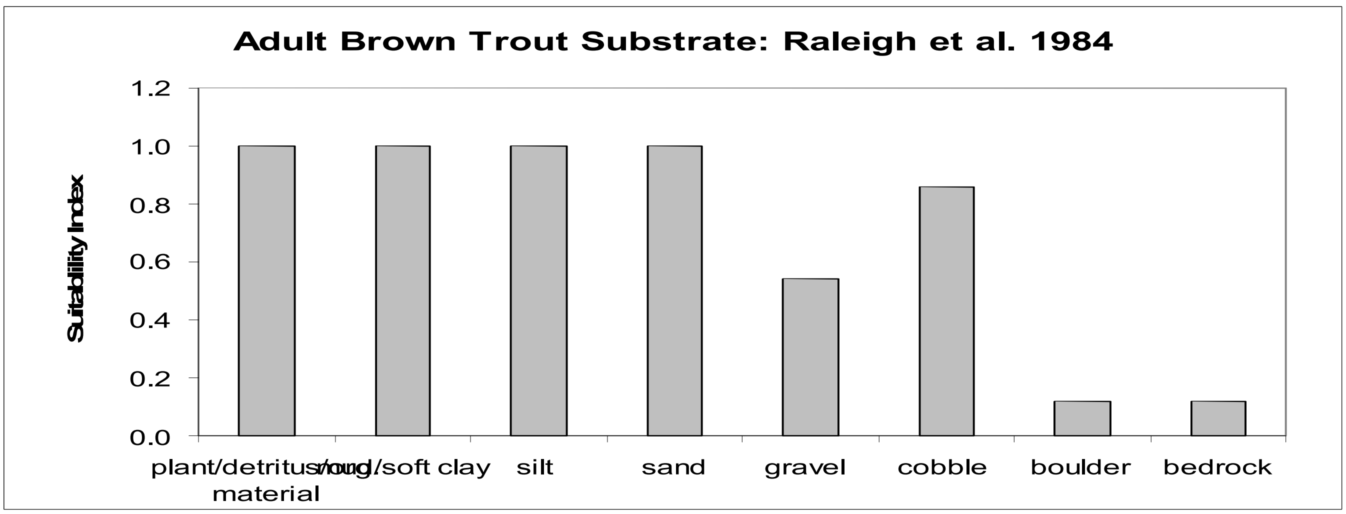
Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

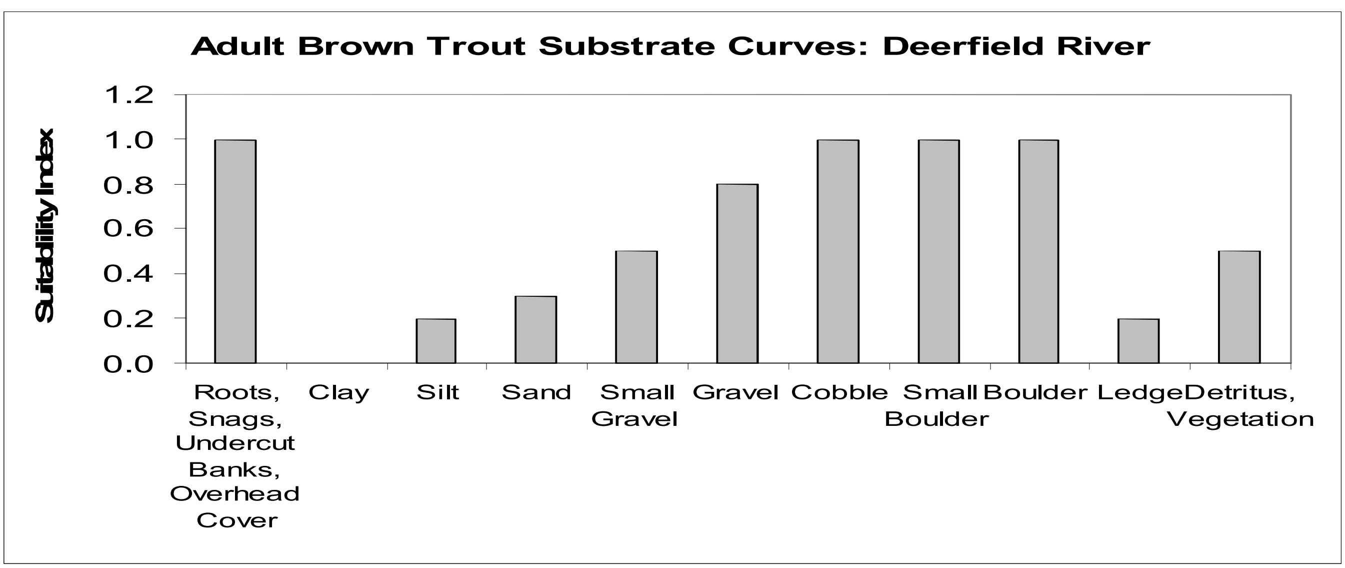
Appendix A, Table 3: Substrate Classification Codes - Farmington

Code	Description	Size (mm)	Size (in)
1	Fines/Flat Bedrock	< 2	< .08
2	Gravel	2 - 16	0.08 - 0.63
3	Pebble	16 - 64	0.63 - 2.52
4	Cobble	64 - 256	2.52 - 10.08
5	Boulder	> 256	> 10.08
6	Irregular Bedrock		

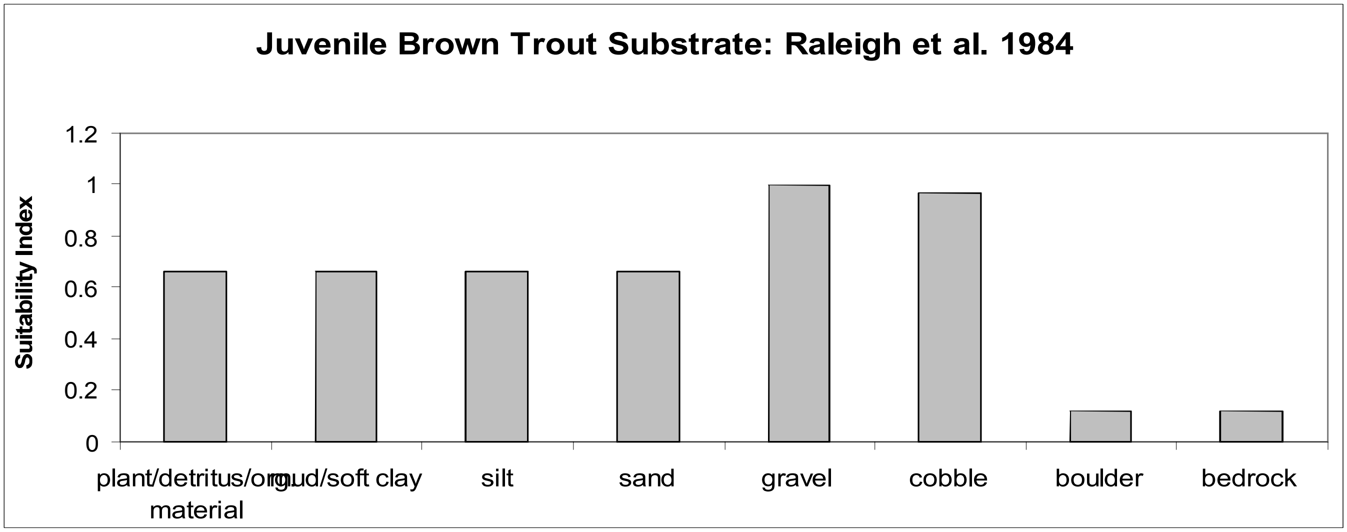
Adult Brown Trout

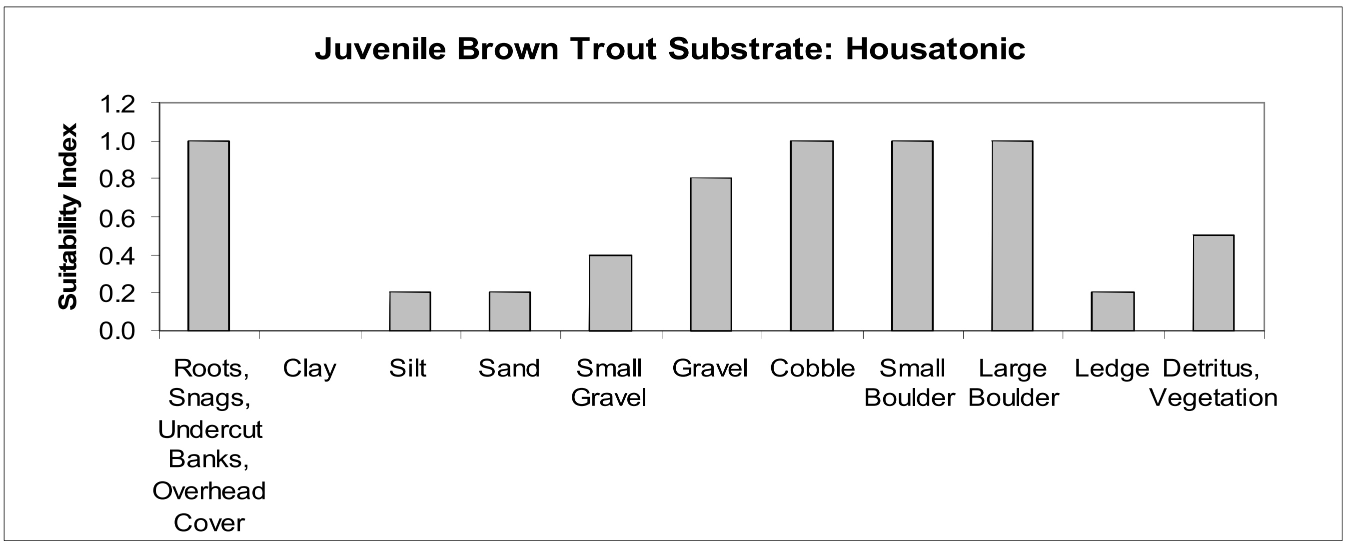


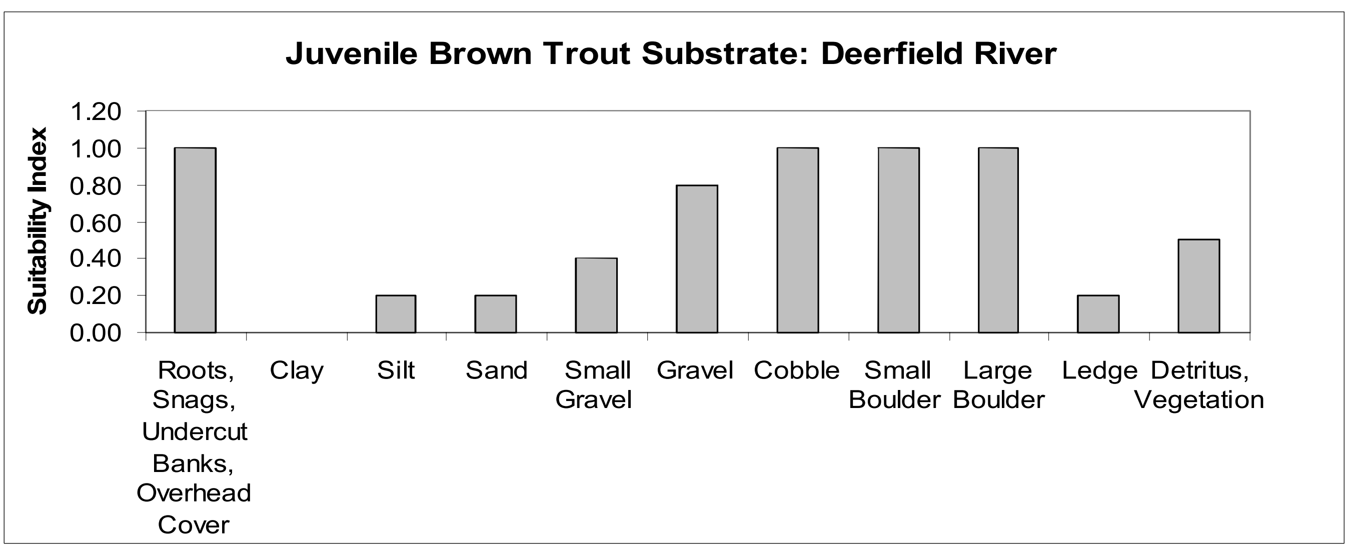




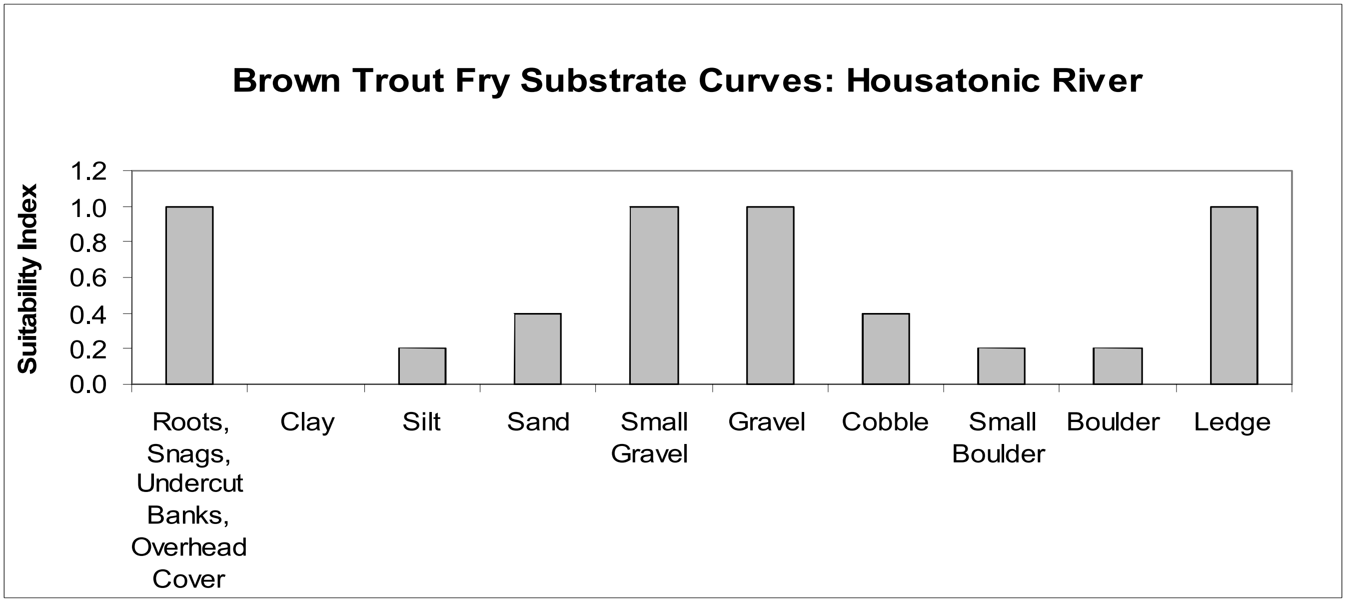
Juvenile Brown Trout

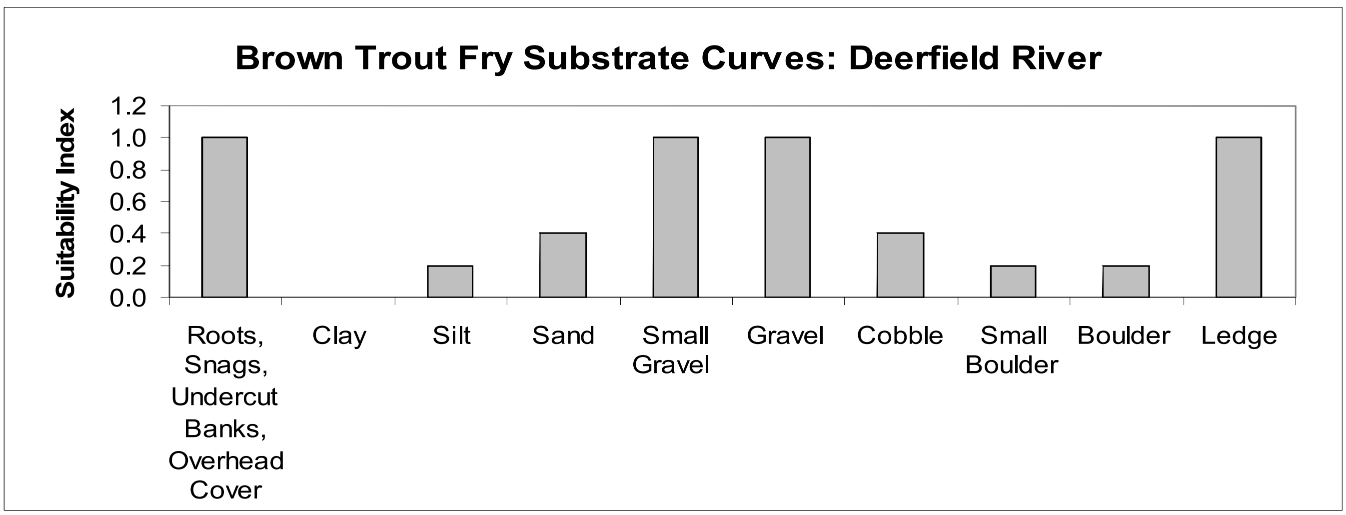


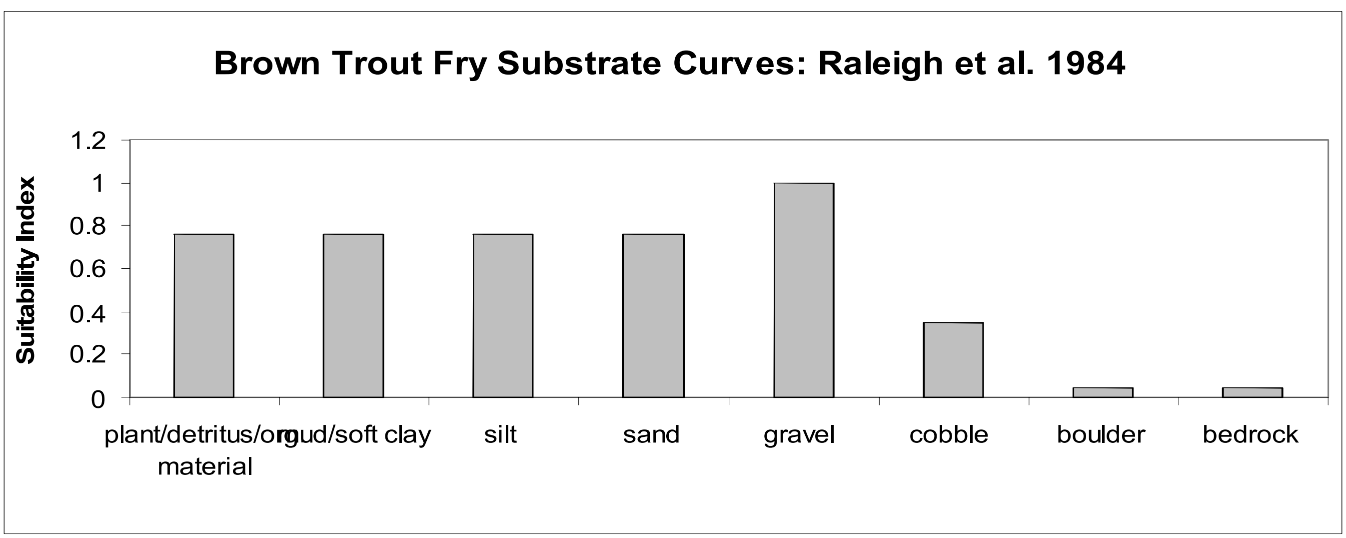




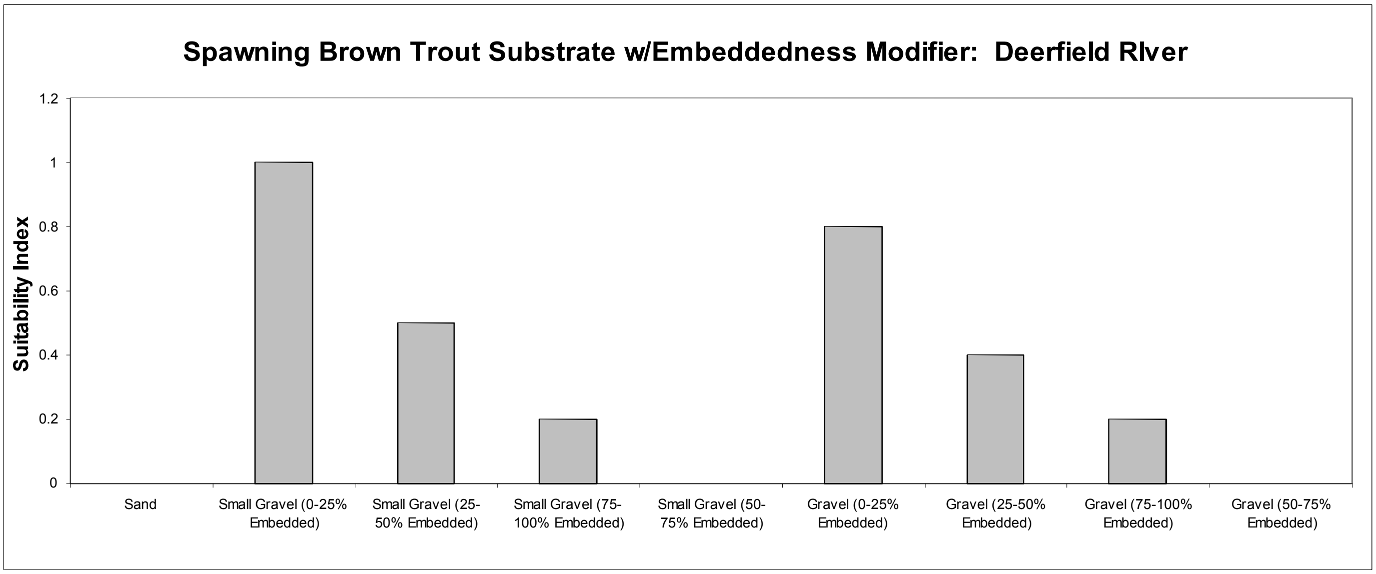
Brown Trout Fry

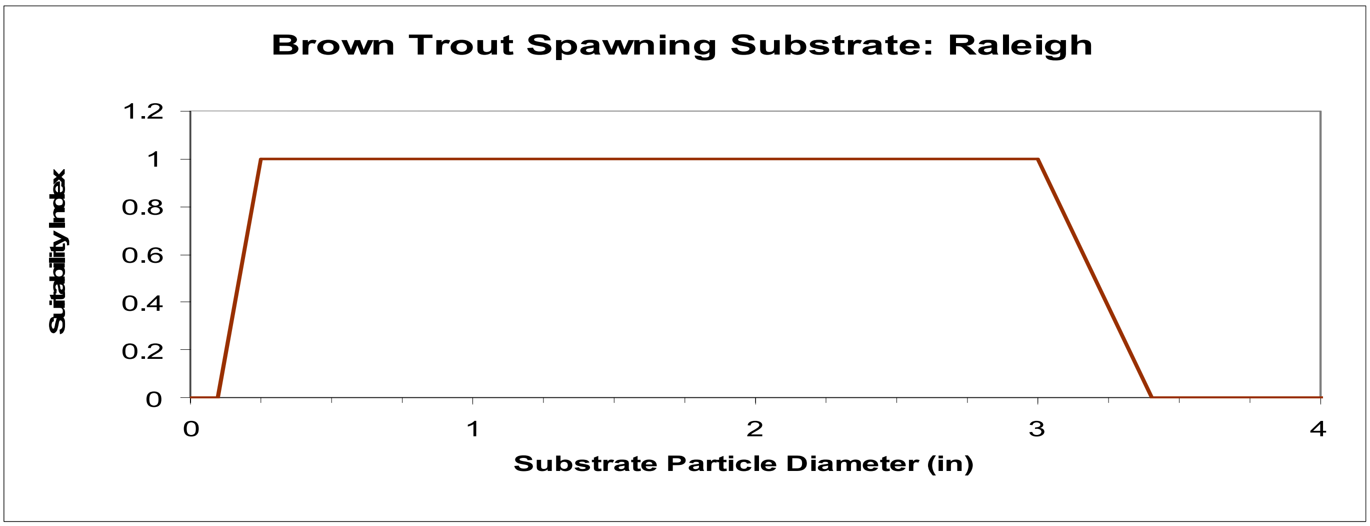






Spawning Brown Trout

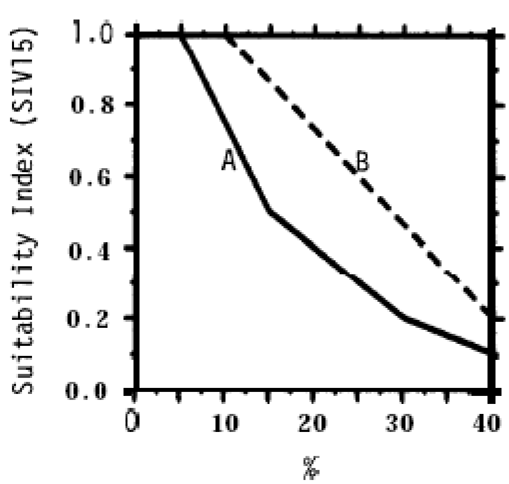




Brown Trout Spawning: Substrate Embeddedness (Raleigh)

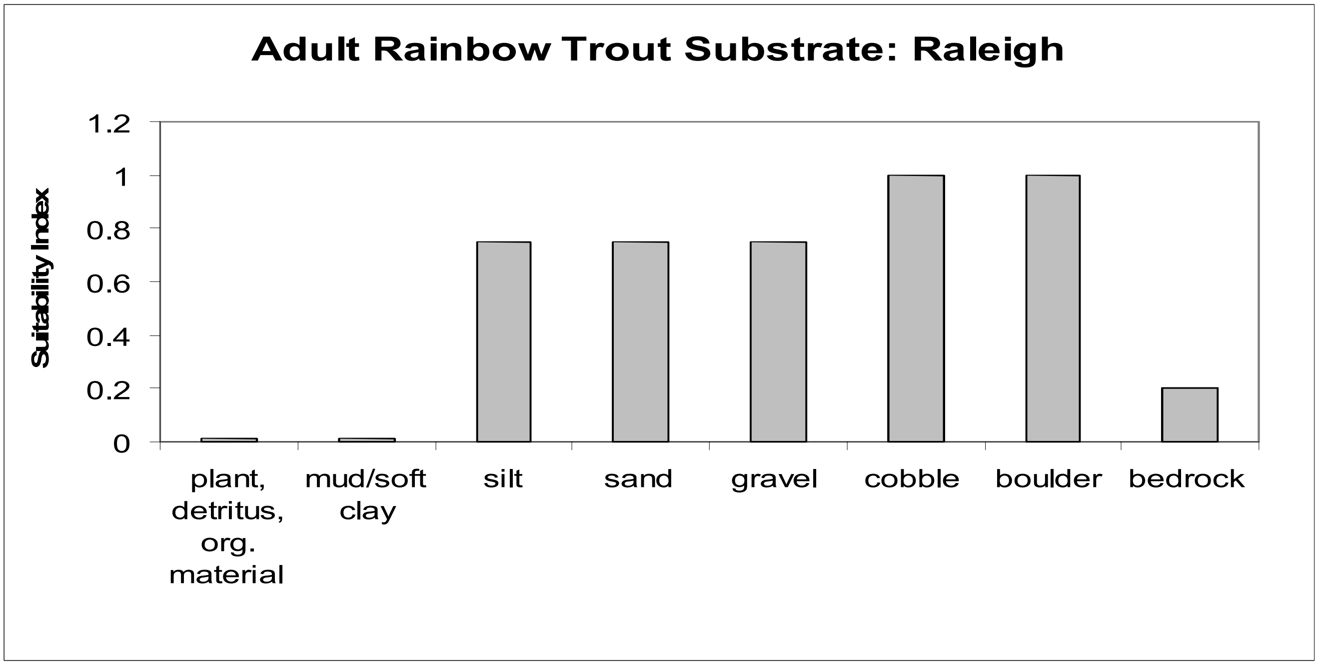
Percent fines (<3 mm) in riffle-run and spawning areas during average summer flows.

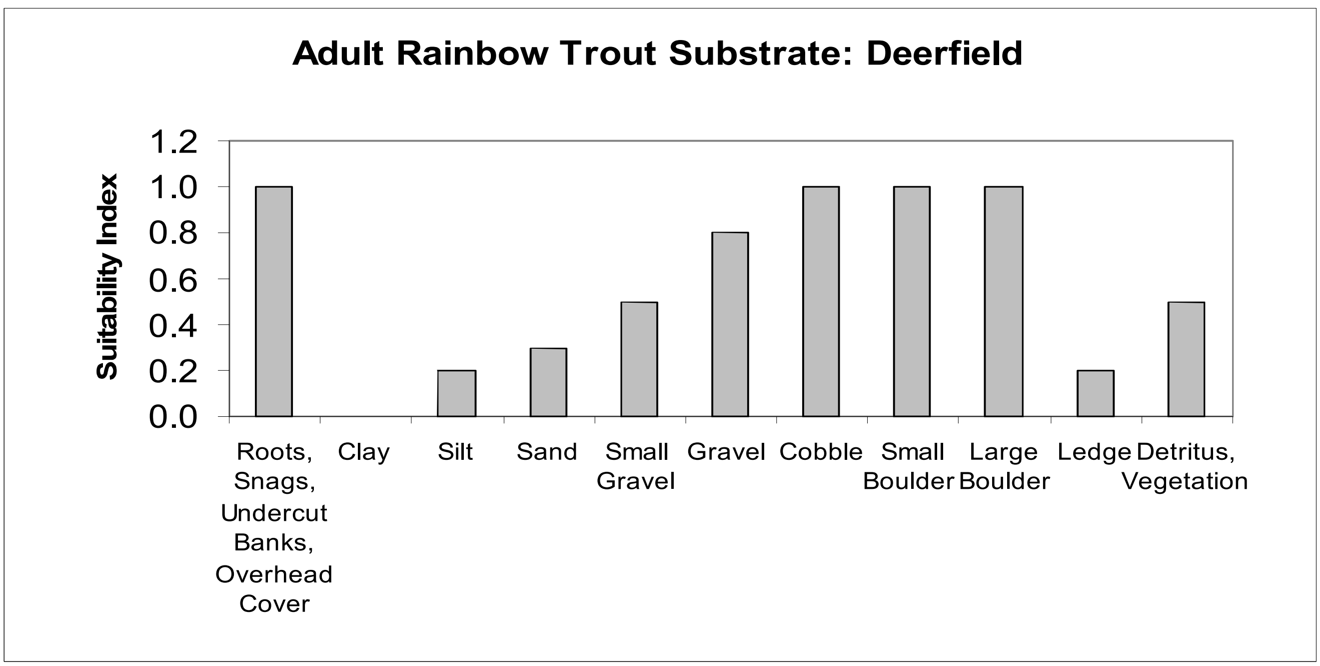
A = spawning
B = riffle-run



Appendix B
Rainbow Trout Substrate Habitat Suitability Criteria

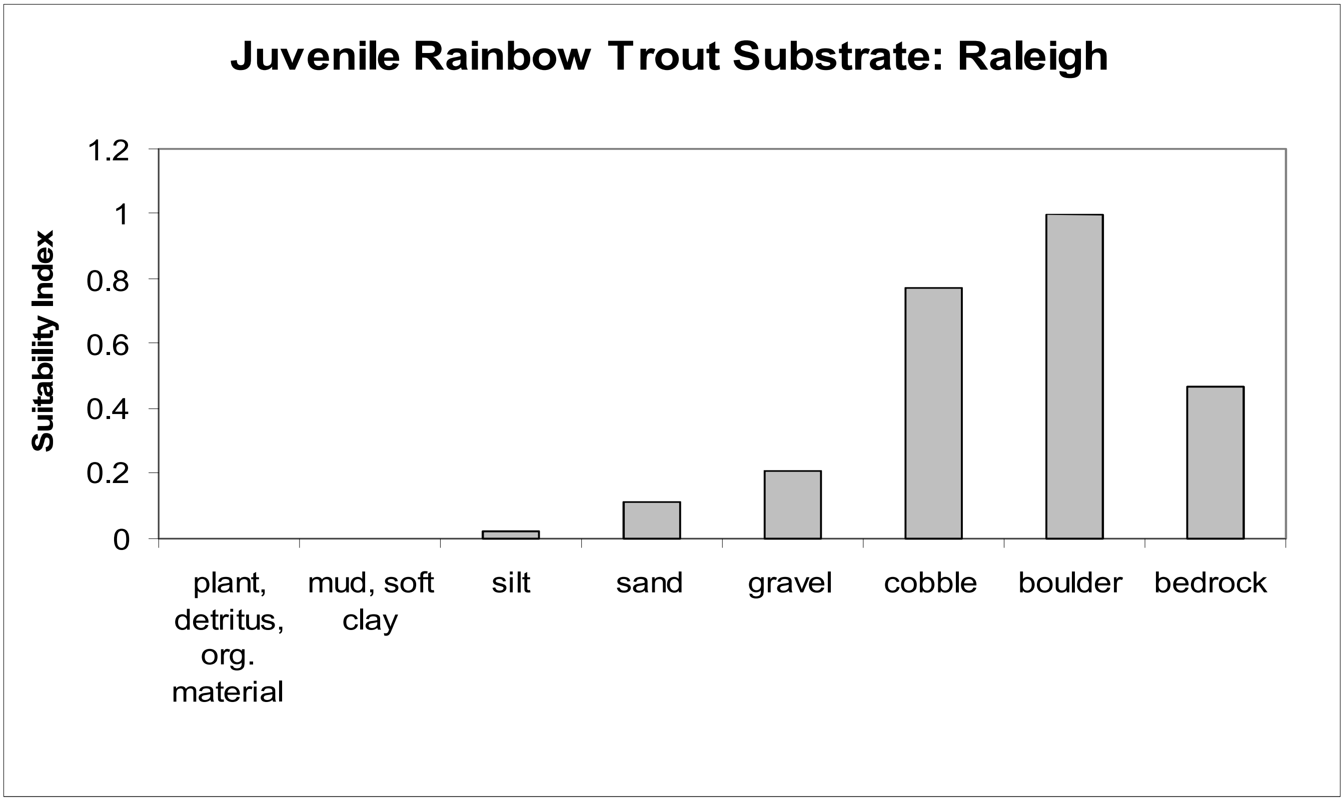
Adult Rainbow Trout[1]



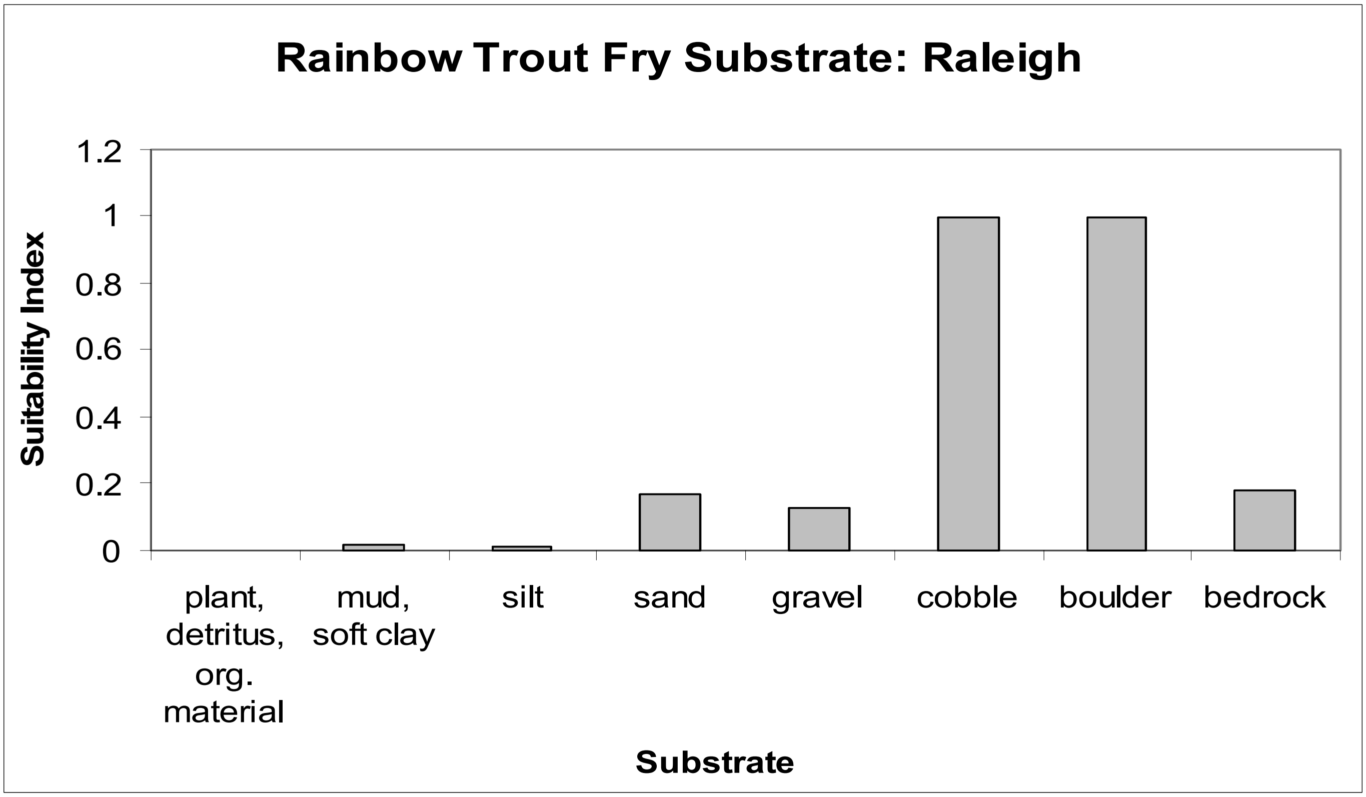


[1] See Appendix A for substrate codes and descriptions.

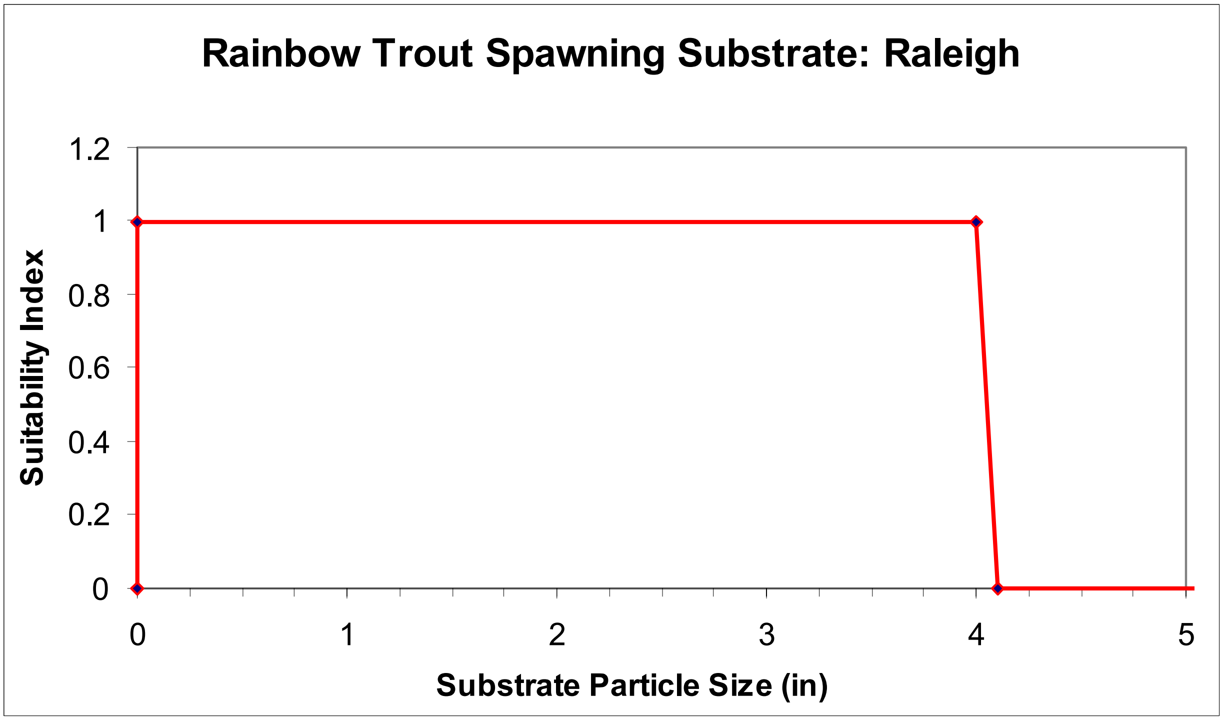
Juvenile Rainbow Trout

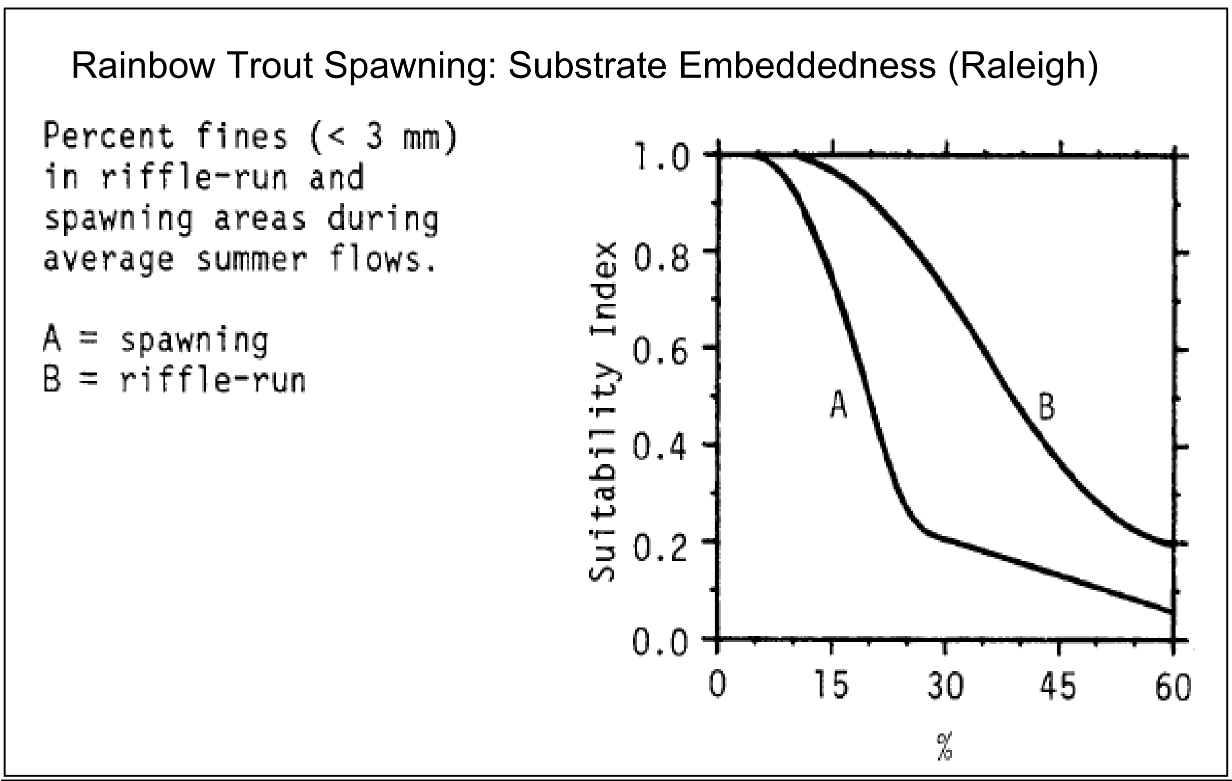


Rainbow Trout Fry



Rainbow Trout Spawning





Appendix C
Smallmouth Bass Substrate Habitat Suitability Criteria

Appendix C, Table 1: Substrate Classification Codes - Bain

Code	Description	Size (mm)	Size (in)
	Silt		
	Sand		
	Gravel	4-75	< 3 in. diam,
	Rubble	75-300	3-12 in. diam.
	Boulder	300-600	1-3 ft. diam.
	Bedrock		

Appendix C, Table 2: Substrate Classification Codes - Deerfield

Code	Description	Size (mm)	Size (in)
1	Roots, Snags, Undercut Banks, Overhead Cover		
2	Clay		
3	Silt		
4	Sand		
5	Small Gravel	< 5.1	< 2
6	Gravel	5.1 - 10.2	2-4
7	Cobel	10.2 - 25.4	4 - 10
8	Boulder	25.4 - 61	10 in - 2 ft
9	Boulder	>61	> 2 ft
10	Ledge		
11	Detritus, Vegetation		

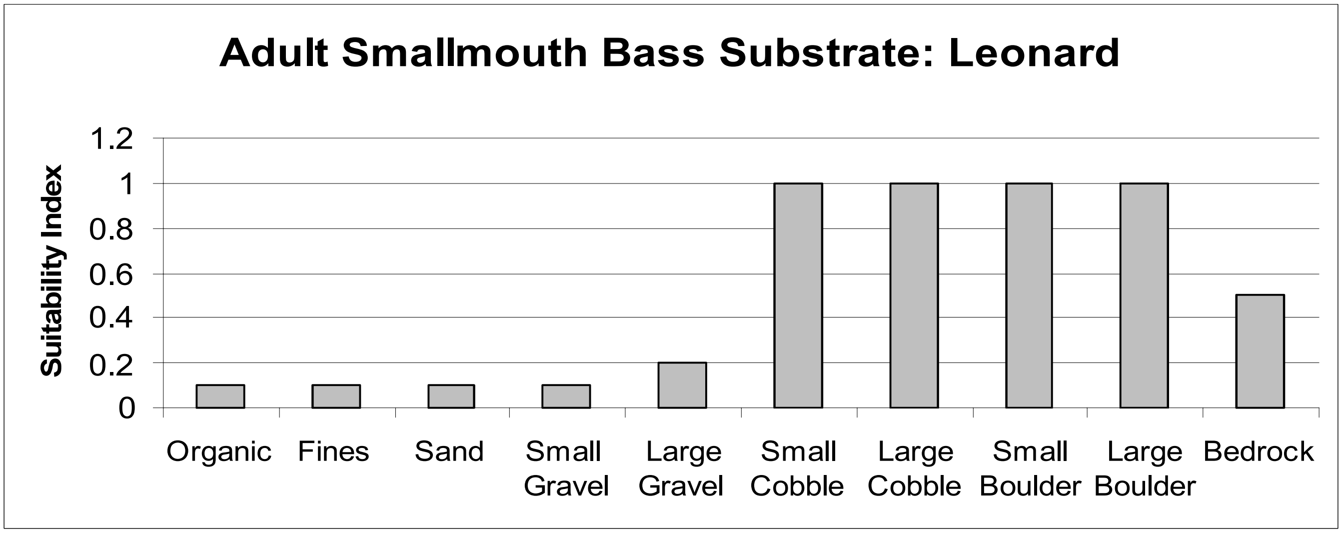
Appendix C, Table 3: Substrate Classification Codes - Leonard

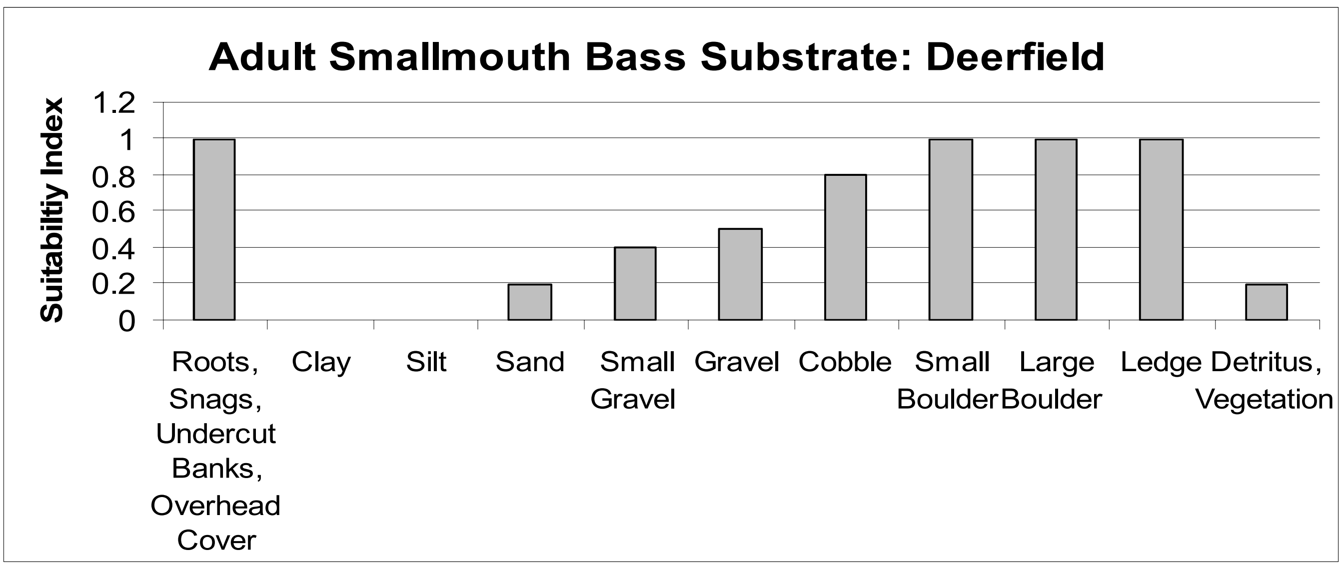
Code	Description	Size (mm)	Size (in)
1	Organic		
2	Fines		
3	Sand		
4	Small Gravel		<2 inches diam.
5	Large Gravel		2-4 inches diam.
6	Small Cobble		4-7 inches diam.
7	Large Cobble		8-10 inches diam.
8	Small Boulder		10-24inches diam.
9	Large Boulder		> 2 ft diameter
10	Bedrock		

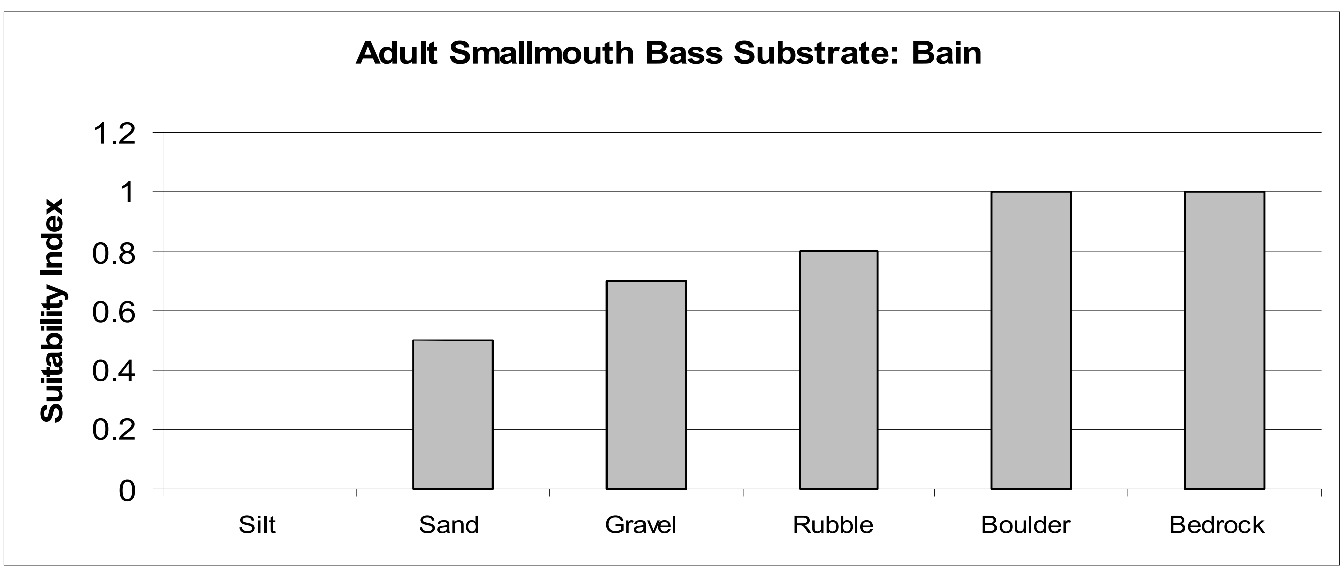
Appendix C, Table 4: Substrate Classification Codes - Lockhart

Code	Description	Size (mm)	Size (in)
1	mud	<1	< 0.4
2	sand	1 - 2	0.4 - 0.8
3	small gravel	2 - 16	0.8 - 6.3
4	large gravel	16 - 64	6.3 - 25.2
5	small cobble	64 - 128	25.2 - 50.4
6	large cobble	128 - 256	50.4 - 100.8
7	small boulder	256 - 512	100.8 - 201.6
8	large boudler	> 512	> 201.6
9	bedrock	-	

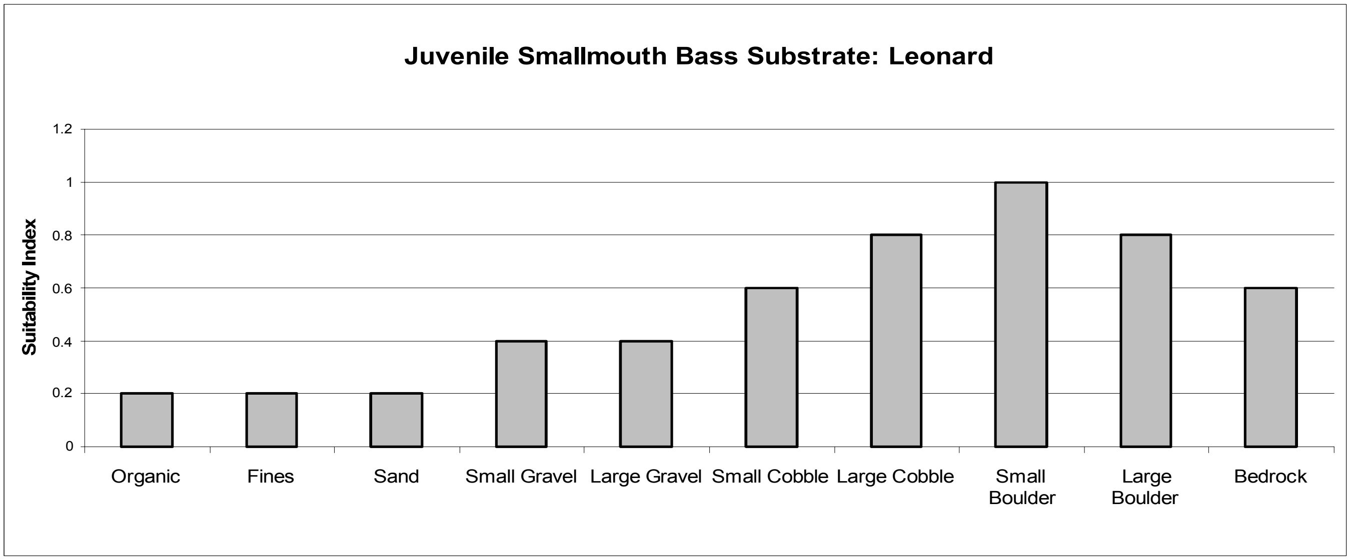
Adult Smallmouth Bass

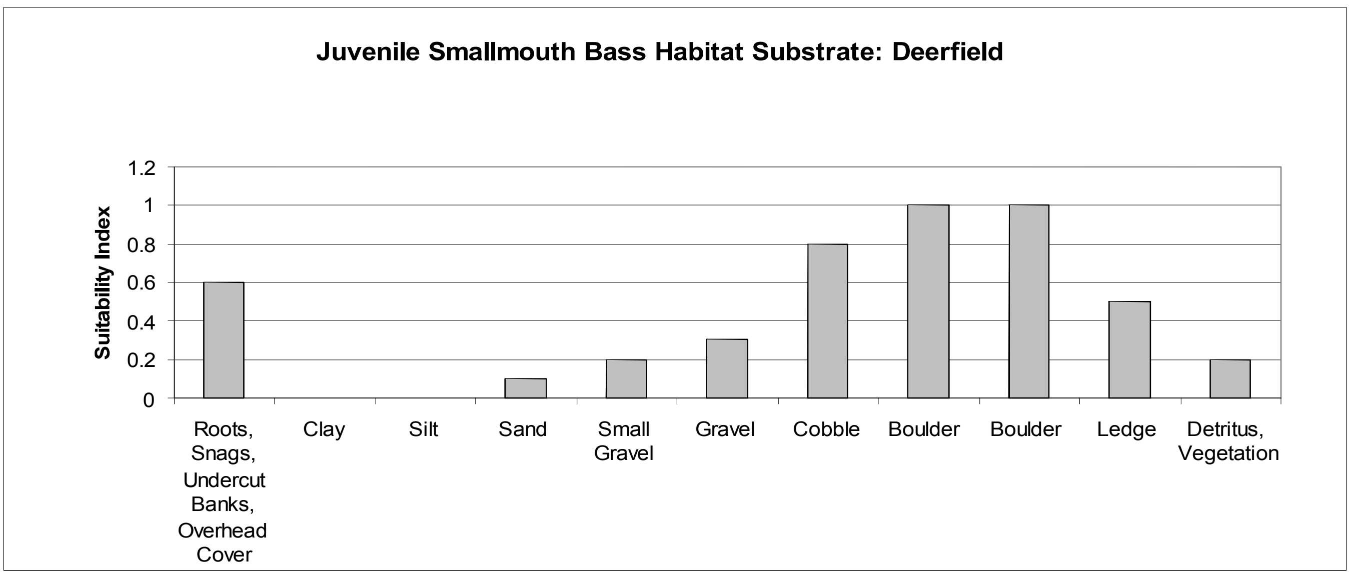


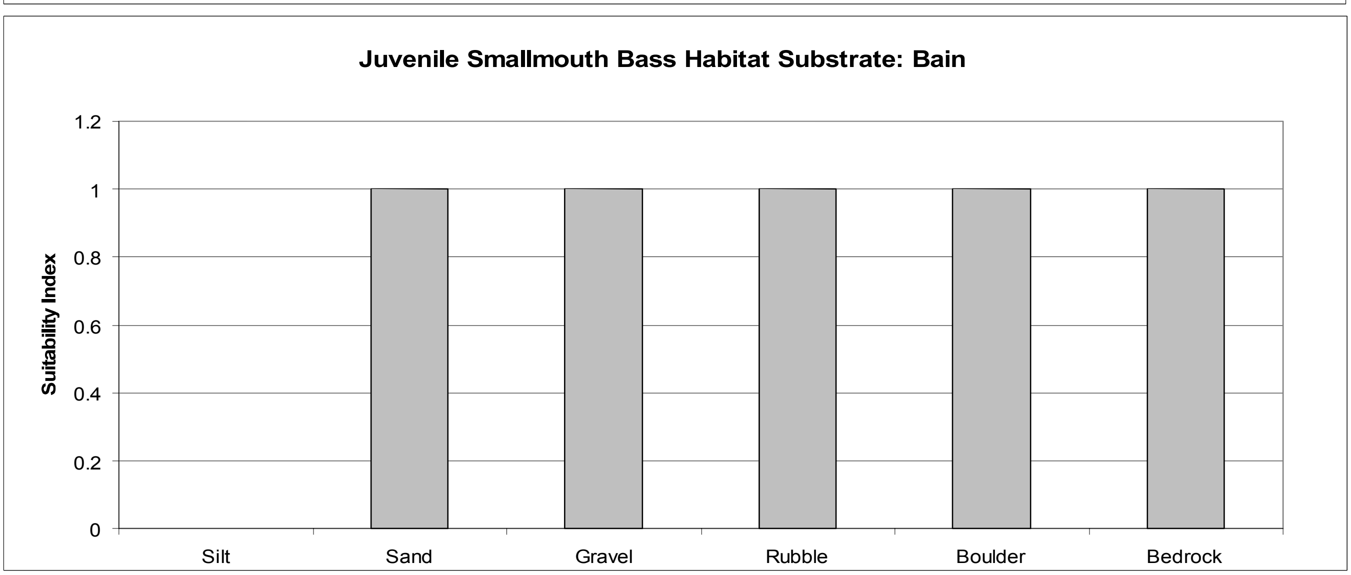




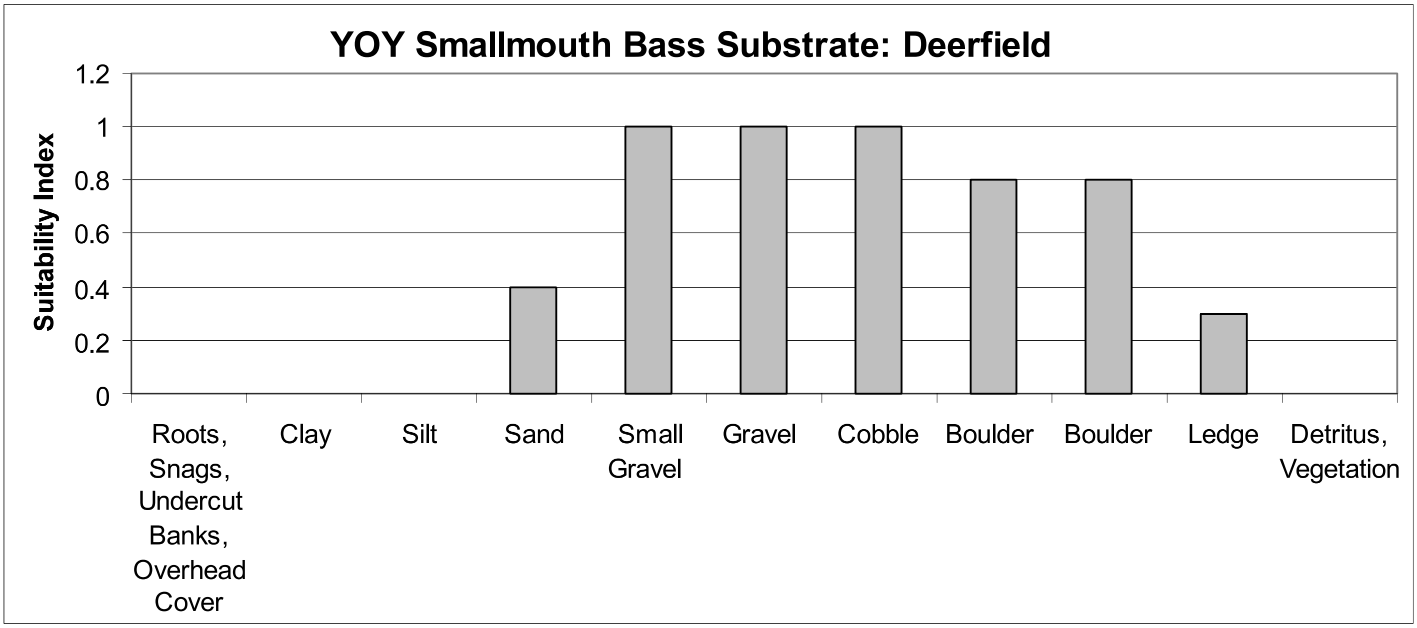
Juvenile Smallmouth Bass

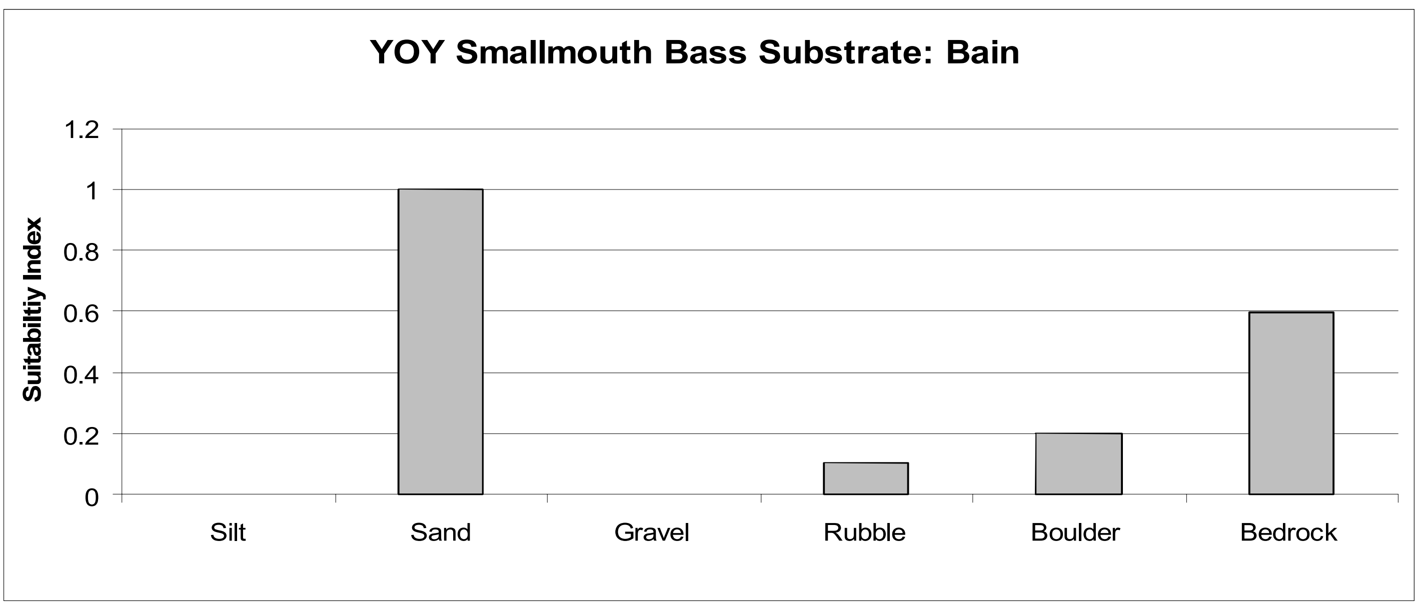




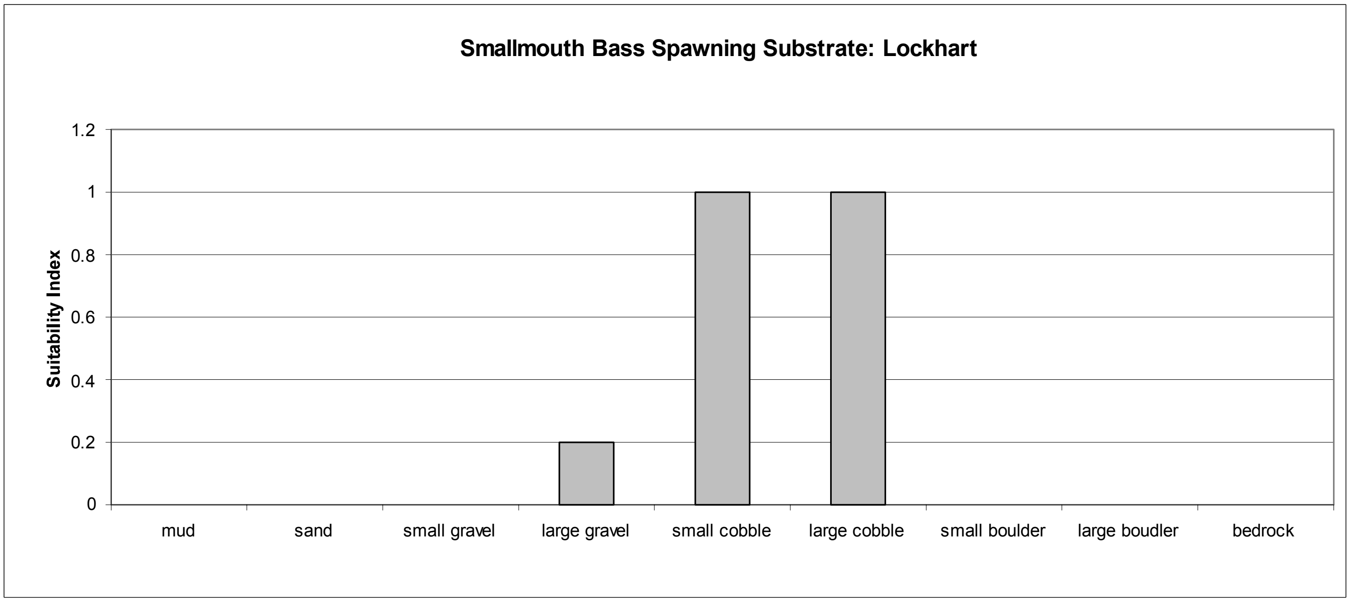


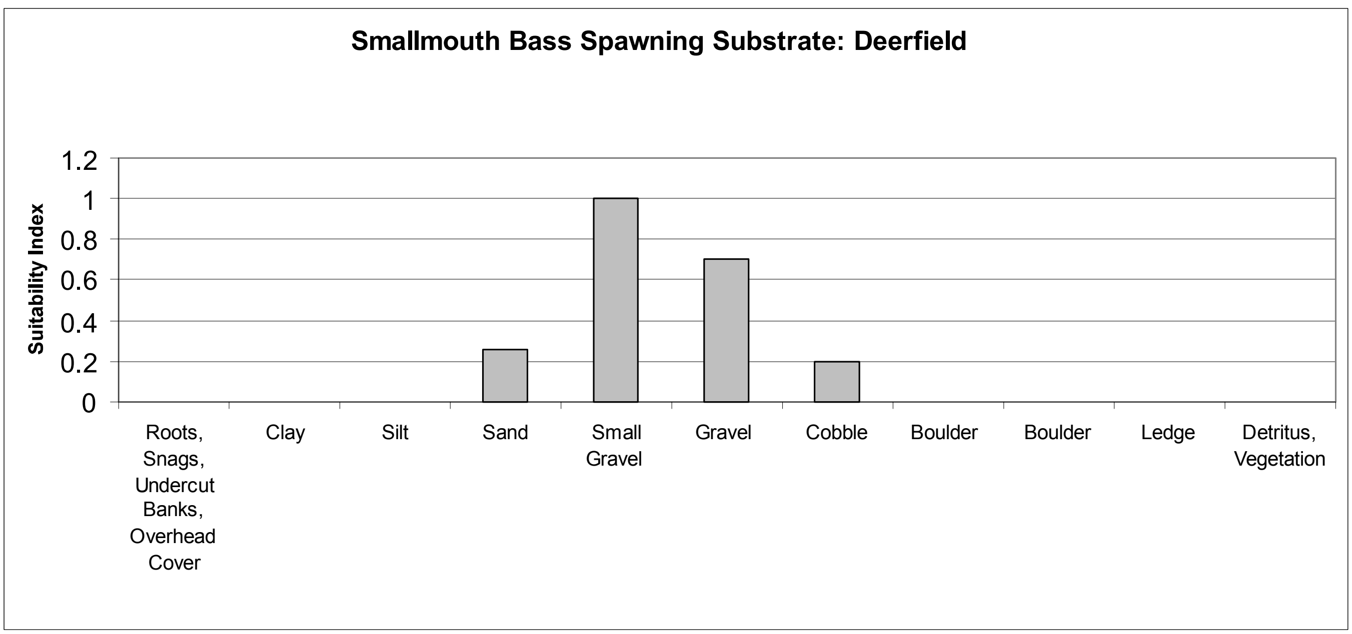
Smallmouth Bass YOY





Smallmouth Bass Spawning





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