Ecological Flows Science Advisory Board (EFSAB)
Meeting Summary July 16,17, 2013
Stan Adams Training Facility, Jordan Lake, Chapel Hill, NC

Approved for Distribution Aug 20, 2013

Attendance (for both days unless otherwise noted)

Members
Hugh Barwick, Duke Energy
Mark Cantrell, USFWS
Bob Christian, ECU (online 7/16)
Tom Cuffney, US Geological Survey
Linda Diebolt, NC League of Municipalities
Chris Goudreau, NC Wildlife Resources Commission
Jeff Hinshaw, North Carolina State University (only 7/16)
Amy Pickle, EMC, Duke (online 7/17)
Sam Pearsall, Environmental Defense Fund
Judy Ratcliffe, NC Natural Heritage Program
Jaime Robinson, CH2MHill
Jay Sauber, NC Division of Water Quality
Bill Swartley, NC Division of Forest Resources
Fred Tarver, NC Division of Water Resources

Division of Water Resources
Tom Fransen
Harold Brady

Alternates
Rebecca Benner, The Nature Conservancy (7/16 only)
Sarah McRae, US Fish & Wildlife
Fritz Rohde, Natl. Marine Fisheries Svc
Vann Stancil, NC Wildlife Resources Commission
Tom Thompson, Duke Energy
David Williams, Div. SWC (7/16 only)

Guests:
Eban Bean, ECU (7/16)
Dean Carpenter, APNEP (7/17)
Kimberly Meitzen, TNC (7/16 only)
Kay Towers, Duke Nicholas School

NCSU Facilitation Team
Mary Lou Addor, NC State University/NRLI
Christy Perrin, NC State University/WECO
Nancy Sharpless, NRLI

The purpose of the Ecological Flows Science Advisory Board: The Ecological Flows Science Advisory Board (EFSAB) will advise NC Department Environment and Natural Resources (NCDENR) on an approach to characterize the aquatic ecology of different river basins and methods to determine the flows needed to maintain ecological integrity.

Presentations, reports, and background information of the EFSAB are available at:
http://ncwater.org/?page=366 (please note that this URL has changed since the last meeting summary)

Webinar Response: If you cannot attend the meeting in person but would like to join us via the webinar, you can watch the presentations and listen to the live streaming audio of the meeting by going to https://denr.ncgovconnect.com/sab/ and typing your name in the space labeled "guest."

NOTE: The EFSAB will meet **Aug 20 @9:00am until 4:30pm and @8:30-4:00pm for Aug 21** at the Stan Adams Training Facility, Jordan Lake Educational State Forest Center Chapel Hill, NC (see last page for meeting agenda topics and directions to location).

July 16 & 17, 2013:
Summary of Decisions, Recommendations and Proposed Actions

Decisions and Recommendations:

1. Consensus recommendations generated on July 17 are preliminary until those who missed part or all of the meeting have an opportunity to review the discussion and recommendations for moving forward.

2. Mark and Chris were tasked with generating draft recommendations for the list of topics discussed on the afternoon of July 17. The proposed recommendations will be inserted in to the Report Outline and be the major agenda item for discussion at the August meeting. Jamie and Linda will be reviewing the draft recommendations generated by Mark and Chris.

3. Add to the Charter, a list of EFSAB members and alternates who served previously but are no longer serving for various reasons and include in the Charter Appendix and the Report Outline. The list of previous members and alternates has been included in the Charter and list of members posted online at NCWater.org; the Report Outline will include the EFSAB members and alternates.

4. Add to the Report Outline, the recommendation about the T&E species developed by the T&E subcommittee with the EFSAB's approval

5. The EFSAB was informed that the Report to DENR will be due by the end of October. Members were still asked to hold the Dec 3 meeting which can be readily cancelled at a later date.

6. A number of preliminary recommendations were made during discussion on July 17. These are reflected within the Executive Summary sections relative to their topics, but are not included here as they have not yet been tested for full consensus with all EFSAB members.

Proposed Actions

1. Fred will share the mountain PHABSIM analyses when they are completed.
2. Lou will compile and distribute the trial balloons, presentation, and general meeting discussion to the EFSAB the evening of July 16.
3. The ad-hoc group will present examples from the Neuse River of what their method would look like using OASIS.
4. DWR go back and look at some of the manipulated flow records and find out where 10% eco-deficit falls in that spectrum of the work that Jim Mead did.
5. Rebecca Benner will provide the final TNC report to EFSAB when it is completed.
6. Chris Goudreau will go through reports to see if there are other key concepts about ecological responses to flows that could be added to the list.
7. Characterize the distinction between a large river, a small catchment, and a wadeable stream. [This was added during the discussion on flow approaches for large rivers.]
   - Tom Cuffney was to email a stream size class distribution table to Christy to distribute to the EFSAB (done, this was sent to EFSAB in an email)
8. The bulk of the characterization of the Coastal Plain will be addressed in the proposal from the Coastal Plain subcommittee.

9. Make sure that whatever methods are used in the recommendations for wadeable streams address the issue of extra protection for small streams.
10. Clarify what site-specific evaluation means.

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I. Executive Summary

TITLE: PHABSIM on Mountain Sites
Presenter: Fred Tarver

EFSAB had expressed interest in resurrecting more IFIM sites to look at habitat responses in other parts of the state, particularly in the mountains. Fred spoke with Chris and Jim to select some IFIM sites in mountains that were good candidates in their ability to model properly, were well calibrated, and had diversity of sites in terms of streams and river characteristics. They selected 7 sites in the Little Tennessee River Basin (Tuckasegee and Nantahala rivers and Whiteoak Creek), and 3 in the French Broad Basin. Fred showed the suite of species and life cycles that will be used, based on availability of

suitability curves for studies, and into deep (7 guilds) and shallow (12 guilds). Jim also had deep and shallow, he also had bugs grouped with shallow as opposed to deep grouping. Fred was still working on calibrating the substrate cover data, since various evaluation methods were used over the years. RTI kindly provided a record of flow since there are no OASIS models to provide a period of record for the mountains, though it is for 40 years rather than the typical 80 years for OASIS. Fred will share the PHABSIM results for review when they are completed.

Major Discussion items/concerns/questions: none

Decisions Made: none

Proposed Actions or Identified Decisions to be made: none

Title: The Alberta Method
Presenter: Chris Goudreau

Chris Goudreau presented a method used in Alberta, Canada. It addresses some simple concepts:

- The natural hydrograph should be followed as a template to capture the five components of flows: magnitude, timing, duration, frequency and rate of change
- Percent-of-flow is the easiest way to maintain all five components, including intra- and inter-annual variability. It is easier to understand than frequency-based standards or statistical targets.
- It uses a Sustainable Boundary Approach, which allows for some deviation from the natural hydrograph
    - <10% for high level of ecological protection
    - <20% for moderate level of ecological protection

In addition to the percentage of flow concept, this method has an ecosystem base flow (EBF) component, which can go by other names: minimum flow, cut-off flow, or a sustainability flow.

With the percentage component, there are several things to keep in mind. First, it is the cumulative reduction of flow at the point of interest in the basin. If you want a 10% flow reduction, it is 10% cumulatively. Second, the percent reduction should be calculated from the natural (unaltered) flow, but you can run it on a natural flow baseline, a current condition baseline, and a future condition baseline. Third, it is calculated using an instantaneous flow. In the OASIS model it would be a daily time step. In Alberta, they use a 15% reduction, which is 85% flow-by.

The other part is the ecosystem base flow component, protecting what is out there during low-flows. If you did not have the EBF you would essentially have a low-flow that should only occur 20% of the time that would occur 33% of the time. The actual flow recommendation that would be plugged into the model would be the percentage of flow-by, which you would use until you get down to the EBF, and then follow the EBF. Then when it gets down to really low flows you would use the actual natural inflow. In other words, when it naturally gets below the EBF, you recognize that those low flows on the extreme end do occur.

Major Discussion items/concerns/questions:

- The river used in the graphs is hypothetical.
- The water that flows by is available to the next downstream user. It's riparian.
- That's one of the good things about having it as a cumulative because then it allows not only the critters, but also the users, downstream to have water.

Decisions Made: none

Proposed Actions or Identified Decisions to be made: none

TITLE: Biological/Environmental/Flow Relationships—Further Analyses, Revised Assumptions, Responses to June 18 questions, and Recommendations

Presenter: Bob Dykes, RTI
This powerpoint presentation can be found here

Bob presented the recommendations of the *ad-hoc* group that has been working with RTI and USGS in their development of biological/environmental/flow relationships. The recommendations are:

1. The diversity of species within the riffle-run guild, using the Shannon-Weaver Index, should be used as the measure of ecological integrity for fish. Ecological integrity of benthos should be based on EPT richness.
2. A reduction in fish diversity or benthos species richness of 10 percent or more represents a probable violation of ecological integrity.
3. Five hydrologic metrics should be considered by NCDENR for evaluation further alterations of surface water flow conditions:
    a. Decrease in annual 30-day minimum flow;
    b. Summer eco-deficit;
    c. Fall eco-deficit;
    d. Winter eco-deficit;
    e. Spring eco-deficit.
4. The statistical model employed to establish ecological responses to changes in flow metrics should be based on:
    a. Fish data normalized by the 80th percentile Shannon-Weaver index value by drainage basin;
    b. Benthic data normalized by the 80th percentile EPT Richness value (within the "excellent" DWQ Benthic Site Condition Class;
    c. Non-linear 80^{th} quantile regressions of the normalized data
5. Further data collection and research should be undertaken to enhance the preliminary flow-biology relationships developed through the work of the *ad-hoc* advisory group.

Major Discussion Items/Concerns/Questions:

- We used data from 649 fish sites comprising 42 riffle-run fish species and 1320 benthos sites comprising 261 benthic taxa. So we did our best to use as much data as we possibly could. We used all of the data that was available for North Carolina, constraining it by the riffle-run and EPT boundaries, which seem to represent the most sensitive representatives for fish and benthos.
- The riffle-run guild, were well represented across all regions in the state with the exception that the coastal plain is poorly represented.
- The data represented a broad range of drainage areas.
- So how we envisioned this might be used by DENR is that it would be relatively straightforward to use OASIS to calculate the change in the seasonal eco-deficit based on a proposed alteration in flow. DENR then looks at the delta eco-deficit. The bottom, the x-axis, is delta eco-deficit and so if you are going to increase the summer eco-deficit by 20%, then you go to the 20% line on the summer eco-deficit graph and then you go up to the black line and left to the y-axis and that tells you what fraction of the species diversity—not richness but diversity for fish—you can expect to have after that change. So it is just 20% up to the line and over so it becomes a

transform curve. The suggestion we made was that DENR should—remember this is not for regulatory purposes, it is for planning purposes-- so when DENR sees that a change of 10% or more in fish species diversity or benthic species richness looks like it is probably going to occur as a result of a proposed alteration in flow or future demand or for that matter, climate change, then DENR has some motivation to do additional research and additional analysis for that change in that basin. So we are not at this point suggesting a regulatory-like response; remember the question of the legislation is what is it, how much water can you take out of a river before you begin to challenge ecological integrity? We think that the ecological integrity is surely challenged by the time you start talking about a 10% change in the biota. Whether it is measured at Shannon-Weaver diversity of fish species or richness of benthic taxa.

- The 20% reduction in biological condition translated to about a 20% flow reduction due to a 20% reduction in eco-deficit. So a lot of these numbers that Kimberly is throwing out and other folks have thrown out are very similar which is kind of interesting through different avenues of investigation.
- What would help me understand this a little bit in more concrete terms is if we could see in OASIS a site, maybe one of the PHABSIM sites in the Piedmont, where you evaluate eco-deficit with this method and at the same time, evaluate is that flow going to look like 20% of mean annual flow, does it look like 80% flow by. To me, that gives me a concrete connection between what the output from OASIS is and what an eco-deficit is on this graph.
- The quantity of water that will produce a change varies enormously according to basin.
- The reason there are 4 lines [seasonal eco-deficits] instead of 1 is because a proposed flow alteration could change one of those variables much more than any of the others. So, for example, you could change the summer eco-deficit a lot and not change the other 3 much. In that case, that is the graph you should use.
- When DWR goes to modeling these and using an approach for not having biological impacts or safe yield and things like that, do you think they can use the same, if you will, 10% approach in dealing with those large systems? Or do you want to put some kind of caveats on this and say it is good up to whatever you just said for your drainage area, 1,000 square miles or something like that? *Response: Well the largest one we have is over 9,000. So I am not sure where we put the caveat.*
- Maybe we ought to use this strategy on the 88% of North Carolina that is a) the most vulnerable, and b) for which we have the most data; and on the other 12%, which is the main stem, let's talk about some sort of other strategy such as a flow by standard. Preferably complemented by a minimum standard.
- I think there is a lot of merit in what you see up there, but I think it is incomplete. I think we should also recommend to DENR some strategies for making it better. We should also recommend to DENR some strategies for operating in big rivers where this may not translate well. We need to be also recommending to DENR some strategies for minimum releases so that when flow by standards and/or this strategy do not work out too well, there is at least a safety net. Meanwhile, we probably also need to recommend to DENR some procedures for what happens if there are vulnerable species or T& and E (threatened and endangered) species. And so on. I think we need a package—a toolbox here.
- I think what we are seeing is a convergence. If you were to take this approach, Kimberly's approach, what will be presented later on, I think what we are homing in on is a convergence. If you were able to give them a common denominator on a particular basin or group of basins, I think what you will see is the approaches, in terms of allowable water use, withdrawal, whatever you want to call it are going to be relatively similar in the bottom line. I think there may be point specific areas where they diverge. That may be something we need to know, but just my impression is that everyone is sort of converging on a similar type of common denominator that would be useful to have some idea of whether or not that is true.

- I do not think it is necessarily our job to pick a specific number. We recommend an approach and we say, if you take this approach and you plug in this number, here is what you get and you plug in a different number or if you do not like it, they can use the same approach and plug in a different percentage and that is not our specific task, I think. We just need to decide which highway we are going to go down.
- based on this discussion and what Judy was requesting, I am thinking that based on the manipulations that Jim did with his bar charts that perhaps if we went back and create flow duration curves on some of that spectrum of hypothetical flow by situations, scenarios that he created that probably these eco-deficits fall within that spectrum. We probably have done that already with the PHABSIM sites that, I guess, we can go back and look at some of those manipulated flow records and find out where 10% eco-deficit falls in that spectrum of the work that Jim or what we are doing with the mountain sites. That stuff exists right now.

Decisions and Recommendations: None

Proposed Actions:

1. The ad-hoc group will present examples from the Neuse River of what this method would look like using OASIS.
2. DWR go back and look at some of the manipulated flow records and find out where 10% eco-deficit falls in that spectrum of the work that Jim Mead did.

TITLE: Presentation: 20/30/40 and 30/40/50 Mean Annual Flow Presentation

Presenter: Hugh Barwick

Hugh Barwick presented on how the 20/30/40 and 30/40/50 method (modified SC method) accommodates habitat in streams. He was able to massage information Fred Tarver provided into the flows for Piedmont streams looking at 20/30/40 annual mean flow. Using WUA habitat, he compared the percentages 20, 30, or 40% of flow as it relates to the unregulated habitats with the key percentage being 80%. Anything below <80% habitat is not good and will be red on the charts; if it's above 80%, then that's good. Hugh provided a handout comparing 9 sites.

Hugh suggested that this method - 30, 40, 50, 60 percent of the mean annual flow– is one method that can improve habitat while providing a floor. That is may contribute to hybrid method.

Major Discussion items/concerns/questions:

Concerned was raised about the significant shift in the type of habitat for the winter months using the Buckhorn Creek presentation. It is believed that this shift will have ecological implications, whether it's through sediment transport or ecological functions.

Decisions Made: None

Proposed Actions or Identified Decisions to be made: None

TITLE: Presentation: How to Compare Alternative from a Water Supply Viewpoint

Presenter: Tom Fransen

Tom began his presentation, *How to Compare Alternative from a Water Supply Viewpoint*, by stating it is a presentation about the next steps of implementation and the start of policy discussion versus a presentation about the EFSAB's charge. DENR will be responsible during implementation of ensuring the ecology is protected while allowing reasonable use of the water. Given the number of questions

and concerns expressed both inside and outside DWR, about what and how DENR will use EFSAB recommendations, Tom thought this was a worthwhile presentation for the EFSAB. His presentation covered two topics:

- Procedure to compare alternatives from a water user's viewpoint.
- How is DWR going to use the EFSAB recommendations

To frame his presentation, Tom posed the following question: *How much water needs to remain in the river to protect ecological integrity and still have adequate water available for reasonable use?* Although the water users' perspective is not part of the EFSAB's charge, it is part of DWR's implementation. We need to determine: what is a reasonable approach to compare alternatives from a water user's viewpoint? And this presentation will introduce the EFSAB to what we do.

Major Discussion items/concerns/questions:

So how will DWR implement an EFSAB recommendation as a planning tool?

- Will not override existing permits, such as FERC license.
- Will not replace site specific studies.
- Will not change the SEPA minimum criteria – 20% 7Q10

Tom provided examples of three flow approaches: 20% 7Q10, 80% Flow-By, and modified SC minimums for illustration purposes.

Decisions Made: None

Proposed Actions or Identified Decisions to be made: None

TITLE: TNC Final report and recommendations

Presenter: Kimberly Meitzen

She conducted a literature search; analyzed spatial-temporal pattern in flow changes and biota over time; and explained how they are relevant to environmental flow guidelines. The project is meant to inform TNC on conservation areas that are priority to their mission and also to provide information that may help this group.

She looked at how fish diversity and abundance changed over time (results were shown across the state). She also present results of fish response to withdrawals:

- 5-10% species diversity decline relative to 10% mean annual flow withdrawal
- 25-30% species diversity decline with 50% mean annual flow withdrawal
- Considerations: only 14 data points, mean annual flow calculated by unit-area-runoff method, not controlling for other factors, inconsistent pattern with at-a-site diversity responses
- This was a proof of concept- she Recommends more fish survey points and accounting for land use/land cover and water quality

She then looked at stream flow changes over time, specifically at changes in patterns over recent history, how they vary spatially among gaging sites and temporally (months) and by flow magnitude (percentiles). Results for the flow percentiles of 90%, 75%, 50%, 25% and 10% were shown. The biggest pattern seen was that the lowest flows are getting lower, and the highest flows are getting higher. At 10th percentile flows, a significant number of gages (57%) are getting drier.

The literature review, biotic and flow change analyses informed a 3 part recommendation. She calls this the Decision Support System for Ecological Flows (DSSEF):

1. Protect the natural flow regime and specifically the seasonal and ecoregional patterns of flow variability
   - Daily average allocation using presumptive standard Percent-of-Flow (POF)
   - Separate criteria for: 1.) normal and wet years, and 2.) drought years (when streams are already stressed they need a minimum flow level to protect them)
   - 5-10% of median flow as net use, variable dependent on drought regimes

2. Prevent further water use-related decreases to 10th percentile flows
   - Pass-by flow flow criteria for minimum flows based off of a P-O-F. Passby when flows reach:
   - Normal years 50% of monthly medians May-Dec, 60% of the monthly medians Jan-April
   - Drought years: 40% of monthly medians May- Dec, 50% Jan-April of monthly medians

3. Restrict withdrawals in drainages Statewide rule, protects headwaters and flow accumulation
   - < 25 sq. mi. no withdrawals
   - 25-50 sq. mi. limit to 1-5 MGD

All flow criteria should be established using the same period of record to prevent biases.

Major Discussion items/concerns/questions:
- Abundance could be normalized with diversity since abundance would have an impact on diversity, (Shannon Weaver evenness scale), though since that method works best with individuals and she was doing community diversity and abundance, this was not done.
- While the 5% and 10% for fish community impacts is a good starting point for discussion, the statistical evidence in this study is pretty weak.
- Significant evidence in the literature review for supporting the number of less than 10% mean annual flow for impacts, though a study using statewide (more) data points would need to be done to give the NC specific study a stronger analysis.
- Concerns about attributing fish diversity declines to water withdrawals without looking at land use were expressed. Looking at land use would be important.
- Why drought years should use a different percentage and how to recognize a drought year.

Decisions Made: none

Proposed Actions or Identified Decisions to be made:
1. Rebecca Benner will provide the final TNC report to EFSAB when it is completed.

TITLE: General Discussion of the 5 Methods Presented July 16, 2013

Presenter: Mary Lou Addor

During the July 16 meeting, 5 presentations of proposed recommendations were provided to the EFSAB. Based on months of exploration and examination, the five presentations were:

1. Alberta Desktop (presenter - Chris Goudreau)
2. Decision Support System for Environmental Flows (presenter - Kimberly Meitzen)
3. 20/30/40% and 30/40/50% of Annual Mean Flow (AMF) and Mean Monthly Flow (MMF) (presenter – Hugh Barwick)
4. 80 Flowby (presenter Tom Fransen)

5. Establishing Ecological Thresholds (Ad Hoc Water Coordination Group)

During the presentations, several members commented that although the proposals were independently derived, they had commonalities; converged was a word heard during the afternoon presentations. The EFSAB members discussed the common themes that they heard and began to examine how the 5 methods addressed the deliverables requested of the EFSAB.

Major Discussion items/concerns/questions:

- smaller drainage areas need more protection than the larger drainage areas
- consider a toolbox not an equation with 4 basic tools
- need to be conservative for planning purposes in order to provide a level of certainty. Certainty is not just an issue for the science board, but for the developer who wants to borrow money to build houses, the bank who plans to loan him the money, the municipality that wants people to live there, or for zoning board that wants to provide fire services during drought years. They want to know the water will be there. Everyone needs some assurance that we're really certain or we're on the edge of certainty.
- one size does not fit all; different sized streams, geography on streams will affect the threshold by whatever definition...
- each presenter believes is he/she is proposing a conservative strategy, and everyone is thinking about 2 things:
    - the dangerous thresholds we don't want to cross and
    - how to measure what's happening to avoid crossing the thresholds
- proposals are essentially the same in sense there is some % of water distributed over some period of time. *We have to determine – how much and over what time?*
- in areas where data are lacking, we conservatively recommend a protective percentage and then the subsequent recommendation is to ask the state to go out and gather information to increase the certainty of our recommendations.

Decisions Made: None

Proposed Actions or Identified Decisions to be made: Lou will compile meeting discussions and distribute to the EFSAB before the July 17 meeting.

TITLE: Update from the Coastal Subcommittee
Presenter: Bob Christian

Bob Christian provided an update on the work of the coastal subcommittee, which had its third and final meeting on July 15. The overall objectives of the group were to: assess applicability of previous coastal work, both in other states and the Greenville study; develop stream typology; advance spatial modeling and mapping; establish what relevant ecological and biological dependencies on flow are; develop frameworks for potential coastal EF criteria and protocols if possible; and identify factors limiting EF protocols and needed research within coastal systems. The group has divided the streams of the coastal plain into three groups: medium gradient, non-tidal; low gradient, non-tidal, and wind or lunar-driven tidal freshwater/natural or engineered (ditch, canal). The medium gradient streams tend to be the main stems and their tributaries. The group concluded that a good threshold would be 0.001m/m, with any stream with a slope of less than or equal to 0.001m/m being low slope, and anything over that being medium slope. The group developed potential ecological flow strategies for these 3 types of streams, depending on geographical area (piedmont origin, upper coastal plain or lower coastal plain). Because of flatness and proximity to the sea in the coastal plain, ground water

and surface water are so closely linked that ground water withdrawal can be important to surface water flow; ground water withdrawal may alter inundation patterns of low order streams, and ground water may be shunted into surface water for agriculture. Also, flow is closely linked to water quality (salinity and dissolved oxygen), so in determining how flow affects organisms one has to take it with a water quality link. Also in the coastal plain, stage is not necessarily well defined by freshwater flow. In discussing what assemblages might be key to focus on in terms of flow relationships, the coastal group chose anadromous fish (upstream spawning, including Blueback herring and alewife (under consideration for endangered status), American shad, Atlantic sturgeon (endangered), Shortnose sturgeon (endangered), and Striped bass (stock status – concern)). Also important are catadromous fish (marine spawning) including eel – (stock status - depleted), and estuarine species – some of the common low-salinity species that occur in river systems: southern flounder, Atlantic croaker, spot, menhaden, bay anchovy, blue crab, white shrimp, striped mullet. They focused on fish because they are ecologically important, they are economically important, and they have some very real and, in some cases, reasonably well defined links to flow. Regarding anadromous fish, there is a large database for the State, spawning flows are important, flows during larval and juvenile grown and development are equally important, not simply spawning season; the position of the salt wedge is important, and habitat suitability models are available. In thinking about the coastal plain there are 2 foundation species groups: riparian swamp trees for which overbank flow frequency, timing and duration is important as well as salinity and dissolved oxygen; and submerged aquatic vegetation for which salinity and dissolved oxygen are important. The group proposed assemblages to focus on in each of the 5 groupings of steams (the 3 stream types in various geographic areas). The group then identified areas needing additional research: juvenile abundance indices vs. flow and salinity/conductivity; salinity distribution across the coastal plain; quantification of stream typology classes; Roanoke slab shell mussel distribution and abundance as representative of benthos; hydrologic metrics and characteristics of coastal streams; determine reference flow regimes for each river basin; and balance of withdrawals from and discharges to coastal streams. Largely, at least initial data are there but have not been analyzed.

Major Discussion Items/Concerns/Questions:

- Whether and how the Roanoke slab shell mussel is representative of benthos, concluding that it may not be representative, but that it has value for bio monitoring
- The coastal plain highlights an area that the EFSAB has not discussed a great deal: goods and services.
- Salt intrusion and DO are both powerfully influenced by flow, and in the coastal plain they may be powerfully influential on the integrity of biological communities
- APNEP and its comprehensive management plan have ecological flows for the Albemarle/Pamlico as a priority item. Dean Carpenter intends to continue the work of this group beyond the length of this EFSAB.
- Bob concluded that a little more thought needs to be given to benthos.
- There are variations between the basins. We need to be basin-specific when we look at these things.
- Is there a threshold for flow measurement that is noticeable, visible in a surface type of velocity or directional velocity or even measurable with a flow meter? I have fooled around with some of these and I want to make sure we have that building block there to make a meaningful dichotomy between flat and really flat streams, and is there a threshold that has something other than the numeric coefficient that we can point back to.
- The estuarine-dependent species, many of them, spend their first three or four months in fresh water. Also, when you talk about estuarine dependent species, you are talking about their resident time in the fresh water.
- If you are in a very low flow system, like a zero flow system, you are going to be concerned about quantity, and water quantity is going to be influenced by water extraction.

- Given the fact that we are not going to be doing OASIS modeling in these reaches, that's going to require some other methodology for other monitoring or planning for those areas so the post-processing we talked about in the other part of the basins where OASIS is going to be used, it is going to be another modeling effort that can handle tidal and variations in flows or some sort of spreadsheet post-processor type of thing.

Decisions and Recommendations: none
Proposed Actions: none

TITLE: Presentation: Review of the EFSAB Charter

Presenter: Mary Lou Addor

Mary Lou Addor reviewed the Charter with members of the EFSAB. The EFSAB did not make any major changes to the Charter which serves as a working document for the EFSAB.

Major Discussion items/concerns/questions:
The EFSAB would like members and their alternates who served the EFSAB but are no longer serving for various reasons to be listed in order to recognize their participation and contributions. In addition, the full list of EFSAB members and alternates will be included on the Report to the EFSAB.

There was request for DENR to continue to inform the EFSAB about the status of their recommendations for at least one year following their Report to DENR.

Decisions Made: Ensure the list of EFSAB members and alternates who served previously but are no longer serving for various reasons are included in the Charter Appendix and the Report Outline. The list of previous members and alternates has been included in the Charter and list of members posted online at NCWater.org.

Proposed Actions or Identified Decisions to be made: None

TITLE: EFSAB Deliverables & Proposing a Framework for Characterization

Presenter: Chris Goudreau

A document describing the deliverables the EFSAB is responsible to provide including a framework for characterization was distributed and discussed at the close of the July 16 meeting and on the EFSAB listserv. The document was composed of three sections 1) statute, 2) characterizing the aquatic ecology of different river basins, and 3) identifying the flows necessary to maintain ecological integrity. The following points were made in the document:

a. characterizing the aquatic ecology of different river basins (setting the stage)
- Need to address this charge beyond exploration of a classification system
- Determine a who/what, where, how, when, and why framework to characterize the aquatic ecology using existing documents and databases like the DWQ basin plans.

b. identifying the flows necessary to *maintain ecological integrity* with data from NC, with data from other studies and jurisdictions including scientific theory to justify flow recommendations

Major Discussion items/concerns/questions:

- Characterization is not really the key part of the work. Let's spend a minimal amount of time on the characterization component -- talk about it, state why we have what we have, how we've richly analyzed the data using available data bases that were not collected for this purpose. Here's what we think and then move onto the additional discussions.
- Give them what we want to tell them and lay all the data out there (there was a time we were thinking about a classification system). This helps us explain why we might recommend these following approaches. And gives us an in-road to justify why we think small streams should be treated one way, main stems another way, coastal streams another way.
- It is not the EFSAB's job to find out or understand what the legislative intent was at the time that the legislation was drafted; it is the EFSAB's job to interpret it to the best of our scientific ability, and to answer it in whatever full capacity we can, and then move on to what folks are really going to focus on.

Decisions Made: Jeff made a request that consensus recommendations are not finalized until Jeff (and perhaps others) can review the discussion items. Jeff's alternate cannot attend Wednesday either.

Proposed Actions or Identified Decisions to be made: Lou compiled meeting discussions and distributed to the EFSAB before the July 17 meeting.

TITLE: Presentation: Review of the EFSAB Report Outline
Presenter: Mary Lou Addor

Mary Lou Addor reviewed the most recent Report Outline with the EFSAB.

Major Discussion items/concerns/questions:

During the July 17, members commented that the Report Outline is too RTI/USGS centric and that other research that has transpired, been conducted and considered should be included in the Report to DENR. The EFSAB is currently focused on providing recommendations at the July and August meeting, intending for the writing to occur in an iterative fashion between the August and October meetings.

Members of the EFSAB generally support the idea of referencing in the Report to DENR, weblinks to the NCWater.org (DENR site) or other information, when discussing supporting documents, research, and larger documents.

The EFSAB was informed that the Report to DENR will be due by the end of October. Members were still asked to hold the Dec 3 meeting which can be readily cancelled at the October 22 and 23 meeting.

Decisions Made:
- Ensure the recommendation on T&E Species is added to the Report Outline.
- The EFSAB was informed that the Report to DENR will be due by the end of October. Members were still asked to hold the Dec 3 meeting which can be readily cancelled at the October 22 and 23 meeting.

Proposed Actions or Identified Decisions to be made: The Report will continue to be updated; the EFSAB will be apprised of any updates and the Report Outline will be distributed for their review when the next round of major changes are made.

TITLE: Discussion of key concepts about ecological responses to altered flows
Presenter: Tom Cuffney

Tom presented some key concepts that are familiar through the literature and investigations. The group discussed them and made some amendments to them. They decided that this list included concepts to keep in mind when discussing potential recommendations and that it was not agreed upon criteria for evaluating methods. The amended list follows:

1. It's important to maintain as natural a flow as we can (changes in frequency, duration, timing and rate of change, magnitude cause damage).
2. To do #1 requires small time step (such as daily). An annual value will not capture the flow regime.
3. Urban studies show and increase in frequency and duration at low flows creates degradation.
4. Droughts and drought conditions are natural, but are extremely high stress events in the ecosystem. Increasing frequency or duration of drought flows will lead to degradation.
5. High flows are important. Streams must get at their floodplains (with consideration of frequency, duration, timing, magnitude). If that doesn't happen you'll change biology. In coastal and lower piedmont streams, high flows also needed for salt and dissolve oxygen management.
6. Size matters – the smaller the system the less it can stand if water is taken out of it.
7. Minimize distance between removal and return. The smaller the gap is the smaller section of stream affected by flow. Interbasin transfers are undesirable.
8. We have few tools that directly assess the biological effects.
    - All the tools point to adverse affects even at relatively low levels of withdrawal. (biological response begins at the origin of the graph and changes continuously; there is no threshold.)
    - Models are all highly variable. There may be a high probability that the models currently do not offer enough protection to the resources.
    - The models will continue to improve over time if thoughtful studies are funded (adaptive management approach).
    - PHABSIM is not a direct but is an indirect measure of effect. But probably will be the best site specific method that we have.
9. All this leads to uncertainty, so we need to be risk adverse in recommendations, and narrow those over time as more data is available.
10. It is possible that a watershed may not currently be supporting stream flow requirements for the ecology of the system.
11. There may be additions to this criteria list based on review of reports & presentation.
12. Impacts to biology when small amounts of flow are withdrawn may be attributed to water quality (though benthos are more affected by water quality than fish).

Major Discussion Items/Concerns/Questions:

- This shouldn't be used as decision-making criteria without more thought and discussion.
- These are things that would go in research assumptions, in preface of the report, as the foundational concepts that research shows, that recommendations are built upon. We need to communicate this within and beyond the board.
- These also might be of value in helping to evaluate the trial balloons.

Decisions and Recommendations: none

Proposed Actions:

1. Chris Goudreau will go through reports to see if there are other key concepts that could be added to the list and present additional concepts at the August meeting

TITLE: EFSAB Discussion on Characterization

Major Discussion Items/Concerns/Questions:

- The RTI/USGS proposal, the Decision Support System for Environmental Flows, and the 30/40/60% proposal offered approaches to characterization
- RTI/USGS recommended normalizing fish data and normalizing benthos data in two different ways and said that biological responses should be determined for flow alterations The work showed that for fish we need to use the Shannon diversity index because it give us more data to work with. For benthos, we did not need to; we used the EPT species richness.
- The presentation on the 30/40/60 approach characterized according to general fish communities and physiographic provinces. Someone could say that it is biological characterization approach.
- One thing we can do in writing this up regarding the characterization, we can characterize by hydrology, biology, geomorphology, and other aspects. We can make that statement then say that we are focusing in on the hydrology and biology. Then it is clear that we acknowledge that these other aspects are out there, but they are not necessarily central to where we are going. Then give the explanation and the details about what we are focusing in on.
- We could just include a table showing all the things we considered, and here is where we want to go.
- We can say here are all the gazillion bugs; here's the communities; we have Atlantic slope basins; we have Tennessee basins; we have different fish communities in some; we have different bug and aquatic conditions; we have cold water communities down to warm water communities; small streams, big streams.
- I think we need a subgroup to make a separate fresh look at independently characterizing the ecology of each and all of the basins just in descriptive terms that we can pull out of basin plans and that sort of thing just to characterize the ecology.
- We might generate a map.
- I think there is a good deal of information that we could cobble together of the distinguishing characteristics of groupings. I don't think we need a fresh look at it; I think we could synthesize what is out there.
- We should use discussion of characterization to set the stage. Why do we think seasonality is important? Because the ecology needs it. Why do we think high flowsin the spring are important? Because the ecology needs it. Through highlighting those things through the characterization can set the stage for what are our recommendation assumptions. Highlight those key features so that they carry forward into the recommendations.
- The complexity of what my fisheries colleagues are proposing for the invertebrates is a little daunting. We have almost a thousand taxa in this descriptive database. I don't know how many fish you have. There is a lot more work than one individual can do.
- I was suggesting just general statements with some specificity as needed to get across the concepts.
- We do have some characterization of the Coastal Plain.
- The bulk of the characterization of the Coastal Plain will be addressed in the proposal from the Coastal Plain subcommittee.

Decisions and Recommendations:

1. Mark Cantrell and Chris Goudreau will write up a draft section for the report on characterization based on the Board's discussions. Jaime Robinson and Linda Dieboldt will review the draft.

Proposed Actions:

1. Characterize the distinction between a large river, a small catchment, and a wadeable stream.

[This was added during the discussion on flow approaches for large rivers.]

2. The bulk of the characterization of the Coastal Plain will be addressed in the proposal from the Coastal Plain subcommittee.

TITLE: EFSAB Discussion on Small Stream Protection (original proposed heading was maximum allowable withdrawals)

Moving down the list of proposed items to address, the group then considered what the various proposals offered regarding maximum allowable withdrawals.

Major discussion items/concerns/questions:

- This exceeds our brief.
- That would fall into the site-specific or project-specific study category.
- I think the part of this worthy of discussion is the small basin protection. There was a specifically outlined recommendation for protecting smaller watersheds. The 30/40/60 approach also mentioned that there might be trout streams or other small catchments that need protection. I would like to ask how we could go forward with a recommendation on how to protect the smallest drainages.
- Our recommendations should include a significant emphasis on the need for identifying some threshold for which no more water should be withdrawn and also note that in some cases existing withdrawals may already exceed that threshold. I think we should provide that framework with emphasis on its needing to be done. Providing information about when there is no more water to be taken is probably the most important aspect of any recommendation that we could provide.
- I agree that the tiniest streams should not have withdrawals, but the fact is that DENR needs to make that call, not us. We can recommend that DENR should make some sort of determination of that, but we should not tell them what it is.
- It has to be put in terms of ecological integrity.
- Our strategy for predicting biological response to altered flows is going to show huge changes in small catchments. The smaller the catchment, the bigger the change.
- That statement demands that we make a recommendation of some kind associated with that. If we don't put something like that in there, then people won't draw that conclusion.
- I would say regarding the small stream discussion that small streams with high flows with a small withdrawal would have a low impact, as opposed to a large stream with a large intake during drought conditions could have more impact. I don't think it is necessarily the size of the stream; the issue is the size of withdrawal relative to flow.
- But we also said, and I know this is true from the PHABSIM results, that the smaller the stream, typically the higher the flow recommendation needs to be to cover all the aspects of the habitat. The further down you go you can get by with less water to maintain the same percentage of habitat. I think we do need to capture this concept as a recommendation. Now how we word it, whether small watersheds or some combination of that and other metrics, we can discuss, but it seems it is an important concept we don't want to lose.
- As a scientific advisory board, I think it is incumbent on us to say that on every stream in NC there is a point at which withdrawing an additional increment of water will change the ecological integrity of that water body. There is a point in every stream, large or small. It may be sooner in smaller ones; it may be sooner in some of the flashier streams; or later in some of the bigger rivers. But there is a point. That can be defined by any of these approaches as a threshold.
- If we write a guideline that says that for catchments smaller than some size extra caution should be used when evaluating biological impacts from flow alteration, and then somebody among us figures out what that size should be, that probably is okay [not outside our brief]. The wording "maximum allowable withdrawal" suggests a form of regulation, which is why I said we should

not do it. Regarding there being a point at which taking water out of a river violates its ecological integrity, I disagree. What we have learned in our work is that if you take any water out of a stream, you will affect its ecological integrity and taking more water out of a stream will further affect its ecological integrity.

- Basically what we are creating is a set of triggers for site-specific evaluation. Perhaps what we need here is a recommended trigger that says if the watershed is smaller than x amount, you should automatically go to site-specific evaluation.
- Reason for this effort was to avoid going to every stream in NC to do an inflow study.
- *In response to the facilitator's question about what site-specific evaluation means,* it just means that we have raised the flag on this. All we are saying from the planning perspective is that further investigation is recommended. Whether that is a site-specific study in the field or something else is at DENR's discretion.

Decisions and Recommendations: none

Proposed Actions:

1. Make sure that whatever methods are used in the recommendations for wadeable streams address the issue of extra protection for small streams.
2. Define small stream.
3. Clarify what site-specific evaluation means.

TITLE: EFSAB Discussion on Large River Approaches

The group then moved down to the next item on the proposed list of items to discuss, which was flow-by goals for large rivers. Discussion led to changing the title of the issue.

Major discussion items/concerns/questions:

- When this list was originally proposed, I don't think this was exclusive to large rivers. I think in our conversations over the course of the day yesterday, we got the feeling that if we don't need to use a flow-by approach anywhere else, we may need to recommend that approach for larger rivers because the data used for other approaches was from wadeable streams.
- There was a thought that we have this wonderful biological data set in wadeable streams and that comprises 88% of the catchments, but it does not include the main stem rivers where the water withdrawals are likely to come from; therefore, maybe we should use a different approach for main stem rivers and use the RTI/USGS approach for wadeable streams.
- So for the second item, maximum allowable withdrawals, we changed that to something about small watershed protection. I think it makes sense to change the 3rd item to "Large River Approaches", which would include the flow-by percentages, the modified SC approach, and the Alberta method.
- What I had in mind was that the RTI/USGS approach works for the 88% of North Carolina catchments that are characterized by wadeable streams. The seasonally stepped minimum flows represent a wonderful safety net we ought to consider for all catchments. For the larger streams that are not characterized by wadeable streams (12%, but they are the biggest ones) we need some other strategy, and perhaps the flow-by goals that were presented by TNC and the Alberta Model and the DENR proposal should be considered. The TNC flow-by goals were complicated, but DENR's goal was 80%; the Alberta Model's goal was 85% and TNC had a sort of stepped flow-by strategy. So the question do we want to adopt flow-by goals for catchments that are not characterized by wadeable streams and if so, what should it be?

- Another question is if the Board supports the idea of having a minimum flow recommendation and whether that would be the SC-modified approach or what was used in the Alberta Approach, the ecological base flow.
- I guess we can get into the details of wording later, but regarding minimal base flow, I'm not sure if that minimum refers to when the flags start flying because in terms of restricting withdrawals, that's more of the permitting arena, not the planning arena. Also, during droughts I hate to see mother nature violate our base flow so during drought I don't know where we are going to set that base flow.
- That's why Alberta deals with both. You may want to call that cut-off flow or low-flow cutoff or EBF.
- I think what was brought up yesterday was to use the modified-SC approach to set the conceptual bounds.
- For clarity, base flow is flow fed by ground water. We should not use the term base flow. We should be talking about minimum recommended flow. It will be up to DENR what to do with that recommendation.
- How are we are going to work in the cumulative nature of those and where is the baseline? Eighty-five % past a point then another point, then another point, then another point can reduce that cumulatively downstream.
- Or it can be done cumulatively or it can be done with the baseline concept and just set it up river-wide and say this is where it is now, and with whatever percentage, that is the baseline at your point.
- It's not 85% of inflow; it is 85% of the hydrograph, the flow duration curve.
- That's an entirely different strategy.
- With a flow-by approach, that could but does not have to have a seasonal component, right?
- The flow-by goal is a percentage of instantaneous flow-by. The seasonally stepped minimum flows may or may not be.

Decisions and Recommendations:

1. For large rivers, acknowledging that we need to define large rivers, use a flow-by approach using some type of floor/cut-off/ environmental base flow (EBF) and address cumulative effects.

Proposed Actions:

1. Characterize the distinction between a large river, a small catchment, and a wadeable stream.
2. Decide what flow-by approach to use for large rivers.
3. Decide what floor/cut-off/environmental base flow (EBF) to use in conjunction with a flow-by approach in large rivers.
4. Determine the term to use: floor, cut-off, environmental base flow, or something else.
5. Determine how to address cumulative effects.
6. Decide whether the flow-by approach needs to use a different percentage seasonally or if the seasonal variation will be captured inherently to the approach (taken from the projected hydrograph, which includes seasonal variation).

TITLE: Wadeable Streams (original topic was seasonally stepped minimum flows)

Major discussion items/concerns/questions:

- When you get to RTI/USGS methods it tells you how those strategies will perform. It's a pretty good way of how an additional alteration will produce an additional affect.
- The RTI strategy cannot be used to prescribe a flow. It can be used to test a flow and what it does to the biological condition.
- I'd hoped to see a stepwise strategy in which we have some sort of flow by target, some sort of minimum flow recommendation, and some strategy for measuring the approach.

- The 5 proposals weren't intended to work as separate components. Everything is still up there for consideration.
- Starting numbers for % are easy, but need to figure out how much biological change do we recommend that DENR should accept.
- Leave it up to DENR to determine what they want to do with target flows, minimum withdrawals. The problem is it's a tall order for DENR to do that for everything all that at once. Probably should look at literature for guidelines for target flows, minimum flows to help DENR.
- I think we should start with safe standards and give DENR an excellent measuring tool.
- The flow recommendation approaches are essentially the same that we came up with; the only difference is for wadeable streams we have this additional measuring stick with which to assess the tool that might be recommended.
- The group discussed the flow by percentages and low flow cut-off provided by the different proposals (see notes further within for more details.)
- Mean monthly flows were more similar to the normal hydrograph than mean annual.
- The only thing we're trying to say is that if you go below that, the ecosystem suffers. We're not saying anything about what you can or can't do; our responsibility is simply to tell you if you cross that threshold, the ecosystem suffers.

Decisions and Recommendations:

1. Wadeable streams approach:
   - Flow by approach
   - Apply EBF/SC modified, for when a flag goes up
   - Characterize difference between wadeable, small catchments, large rivers
   - Address cumulative effects
   - Use the RTI/USGS tool for assessing biological responses to altered flows

Proposed Actions: none

TITLE: Listed Species Triggers

The EFSAB discussed using the proposed recommendation developed by the T&E subcommittee and approved by the EFSAB at the June 2013 meeting. That recommendation will be added to the Report Outline:

> T&E subcommittee review suggests that flow-habitat relationships for these species are broadly addressed by the PHABSIM approach. Rather than further evaluate the developing research on T&E species' flow requirements, the SAB recommends that specific, potentially more limiting, flow needs for resident T&E species should be considered on a project specific basis by the DWR in addition to the more generic recommendations offered by the SAB. For planning purposes, portions of basins (e.g., nodes) that include listed species should be treated by DWR as needing additional analysis.

Major discussion items/concerns/questions: None

Decisions and Recommendations: Add to the Report Outline, the recommendation about the T&E species developed by the T&E subcommittee as approved by the EFSAB, June 2013.

Proposed Actions: None

TITLE: Site Specific Follow Up Recommendation: What Happens when the Flag Goes Up

This section was originally titled PHABSIM as a strategy for site specific follow up. It was the belief of some members that PHABSIM is the only strategy before the EFSAB for site specific follow up. The EFSAB determined fairly quickly that it was neither their role nor responsibility to determine an approach for DENR to use when the flag goes up. DENR will have available a cadre of approaches to use to assess why the flag went up in order to determine next steps.

When in planning mode and a flag goes up, neither the PHABSIM or EIS/EA field work is conducted unless there is a permit application. Rather, DENR will assess why the flag went up given a continuum of means available to them including field studies, talking to water users in the basin about other ways that they can meet their water needs, etc.

Major discussion items/concerns/questions: What role or responsibility does the EFSAB have in advising DENR as to the approach that they need to take with site specific follow up.

Decisions and Recommendations: Review proposed recommendation**.**

> If DENR evaluates a catchment for a larger basin and a flag goes up as a result of that analysis, that catchment or basin *would be identified as vulnerable* and any proposed flow alteration would be evaluated more closely.
>
> When in planning mode and a flag goes up, the PHABSIM and field work is not normally conducted unless there is a permit application. As Fred mentioned earlier, just because a flag goes up does not mean that DENR is off to automatically conduct field studies. *Rather we might want to say for planning purposes in the Report is that when a flag goes up, further analysis is required and that might mean anything from field studies, to talking to water users in the basin about other ways that they can meet their water needs [at that future point] or x,y,z. [include this section in the recommendation?]*

Proposed Actions: None

TITLE: Coastal Plain Strategy

The NC Coastal Working Group will provide information that they are proposing be included in the EFSAB Report outline at the August meeting.

Major discussion items/concerns/questions: None
Decisions and Recommendations: None
Proposed Actions: None

TITLE: Adaptive Management Strategy

The EFSAB discussed using language in the Report Outline to describe Adaptive Management.

Major discussion items/concerns/questions: The word threshold was discussed and qualified.
Decisions and Recommendations: Use existing language in the Report Outline

Proposed Actions: None

II. July 16, 2013 Meeting Orientations and June 18, 2013 Meeting Summary Approval

Members and alternates of the Ecological Board Science Advisory Board introduced themselves and their affiliations. Guests in attendance and the facilitation team also introduced themselves. Everyone was reminded to sign-in who attended the meeting.

A brief orientation was conducted of the meeting facilities (restrooms, concession) and available technology (webinar). Members and alternates are encouraged to sit at the main meeting table and guests at tables away from the main meeting spaces. During discussions of the members and alternates, guests may comment once members and alternates have completed their comments and questions. During small group work, guests can also participate in small group discussions but may not dominate the time. Everyone is asked to ensure that space is created for others to engage. From time to time, the facilitators will conduct a straw poll to determine the current level of support for an idea or what additional information is needed, not necessarily for a final decision.

The EFSAB approved the June 18, 2013 meeting summary, and it has been posted to the NC Water.org website.

III. Presentation: PHABSIM on Mountain Sites, by Fred Tarver

Presenter: Fred Tarver, NC DENR

Fred's powerpoint presentation can be found here

When Jim went through PHABSIM IFIM sites that DWR had when we were trying the classification to look at habitat responses in terms of hydrologic classes that we were trying back then, he picked out some of the IFIM sites that corresponded with existing OASIS models. Based on those analyses he created these bar charts of various flow scenarios. (showed the bar charts)

Fred showed map of sites that Jim used. It was good but the OASIS models were for piedmont, with some sites in Broad basin which is still in piedmont though may be considered transitional. If you recall a GoogleEarth map that showed the 30+ IFIM sites that DWR has across the state. There was talk about resurrecting more IFIM sites to look at habitat responses in other parts of the states, particularly in the mountains. Most of our work for water supply and hydropower relicensing has focused on piedmont and mountain sites. Very few if any in the coastal plain, but there is a current quasi- IFIM site in Greenville on Tar; it's unconventional and not at a point to look at now. Here is what Jim used.

MOUNTAIN PHABSIM SITES

LITTLE TENNESSEE BASIN
West Fork Tuckasegee River - bypassed reach
West Fork Tuckasegee River – peaking reach
"East Fork" Tuckasegee River – peaking reach
Tuckasegee River main stem
Nantahala River – bypassed reach below Dicks Creek
Whiteoak Creek – bypassed reach below Whiteoak Dam
Nantahala River main stem
FRENCH BROAD BASIN
Davidson River
Jonathan Creek
North Fork Mills River

Jim, Fred, Chris looked at other IFIM sites in mountains to see which were good candidates in their ability to model properly, how well they are calibrated, and for diversity of sites in terms of streams and river characteristics. We selected these sites- most are associated with hydropower relicensing in Little TN. The bottom 3 are associated with water supply in French Broad Basin. These are considered either bypass reaches, reaches between the dam and powerhouse when water is diverted around a natural channel to a dam, as opposed to a peaking reach which is downstream from a hydropower dam that doesn't divert water near the powerhouse where you get a fluctuation in flow dependent on the operation of the powerhouse. You could consider Tuckasegee main stem and Nantahala main stem as peaking reaches also, if you are a fan of whitewater you may be familiar withNantahala main stem.

Davidson River is water supply associated with WRC Trout hatchery on U.S. Forest Service land, Jonathan Creek is water supply for Maggie Valley, North Fork Mills is water supply for Hendersonville.

This map with tacks shows the IFIM sites on a map. The yellow dots are sites we didn't select, also associated with various hydropower facilities, mostly Alcoa, TVA, one or two that are recreational dam releases. Far left tacks are Nantahala drainage, middle is Tuckasegee, others are on the right.

When you select the site, you have to pick the species you will model. Jim selected the guilds for the piedmont sites that could have habitat curves associated with flow, depth and substrate. He could use either a species or life stage of species as a surrogate for similar organisms with similar habitat preferences and are grouped into these guilds (see slide in presentation). The deep fast gravel cobble (DFGC) is listed as white bass spawning, and if you look at the description of the suitability curves it may be for a particular time of year. It's extrapolated to encompass other species that may prefer DFGC. The guild approach extrapolates to encompass other species and life stages.

In the mountains there may be slight change in species so we had to look at habitat suitability curves we have that we used for the western study sites. Based on our conversation, we came up with a suite of species and life cycles, and based on availability of suitability curves for studies. We grouped them into deep and shallow. Jim also had deep and shallow, he also had bugs grouped with shallow as opposed to deep grouping.

I ran them all together, I had 7 deep and 12 shallow (slide with list in presentation).

Brown trout spawning abbreviation is wrong (typo).

I'm working on converting calibration. When you do these PHABSIM runs you have suitability curves based on velocity, depth and substrate cover. When you evaluate substrate and cover people use different evaluation criteria- you could be detailed or general. Over the years evaluation criteria has changed. The problem when you use some of these sites is to code substrate and cover equal among various studies- the complicating factor is to recode the field data, which is time consuming.

OASIS flow record- Jim used the OASIS flow models and created a flow period of record in piedmont. Since we don't have OASIS for mountains, RTI kindly produced a flow record using WaterFALL (a 40

year record though OASIS uses 80 year record). Both created using unaltered flow scenarios, and WaterFALL used 1970s land cover. Since we're using different guilds and flow records, the direct comparison between piedmont and mountain may be complicated. The EPT for macroinvertebrates may be most easily compared, since it is an overlap between the two models.

I don't have results from this today. I could send them when done and/or present them in August.

There were no questions.

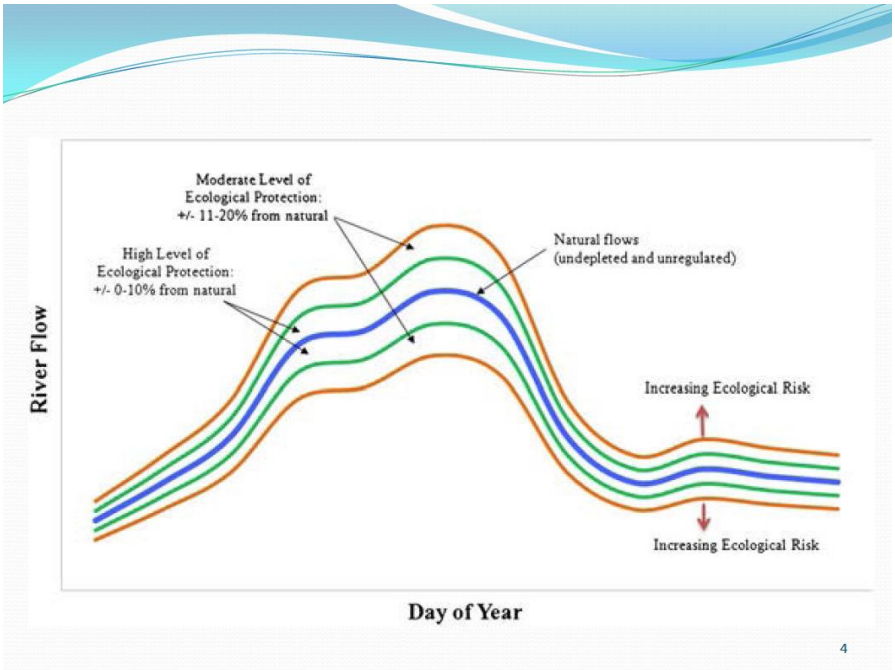
IV. Presentation: The Alberta Method for Ecological Flows, by Chris Goudreau

Presenter: Chris Goudreau

This power point presentation can be found here

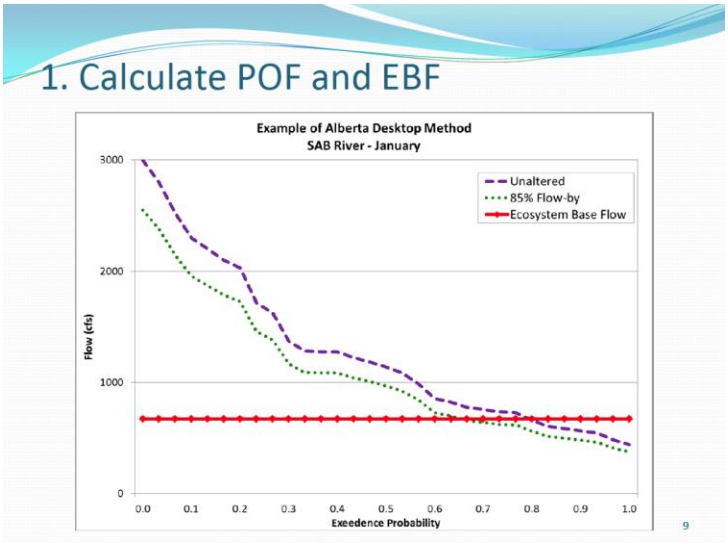
The facilitators sent out an e-mail asking for folks to think about trial balloons and also a couple of questions that were associated with them about the products we are supposed to produce. Last year, maybe, I talked about the combining of Richter's sustainable boundary approach and the eco-deficit approach. I thought I would present that again, but the more I got to looking into it, I thought a simpler way to do that, math-wise, instead of using eco-deficit as the metric is to just use, essentially, a percentage flow by approach which Fred is also, I guess, going to talk about later on. In looking at what other folks have done, just recently, Canada has come up with a method that they use. I thought it was pretty interesting. Essentially it is a desktop approach, but it also encompasses what certain provinces use. What I want to talk about is what Alberta uses, which I think they put out a couple of years ago. I think it was 2011. It is stuff that we have already talked about, so none of these ideas ought to be new, really. It is just the specifics of what I will be talking about here. The paper that describes this is one—I do not think it got sent out—the one that got sent out was the DFO report, but it is very similar. This one can be sent out as well. I think it sent it to some folks, Fred and some others. But I do not know that it got sent out to everyone. [Fred sent it to the Board during the meeting.] But what I will go through is the highlights of that, and it is in fact a compilation and a synthesis of other reports and other work that were done in Alberta and also a literature review and synthesis of work that has been done in field work and other kinds of work in Canada, in the U.S., and elsewhere in the world, including a look at a number of state policies and procedures, as well. So it is not just unique to Alberta.

In essence, it is based on the Richter paper, the presumptive standard paper, that we looked at some time ago, a year or so ago. So again, this is not something that should really be totally foreign to you folks here. Here are kind of the basics. The concept that is pulled out of Richter and his work is that natural hydrographs are preferred rather than flat kind of standards approaches because they maintain the five components of a natural flow regime. You retain magnitude, timing, duration, and so on. So that is kind of a key underlying assumption here. A percentage of flow approach of the natural hydrograph is the easiest way to maintain all of those aspects of the hydrograph. The intra- and inter-annual variability. And that is a pretty easy concept to get across to people instead of trying to explain, well, you know, we are going to take a certain percentage of this monthly flow and so on. That can get kind of unwieldy. In his paper, he talks about sustainable boundaries, what percentages around that natural flow hydrograph is a bound within which you feel like you are retaining all the functions that an ecosystem requires and when you get outside of that, parts of those functions can be compromised.

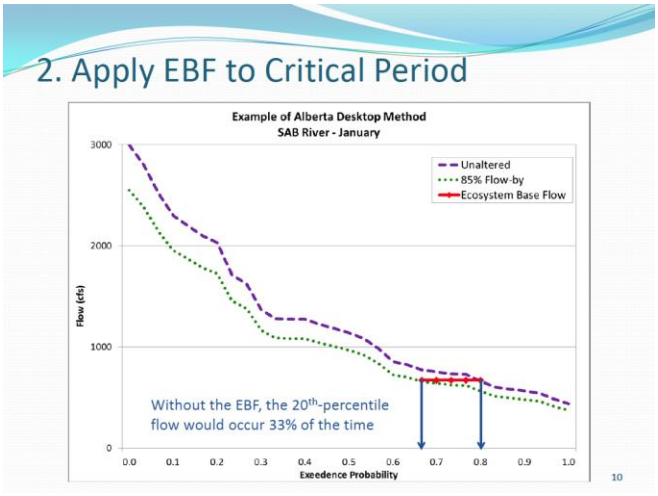


So he talks about in that paper, within 10%, you feel like you have a high probability of protecting all of the aspects of ecology. Outside of 20%, maybe not so much and so that is the figure from the Richter paper that kind of sums that all up.

The specifics of the Alberta Method, they use 2 concepts: the percentage of flow concept, which we have already talked about, but also a ecosystem base flow (EBF) component, which addresses the problem that if you lower everything by x %, at some point you are getting into that low-flow period more often and how do you protect that portion of the hydrograph. The ecosystem base flow can go by other names: minimum flow, cut-off flow, or a sustainability flow. The percentage component, whatever node you are in in the OASIS model, it is the cumulative reduction of flow up to that point. If you want a 10% flow reduction, it is 10% cumulatively. That gets away from an issue brought up earlier in our discussions; if you take 10% here, then 10% there you can run it dry. This gets around that. It is the cumulative effect up to any point on the river. The other thing is that it is reduction from the natural flow. In Alberta, they use this in streams that are not heavily altered. For our purposes, as a planning tool, we can do all kinds of things in the models, so we can run it on a natural flow baseline, a current condition baseline, and a future condition baseline. The other thing they talk about is an instantaneous flow. In the model, like OASIS or WaterFALL, it is a daily time-step. You run it on a daily time step, but you could run it, if you had a hydro-peaking condition and you had 15-minute data, you could do it on that as well. So instantaneous is really dependent on your situation. For us it would be a daily time step. They use a 15% reduction, which is in that range that's in Richter, in that moderate level of protection. They base that not only on Richter; they looked at habitat studies from Alberta and elsewhere. They looked at other states' and other countries' standards, and that number is in the realm of what a lot of other folks are coming up with, either as policy or in field studies. Fifteen percent reduction is the same as 85% flow-by. The other part is the ecosystem base flow component, protecting what is out there during low-flows. [As an example, Chris showed a slide showing natural flow over a month graph of ecosystem base flow]. If you did not have the low-flow protection, and just took x% reduction, you could get below a critical flow, not only for longer, (a couple of weeks rather than a day or two), but also you could dive down deeper. Both magnitude and duration could be increased if you don't use some kind of a low-flow cutoff. They used 80% exceedance flow, which another way of looking at that is a 20th percentile flow. It is the low-end of the flow regime that they use. Another thing about this approach is that you use both of these, combined. Another feature is that you do this for whatever period of interest you are concerned with. Typically, what we have talked about is monthly, so each month you would run this and come up with the numbers to plug into the model. In Alberta they have a really short growing season; it's under ice for part of the year so for certain parts of the year they might run on a weekly time step for a critical spawning period for a salmon species or something like that. For our purposes monthly would make a lot of sense. To demonstrate, Chris showed graphs.

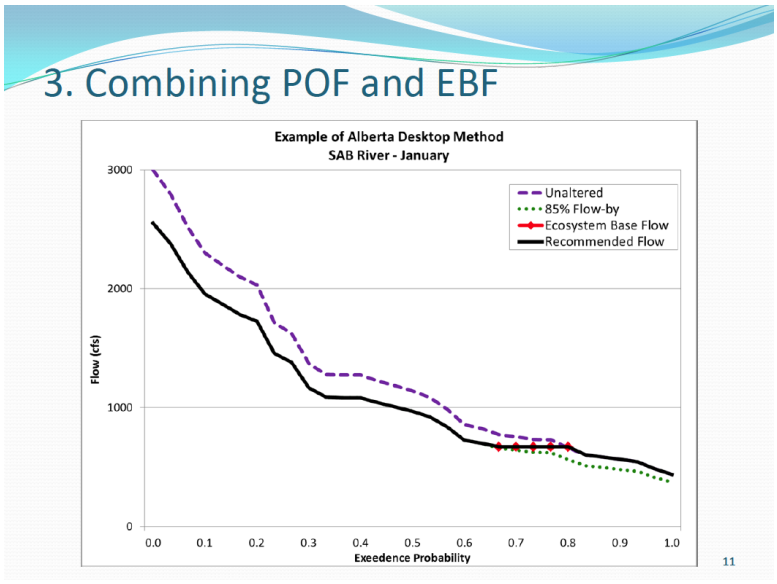


The purple dashed line is the natural flow. This is a flow duration curve. The green dotted line is the 15% reduction. The x-axis is exceedance. The red line is the ecosystem baseline, which is the 20th percentile flow. The next slide shows that you only apply that ecosystem base flow during the period when it makes sense--when you are transitioning from the reduced percentage flow-by over to a natural low-flow period.



If you did not have the EBF you would essentially have a low-flow that should only occur 20% of the time would occur 33% of the time. What you are doing is moving that back to the right for the low-flow period.

The actual flow recommendation that we would be plugging into the model would be the black line. You would use it until you get down to the EBF, and then follow the EBF. Then when it gets down to really low flows you would use the actual natural inflow. In other words, when it naturally gets below the EBF, you recognize that those low flows on the extreme end do occur, and that is just one of those bottlenecks that is going to occur anyway. That is essentially the concept.



C: So if I interpret that correctly, the space between the black line and the dotted purple line constitutes available water.
R: Yes.
Q: Like a yield.
R: If that is how folks look at it.

Q: For that particular example, SAB River, can you give me an idea of what that river's characteristics are? Is it a mountain stream, or...
R: It's just a spreadsheet.
R: I was just curious. It looks like it is a pretty good size.
R: Yes, it's thousands of cfs.
C: I assume that this month of January is the lowest flow typically seasonally because of the ice formation?
R: This is hypothetical.

Q: What happens to all the water here? Downstream?
R: It flows on through.
Q: Unavailable for anything else?
R: Yes, I guess that would be a way to look at it.
R: It's also available to the next downstream user. It's riparian.
R: That's one of the good things about having it as a cumulative because then it allows not only the critters downstream but also the next town or whatever downstream to have water.

C: Fred, perhaps you could send out that report. I should have mentioned that I could send out the report behind this report that was an earlier report that Alberta had done. It was a detailed summary of all the other reports and field data done by Crittenden (2002). [This was sent].

V. Presentation: Biological/Environmental/Flow Relationships—Recommendations of the Ad-hoc Group, by Bob Dykes, RTI

This powerpoint presentation can be found here

I am here on behalf of the ad hoc working group, which Sam, Tom Cuffney, Fred and Chris have been a part of. We have been working to take what we have been able to discern from the data at this point and make some specific recommendations.

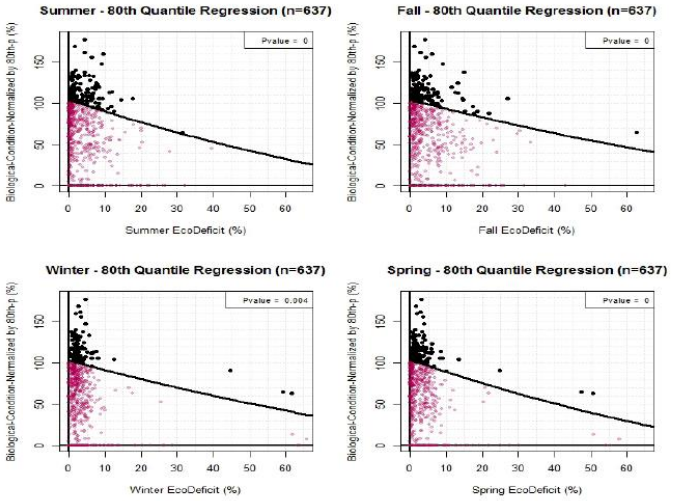
For background, of course you know, the law requires that DENR base their policy by establishing flows that will preserve ecological integrity of the surface waters in North Carolina. So there is a clear need to establish some quantitative relationship between the change in flows and the change in biological assemblages within the surface waters. That, of course, presents the big challenge. Those types of quantitative correlations have not previously been established, basically, anywhere but, in particular, have not been established for the state of North Carolina. I want to emphasize that again as we go through some of the data that we have been working with over the last several months and that we will summarize again today. These are data for the state of North Carolina. We have been working for several months to derive these correlations. We now have considered both fish and benthos in these analyses. The time frame for doing this work has been highly constrained. I think as a scientist I could speak for all of us that we certainly would like more data, and even with the data we have we would have liked to have more time to analyze that data. But at this point we are on a time line that is not of our choosing, and we are presenting this now to be consistent with the time line that has been established with the work of this committee.

So these are our consensus. I want to emphasize the word here—consensus—of recommendations of this particular group. Number one, we think in terms of the species that would be the indicator species. We believe that the riffle run guild should be used for purposes of establishing ecological integrity for fish based on the Shannon Weaver Index, and ecological integrity of benthos should be based on EPT. A reduction in fish diversity or species richness, EPT for benthos, of 10% or more represents a probable violation of ecological integrity. I think there are probably five metrics that ought to be used by NC DENR as the primary flow indicators of changes in flow regime: decrease in the average annual 30 day minimum flow rate, and then four seasonal measures of eco-deficit. And I should say that the way the seasons are defined could be done in different ways. In our analysis, the seasons were set in a way that corresponded with the PHABSIM work that NC DENR has been doing in parallel, but you could also set up these seasons to correspond, for example, with the South Carolina regulatory scheme that groups essentially a summer /fall period as a single season. It does not really make a difference in the analysis. No significant difference depending on how you group those months.

The statistical model that we ultimately employed to establish the relationships that we are going to present today: the fish population data were normalized to the 80th percentile, based on the Shannon Weaver Index value by drainage basin; the benthic data were normalized by the 80th percentile EPT value within the excellent DWQ benthic site condition class, and that was at Omernik Class III. And then the non-linear 80th quantile regression of the normalized data was used to establish the correlations. A final recommendation is that further data collection and research should be undertaken to enhance the statistical relationships that we have developed up to this point. These are the results of the analysis as performed consistent with those relationships.

I have been at some of the prior meetings. I know one of the comments was setting up the data analysis in a way that the y-intercepts were closer to 100% given that we are using normalized data with multiple basins so the switch to looking at the 80th percentile of the data as opposed to the 90th percentile of the data did do that. The black dots in each one of these represent the data points that were actually used in the regression. You can see the relationships are in all cases somewhat linear. They are not perfectly linear, but if you go back to, for example, the hypothesis that was initially presented by the ELOHA framework, there is a question of whether you would see a threshold response or if there would be some tolerance of change in flow up to a certain point and then some sort of clear rapid fall off or if you get a more linear response or you get some sort of exponential response. What we are seeing is something that behaves in a much more linear but not exactly linear pattern. There is not a great deal of difference. It is very consistent. This is just for the response curve for where eco-deficit is used as the flow metric.

RIFFLE-RUN FISH GUILD RESPONSE CURVES



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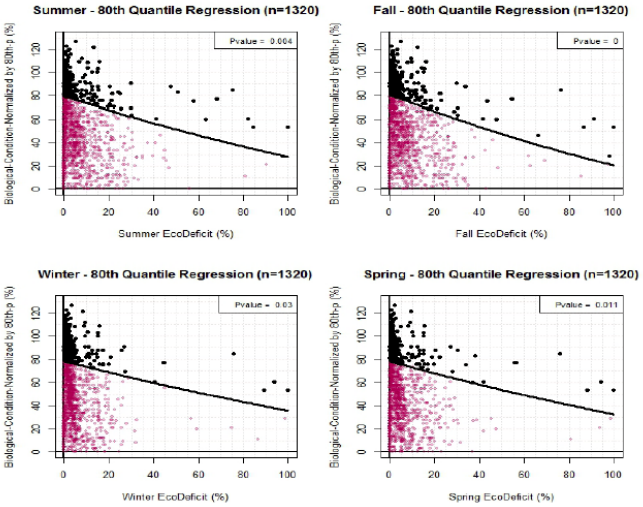
BENTHIC RICHNESS RESPONSE CURVES



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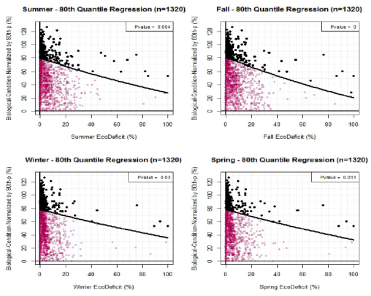
You can see there is not a tremendous amount of difference between the seasonal groups with the exception that summer is a little bit more sensitive in terms of the flow alteration that can be withstood which makes sense since that is essentially representing already low flow periods. We see very much similar patterns with the benthos data.

BENTHIC RICHNESS RESPONSE CURVES



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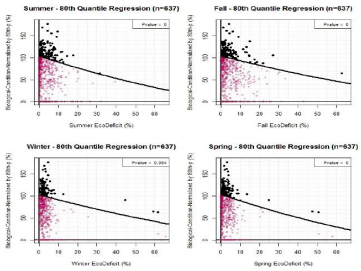
RIFFLE-RUN FISH GUILD RESPONSE CURVES



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Again, all these relationships are for eco-deficit. There are, both in terms of the shape of the curve that is generated and the degree of drop off, not huge differences, but in summer you see greater sensitivity, and in this case you see perhaps also an equal sensitivity in the fall period. These are the same data for fish and then for benthos, but looking at change in the 30-day minimum flow as a percent. We have fewer sites because we had fewer sites where there had been a reduction in that minimum day 30-day flow. What we do see, at least in the fish data, we continue to see a similar relationship. For benthos, with the quantile regression as it was set up here, a .05 value is the measure of significance. This is above .05 and therefore would not be considered statistically significant.

That is it. Short and sweet is what I was told. I do not know if I missed a key point Sam or Tom, Chris,

Fred—I am the spokesperson for the committee here so, is there something I left out that is important?

Comment: Just to remind you folks, we used data from 649 fish sites comprising 42 riffle run taxa and 1320 benthos sites comprising 261 benthic taxa. So we did our best to use as much data as we possibly could. We used all of the data that was available for North Carolina, constraining it by the riffle run/EPT boundaries, which seem to represent the most sensitive representatives for fish and benthos.

Question: Just a question. I know we have been through this stuff before, but can you refresh for me what parts of the state, what basins are represented? Is this data spread out in a fairly representative fashion over all the basins in the state, or is it concentrated in a particular region or domain?
Response: No it is not concentrated. I think that was one of the initial findings, somewhat surprising findings. Especially with the riffle run guild, they were well represented across all regions in the state with the exception that the coastal plain is poorly represented.
Comment: And the sand hills—
Comment: If you look back, and I think we shared this figure at one point in one of Jennifer's presentations, where the samples were the fish data at least were from across the state.

Question: Is drainage area represented in the same vein? Is it also fairly representative over a wide range of drainage areas, or is it concentrated in a particular boundary of drainages that are showing up in your sample points that are only between 50 square miles and 100 square miles or something like that. Does that make sense?
Response: Yes. I know that was something we looked at. I do not have the exact numbers off of the top of my head anymore, but it was a broad range. I know we did several iterations where we actually tried to normalize by that to see if there was any impact, which we did not see simply as a function of the size of the drainage area. I forget what the upper bounds were, probably went into several hundred square miles of small—
Comment: It was well above that.
Response: 400 was about the max.
Response: Okay. And probably down to 30 or 40 is the range.
Response: They are a little bit lower.
Question: A little bit lower?
Response: Yes.
Response: All of the PHABSIM sites have been shown so far in this data set.

Comment: So how we envisioned this might be used by DENR is that it would be relatively straightforward to use OASIS to calculate the change in the seasonal eco-deficit based on a proposed alteration in flow. DENR then looks at the delta eco-deficit. The bottom, the x-axis, is delta eco-deficit and so if you are going to increase the summer eco-deficit by 20%, then you go to the 20% line on the summer eco-deficit graph and then you go up to the black line and left to the y-axis and that tells you what fraction of the species diversity—not richness but diversity for fish—you can expect to have after that change. So it is just 20% up to the line and over so it becomes a transform curve. The suggestion we made was that DENR should—remember this is not for regulatory purposes, it is for planning purposes-- so when DENR sees that a change of 10% or more in fish species diversity or benthic species richness looks like it is probably going to occur as a result of a proposed alteration in flow or future demand or for that matter, climate change, then DENR has some motivation to do additional research and additional analysis for that change in that basin. So we are not at this point suggesting a regulatory-like response; remember the question of the legislation is what is it, how much water can you take out of a river before you begin to challenge ecological integrity? We think that the ecological integrity is surely challenged by the time you start talking about a 10% change in the biota. Whether it is measured at Shannon Weaver diversity of fish species or richness of benthic taxa.
Comment: Just to follow up on that, I saw an earlier graph of these, at least for the fish stuff, not for the full set of benthos, those curves by month, a 10% reduction in biological condition for the fish was

equated to about a 9 to 14% eco-deficit depending on which season you were in—
Response: Additional eco-deficit.
Response: An eco-deficit change, right. So it is in that 10 to 15%. The 20% reduction in biological condition translated to about a 20% reduction due to a 20% reduction in eco-deficit. So a lot of these numbers that Kimberly is throwing out and other folks have thrown out are very similar, which is kind of interesting through different avenues of investigation.

Comment: What would help me understand this a little bit in more concrete terms is if we could see in OASIS a site, maybe one of the PHABSIM sites in the Piedmont, where you evaluate eco-deficit with this method and at the same time, evaluate is that flow going to look like 20% of mean annual flow, does it look like 80% flow by. To me, that gives me a concrete connection between what the output from OASIS is and what an eco-deficit is on this graph.
Response: Yes we can do that. In fact, we already have done that for a couple of sites on the Neuse and I do not have that information ready to present but it looked pretty good in that it looked like there was water available. Just to remind you, the eco-deficit is the space between two flow duration curves, one being the current condition and the other being the proposed flow. And so if the proposed flow produces a flow duration curve that is below the current flow duration curve, the area of the space between them by season is the eco-deficit.
Response: I am with you on that. I need it translated into OASIS—
Response: Yes you are just trying to translate that—single number into what it looks like more on the ground.
Response: Yes, what is the flag going to look like in OASIS?
Response: The flag in OASIS would just be that—for that season that eco-deficit was exceeded.
Response: OASIS does not raise the flag. OASIS says here is what the delta is in 4 seasonal eco-deficits and your 30-day minimum flow. And DENR sits there with 5 graphs and says the proposed change in flow produces the following changes in ecological condition, the following changes in biological condition, according to which graph we use. And my recommendation to DENR is to use the most sensitive graph. I mean if it turns out that it is the summer eco-deficit that drives the system, then they should be thinking about that. In some other basin, it may turn out—or some other proposed duration—it may be the fall eco-deficit, or for fish, but not for benthos, the 30 day minimum flow. Did that make sense?

Response: Yes. And I may be just stubborn which is probably true. We will bring some examples next time, I promise.
Response: I am very curious to know what quantity of water withdrawal would trigger this flag to be raised.
Comment: Well you should know that the quantity of water that will produce a change varies enormously according to basin. So—
Comment: But right now, this is a statewide application. So it is—[Break in recording]
--use it in basin by basin, site by site.
Response: So we will bring some examples from the Neuse River that we are going to work up to the next meeting just to give you an idea of how it
Comment: Looking at the graph, if you were to overlay all of those, the slope of the lines is not exact but it is fairly similar.
Comment: That is what I was saying earlier.
Comment: But it really seems that you have a summer/fall, just looking at the change, I guess summer is really the only that looks to be significantly different. But then again, I guess it is—
Comment: Actually the fall had the steepest slope.
Comment: But it is a function of this—I guess the quantile regression structure. Unless I am not seeing data points when you get above 10% in the winter, for example, on the x-axis, all of your data points are fairly significantly above your regression line.
Response: Well 20% of them are.

Response: Okay.
Comment: So I think I know where you are going with this question—
Comment: I just cannot see them under there. The light pink data points under the line, I cannot see those from here.
Response: Yes, there are some sitting out here.
Comment: Yes.
Comment: So basically, the reason there are 4 lines instead of 1 is because a proposed flow alteration could change one of those variables much more than any of the others. So, for example, you could change the summer eco-deficit a lot and not change the other 3 much. In that case, that is the graph you should use. So we originally picked summer eco-deficit as the representative one and the more examples we looked at, the more it became clear that the summer eco-deficit might not be what changes. Your proposed flow alteration might actually change the winter eco-deficit and not the summer eco-deficit. So we left all 4 in play, and we feel pretty good about that since they are so similar. And then the 30 day minimum flow is in there as kind of a safety net variable to use in case for some reason DENR's OASIS analysis pops that up as a variable even though it does not register on one of the eco-deficits. But remember that the 30-day minimum flow variable is not significant for benthos.

Question: When you were looking at these analyses, if you did not have the extreme eco-deficit numbers, there seems to be not too many data points in the data set for the upper end, does the slope of that line change up or down? I mean the slope is going to be determined most likely—maybe Tom could answer this—in calculating this, it looks like the slope is determined primarily by those numbers in the 0-10% eco-deficit range. Well I am just looking at the winter; for example, you have a broader range of numbers in the other seasons. So say 30% eco-deficit and below is where the vast majority of your data points are falling in the 0-10% range. That is pretty much what is determining the slope. And it is not really a question; I guess it is just an observation. I would be curious to hear—
Response: I suspect that if you were able to truncate that in a more—values at the higher end, the slopes would actually be much higher.
Comment: That is what I am wondering is what would the impact be.
Response: Yes, when we looked at it with the linear regression, they were very, very steep. So if you are just extrapolating essentially from those clusters of points here and regressing linearly through them, all of the lines were intersecting the eco-deficit, the x-axis, at less than 50%. And most of them fall below that. So you should see a very, very steep fall off. And you may recall, I know we have done some as part of our internal research and development, not part of the work that has been supported by this group, we have looked at some other regression approaches as well. Those tended to show a kind of more exponential, very steep fall off early and then leveling out. But that is, I think, another sort of qualitative indicator that probably influenced the group of us that have been looking at these data kind of continuously for six months. Of all the ways we parse the data and analyze the data, this gave probably the most gradual change. Everything else showed that first 10% of eco-deficit being a very significant part of the reduction in biologic activity.
Comment: These are actually very conservative curves.
Comment: And I want to get back, Jeff, I think to your first question, too and then the part of that answer about whether the state could look into what is the relative sort of abundance or prevalence of riffle run in a particular basin and making that decision. If that is a correct interpretation of the question, that data is available because we normalized against those.
Comment: We know how many species are present in a basin, or for that matter, at any sample site. But as I understood your question, you were asking what percentage of the habitat is riffle run habitat, and that you do not know until you run transects.
Response: Right. That was really just a question to throw out because that would be a challenge for DWR.
Response: I think they record that, though. There is some representation in their data—the standardized groups that they do.

Response: Well we do indeed have habitat analysis for all of our sites. Probably for about half the period of record that you all looked at, which include quantitative estimates of how much of that is riffle run. So that could be obtained without much difficulty.
Response: But that is for the site and not the basin.
Response: Correct.
Comment: But the fish community sample is for the site.
Response: Correct.
Response: But it is normalized to the basin.
Comment: This was our best work with all of the data we could get our hands on; we did the best job we could. Tom Cuffney who knows more about statistics in his little finger than I do in my entire career rode herd on us pretty strictly. And I think we have done a good job. I also know that we have done an inadequate job. I know for a fact that what needs to be done is lots more data needs to be collected and lots more analyses need to be conducted, but we have to make a recommendation to DENR on the basis of what we know now. And so what I want to do is recommend something based on the best available analysis and the best available data with the caveat that DENR needs to do better over time.
Comment: Jeff, I want to go back to the original question in terms of basin sizes. I went back and looked at the NHD plus data we have and the invertebrate data set. We have 107 sites about 10% or greater in 500 square miles. We have about 5% that were greater than 1,000. So it covers quite a range.
Question: So in order to re-translate that same question, Tom, where we have proposed needs of analyzing water withdrawals in our large systems, which of course our data does not support—say that we have 1,500 square miles, do you think this is still a good surrogate to apply to that?
Response: Well I think the areas you are looking at, when you look at what we saw today at the Eno, French Broad—these are all the ones that are in these data sets. They all encompass that.
Question: Yes, but my question is really if we look at portions down at the middle Cape Fear and those kinds of areas which have huge drainage areas. Below Jordan we are looking at 1,500 square miles or something like that but what I am asking is do you feel like you have enough confidence in this approach to apply to large systems as well? When DWR goes to modeling these and using an approach for not having biological impacts or safe yield and things like that, do you think they can use the same, if you will, 10% approach in dealing with those large systems? Or do you want to put some kind of caveats on this and say it is good up to whatever you just said for your drainage area, 1,000 square miles or something like that.
Response: Well the largest one we have is over 9,000. So I am not sure where we put the caveat.
Response: Yes.
Comment: Let me offer a suggestion. 88% of the NHD plus catchments in North Carolina are characterized by wadeable streams. That leaves 12% and if you map that 12%, they are right along the main stems of the big rivers. So we acknowledge that by using wadeable stream data, we are leaving out that 12%. There are three ways to respond to that. One way to respond to it is the wadeable streams are more sensitive and so if you use this strategy on the main stems, you are probably okay. As a matter fact, you probably should be better than okay. Which brings me to strategy number 2, which is the main stems are way less sensitive than the 88% that are feeding into them. And the third possible response is main stems might be just the right place to talk about a flow by standard instead of using this strategy. Maybe we ought to use this strategy on the 88% of North Carolina that is a) the most vulnerable, and b) for which we have the most data; and on the other 12%, which is the main stem, let's talk about some sort of other strategy such as a flow by standard. Preferably complemented by a minimum standard.
Response: And you are getting to the rationale behind my question about percentage area represented from these riffle run guilds and how well are they represented in the main stem areas. The main stem of the river is where a lot of the large withdrawals are likely to be. Is this the appropriate curve guild response for those areas where you are likely to have questions about significant withdrawals?
Response: When you get down to the Roanoke in the vicinity of Williamson, no.
Comment: I mean it may be a great approach; you may need to switch the guild for example.

Comment: Let me suggest something here. One of the things I am uncomfortable with is the idea that we have competing proposals because I think that all the proposals on the table have merit and that what we really need to be doing is thinking about what are the tools DENR needs to have in its toolbox in order to answer the question in the legislation. And what we as the scientific advisory board need to do is help extract, figure out what the best science is and these varied proposals and package that and give it to DENR. I think there is a lot of merit in what you see up there, but I think it is incomplete. I think we should also recommend to DENR some strategies for making it better. We should also recommend to DENR some strategies for operating in big rivers where this may not translate well. We need to be also recommending to DENR some strategies for minimum releases so that when flow by standards and/or this strategy do not work out too well, there is at least a safety net. Meanwhile, we probably also need to recommend to DENR some procedures for what happens if there are vulnerable species or T&E species. And so on. I think we need a package—a toolbox here, not—
Comment: A standard equation.

Comment: On the riffle run, ignoring the species that we put in that guild, the habitat itself is one that is characterized by being where both depth and velocity are important variables in terms of the hydraulics and creating that habitat; therefore, if you are trying to base any kind of a standard around flow, those are the two things flow are going to impact most, right, depth and velocity. So it is a very—when you chart that out and maybe in one earlier presentation we presented this slide, I do not know, I know we have one. It sort of characterized habitats by contribution of—or importance of depth relative to the importance of velocity and you sort of get that riffle run—takes a big piece of that center. So it is just a representative habitat, it is a representative fish habitat.
Comment: That might have been a Kim graph.
Response: There was a graph that showed the various guilds and their distribution depth versus velocity and the big green circle in the middle is the riffle run guild. As the only member of the Venn diagram that significantly overlaps all the other members of the Venn diagram.
Comment: Just a suggestion. I always come back to putting these in context to a river basin because DWR is going to ask to evaluate the river basin at the river basin, right, so they have an OASIS model for the Cape Fear, they have one for the Neuse. I wonder if we might demonstrate a tool box approach because the tools that are going to be needed in the Little Tennessee, for example, versus the tools that you would have to employ, potentially, in the Cape Fear might be different. I mean, you might draw from different tools from the tool box and again, for me, I just like to have concrete examples of what—if we go forward with that approach, what would it look like in one of the Piedmont basins, for example. Our average catchment size in the Neuse, within the Piedmont, might be well within the wadeable streams. It might fall under one of the recommendations that Kimberly made about the very smallest ones; we would recommend avoiding large withdrawals for those habitats. In the same thing, some of these have FERC licensing all along the main stem. The need for a large river protocol might be eliminated by the fact that we have FERC re-licensing that is already in existence. It has been negotiated, so we do not actually have to provide a threshold under those circumstances because it is doing under current.
Response: Judy I like all of your comments. But I kind of get the feeling like we have been at this soon to be three years and our role, as an SAB, is to evaluate the evolving science and to make recommendations to DWR on some possible approaches that they could use. I think we are getting there based on what has been occurring in the science and what has been occurring in the data analysis from around the country. I do not think that is going to stop, ever. But many of the issues that you raise, which I am very sensitive to and have a lot of questions on myself, to me are about the implementation of our recommendations. And clearly that is going to have to go forward as well. But early on, when we were first challenged and stuff, we were given very specific instructions that we are not the decision-making group, we are the science advisory group and we are not going to have a perfect product and we are not going to be able to show how our advice can be implemented in enough examples that will prove satisfactory to people that may have alternative opinions. I do not think it is an area that we should start building or exploring. If we are going to wrap up our mission by December, I

frankly think we have enough to do on our plate besides implementing examples of how the toolbox could be applied in one area versus another. I hope our other professional colleagues will get that assignment rather than us. But I agree with all of your comments that those are issues that will not go away. I just do not want to deal with those at this SAB.
Comment: We can provide some examples, and we will get some Neuse River examples in front of you at the next meeting, but I would like to point out that we do not have until December to wrap up our mission. DENR has until December to deliver a final report to the ERC. We have—what?
Facilitator: No, I think it is different; we are going to talk about the report tomorrow.
Comment: Okay so we probably have until the end of August to get something to DENR. Maybe until the end of September to give DENR 30-60 days to work on it. Guys, we do not have a lot of time, and RTI is not going to be doing any more research. RTI has to write up the work they have done. At least on my dime. So what we need to do is beginning I think tomorrow, decide what portions of these proposals have enough merit for us to try to cobble them together into a recommendation.
Comment: Just for my edification as looking at the different approaches, I think the value in what Judy has requested and not to delay any implementation, I think what we are seeing is a convergence. If you were to take this approach, Kimberly's approach, what will be presented later on, I think what we are honing in on is a convergence. If you were able to give them a common denominator on a particular basin or group of basins, I think what you will see is the approaches, in terms of allowable water use, withdrawal, whatever you want to call it are going to be relatively similar in the bottom line. I think there may be point specific areas where they diverge. That may be something we need to know, but just my impression is that everyone is sort of converging on a similar type of common denominator that would be useful to have some idea of whether or not that is true. It is hard for me to translate what this means into what Kimberly presented or what will be presented this afternoon and understand where they converge and where they diverge without seeing some example of a specific number. That is all. Just a comment.
Comment: Can I just make a quick comment? I did not present you this and I am not going to, it was just a test drive, but I wanted to see just on my own what that withdrawal of the 10% of the mean monthly annual flows looked like in terms of calculating eco-deficits. In most cases, it came out to be about 15% change within the eco-deficit change. Now, one of the things I looked at in the papers was that you are going to have a natural amount of change associated with your percentiles, so I think it is also important to incorporate whatever that window is. The ___ paper and Richter and a couple of others have said a range of between 10-20% natural fluctuation around your flow duration curve could happen naturally because those are just natural ____. So one of the other reasons I like dealing with the medians and that 10% of the median is that overall deficit change was within a basically 15% window for most of those 63 gages. Some, it was less. Some it was only at 5% eco-deficit change. I mean, others it went right up to like about that 15% point. So it will be interesting to see the translation of the discharges relative to their eco-deficit with what I did because I found it was about a 15%, which is more change than some of the recommendations I think that they are going with. Theirs have actually been more protective. So it might be that it is more protective than that 10% of median.
Comment: And I do not think it is necessarily our job to pick a specific number. We recommend an approach and we say, if you take this approach and you plug in this number, here is what you get and you plug in a different number or if you do not like it, they can use the same approach and plug in a different percentage and that is not our specific task, I think. We just need to decide which highway we are going to go down.
Response: I agree. I would be really interested to see that comparison because that was something I was trying to look at with the numbers I was doing.
Comment: I do not have any basis at all for it, but I think they are converging.
Question: Kim, let me understand what you said. A 10% reduction in median mean annual flow tends to produce a 15% increase in the eco-deficit and I assume you are looking at annual.
Response: Yes. It was the eco-deficit calculated by using that change. So if you take a hydrograph and then you apply that deficit of the 10% median monthly, create a flow duration curve from that, the difference between those was about 15%. But like I said, some gages it was 5, and some were closer

to 15. It varied.
Question: So it was 5 to 15?
Response: Yes, right.

Comment: Yes, based on this discussion and what Judy was requesting, I am thinking that based on the manipulations that Jim did with his bar charts that perhaps if we went back and create flow duration curves on some of that spectrum of hypothetical flow by situations, scenarios that he created that probably these eco-deficits fall within that spectrum. We probably have done that already with the PHABSIM sites that, I guess, we can go back and look at some of those manipulated flow records and find out where 10% eco-deficit falls in that spectrum of the work that Jim or what we are doing with the mountain sites. That stuff exists right now.
Question: So you are saying you could pull it together?
Response: Yes.

VI. Presentation: 20/30/40% & 30/40/50% of AMF and MMF -Updates

Presenter: Hugh Barwick

Presentation online at:
http://ncwater.org/Data_and_Modeling/eflows/sab/presentations/20130716/Seasonal_Percent_Flows_Proposal.pdf

http://ncwater.org/Data_and_Modeling/eflows/sab/presentations/20130716/Adjustment_to_seasonal_percent_flows_example.pdf

Hugh Barwick presented the 20/30/40 and 30/40/50 method of mean annual flow.

Hugh: At the June meeting, I was asked to present in July on how the 20/30/40 and 30/40/50 method accommodates habitat in the streams. Fred Tarver sent the base information of spreadsheets and figures which took about 3 weeks to decipher. With Tom Thompson's and Tom Fransen's assistance, I was able to massage some of the information into the flows for Piedmont streams looking at 20/30/40 annual mean flow.

This is WUA habitat, and it's compared in percentages with the key percentage being 80% but it is the comparison between the flow, either 20, 30, 40, or as it relates to the unregulated habitats. Anything below <80% is not good and will be red on the charts; if it's above 80%, then that's good. You have a handout of charts for 9 sites.

In June, I presented a high flow recommendation of 40% for either the annual mean flows or a percentage of the monthly flows with a transition period at 30% and a low flow period at 20%.

The first table is Buckhorn Creek. The green is >80 and <120; the red is <80, and yellow is >120. I'm not clear why we wanted to look at a habitat above 120 but followed Fred's previous chart format. I have provided a code for the guilds – example the riffle-run dwellers for shallow to fast flows.

For your reference, as you might expect, if you look at the percentages of flows, we are recommending 30% in January, 40% in February, March, and April, transitioning down to 30% again in May and June, and then 20% the rest of the year. For most of these shallow water species, we had >80% habitat. We start running into trouble here for these shallow species with high velocity guilds where we simply do not have enough flow to accommodate an >80% habitat for them. For these deep pool guilds, we have

adequate habitat for deep slow cover and; when we get into the deep fast flows with gravel, cobble, coarse habitats, we see deficits. It's kind of variable through here for some months. For the deep fast gravel and cobble – all the way across is limited for white bass spawning. I believe there are other fish that would fall into that guild. During the summer, we have adequate habitat for a portion of those. We considered other species like American shad juveniles which had limited habitat some months.

C: When you use the guild approach, it doesn't necessarily mean the species is there, but that the habitat – that preferred habitat – is represented amongst that particular guild. So even if you have a stream that won't in all likelihood have American shad, that preference represents some guild though.

Hugh: That's also true for golden redhorse adults and I assume for other adult redhorse species. For juveniles, there is a suite of other species like the creek chub here, and other adults as well.

Next, are the invertebrates, the EPTs. Moving away from the redhorse species in the early winter and in the fall, there seems to be adequate habitat here on Buckhorn Creek at the flows we were proposing in the original trial balloon. So, questions on that before we move from Buckhorn Creek?

C: An observation is that when I see these January through April numbers or December through April numbers, I'm more worried about the actual animal fields. It tells me it's becoming a much shallower system. That if you're total available slow- shallow or shallow slow coarse increases by almost 500%, you are shifting the habitat to a much shallower system in the winter time. This is also reflected simultaneously by a reduction in the deep coarses.

So rather than thinking about the species at this point, that's a significant shift in the type of habitat for the winter months. For me, that's going to have ecological implications, whether it's through sediment transport or ecological functions. It seems like that could precipitate change.

Hugh: Let's go back a second. Is habitat driving the fishery here? In some respects, we all know that it is but it may not be the only driver. Is productivity of the stream based on food, water quality, and other aspects the stream? Remember, habitat is not the only driver, but you're right – there is an obvious shift in the habitat. For me, I've seen shift in habitats in a lot of streams I've sampled over the years that didn't necessarily reflect a change in the abundance of fish. I think about the concept of a raceway, where in a raceway we would probably agree there's virtually no habitat for fish. However, if you dump enough food and water in the raceway, you can produce a lot of fish.

I'm not suggesting there is not an impact with shifting habitat; there is a change based on these flows and I do not know if it's causing a change in the fish invertebrate populations here. It does switch into a more shallow water type of system. Remember, this is just one particular location on a local creek. As an old field biologist and what I see in the field is that there are various stretches of streams that do not hold the same species of fish. Fish distribution is oftentimes clumped based somewhat on habitat. So, there may not be a lot of habitat for some species at a particular location though they could be somewhere else in the stream. I'm presenting habitat numbers here – not whether it's good or bad on the fishery. There are places when you start looking at a 400- 500% change in habitat, there will be an increase/decrease for some species of fish.

C: And this is a percentage that's expressed as a percentage of the unregulated index B? Meaning Index B, which is the mean of the 10% to 90%?

Hugh: That's right. An average for one thousand feet of stream, weighted usable area.

C: Is this a percent of the percent or the percent of the mean of the percent?

There was discussion here about not going backwards and returning to discussions from several years ago.

C: One thing that we did ultimately consider when we first discussed habitat was if any of these habitat types represented by the guilds, were less than say 1%, then we recognized these habitats were not widely represented in the sample. If the actual habitat area was less than so many of whatever that number is – so many square feet – then we put an asterisk on it or whatever to say it's a high percentage change but it's probably because you had almost no habitat to begin with.

Hugh: True. I saw there were habitat numbers in the data set and I saw there were percentages. I decided to use the percentages because I thought that made more sense.

C: That's the reason why Jim did it that way, to separate out those that had changed because of a low denominator essentially. So, if you didn't have the benefit of seeing that or being able to represent that here, it's certainly possible that some of these habitats were not well represented to begin with. And so, a 400% increase does not have to be a substantial change in availability.

Hugh: It could simply be a small change in habitat area, but a high percentage.

C: Exactly.

Hugh: Great, we've got a lot of that out of the way on the first presentation so that's good. Maybe we can cruise through these others. So, here again for Buffalo Creek, there is a lot more red. Again, there are some high percentages for the shallow guilds. We're are getting into the higher velocities and beginning to run into trouble with these flows. For the deep fines, the fast gravel coarse, the American shad and the redhorse, it looks like habitat not adequate. Although I thought in some cases it was approaching 80%. It's in the 60% range and doesn't look like to me it's approaching anywhere close to 80%. It is quite low all the way across for the months. With the invertebrates, the system appears to be functioning fairly well for most of them. Maybe there is a little deficit for PLECO in Buffalo Creek. Starting to see a pattern in the Eno River which is very much the same pattern again. Here you're seeing habitat for some guilds not reaching the 80%, although they're approaching that in some months. They're in the 60-70%, but it's still lower than you would expect or want to see.

For the Eno River the red is scattered throughout. It seems like the shallow slow guilds or species that are associated with these guilds and the invertebrates do well. The shallow species requiring a good bit of velocity and deep species requiring velocity are not getting sufficient habitat numbers. The West Fork of the Eno is a little more scattered with a little more red. If you see something specific in this chart we need discuss, please raise the question or comment, otherwise I'll keep moving if that's okay with everybody. [No additional comments or questions were raised].

For the upper First Broad there is little >80% values and that's a red flag to me. We talked about a red flag for planning purposes and I believe we could/would set off one right there because there's just not a lot of water. It's an upper portion of a small watershed. Correct me if I'm wrong, Fred. I went back to review what 60% would look like, and it was difficult to get 80% habitat with this flow. That's quite telling here that the 30/40/20 flows do not provide a lot of protection for those guilds and for those species associated with it. Even habitat for the invertebrates seems to be pretty limited.

C: Do you have an idea of the drainage basin area for that site?

C: I was just looking it up; it's in the Casar area and it's 60 square mile at the gauge. So that's one where I'd be concerned to limit withdrawals from.

Hugh: Well, it's right below the mountains. It may fall into one of the categories where it's too small for consideration.

C: Yeah, it's in a category where there's no more than like 1 mgd. (million gallons/day).

Q: Will somebody who understands this way better than I do tell me how we pick one of the deep guilds where there's the green stripe, and tell me how we go from 0 to 100 with a 10% decrease in flow?

C: It just means that the habitat that formerly was in a different velocity type now has fallen into the slow category. It may have been deep and fast, and now it's deep and slow. It might be one unit that could go from 1 to 2.

C: It sounds like there was one unit of that habitat that went into one binary conversion.

C: It is true that some of these curves, where you have to have the right depth and velocity and cover all at the same place. And so, it could be that some of those simple curves are essentially binary type criteria.

Hugh: Well, I don't know about that, but it is what it is folks. For the First Broad middle area you can see we're going back to something that looks more similar to what we've seen in the other streams – this is downstream a little ways from the upper location, and now we're getting more yellows and greens showing up. We still have issues here in the shallow high velocities, and these deeper pools. The invertebrates are certainly back in the yellows and greens, but there's still some red. We're not avoiding the red on much of any of these locations.

C: On that one, Hugh, though, you've got the deep fast. One of those categories is the 0% all the way across.

Hugh: Correct, that's the deep fast gravel, cobble guild. There's nothing there or there was not much to start with. I assume that's what the zeroes mean. I'm somewhat handicapped in reviewing this as I'm not an instream flow person. That's not a revelation to folks, I cannot tell you what causes these nuances in the data though Chris or Fred may.

Let's go to the Lower Broad. The shallow guilds seem to be functioning quite well here but the deep slow cover not so well. I don't know what happened here, or why there are all zeroes. There was no habitat there. Maybe it should be left blank when there are all zeroes. But again, the suckers are somewhat limited as far as the habitat that's available there for them.

Regarding the Rocky River - very similar to what we've seen on the other rivers. There's a good bit of red showing up there for the deeper fast cobble, coarse habitats. Seems for the most part, the invertebrates are okay. American shad spawning here is limited. And I think that's a future area for fish to be moved into.

For the Tar River – you think of the Tar as being a Piedmont section. Again the shallow guilds seemed to handle these flows quite well and have sufficient habitat. Not so with some of the deeper faster guilds. The invertebrates seem to have adequate habitat under those suggested flows.

Tom Fransen is going to follow me. He reviewed our June 20/30/40 and 30/40/50 proposal. Tom looked at some additional sites that were not in the examples I used at the June presentation. He'll go into greater detail on how the 20/30/40 and 30/40/50 actually applies to a larger data set. Tom can add

some examples of how this 20/30/40 either annual mean flows or monthly mean flows actually compares with the 80% flowbys.

Hugh: This is what I was tasked to do.

C: And you did it well.

There were not additional questions for Hugh on this part of his presentation since he planned to present his trial balloon on Wednesday.

Later in the afternoon, Hugh provided additional clarity on his presentation.

Hugh: One thing I wanted to cover (and had planned to cover tomorrow) but decided it would not be appropriate to wait was to revisit/discuss the red on all those PHABSIM sheets I generated. Let's return to the Tar River graph. There may be a way we can fix some of the red proposed using the modified South Carolina version.

If you modify the proposed percentages just a little bit higher, you can eliminate most of the red for these deeper higher velocity yields while bringing the shallow percentage down, which kind of goes back to Judy's concern that we were forcing these streams with these low percentages of having a lot more shallow habitat and a lot less deep habitat. But you can shift that back by tweaking these percentages, and that's basically what I wanted to do. The 20/30/40 isn't set in stone and I do not want to you leave here today thinking that it is. There's some flexibility to make it somewhat more conducive to providing the values you'd want to see which may protect the ecological integrity of those streams. This is a fairly easy way to do that.

With respect to the gray areas, we grayed sections because we thought that we were primarily talking about spawning of white bass there. So we just looked at the 3 months when white bass would be spawning.

Q: So it's a way of highlighting that row?

Hugh: It's just highlighting that row as if you were just thinking in terms of white bass. But there are other fish that fall into that guild other than white bass. But on the original sheet, it was highlighted as white bass spawning habitats.

M: If that section weren't highlighted with gray, would it be green, yellow, or red?

Hugh: It would be red all the way across; it is one of those that is almost completely red all the way across all the streams examined.

C: I'm just trying to understand. Rather than the previous percentage that we saw on the other table, it's now a 30, 40, 50 percent of mean annual flow?

Hugh: It's a 30, 40, 50, 60 percent of the mean annual flow of index B.

It's just a way to improve your habitat and protect that floor. What this does in my opinion, is provide a floor that you wouldn't go below. What I am thinking is we're looking at a flow by percentage up here that's starting to create the top of the zone of protection. Then there's a lower floor here that this may fit. According to Tom, he's looking at a yellow flag more up here, and a red flag the closer you get to the bottom. And maybe there's some sort of compromise. Maybe there's some sort of hybrid method

here using a couple of things. It kind of fits the Alberta model a little bit, that maybe we should consider.

Like I said, I don't want you to go home tonight and all you can remember is all the red because it doesn't have to be red. It's red because we choose to make it red, and maybe we can do some modifications there to help that and to provide a floor that will help in determining the ecological integrity and protecting that for these streams. So, that's all I really wanted to say that I didn't say earlier was to offer some flexibility– does this make sense?

C: Hugh, one thing that might be helpful on some of these would be the numeric values, like Chris suggested earlier. Because on some of these habitats, it may be as much the fact that there's just not much up there.

C: There's another whole bunch of data spreadsheets you can mess around with.

C: Hugh, one question - as you raise your threshold, you're going to trigger more flags. Are you concerned about flag fatigue?

Hugh: Well, we're always concerned. From Duke Energy's standpoint, we don't want to see a bunch of red flags out there, because people are going to look at that and say, 'North Carolina has no water and thus we're not going to put a facility there. We want to sell power to industrial customers. So obviously we don't want to see a lot of red flags out there. However we want to protect the resources and determine a line that does not send red flags all the time. I guess that is what this advisory board's all about.

C: Hugh, is that an active spreadsheet. Can you play with the percentages on the screen?

Hugh: No, and I'm not one to do that.

M: Essentially though that's kind of what we would do in a state specific study, is keep playing with those numbers. And that's also essentially what the summary is that Jim did for the other ones, and what Fred's going to be doing for the mountain ones, is to look at them all. And then you can pick the numbers you want.

Hugh: Yeah, I copied and pasted from Fred's spreadsheets.

M: Jim had only modeled flows from 20 to 60 percent, so that's all they had of mean annual flow.

Lou: Sam, was there something that you were getting at by raising the question to continue working the numbers?

C: Well, I was wondering what would happen if we took the October and November numbers and popped them up to 40%. In the places where DENR has PHABSIM data I would encourage DENR to take a spreadsheet like this that's very active and play with the percents until the red goes away. And that gives them a very powerful tool. The problem is that the vast majority of places where decisions have to be made, there's no PHABSIM data.

And so, we need some sort of strategy for deciding whether or not DENR needs to go and get PHABSIM data, or whether we're probably okay, or are those are really the two options? That they need to get PHABSIM data, or are we probably okay?

And that, when the red flag goes up it means we're probably not okay. We need to go get PHABSIM data. Having done that, you've got an active spreadsheet – you just mess with the percentages until you've got- until the red goes away.

C: My question - is the red all we're concerned about? Like aren't the yellows a little disconcerting as well? We may move from less red to more yellow?

Hugh: As I understand it, when you get less red, the yellow declines as well, because the stream is getting deeper because you're adding more water.

C: It's largely going to depend, because your denominator here is a percent of the percents of the total habitat. It does reflect the hydrograph. This is a flat line, the mean annual flow.

C: As compared to a hydrograph that we've looked at, that some of the models look at –seasonal variation is inherent around whatever the mean or median. But that seasonal variation of higher flows in the winter and lower flows in the fall.

Hugh: Now remember, one of the things we proposed in the earlier proposal was looking at the mean monthly flows, which is more similar to the hydrograph. That's the reason we presented that, because you have more normal hydrographs over the year where you get flows that kind of peak in the late winter and spring and then decline in summer and fall. But there was no information in the spreadsheet of mean monthly flows for me to look at PHABSIM.

M: So, one way to play with the red light, green light scenario is to also have that compared interactively. The mean annual flow that comes to mind like Chris said – that's going to come to a number for each one of those entries in there for habitat values. But that also equates to a cubic feet per second, or some other amount of volume of water. And then, that can be drawn as a hydrograph across the months so that you could see how that reflects either the natural hydrograph or that this would be some modified hydrograph. There's some threshold hydrograph, for which everything goes from red to green or yellow, and so on.

C: If somebody was going to do that, how much time would that involve then? Seems somewhat similar to what Tom provided earlier. He showed these numbers, at least at the very beginning were in there. Not the adjusted numbers, but the original 20, 30, 40 numbers which shows you exactly what that impact would be on the natural flow pattern over time. Again, it was based on mean annual, not mean monthly or median monthly.

There were no more questions for Hugh.

VII. Comparison of minimum flow and 80% flow by approaches, by Tom Fransen

How to Compare Alternatives from a Water Supply Viewpoint

Presenter: Tom Fransen
Presentation online at:
http://ncwater.org/Data_and_Modeling/eflows/sab/presentations/20130716/Water_Supply_Proposal_Comparisons.pdf

Tom began his presentation, *How to Compare Alternative from a Water Supply Viewpoint*, by stating it is a presentation about the next steps of implementation and the start of policy discussion versus a presentation about the EFSAB charge. DENR will be responsible during implementation of ensuring the ecology is protected while allowing reasonable use of the water. Given the number of questions and concerns expressed both inside and outside DWR, about what and how DENR will use EFSAB recommendations, Tom thought this was a worthwhile presentation for the EFSAB. His presentation covered two topics:

- Procedure to compare alternatives from a water user's viewpoint.
- How is DWR going to use the EFSAB recommendations

To frame his presentation, Tom posed the following question: *How much water needs to remain in the river to protect ecological integrity and still have adequate water available for reasonable use?*

Although the water users prospective are not part of the EFSAB's charge, it is part of DWR's implementation. We need to determine: what is a reasonable approach to compare alternatives from a water user's viewpoint?

Last month's Hugh's presentation Modified SC Minimum Flows raised the concern that 80% flow-by appears overly protective. DENR has been looking at how protective are these various options from a water supply perspective and are they giving us enough flexibility to make reasonable use of the water. Thus we looked at 3 alternative approaches. If requested by the EFSAB we can add other alternatives. The three approaches considered were:

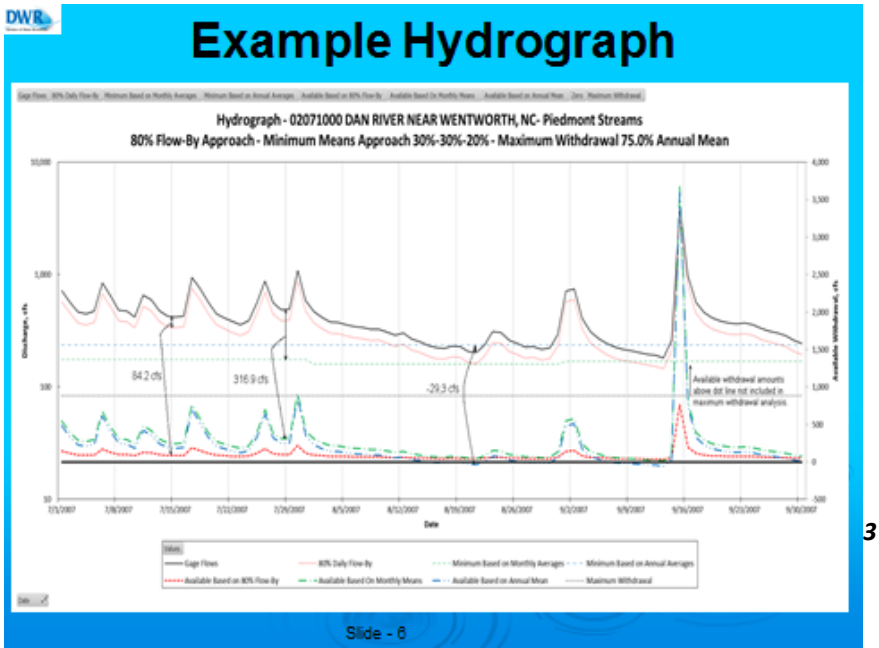
1. Maximum withdrawal – SEPA minimum criteria, 20% 7Q10.
2. Flow-By – DWR's 80% Flow-By
3. Minimum Flow – Modified South Carolina minimum flows.

Although the 20% of the 7Q10 isn't one of the options that the EFSAB is looking at, since it's the current approach, it's included to compare alternatives to what is currently been done.

Tom used an two-pronged analysis approach for the three alternatives to determine:

1. Worse Case average daily demand (ADD)
   a. Analysis assumed a run-of-river intake based on the lowest flow for the period-of-record (POR). Assumed a 1.35 peaking factor and 32.5% mandatory drought conservation.

2. Maximum Pumping
   a. Maximum pumping volume with a maximum pumping limit of 75% of the mean annual flow (reservoir type of scenario).



The assumptions of the worst case average daily demand (ADD) included taking the POR intake 1st cut look at minimum flow of record. True POR has no storage so a conservative approach is to use the minimum historical flow. Assume the record low occurred on a peak day demand and the user was under mandatory conservation to be able to estimate ADD.

For the Maximum Pumping, it is a theoretical maximum volume that could be withdrawn, means having the capability to vary withdrawals daily with a maximum pumping capacity equal to 75% of the mean annual flow.

To understand the next few slides [Slides 6- 9], it is useful to see the results graphically.

To use the graphs, distinguish between the red and black line, with the black line being stream flow. Top 4 lines use left axis. Bottom 4 lines use the right axis. Band at the bottom represents what is available for withdrawal. Looking at the monthly means would be the difference between the green and black line. As you can see highlighted for the annual, there are times when natural flows go below the minimum target so you end up with a negative. For the pumping scenario, you can think about taking all the water up to the gray line with nothing above it. These are the basic graphical concepts on which Tom presented. Tom has a spreadsheet he can make available to the EFSAB. In order to use it, it requires a good Internet connection as it pulls data from the DWR website dynamically.

For Average Daily Demand Summary [slide 7] – Tom compared a (SEPA Alternative) 20% of 7Q10 with an 80% Flow-by approach maximum withdrawal set at 20% POR minimum, and with a 80% Flow-by approach maximum withdrawal set at 10th percentile. Using 80% Flow-By, examined two ways for full period of record and Index B approach of using the dataset between the 10th and 90th percentile. POR 80% flow-by is more conservative than 20%7Q10 – on the average 59% less ADD.

Tom reminded the group he was using a run of river intake using the lowest flow of record – how much would an average day of withdrawal be without meeting the criteria.
He offered an example using the Roaring River gage listed (mountain stream) where the 80% Flow-by set at 10th percentile offered 9.93 mgd of water available for an average daily demand:

SEPA Minimum Criteria 20% 7Q10	80% Flow-By Approach Maximum withdrawal set at 20% POR Minimum	80% Flow-By Approach Maximum withdrawal set at 10th Percentile
ADD mgd	ADD mgd	ADD mgd
5.14	1.84	9.93

The Modified South Carolina Alternative is not part of the comparison because the mgd would be zero. Tom notes that the Cape Fear at Lillington looked at POR, pre-impoundment, and post-impoundment to highlight the large difference time periods and changes in the hydrology can make. The comparison is done to highlight whether the 80% Flow-by gives you more pumping availability than the SEPA criteria. Tom pointed out that Index B 80% flow-by allows more withdrawal capability – on average 121% more.

Based on Annual Mean Approach Modified SC Minimums	Based on Monthly Means Approach Modified SC Minimums

Using a Modified SC Minimum Flows Scenario, Tom has to look at the minimum flow approach differently because flows naturally drop below the minimums. He used both annual mean and monthly means. Looking at the table presented on Slide 8, would require a lot of refinement before use in Tom's opinion. As Tom understands it, when South Carolina's flows drop below the minimums, "soft" conservation measures are required.

Days Below Minimum, Percent	Number of Periods, Periods/Year	Days Below Minimum, Percent	Number of Periods, Periods/Year
18.7%	6.87	16.5%	7.14
1.1%	0.75	1.7%	1.12

To illustrate, Tom discussed the US Drought Monitor's Streamflow classification scheme where:

- Abnormally dry is 21 – 30th percentile
- Moderate Drought is 11 – 20th percentile

Thus, for about 7 to 10 gages, flows drop below minimums when we would not even be classified abnormally dry. Also working on drought plans & LIPS, DENR does not usually want to trigger them more frequently than once every 5 to 10 years (.2 to .1). As shown, this alternative would be on the average about 7 times a year. The goal is to look for periods/year .2 or less.

Using a Maximum Pumping developed scenario, the volume is displayed as an average to make it easier to put into context with the other results. Thus the SEPA 20% 7Q10 is not as conservative as one might assume. For a maximum withdrawal approach it is set at a level less than the historical minimum. Note, at 2 gages the minimum is greater; 1 is at the Lillington gage.

20% 7Q10 Alternative is by far in this analysis the least flexible in allowable withdrawals with minimums about 1.8 times more than the flow-by.

On slide 10 hydrograph, showed a couple of examples using the 2 year period of 2006-2007 which resulted in a good example in these 2 years of both high and low flows. Slide 11, presented the end of the 3 alternative analysis.

So how will DWR implement an EFSAB recommendation as a planning tool?

- Will not override existing permits, such as FERC license.
- Will not replace site specific studies.
- Will not change the SEPA minimum criteria – 20% 7Q10

Currently, there are no rule-making proposals from DENR to change the SEPA requirements so existing permitting requirements will remain as they are. During the planning process if ecologic integrity is determined or projected to be adversely impacted, DENR will flag the river reach for additional studies.

Tom provided examples of using the 80% Flow-By for illustration purposes only using the:

- EMC approved river basin model compare the current conditions scenario (SIMBASE) with a future condition alternative.
- Permitted flow requirements.
- Nodes with no permit requirements. Create an 80% BASELINE using SIMBASE and compare future conditions scenarios to the baseline. When a scenario flow is below the BASELINE that represents a potential adverse ecological impact.

- Summary of analysis for both the full model period-of-record analysis where none of the flows drop below 80%, that node would register as green (no impact)
- If the Index B approach of using the subset of the data between 10th and 90th percentiles, and if there are days that drop below full POR but not below Index B, this would be a yellow (or watch area).
- If using both the full POR and Index B approach there are days where flows drop below 80%, then the reach would be marked as red to determine why and what additional steps/studies are required.

Again, the results interpretation of levels of impact:
- No Impact (Green) – POR no days with flows < 80%.
- Watch (Yellow) – POR of has 1 or more days < 80% and Index B has no days < 80%.
- Additional Study (Red) - Both the POR and Index B have 1 or more days < 80%.

There is no biological basis for this analysis but it does incorporate other methods of determining when further examination is needed.

Going back to the Board Model, using the criteria described, 7 of the nodes would be green, 17 would be yellow, and 4 flags with the need for additional studies. So for 90% of the time, all the difference is in the low flow range. Used the Index B approach as an alternative to making up a days and/or periods threshold, 10% is severe drought and in the Broad most of the differences were at 5% or less (extreme and exceptional drought). In the Broad Model Example, issues that come up are at reservoir releases and downstream.

Thus, Index B 80% of time no potential impacts.

Tom has suggested to the Board that if EFSAB presents to him other options, he run the numbers for the EFSAB to examine.

Discussion, Questions, and Comments about Tom's presentation:

Q: To understand, you are using the 80% Flow-by as the flow recommendation and using the habitat as an indicator for when the flag goes up.
Tom: I was not using the habitat as a metric, I was using the 80% Flow-by as a BASELINE using SIMBASE and compare future conditions scenarios to the baseline. So first it was compared with full POR, when the light was no longer "Green" and potentially "Yellow" or "Red", then I looked at using the Index B to the 10th and 90th percentile not using the extreme lows or high flows, then if no days dropped below 80%, this area would be tagged as "Yellow" as an area to monitor, but if there were days that dropped below 80%, then the area would be tagged as "Red" and require an assessment as to why. This may not make sense biologically but it does mathematically.
C: So when you are using Index B, you are looking at a truncated flow duration curve.

Q: What is up with Kings Mountain and Buffalo Creek on slide 15?
Tom: They may have some permitting issues or the nodes are right below reservoirs.

Q: So in going back to the spreadsheet, it says when the ecological flow is not being met during a specific number of days. What is it telling you about the number of days that you're water demand is not being met.
TOM: That is a separate analysis. DENR will be charged in the statue of responding to 3 questions:
1. ecological flows being protected
2. all water uses being met
3. all essential water uses being met

So I will need to analyze all three independently and overlay them to determine what it is telling us about all three. Then lastly, DENR is now charged (outside of this statue) with doing an integrated water river basin plan of water supply and water quality plans.

C: Why can the 20% of 7Q10 be evaluated but the 20/30/40 of MAF cannot be evaluated in the same way?
Tom: Except for the Deep River and full POR, all of the 20% of the 7Q10 value is lower than the lowest POR. So you can look at 20% of 7Q10 in the same way you can 80% of Flow-by. Because the Modified SC Approach naturally drop below their thresholds, cannot look at these the same.

The three alternatives presented – Maximum withdrawal – SEPA minimum criteria, 20% 7Q10; Flow-By – DWR's 80% Flow-By; and Minimum Flow – Modified South Carolina minimum flows, are very different in terms of maximum withdrawal, flow-by, and minimum thresholds and thus give DWR insight to consider different things. So if you use the SEPA approach, you probably want a maximum that's less than where flows would naturally occur. If you use the Modified South Carolina approach, you need to determine what to do when the flows fall below those minimums.

C: Tom we were discussing earlier today what a comparative example might be of looking at the Ecodeficit approach and modeling that on a specific stream reach. This would give us insight into what flows would be available for withdrawals or residuals in the stream. Using the comparisons method you have demonstrated, how difficult would it be to enter a comparison of Eco-deficit?
Tom: I would need to understand what went into the Ecodeficit calculations in order to know if those numbers could be run.
Kimberley: Made the point that during her presentation, that there are graphs that provide the mgd available. The 10% of median shifts more to the 85 or 90%
C: But what we do not have is the Ecodeficit approach in Tom's comparison.

C: Struggling to understand the presentation since it is being presented from a water supply viewpoint.
Tom: I approached it from a planning approach and how you would use the recommendations in terms of how much water would be available at the nodes available in the model.
Q: If I am a water user, I want a maximum sustained yield if I am a water user and a number of people are depending on me. For my customers, I want to know what I can produce on a sustained basis without building a dam or adding additional storage.
Tom: the ADD Summary will tell that information. For example if water users needed more they would look into how much water storage they needed, interconnection with another town, can I do supplements when it gets to low, and other types of planning tools. Water Supply planners typically do not use the term "Maximum" but do use average daily demand so I put the comparison in their terms.
Q: In terms of supply in demand when there is a drought and everyone wants to do things associated with water use (water their cars, water lawn etc) is the average daily demand 1.5.
Tom: I used two factors –peaking factor and adjusted for drought conversation so you can adjust these factors.

Q: When it says ADD is 5 mgd – does that mean the demand is for 5mgd or there is 5mgd available to meet the demand.
Tom: Could be both but it's the maximum you could take under these assumptions on average.
C: This is a hydrograph analysis and the EFSAB is responsible for the biological component. It is a relief to know that DENR has a three-pronged approach to address how ecological flows are being protected, all water uses being met, and all essential water uses being met.

VIII. Presentation: TNC Final Report and recommendations, by Kim Meitzen

Presenter: Kimberly Meitzen, The Nature Conservancy

Kimberly's presentation can be found online at
http://www.ncwater.org/Data_and_Modeling/eflows/sab/presentations/20130716/

This is the final presentation from the TNC work to determine set of environmental flows, developed for TNC but with the hopes it can inform your work. Some quick background -first I did a literature search. The other part was analyzing changes in flow patterns and biota over time- I'll present those results to show how that can inform environmental flow guidelines. First we'll look at patterns in biotic changes, then spatial-temporal patterns in flow changes, how those can inform environmental flows. The project is meant to inform TNC on conservation areas that are priority to their mission and also to provide information that may help this group.

Biological data evaluation- we're only working with fish data at this point. Filtered all the data points from 4 basins down to the points with greater than 2 samples, from NCDWQ wadeable streams data 1992-2009. We looked at these questions:

- What are the prevailing patterns of fish communities?
- How have fish diversity and abundance at-a-site changed over time?
- How has water-use affected fish diversity and abundance?
- Can we define a flow-ecology response relationship?

She showed quick summary statistics on % species represented by the wadeable streams. They represent 34- ~50% of species for these basins. We're leaving out a lot of tributary mainstem individuals. There are some limitations with only using wadeable streams

Background from fish survey data- Fairly large range of diversity and abundance. There's a decent relationship between increasing diversity and increasing abundance at a site. Fish organized into different habitat based guilds. Of wadeable streams, of adult phase pool and pool run were most commonly represented and in spawn phase was mostly pool and pool run.

She looked at what influence do these 14 environmental factors have on the fish community patterns in wadeable streams?

Physiographic (2):

- drainage basin area, stream gradient,

Hydro-climatic variables (4):

- precipitation, temperature, mean annual flow, mean annual flow velocity

Land use variables (2):

- departure from natural conditions in the active river area and HUC 12

Habitat condition (3): (from Cat Burns' work)

- Statewide condition, ecoregional condition, Conservation Planning Tool condition

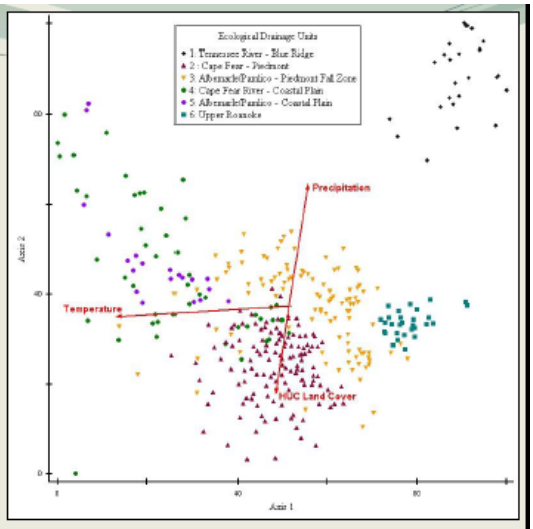
Biogeographic (3):

- river basin, ecoregion, Ecological Drainage Units (EDUs) Influence of environmental variables

This slide shows NMS Ordination of community patterns that fell out looking at environmental variables. Two were not significant, the rest were.

NMS Ordination of Community Patterns

- 77% of the variance explained
  - Axis 1 = 55%, Axis 2= 22%
- Temperature, Precipitation, HUC 12 departure from natural conditions, and Ecological Drainage Units strongest control on community patterns
- Mean annual flow velocity and drainage basin area were only variables without significance



Pearson's results for quantitative variables

Variables	r – Axis 1	r – Axis 2
Mean Flow	0.253	0.293
Mean Velocity	0.336	0.343
Stream Gradient	0.285	
Precipitation	0.296	0.737
Temperature	-0.875	
ARA Land Cover		-0.320
HUC Land Cover		-0.624
Statewide Habitat Condition		-0.423
Ecoregional Habitat Condition		-0.332
CPT Habitat Condition		-0.419

MRPP results for categorical variables

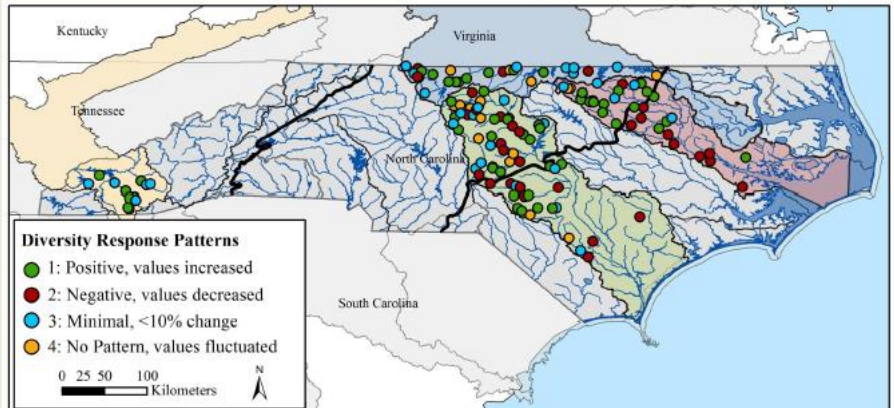
Variables	p	A
Ecoregion	0.000	0.128
Ecological Drainage Unit	0.000	0.227
River Basin	0.000	0.168

The four strongest variables for fish community patterns were temperature, precipitation, HUC 12 departure from natural conditions (non-natural cover had a relationship), and of the grouping variables- EDU was strongest grouping (purple-Tar Pamlico; green- Cape Fear- little variability in EDU. I recommend for a state class that you use EDUs, even though only for wadeable streams….EDUs could represent a way to classify biological communities in state.

I looked at how fish diversity and abundance changed over time. I calculated coefficient of variation- some areas are with a lot of change and some not, and I calculated direction of change. Four groups resulted- see slide for results.
No pattern- no trend associated with the change.

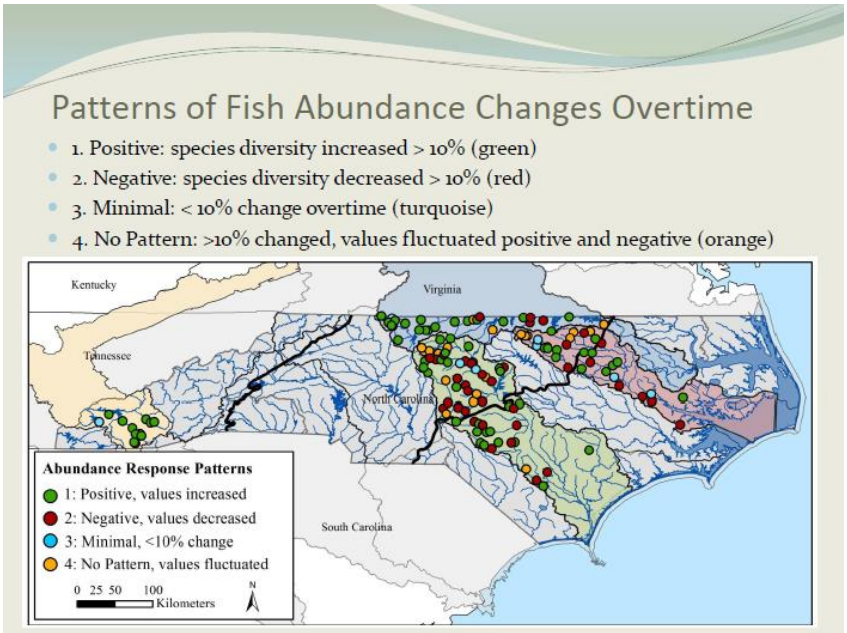
Patterns of Fish Diversity Changes Overtime

- 1. Positive: species diversity increased > 10% (green)
- 2. Negative: species diversity decreased > 10% (red)
- 3. Minimal: < 10% change overtime (turquoise)
- 4. No Pattern: >10% changed, values fluctuated positive and negative (orange)



These maps represent the pattern of the 4 different response mechanisms. Green- diversity is increasing over time, red- diversity decreasing, turquoise- stable, orange- a lot of change but fluctuating between sampling period. Influences include variations in flow patterns, interspecific competition, land use cover change. Something that pops out- Little TN looks good, Dan River looks good- green, some of the headwater areas of Tar-Pam for most part have a lot of diversity. Positive change in piedmont Tar River, the negative change in the coastal area shows something going on, maybe land use change or water quality driving the patterns. Could be good for DWQ to look at what some of these sites are.

Next slide, patterns of fish abundance over time, same legend-similar to diversity in format. Results are similar to the diversity over time slide.

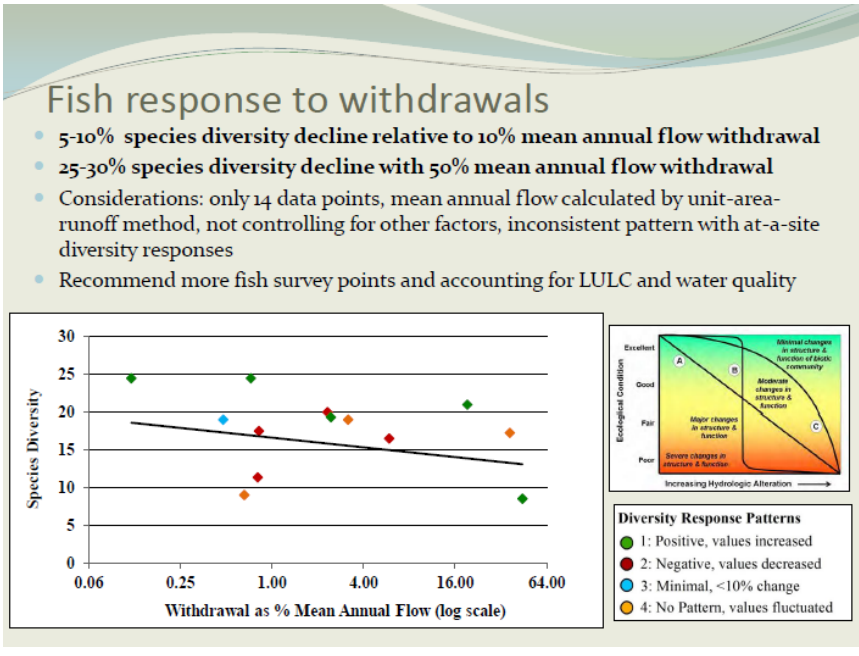


Q: what is the time frame of sampling?

R: Fish survey sampling 1992-2009. Showed the clustering of all the data (descript) represents each year of diversity and abundance- I tried to see if there was a pattern but didn't see one, shows the spread of data.

This data is available to DWQ, DWR, I could provide the data responses for each station, could be useful for future monitoring efforts.

Another component of biotic analysis, determine changes in biota relative to water use. The challenge is that only 10% of wadeable sites fell downstream of water use source. It's difficult to tie to water use. From the remaining 14 points that were downstream of documented water use source, I looked at the amount of discharge withdrawn at the location and relative to mean annual flow. This is raw data. Mean site diversity related to withdrawal daily average (slide with graphs). Once you normalize water use as % mean annual flow. When you do that, you get a negative trend associated with the amount of water use as % of mean annual flow and a decline in mean site diversity. Shows abundance is increasing, though could be with generalists. Diversity decline is of concern.



Regarding the declining relationship,-can find a 5-10% diversity decline relative to 10% mean annual flow withdrawal. This lower axis is a log scale keep in mind. Follow the trend line further, a 25%-30% species diversity would decline with 50% mean annual flow withdrawal.

I'm glad we were able to pull this out with the data, a limitation was 14 sites of the 141 sites in the 4 basins I looked at, but the other ones are small streams without water supply use. You may be able to find 100 points in all the basins. This is largely a proof of concept that the data is there, though it doesn't account for water quality or land use. You're just looking at diversity relative to withdrawal as % of mean annual flow.

Strengths & weakness of Fish Community analysis

Strengths:

- Useful for characterizing fish ecology of wadeable streams
- Community analysis showed importance of hydro-climatic variables, EDU classification, and land use impacts (mean annual flow was strong, but as strong as these)
    - Supports the need and importance for protecting naturally variable flow regimes indicative of different hydro-climatic areas and EDU's
- Diversity and abundance response patterns help identify areas of concern and show potential for monitoring fish impacts from flow alteration
    - Need to better quantify land use effects on aquatic ecology to separate them from water –use (withdrawal and return) related effects
- Fish diversity and withdrawal plots shows negative relationship
    - 5-10% diversity decline with withdrawal > 10% of the mean annual flow
    - 25-30% diversity decline with withdrawal >50% of mean annual flow

Weaknesses:

- Only applicable to wadeable streams (50-34% of other fish species from each basin absent from the analysis, ex. anadromous fish)
- Data limitation prevented including water quality and water use-related effects
    - Only fraction of the sites had these data associated with them
- Few wadeable stream sites occur in proximity to monitored stream flow gages making it challenging to develop flow-ecology relationships

So that was biotic changes over time- most important part of that was the last map with the diversity and abundance with withdrawals.

Stream flow changes over time: Sought to answer:

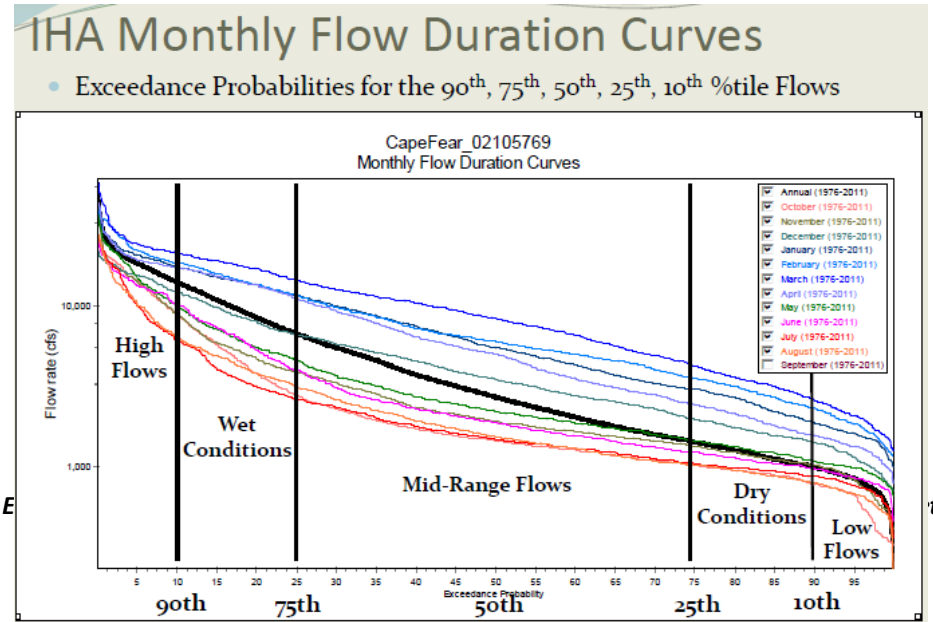
- What are the changes in flow patterns over recent history?
- How do they vary spatially (among gaging sites) and temporally (months) and by flow magnitude (percentiles) ?
- How can changes in flow patterns inform environmental flows?

I looked at 63 USGS gages with 57 years of record, 1955 - 2012

- Period 1 (recent historic conditions): 1955 – 1980 (25 years)
- Period 2 (current contemporary conditions) : 1980 – 2012 (28 years) Should be 1984- 2012 since Jordan Lake dam built between 80-83

She showed a map with those gages numbered across the states- the numbers refer to the Map ID on the related table. I calculated:

- Mean Daily Flow



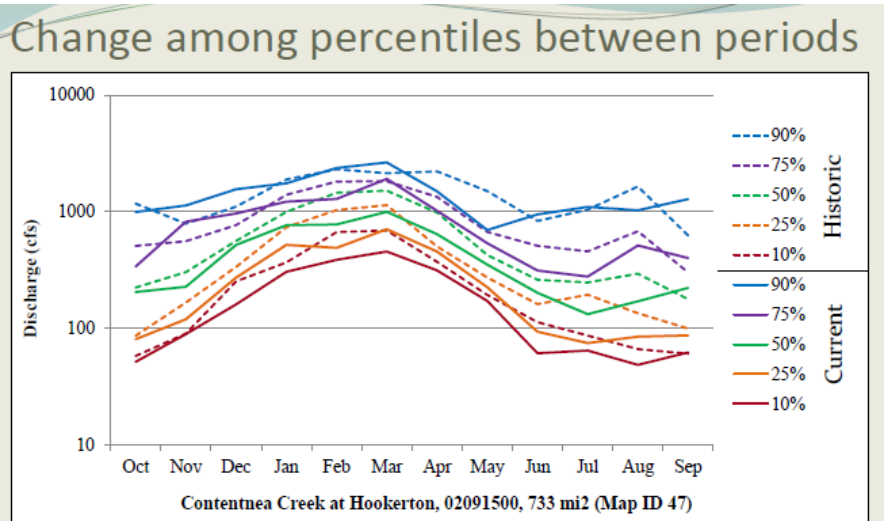
- IHA for calculating monthly percentiles for both periods:
- 90th, 75th, 50th, 25th, 10th (highest flows down to the lowest flows)
- % change between time periods calculated post-processing
- Mapped % change

E ting Summary

across the state for each percentile

For the IHA monthly flow duration curves- black is mean flow duration, colors are months.

Change among percentiles between periods (slide)- look at that % change, what we'd use for post processing- solid lines are current, dotted lines are historic. For each month calculated % change difference relative to the percentiles. For each month looked at % change. Green, orange, red current lines are below dotted line for this gauge our 50th, 25th, and 10th flow are going down, tending towards dryer conditions….



Plotting scheme for % change to percentile:

- Example: % change to one percentile for one gage
- Calculated % change for the 5 percentiles for each month
- Grouped % change into 4 categories: 1) 0-25% drier, 2.) > 25% drier, 3.) 0-25% wetter, 4.) >25% wetter (all 5 percentiles for every month – 60 metrics)
- >25% drier or wetter is significant change (Kennard et al., 2010)

Between dotted line is normal variability. Green is tending towards wetter but within normal variability. This is looking at those patterns statewide (there is a slide in the presentation with maps for each percentile):

Changes to 90th Percentile: highest flows:

- 90th percentile flow magnitudes are increasing more than decreasing
- Blue Ridge region most stable relative to high flow changes
- Dam regulated high flow increases: Cape Fear below Lake Jordan, Neuse below Falls, and Roanoke below Roanoke Rapids
- Coastal Plain increased intensity of precipitation events?
- some of greatest changes were increases in 90th percentile, mostly below dams

Changes to 75th percentile- greatest change was increases.

- The percentile with overall least amount of change
- Blue Ridge region most stable relative to high flow changes
- Coastal Plain increased intensity of precipitation events?
- Dam regulated high flow increases: Cape Fear below Lake Jordan, Neuse below Falls, and Roanoke below Roanoke Rapids

Changes to 50th percentile- moderate flows

- Median flows are indicative of central tendency and most prevalent flows
- 32% of gages have significantly drier conditions for more than half the year
- Changes greatest in Piedmont and Coastal Plain, upper Roanoke an exception
- Blue Ridge tending toward drier 50th percentile flows but still within range of normal variability

Changes to 25th percentile- low flows

- Statewide decreases in 25th percentile flow magnitudes, 51% of gages showed significant flow

decreases with conditions being much drier >50% of the time
- Most emphasized in Piedmont and Coastal Plain with exception of Roanoke Basin (which looks pretty good)
- Climate change and increased pressure on water resources

Changes to 10th percentile- lowest flows
- Statewide decreases in 10th percentile flow magnitudes, 57% of gages showed significant flow decreases with conditions being much drier >50% of the time
- Most emphasized in Piedmont and Coastal Plain with exception of Roanoke Basin
- Climate change and increased pressure on water resources
- The 10th percentile low flows need better protection from water users

The maps show a quick image of how patterns change over time relative to different flow magnitudes and also to (inaudible) which times over the year are they wetter or drier.

Biggest pattern is as we go to lower flows, lowest flows getting lower, highest flows get higher.

A most important point- at 10 percentile flows, 57% of gages getting drier- that is significant. These areas need to look at flow protection to ensure water for ecosystems and for people.

The biotic analysis and flow change analysis have set us up for 3 part recommendations. Here is the context for flow recommendations. If we protect all those things ideally we'll be protecting aquatic habitat for aquatic biota.

1. Protect flows from withdrawals > 10% of monthly annual flow (MAF). A lot of literature has shown that a pretty regular cutoff as far as biotic determinant
2. Preserve seasonal and inter-annual variability of flow patterns (between wet years and dry years)
3. Protect ecoregional and river basin related variability of flow patterns
4. Prevent further water use related impacts to 10th percentile low flows
5. Protect headwaters- we see more impacts on smaller drainages

Decision Support System for ecological flows (DSSEF): 3 parts:
1. Protect the natural flow regime and specifically the seasonal and ecoregional patterns of flow variability
- Daily average allocation using presumptive standard Percent-of-Flow (POF)
- Separate criteria for: 1.) normal and wet years, and 2.) drought years (when streams are already stressed they need a minimum flow level to protect them)

2. Prevent further water use-related decreases to 10th percentile flows
- Pass-by flow flow criteria for minimum flows based off of a P-O-F

3. Restrict withdrawals in drainages <25 sq.mi. and limit withdrawals to drainages 25-50 sq. miles to set limit (e.g. 1 MGD avg. per day)
- Statewide rule, protects headwaters and flow accumulation

All flow criteria should be established using the same period of record to prevent biases.
- Prevent climate, land use, and pre dam-related biases
- Our study uses 1984-2012, 28 year contemporary record
- Reasonable length record most indicative of "current prevailing conditions"

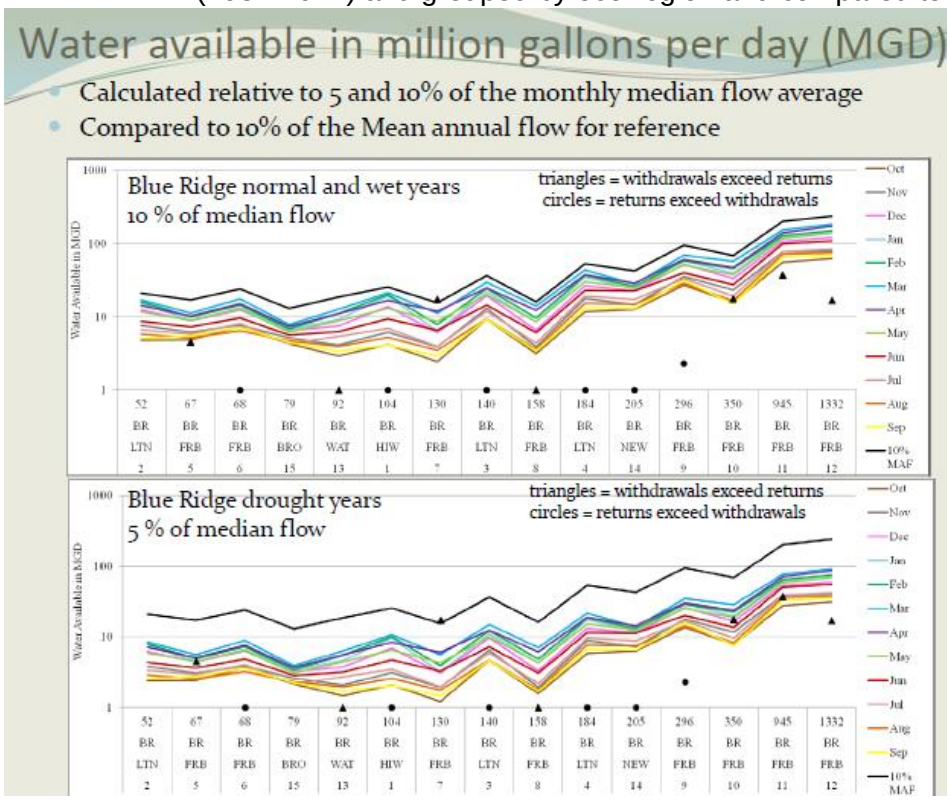
Protect Natural Flow Regime

- **Allocate a percent of the monthly median flow to net water use**
    - **5% allowable in drought conditions**
    - **10% allowable in normal to wet conditions**

- Protects range of natural variability and normal periods of drought stress
    - Calculated from monthly medians, protects seasonal flow patterns
    - Amount available varies geographically
    - More indicative of prevalent conditions and central flow tendency
    - Consistently lower impacts than allocating 10% Mean Annual Flow

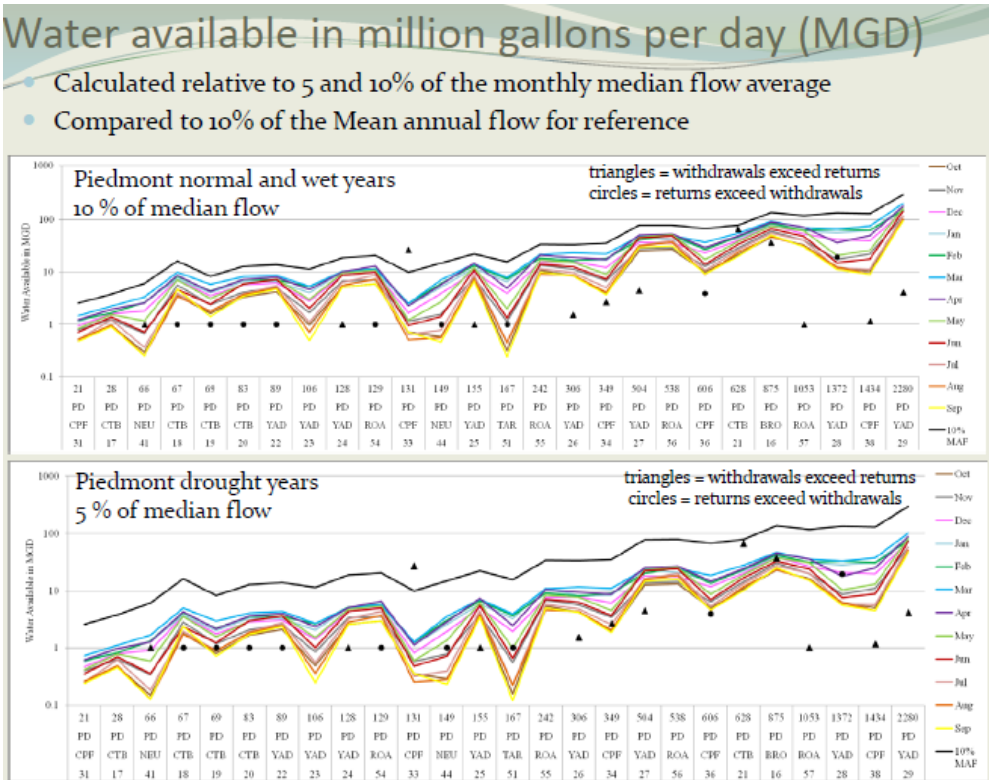
The following example shows this recommendation relative to the 63 gages used in the stream flow change analysis.

- Available MGD calculated from current statewide flow conditions from the current period (1984-2012) and grouped by eco-region and compared to 10% of Mean Annual Flow



To protect natural flow regime- it's not using annual mean flow but annual median flow, using monthly will protect seasonal variability associated with each month.

In reference to the Water available slide- as you move through graphs increasing drainage area…this shows how much water is available relative to that rule as you increase in drainage basin area. Dots on graph represent specific gages. Shows Blue Ridge then acronym. For protecting headwaters, between 80-100 mile drainage area- read graph. Black line is % mean annual flow. Our rule keeps you below that, dealing with median deals with variability across seasons. Then during a drought flow year, less water available you're further below mean annual flow. Triangles represent withdrawals that exceed returns. That is completely allowable with this set of rules. It may put a cap on this withdrawal or require trading scheme. Black circle is where return exceeds withdrawal. Could easily calculate cumulative withdrawals, there are a lot of things that could be done.



Piedmont slide- a lot more variability, still a general pattern, you're still in general supporting current uses with a few exceptions (Neuse, Catawba), for most part the rule keeps you within water you are already using, but gives us an idea of where it.may be important to limit further withdrawal, and gives you idea where there is more water available. Using the 10% median annual flow and 5% you're always below that 10% mean annual flow. Having the variable monthly pattern keeps that seasonal variability.

Q: Tell us where those triangles are on the upper ends?
R: This one is on Cape Fear, not sure exactly where, some are on the lakes, this would be water in the stream but there is more water available in the lake. The return is most likely a lake withdrawal which is why it can be much higher than what is normally available. But the good thing is, the use falls within this, this gives idea of how much water is available with this rule.

You could create a curve or trend line associated with each month. Areas you don't have true flow data you could create a rule based off of drainage basin area for a monthly curve. For March for a 160 sq mile drainage basin this is the amount of water available using this type of rule. It could be extrapolated to areas where you don't have stream flow data. You could even set that with 5% median flow, if a potential project exceeds that then that's a red flag. That would be sensitive criteria, a good way to see how some of these projects might trip a flag.

Coastal region slide: Best way to look at a tighter spread was by eco-region. With the 10% of the median monthly flow, we're falling well within monthly water use now. Again, Neuse pops up, Cape Fear pops up. Looking at those areas and looking at alternatives or smarter ways to use water, or trading schemes. Generally we're well within the water use. It helps to set limits where we know we're already stressing the system.

Protect Natural flow regime, continued.

- Calculated from median flow from the current altered record
  - More indicative of prevalent conditions and central flow tendency
  - Consistently results in less impact than 10% of Mean Annual Flow allocation
- Defines allowable daily net water use
  - Amenable to management because it involves a set-amount that does not vary with daily flow, only monthly and annual flow patterns
  - Net of old and "new" allowances on top of existing users
  - Identifies area where no new use is available

Prevent water use related decreases to the 10th percentile flows

- **Pass-by flows when flows decrease below a percent of the median monthly flow**
  - **60% of median Jan-April (50% in drought years)**
  - **50% of median May-Dec (40% in drought years)**

  - These flows correspond to the range between the 10-25th percentile flow averages for the period of record and provide protection when flows decrease below this range
  - Calculated with same flow record as the P-O-F daily avg. water allocations
  - Varies by month, drainage basin area, and ecoregion
  - Only implemented during infrequent low-flow episodes and droughts
  - Requires daily monitoring of flow conditions

As well as having the % monthly flow, its also important to have a minimum flow, when flows decease below a certain % of median. In drought years you can go a little lower because naturally it would go lower. A graph using the French Broad River was shown as an example. It's fairly over allocated so you could see what that looks like with a gage with flows heavily impacted by water use

Environmental Flow Rules
1. Protect Natural Flow Regime
- 5-10% of median flow as net use, variable dependent on drought regimes

2. Prevent further water use-related impacts to the 10th percentile flow by using pass-by flow in times of extreme drought and/or periodic low flow periods. Pass-by when flows reach:
- Normal years 50% of monthly medians May-Dec, 60% of the monthly medians Jan-April
- Drought years: 40% of monthly medians May- Dec, 50% Jan-April of monthly medians

3. Drainage basin area withdrawal cut-off:
- < 25 sq. mi. no withdrawals, 25-50 sq. mi. limit to 1-5 MGD

4. Manage use relative to climate conditions
- Variable rules for normal/wet years and droughts

There is a summary in the hand out you have.

Questions (Q), Responses from speaker (R), Comments (C) follow:

Q: The diversity impacts on plot- is that the basis for this 10% number?
R: This plot is the basis (Context for Environmental Flow Recommendations slide).
Q: I'm reading the R square as .056. What other things did you come across that could be sources of variability?
R: I didn't include any other variables on this one. From the community analysis, the departure from natural land cover in the HUC showed up as a strong influence on community patterns, so I suspect water quality and land use, some of the other declines could be associated with those. Go back to fish response to withdrawals. This is when we plot the points just relative to water withdrawal. Shows a little negative relationship but due to some of fish survey sites may be a large drainage area, you're not quite capturing how much of impact the withdrawal has on that system. By calculating withdrawal as % mean annual flow for that site, it gives you better idea of effect on site withdrawal can be having.There aren't any other variables of factors brought into the analysis, but you do see change in trend so I think it's telling. In my data set only 10% fell downstream of water uses. Most fish survey sites are above water withdrawals, so most of impacts you'll see will be due to land use change, water quality.

Q: You mentioned density was flat or went up? Abundance?
R: Yes, there is an increase in abundance but could be because diversity could be decreasing towards generalists or tolerance.
Q: Did you try normalizing abundance with diversity because abundance would have impact on diversity. (Shannon weaver evenness scale)
R: No but it could be done. Because I was doing community diversity or abundance, Shannon weaver works best with individual species abundance. So I kept them separate. Trying to get a statewide approach with this, there could be 100 sites, but the 14 provided proof of concept. It would be good to pull out water use effects separate from land use.

Q: This data and these stations for fish community structural analysis, we selected where our metrics work. We do not sample in areas where we cannot prove the concept of our methods. The justification on the fish samples generating the 5% and 10% is rather weak. Issues remain that we want to make recommendations that we are most confident in. There is going to be some uncertainty. The 5% and 10% are good departure points for discussion; the support though is pretty weak.
R: In my report there is a significant literature review that supports the less than 10% mean annual flow, and significant component in review where below the 50% you have significant detrimental impacts to biota. It was a relief that even with the small proof of concept it fell within realm of what we're seeing in literature from samples using hundreds of data points. There is that bit of confidence with it, but I agree you would need to do it statewide. Of the 1200+ stations in NC you may end up with 120-150 points which would give you a stronger analysis, with that you could try to tie in land use and other variables.
C: I also find it interesting that your recommendations fall in line similar to lots of literature's recommendations on % impervious cover, any greater than a 5-10% range shows impacts on biota.
R: This is our opinion to try to accommodate reasonable water use with the least amount of impact to the natural system. I think I've demonstrated that there is plenty of water available for use with these rules, you can use % of flow approach to preserve seasonal variability and that between different ecoregions. The other thing I think is useful, trying to look at (referenced water available slide) relationship of trying to find where we don't have measured stream flow-say in the month of June relative to basin drainage area, you could get a reasonable idea of water available at site. If you are using lower approach of 5%,and putting that into a desktop approach and they put in what they want to withdraw and it falls above this line it may trigger a site specific study. Shows desktop method to identify where you can more easily and efficiently accommodate water users and where they need to have more protection. Going with the protective flow will provide the red flag. There are a lot of ways to use this, to think about how much water you have available in the system versus how much water are we trying to leave in the system. It's easier to think about cumulative water use when you think about how much is available. An example on graph- you can go back and make sure that these water uses don't cumulatively over allocate at this lower point. In all cases you fall under 10% mean annual flow and largely accommodate current water use.

Q: Seems like the 14 points were in the same region where there were concerns with land use changes as well. I'm struggling with how you can draw conclusions that water use is impacting that rather than land use?
R: I'm not saying that, I'm saying that without looking at land use that's the trend you have.
C: If you have land use impacts, withdrawals will be an additional stressor. For locations of concern and where there are red flags I think it still stands.
R: To ease your minds, I have % departure for all of these fish points and could plot % departure relative to the points, though haven't done that, have had an intense time so far- all the work has been done independently by me. There are limitations for what I could physically accomplish this last year. I could do that, I have 2 weeks left before final report.

Q: One of the weaknesses you stated- gages are for wadeable streams. Is that true- seems like a lot of stream gages are associated with wadeable streams?
R: For the 63 gages I looked at, only 10% of those fell in proximity. Not having a major tributary come in, or being closely upstream or downstream without any major flow component coming in.
C: You're referring to monitoring sites not streams in general…
R: yes there are few fish sample sites that were also flow monitoring/discharge gages. That was initially what we tried to do and that was the first limitation we faced.
Q: At the end you talked about monthly median flow or I think you grouped instead of by month, by Jan- April, instead of using monthly.
R: It's still monthly, the difference is for this group of months you're calculating 60% of median, for this group of months you're calculating 50% of the median, to accommodate higher spawning events and spring flows. It's still monthly but the percentile used for calculating it is slightly different. The other reason, seasonally to make sure the dotted line didn't drop below the 10the percentile flow, was using the 60%. I ran through different iterations- goal was to find cutoff that protects the 10th percentile flow (because of impacts seen in the stream flow analysis) and the monthly variability.

Q: Can you explain why the drought years with a different percentage?
R: we naturally have droughts, they are important for freshwater ecosystems. You're accommodating less water in the drought years, you allow them to go fairly low but you still need water so it's still allowing slightly longer…doesn't sound intuitive, because of natural droughts you want to let the system to go that low.
Q: How do you recognize a drought year? A dry winter? Wants the trigger to see that, if you wait until July or August you may have gone too far.
R: Absolutely. My analysis didn't look at cutoff for drought years. But I think it would be a challenge. Recognizing that is something. I think it's important to have variable rules for different years. In drought years you'd take 5%, then it goes into the 40 and 50 variable rule since you're starting with a lower amount. If you have this lower amount then you won't run into having "2 days of water left", you'll have more foresight.

Facilitator: I want to make it clear that this is your last time meeting with us Kim, so if you have questions ask them. In the handout Kimberly has provided, it may be helpful to look at handout to see if there is anything she could clarify.

R: You will also have the actual report, it's not yet ready for distribution. It has a lot more detail, and the full literature review and that covers a lot of questions you were asking. (Becca will ensure group has it)
Q: Can you tell us how you titled the method?
R: Decision support system for environmental flows. The Important thing is the 3 parts of it- % of flow and it varies wet, normal, drought years; minimum flow threshold, and also have a drainage area cutoff where you don't have withdrawals above a certain point. Even if it's not so much the numbers I have, I think those 3 components are important. % of flow to protect variability, minimum pass by flow for drought, and how much water you can withdraw from small drainage basins.
Q: Do you provide more information on the headwaters in your report, small agricultural users for example, that's likely to be centered on the smaller areas. They won't be a constant withdrawal, but periodically it might be important.

C: If you can't protect the headwater streams then don't ask people to register those withdrawals.
C: Registering use is triggered at a 100,000 gal/day threshold, below that registration is not required.
R: The headwater rule is protecting the 1 mgd withdrawals.
C: That's really not that large of a withdrawal.
R: No. I showed even with a 50 mile square drainage basin, you have rough 5- 10% of mgd per day going by the 50% of median

C: The mgd registration, there are a handful of agricultural operations that meet that as opposed to the 100k gpd that is for everyone, not agriculture.

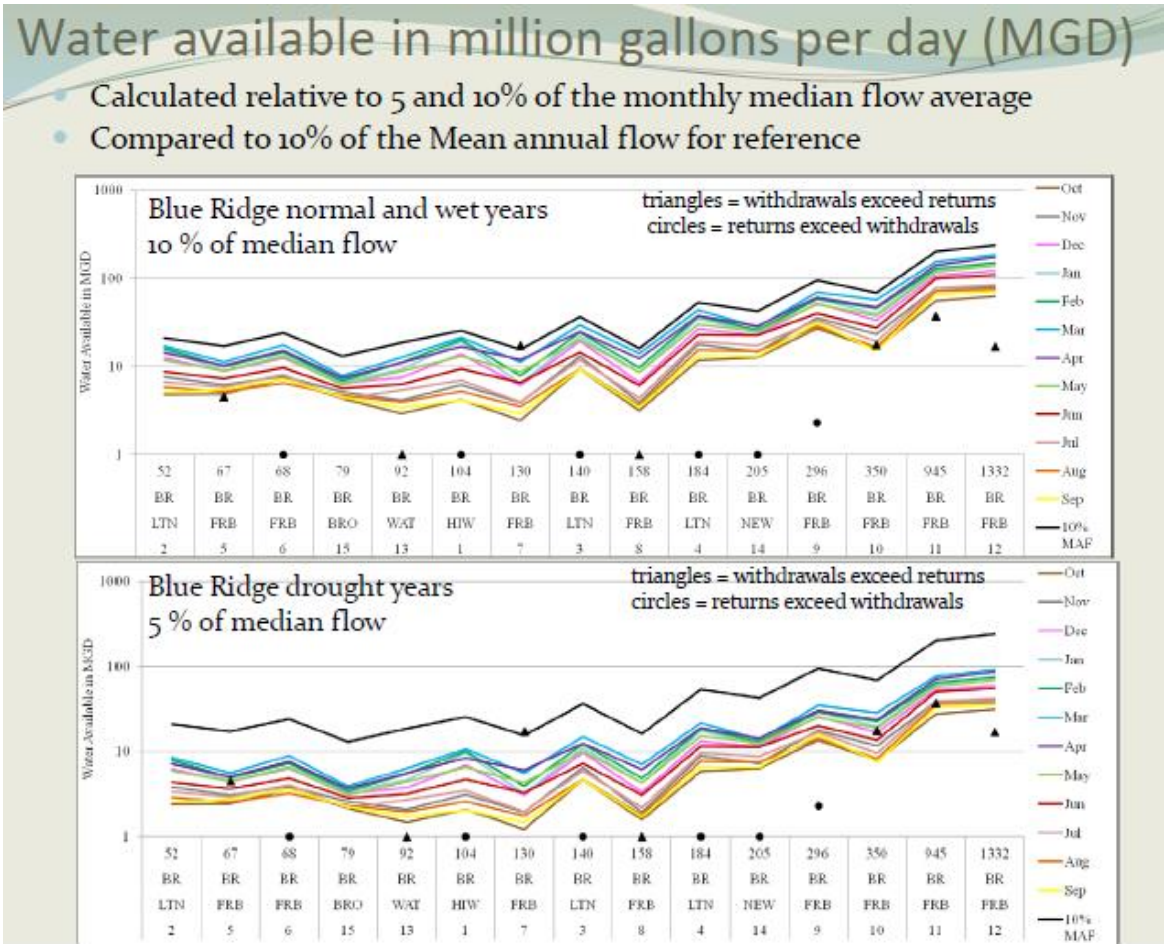
C: Well done, Kim.
Facilitator: if you haven't read her handout, you may want to read it since she won't be here tomorrow.

Q: Regarding the location of the 14 sites downstream of water supply withdrawals- do you know if the water is returned by NPDES below the sites?
R: Those are calculated from net withdrawal, so the return is within that.
Q: I note there is a presentation this afternoon by Tom Fransen, most of it is based on the PHABSIM work and has monthly means instead of medians. We were postulating how the monthly median flows in your characterization compared to those metrics. Is it generally higher or lower?
R: I went with medians because the relationship between means and medians varies across months- some months have more extreme flow values. I wanted to go with metric with the most central tendency in prevailing conditions. I looked at it on a handful of gages to decide it, median showed a more consistent relationship. They do vary, more with the larger drainage basins. I did use the 10% of mean annual flow as a comparison of the monthlies relative to that.
C: If looking at it on a seasonal basis, would the mean or median, a pattern where one would fall above the other at one point?
R: It might be with the mean you don't need the variable 50 or 60, one might work.

End of presentation.

At the end of the meeting, Kim offered to show the group how to better interpret how the numbers were determined.

C: your information is not quite ready to send out, will you make your spreadsheet available?
R: yes. On this map, this represents where the gages are, each gage has a number associated with the gage. This table has the number (map on top) references back to number on the gages, each gage has a unique identifier number, is also on the map, and on the graph with mgds. Shows where it is geographically, the top number is drainage basin area, from small up to largest. Example- This is French Broad gage 12- French Broad River at Marshall. Links MGD available at gage. So when Tom Fransen was doing his, I was looking at the gage he had and looking at mine.



Q: Of Fransen's list, how many are in your report?
R: I noticed 4-5, but probably more. That will give you a reference for what 5, 10 look like at particular gages. If you pull up the presentations tomorrow it may be helpful.
C: We can put any gauge into Tom's spreadsheet and look at it.
R: The black line is 10% mean annual flow, it's a reference you all can come back to. MGD available under this scenario.
Q: You've got them ordered in some way. How?
R: From smallest drainage basin to largest.
C: I want to compliment you on this graph, it's a neat way of comparing it. (Water available in MGD)
C: Request- both agricultural representatives will be gone tomorrow. If there is a need to do a consensus type of agreement let us know or delay it so we can weigh in.

IX. Presentation: General Discussion of the 5 Methods Presented July 16, 2013

Facilitator: Mary Lou Addor

Given what you have heard and read about the five methods introduced today, what was of value to you across the board with these 5 presentations? A couple of you used the word convergence -what were you converging on?

1. One common theme amongst the proposals: the smaller drainage areas need more protection than the larger drainage areas (the main stems are probably more resilient than the smaller drainage areas).

2. 80% flow by is likely not conservative enough for planning purposes and looking at ecological impacts. Planning purposes can be more conservative which puts the burden on site specific analysis.

   The 80% flowby as compared to Kimberly's presentation gives me concern for planning purposes. Been wrestling with the 5%, 10% to the 80%. If we don't know what biological impacts are there, let's plan for them so we can deal with the natural stresses that are going to be out there that cannot be predicted. Recommend we pick something more conservative than 80% flowby whether it's 5, 10 or 15; there's plenty of opportunity to challenge the conservative with site specific studies.

3. Want to see a toolbox not an equation with 4 basic tools:
   a. strategy for establishing flowby goals for main stem rivers (where there was not biological data)
   b. strategy for setting seasonally stepped minimum flows such as 30 40 50
   c. some ecodeficit based tool for predicting biological responses to altered flows
   d. coastal strategy.

   We've talked about how water supply responds, how habitat responds; need to talk about how organisms will respond. The other 3 complement each other very well, but coastal is unknown at this point.

   Question about the tool box approach:
   Q: Is your flow by point only for main stems? If so, what about all the other streams?
   R: I think the point being made here is that we have a lot of ways of representing flows and how we can remove water; we have very few tools to relate that to the biology in wadeable streams and none right now in the large main stem sites.

   We have a plethora of things that we're assuming are protective, but we have very little information to prove that they are protective as relates to this statue.

   R: For 88% of the watersheds that are basically characterized by wadeable streams, we ought to be using the data we've got and the best analysis we have. For the main stems, where the data is limited or non-existent, we ought to set a conservative flowby standard as our strategy. In all cases, we ought to have some sort of bottom threshold that we don't think we should cross – the floor. And then whatever the outer Coastal Plain brings to the table will stand probably on its own.

4. Our enemy here is uncertainty, when we have no database to analyze or work with; we need to be conservative for planning purposes. That makes good planning sense. In actuality, what you do when you have a particular application come in is something completely different than planning.

5. What I heard amongst the proposals is that each presenter believes is he/she is proposing is a conservative strategy, and that everyone is thinking about 2 things:
   a. the dangerous thresholds we don't want to cross and
   b. how to measure what's happening to avoid crossing the thresholds

6. What I heard is that the recommendations need to be adaptable to future knowledge and studies.

7. Time is a limiting factor. We could go somewhere else with each approach, and the recommendations given more time but we need to make the cut now.

8. Heard amongst all the methods is that one size does not fit all- different sized streams, geography on streams will affect the threshold by whatever definition, red light, green light, that we can provide some assurances.

9. Encouraged about the positive atmosphere and commonality of the proposals. [these proposals were independently derived and yet have commonalities].
   a. Proposals are essentially the same in sense there is some % of water distributed over some period of time. *We have to determine – how much and over what time?*

   b. A key piece is when we make that decision how does that affect the stream? We could take conservative approach but how will we have confidence it will protect it?
      i. USGS RTI attempts to demonstrate impacts on 88% of wadeable streams
      ii. EFSAB has 2 tools that can relate: one is the RTI/USGS work and the other is PHABSIM.

      Another way of stating this, is what comfort level do we have with using these data backed recommendations versus maybe a simpler approach more based on literature and studies from other locations? The TNC and RTI/USGS can be difficult to explain with all the statistics and varying percentages and numbers but these methods are based on current data from North Carolina.

      There are limitations as well with RTI/USGS, TNC, PHABSIM and we've acknowledged some of those limitations in our discussions. Thus regardless of whatever we recommend, we will need to be clear about the limitations of whatever data we use to explain the recommendations.

   c. When you rely on the literature, you're relying on someone else's interpretation of their data. If we have to choose between the best available North Carolina data, the best somebody else did with the best available data from somewhere else, or something that's not data based, I'm inclined to go with the best we can do with North Carolina data.[Comment – with any study you are relying on someone else' interpretation if not your own].

   d. I appreciate Sam and Jay's perspective, that maybe we need to be very conservative with the main stems as a planning tool. Although there is RTI data for wadeable streams, perhaps our recommendations are that in areas where data is lacking, we conservatively recommend a protective percentage and then the subsequent recommendation is to ask the state to go out and gather information to increase the certainty of our recommendations.

   e. Certainty is an issue not just for the science board, but for the developer who wants to borrow money to build houses, the bank who plans to load him the money, the municipality that wants people to live there, or for zoning board that wants to provide fire services during drought years. They want to know the water will be there. Everyone needs some assurance that we're really certain or we're on the edge of certainty. I recommend then being broadly conservative. They do not want to be discussing how big a pump to install. So instead of white and black, make it wide and gray, and come way down on the conservative side. That's where we need to make

sure folks understand that we are, especially as we go into different climate scenarios and look across that range of variability in the flow itself.

f. I don't believe anyone is asking to set aside the NC work but the question may be, does our report lead with these ideas? Do we consider the bulk of what other states have done initially and then present the NC work and how it fits our recommendations or something else?

g. With respect to uncertainty, it would be a greater conundrum if the biological response to flow was more of a threshold. Is it 20%? 25%? 31%? What our data in NC shows consistently is that any change in flow stimulates a biological response. Based on the data how much are we willing to accept? The uncertainty is minimal since anything you do to reduce the water in the stream is going to degrade integrity.

   I'd add we chose the flow variables because they have the highest significance level. All of the flow variables produced curves that looked just essentially the same whether it's using the Richter statistics, or eco-deficits.

10. Consider what other states like Michigan, Maine, and New York have enacted, their criteria and justification. Although these are examples of policy framework – it might be helpful to see where North Carolina falls amongst them.

X. Presentation: EFSAB Deliverables & Proposing a Framework for Characterization

Presenter: Chris Goudreau

Handout of EFSAB Deliverables: document was distributed to the EFSAB at the July 16 meeting and on the EFSAB listserv.

Facilitator: It might be helpful to leave today with a brief presentation about the EFSAB's deliverables using a document Chris Goudreau crafted for your review.

Introduction of EFSAB Deliverables Document
Three sections were presented in the document titled: EFSAB Deliverables to DENR: 1) statute, 2) characterizing the aquatic ecology of different river basins, and 3) identifying the flows necessary to maintain ecological integrity. The document was distributed to the EFSAB at the July 16 meeting and on the EFSAB listserv. The following points were made in the document:

a. characterizing the aquatic ecology of different river basins (setting the stage)
- Need to address this charge beyond exploration of a classification system
- Determine a who/what, where, how, when, and why framework to characterize the aquatic ecology using existing documents and databases like the DWQ basin plans.

b. identifying the flows necessary to *maintain ecological integrity* with data from NC, with data from other studies and jurisdictions including scientific theory to justify flow recommendations.

Discussion of the EFSAB Deliverables Document
C: This is good stuff Chris. Would you consider establishing a fish and separately a benthos standard for each basin to be a characterization? We normalize the fish data by basin in the top 20%, and we normalize benthic data by the eco regions for the excellent class. This was just setting the bar for high

standard. In doing so, have we effectively characterized each basin in terms of something? Namely, what is the high standard for the riffle run guild? Namely, what is the high standard for EPT based on data? Can we consider this a form of characterization?

Chris: I don't disagree with that though I'm not clear what was in the minds of those who drafted this statute, as to what they wanted in characterization of the aquatic ecology of different river basins. To me, that phrase is important though it does not indicate the kinds of information that they are looking for and the purpose for separating this deliverable from the actual flow recommendation.

C: Though not there during actual drafting of the statute, I was there during much of the legislative discussion. The conversation tended to wrap around, what are the prevailing conditions, what is the condition of a basin against which changes in flow should be measured?

Chris: I listed this deliverable because I believe we need to have a discussion about what the minimal standard is for maintain ecological integrity. 'Go look at a bunch of DWQ basin plans and there's the answer there to characterize the ecology.' The basis for that discussion is still DWQ's biological data.

C: I would put forth that the characterization request from the legislature was not really the key part of the work. We're being asked to do an impossible task. We clearly understand that there's an effect of flow on the biology but the challenge is to quantitatively come up with a suitable decision threshold that can be used for planning. You know, it's kind of like coming up with a cancer risk factor of 1 in a million, if you will. Only, instead of trying to do it for 1 organism, we're trying to do it for a plethora of organisms.

Let's spend a minimal amount of time on the characterization component -- talk about it, state why we have what we have, how we've richly analyzed the data using available data bases that were not collected for this purpose. Here's what we think and then move onto the additional discussions.

C: I wasn't there for the legislation either. I think the idea of just referencing some of the DWQ basin plans is great – put in 2 sentences. Let's give them what we want to tell them and lay all the data out there (there was a time we were thinking about a classification system). This helps us explain why we might recommend these following approaches. And gives us an in-road to justify why we think small streams should be treated one way, main stems another way, coastal streams another way.

Chris: The reason for this question was in developing the trial balloons, we were asked to respond to two questions: 1) how does the method help the EFSAB respond to characterizing the aquatic ecology of different river basins and 2) identifying the flows necessary to maintain ecological integrity? With respect to the first question, "how does this trial balloon help to characterize the ecology", I'm thinking, most of them don't so we haven't really defined this subject with the exception of the exploration we have accomplished around classification. If we plan to respond to this question, we need to give attention.

C: Along those same lines, we haven't really approached the recovery discussion either.

C: As a lawyer in the room, I will tell you that legislative history has no precedential value and thus writing the statute has no legal relevance. So in support of Jeff's proposal

[let's give them what we want to tell them and lay all the data out there (there was a time we were thinking about a classification system). This helps us explain why we might recommend these following approaches. And gives us, an in road to justify why we think small streams should be treated one way, main stems another way, coastal streams another way].

the language is in the statue, and there needs to be a response to it in the report. But we don't need to find out or understand what the legislative intent was at the time that the legislation was drafted. It's our job to interpret it to the best of our scientific ability, and to answer it in whatever full capacity we can, and then move on to what folks are really going to focus on.

Others concurred.

Jeff made a request that consensus recommendations are not finalized until Jeff (and perhaps others) can review the discussion. David, his alternate cannot attend on Wednesday either.

Lou will distribute copies of the July 16 presentations and trial balloons later in the evening on July 16. She stated that the morning's session would begin with a discussion about the charter and the Report Outline followed with a discussion of the trial balloons.

The July 16 session was adjourned; the July 17 session will begin at 8:30am.

July 17, 2013

XI. July 17, 2013 Meeting Orientation

Members and alternates of the Ecological Board Science Advisory Board introduced themselves and their affiliations. Guests in attendance and the facilitation team also introduced themselves. Everyone was reminded to sign-in who attended the meeting. It was noted that several members were unable to attend the July 17 meeting (Jeff Hinshaw, David Williams, Becca Benner, and Amy Pickle) and

A brief orientation was conducted of the July 17 meeting agenda. Members would first hear from Bob Christian regarding the status of the Coastal Working Group, followed with a review of the EFSAB Charter and Report Outline. The major portion of the day would be reviewing the trial balloons and discussing the value across the board of these proposals and how this work can help the EFSAB meet the charge given to them.

XII. Update from the Coastal Subcommittee

Presentation: Coastal Subcommittee Update and Recommendations

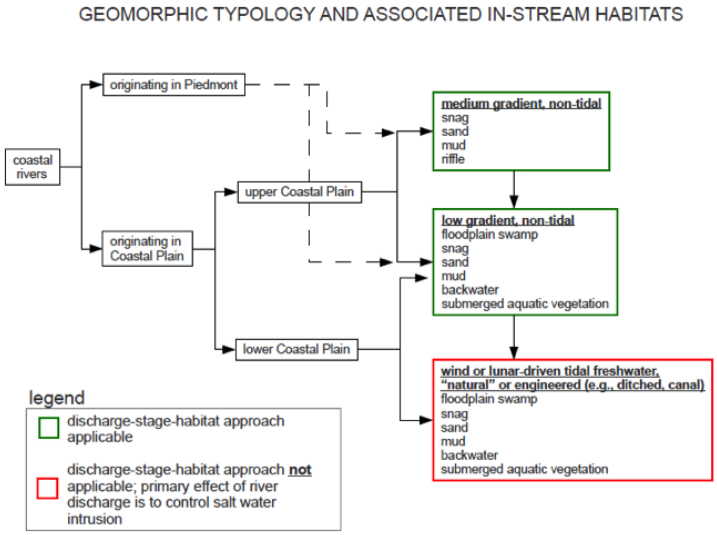
The Coastal Working Group had its third and final meeting on July 15, 2013. Members of the group include:

- Bob Christian ECU
- Eban Bean ECU
- Dean Carpenter APNEP
- Scott Ensign Consulting
- Mike Griffin ECU
- Kevin Hart NC DMF
- Mike O'Driscoll ECU
- Mike Piehler UNC IMS
- Judy Ratcliffe Natural Heritage

- Fritz Rhode NOAA
- Bennett Wynne NC Wildlife Resources

Bob noted that the overall objectives of the group were to: assess applicability of previous coastal work, both in other states and the Greenville study; develop stream typology; advance spatial modeling and mapping; establish what relevant ecological and biological dependencies on flow are; to develop frameworks for potential coastal EF criteria and protocols if possible; and identify factors limiting EF protocols and needed research within coastal systems.

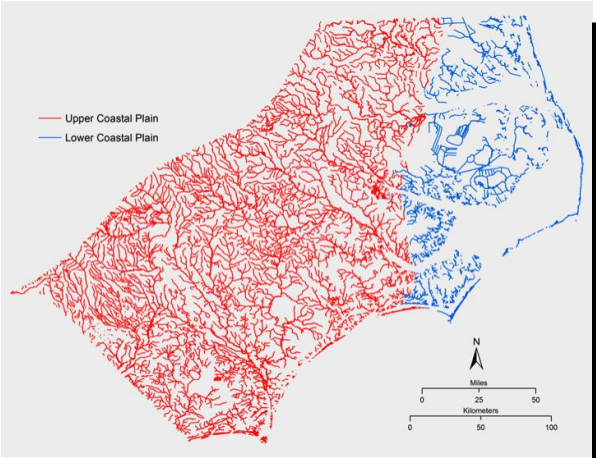
Bob showed a slide showing geomorphic typology and associated in-stream habitats by Scott Ensign. The resultant conditions of flow are divided into three groups: medium gradient, non-

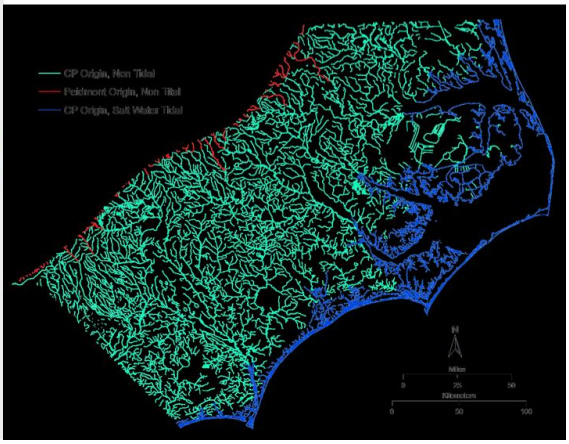


tidal; low gradient, non-tidal; and wind or lunar-driven tidal freshwater, "natural" or engineered streams. He then showed a slide of 5 key stream conditions associated with origin and slope, depicting 3 strategies for ecological flows (EF): one based on discharge to habitat relationship, very similar to PHABSIM. The second is an approach taken by a number of states as well as the Greenville planning document, which is to try to set conditions around the position of salinity, either the amount of salinity at a particular location on the stream or the position along the river where a certain salinity occurs. In other words, one is salinity at a fixed-point; the other is as you move up and down the river, where is the salinity. The final strategy for EF is overbank flow and how changes in water availability or withdrawal would affect the capability of having overbank flow. Eban Bean and Mike Griffin at ECU developed a series of GIS maps based on a variety of datasets: insert slide] showing the Suffolk scarp and delineating the upper and lower coastal plain {slide] showing the streams originating in the piedmont and the tidal streams. The next slide [Natural vs. Engineered]. Bob noted that engineered "ditches" could dominate in parts of the coastal plain. Because our typology, the classification scheme in conjunction with EF determinants is

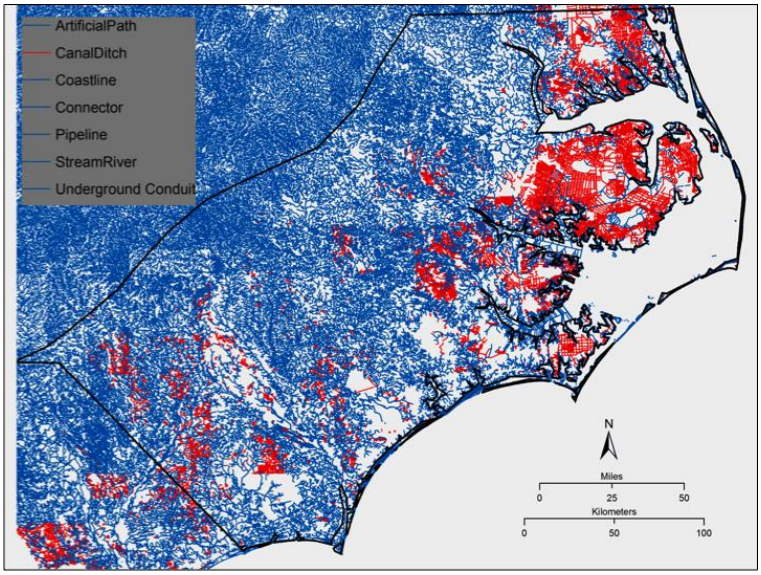
Origin	Slope	EF determinant		
		Discharge & Habitat	Downstream Salinity	Overbank Flow
Piedmont	Medium gradient	X	X	
Upper Coastal Plain	Medium gradient	X	X	
Upper Coastal Plain	Low gradient	X	X	X

Lower Coastal Plain	Low gradient	X	X	X
Lower Coastal Plain	Wind or tidal driven flow		X	X





associated with slope, the group wanted to get a sense of what the slopes of the different streams are. [Kimberly Meitzen, TNC, provided information on slopes of streams, with a range of 0.00001% - 2.9% and distribution of 0.00001% to .2%. The group was trying to divide up the streams into medium gradient and low gradient streams. Where do we draw the threshold?



Eban Bean and Mike Griffin developed, based on the TNC information, maps showing the distribution of low slope and medium slope streams using various thresholds. When you get to slope of 0.001m/m, you see pretty much the main stems and the feeders tend to be the medium slope. By the time you get to 0.0001m/m you no longer have low slope streams.

The group concluded that a good threshold would be 0.001m/m, with any stream with a slope of less than or equal to 0.001m/m being low slope, and anything over that being medium slope. Within that division they divide largely as main stems versus the tributary streams, at least based on those streams at this level of resolution. This threshold of slope relates to other geomorphic characteristic of the stream such

as stream order and catchment size. Going back to the slide showing geomorphic typology and associated in-stream habitats, you have a first cut for the divisions. When the group met on Monday, they worked to establish relevant ecological and biological dependencies on flow, to develop frameworks for potential coastal EF criteria and protocols if possible, and identify factors limiting EF protocols and needed research within coastal systems.

Going back to the model of EF determinants (discharge and habitat, downstream salinity and overbank flow) within the context of the 5 classes (piedmont, upper coastal plain, upper coastal plain, lower coastal plain (low gradient) and lower coastal plain (wind or tidal driven flow), there is a lot of difference between coastal streams, especially low gradient and tidally driven streams, and the types of streams that the EFSAB has been discussing. Because of flatness and proximity to the sea in the coastal plain, ground water and surface water are so closely linked that ground water withdrawal can be important to surface water flow; ground water withdrawal may alter inundation patterns of low order streams, and ground water may be shunted into surface water for agriculture. Also, flow is closely linked to water quality (salinity and dissolved oxygen), so in determining how flow affects organisms you have to take it from a water quality link. Also in the coastal plain, stage is not necessarily well defined by freshwater flow. In discussing what assemblages might be key to focus on in terms of flow relationships, the coastal group chose anadromous fish (upstream spawning, including Blueback herring and alewife (under consideration for endangered status), American shad, Atlantic sturgeon (endangered), Shortnose sturgeon (endangered), and Striped bass (stock status – concern)). Also important are catadromous fish (marine spawning) including eel – (stock status - depleted), and Estuarine species – some of the common low-salinity species that occur in river systems: southern flounder, Atlantic croaker, spot, menhaden, bay anchovy, blue crab, white shrimp, striped mullet. They focused on fish because they are ecologically important, they are economically important, and they have some very real and, in some cases, reasonably well defined links to flow. Regarding anadromous fish, there is a large database for the state, spawning flows are important, flows during larval and juvenile grown and development are equally important, not simply spawning season; the position of the salt wedge is important, and habitat suitability models are available. Bob showed a slide showing at least some of the relationships between flow and spawning. Bob noted that the EFSAB has not gone beyond looking at community structure from the point of view that all species are equal whether fish species or macro invertebrates, and the EFSAB has not taken into account food web structures and the idea that there are foundation and keystone species and that the role they might play is more important in terms of ecological integrity than other species. In thinking about the coastal plain there are 2 foundation species groups: riparian swamp trees for which overbank flow frequency, timing and duration is important as well as salinity and dissolved oxygen, and submerged aquatic vegetation for which salinity and dissolved oxygen are important. Bob then showed a slide showing the 5 groupings of streams and which assemblages you might want to focus on in each category.

Origin	Slope	Assemblage		
		Anadromous Fish	Resident fish	Vegetation (Foundation species)
Piedmont	Medium gradient	X		
Upper Coastal Plain	Medium gradient	X		

Upper Coastal Plain	Low gradient	X		X
Lower Coastal Plain	Low gradient	X		X
Lower Coastal Plain	Wind or tidal driven flow		X	X

The group then identified areas needing additional research: juvenile abundance indices vs. flow and salinity/conductivity; salinity distribution across the coastal plain; quantification of stream typology classes; Roanoke slabshell mussel distribution and abundance as representative of benthos; hydrologic metrics and characteristics of coastal streams; determine reference flow regimes for each river basin; and balance of withdrawals from and discharges to coastal streams. Largely, at least initial data is there but has not been analyzed.

Q: Why do you say the Roanoke slabshell mussel is representative of benthos and, therefore, important to determine their distribution and abundance?
R: It is a species that is distributed in the coastal plain; we think it has anadromous fish hosts and usage. It can be pretty abundant; it is long-lived. In the Greenville study there was suggestion that they were seeing dead animals whose deaths were attributed to the salinity wedge moving up over the existing beds. If that is true and that could be investigated across the larger main stems, it might give a long-term monitoring opportunity to see how that might influence distribution and abundance and also reflect back on flow.
R: I don't want to challenge that; I understand clearly what you say; it's probably not representative of benthos, but it is probably providing the other things you mentioned.
R: I don't know if it is representative of the benthos. It certainly is a component of the benthos. It is a relatively non-mobile species that can tell us a lot about a given location in the system.
R: We (DWQ) have invested a great deal of time trying to use benthos as a good indicator in our estuarine systems. To be perfectly candid, we have pretty much failed miserably. Not that we have not collected a lot of data and done a lot of work, but we have not been able to find good indices or good representations within those benthos communities that are widely applicable. I would just suggest that the slabshell stuff is good, and I would like to see you keep it included, but I do not believe that it is representative of benthos. The benthos challenges are very similar to the other challenges that you have gone through: water quality dependence, salinity dependence, slope dependent and all these other features as well as there is just so noise in the benthos signals that we aren't able to tease those out and be able to support using benthos as a good indicator. That's related to water quality parameters, let alone the flow parameters. I really don't think the benthos offers us a lot of help as it relates to the flow relationships.
R: I think this species, if not taking it as representative of what DWQ is trying to achieve with benthos and macro invertebrates, I think does have real potential as a bio monitoring feature in our coastal plain.
Q: For flow though?
R: Yes, in the sense that if there is relationship between the salinity wedge and freshwater discharge, this might be one metric that can be evaluated, tying it to an ecological component of the system as opposed to strictly flow versus a chemical feature being measured, for example.
R: I want to add that although it may not be representative of the benthos, it does give you a good indicator of how the salt wedge is moving up the stream. In the work I did on the Savannah, where we were doing salinity studies with drought effects, looking at alteration of freshwater outflows and trying to

identify how the salt wedge is progressing upstream we had dead mussels where formerly there were stable freshwater flows, indicating that the salt wedge had come up that far and had killed those bottom-dwelling organisms. Since then that has been tied back to salinity measurements in the stream. I think it is good measure of alteration of freshwater outflows in some of these systems to help establish where there has been that change.
R: I think that is a real good idea. We have so little controls, dams if you will, down in the coastal plain that I think it is going to be a challenge to tease some of that out, but I am all onboard for trying to explore that.

Q: Do we know what the fish host is for the Roanoke mussel?
R: Some research has been done, but off the top of my head, I don't think it has been very strictly defined. It has either been attributed to anadromous species due to their distributions throughout their range, or there may be some laboratory evidence. I am not sure which.

Q: How vulnerable are beds of Roanoke slabshell mussels to Asiatic clam invasions?
R: The Asiatic clam is ubiquitous in NC. I would say that every bed of Roanoke slabshell mussels probably shares that space with them. There are probably very few that don't have them.
Q: Are they replaced by Asiatic clams?
R: I don't know of any species that have been replaced by Asiatic clams.

C: I was part of that study reviewing the Greenville project and I think Mark characterized it well. Instead of Roanoke slabshell being the only species, it is any of the freshwater mussels that are influenced by the salt wedge, and conversely, the other way around, some of those estuarine species that move up the river during drought periods, then when we get higher flows again, they get killed so there is that shifting of band over long periods of time of what species you are going to find. I think Mark's characterization of the benthic fauna that changes in relationship to the salinity and DO is a good marker to use.
R: These are points well taken. Again, because of the group we had assembled, we probably did not do justice to the benthos.
C: I just don't think that we are going to be successful in the time we have to deliver relationships.
C: I don't think the coastal group is really seeing a likelihood that we would have a product between now and October 30. The slabshell is one of the few species that has high enough population densities that you can actually look at population and look at metrics that you are not usually able to look at with freshwater mussels because of rarity and patchiness. That's why that species came up in the conversation.

Bob: We had some discussion about the fact that we really don't have a good handle on the metrics of flow in the coastal plain especially in some of these areas where you have bi-directional flow. Probably it would be beneficial to have an analysis of several of the gages that do exist down where you have bi-directional flow and try to analyze the information based on some of the metrics that we have for uni-directional flow and try to get a handle on what metrics of flow or stage would be useful and what would be reference conditions for these looking at the long-term records. Finally, there was discussion about the balance of withdrawals and discharges, which I heard yesterday.

So where is the coastal group? We are certainly not far enough for a trial balloon. I'm thinking that what we will perhaps contribute for the coastal plain at a level where the EFSAB was about a year ago elsewhere in the state. That's hard to stay, but we are going to be short of suggesting a percentage of reduction of flow or eco-deficit or anything like that. We probably will not be quantitative; however, after what I heard yesterday and some of the extrapolations that Kimberly was able to do into the coastal plain with her data, it may be that at least for medium gradient streams, we could extend some of that information into the coastal plain and not just say it's the coastal plain and we can't do anything about it.

I think there might be an extension of what is decided here into the coastal plain. I don't think that's going to occur for the low gradient and tidally dominated streams. I think we need to have a better idea of gage/discharge relationships and maybe begin to understand a little bit better about, for the conditions in the coastal plain, what are the relationships between discharge and stage and what proportion of stage is controlled by discharge. I think there are some statistical analyses that could be done. I don't think we are actually capable of doing those analyses for this group in the time allotted, but we can at least give some direction. We have to highlight that water quality cannot be separated, and the key assemblages of organisms may be different from the guild structure we have talked about here.

C: I think it is very logical. There are a number of things up there I had not thought about and it's very insightful. I can't help but think about the recent discussions about the discharge from the Vanceboro quarry where we are actually adding flow and what kinds of changes we expect from that. I try to run that scenario through my head if we were reversing the situation, taking flow out; the same connections make sense to me. I am pretty impressed. The contribution of the coastal component to the EFSAB also seems to highlight one area, which we have not talked about much, which are the goods and services. The goods and services in the coastal area are extremely important, not just in the quantity of flow that is available, but also in the harvest of these commercially important species. So I think you all have done a really good job.

C: I really appreciate the quality and the hard work that you present. One comment, it seems to me that salt intrusion and DO are both powerfully influenced by flow, and it seems to me that in the coastal plain they may be powerfully influential on the integrity of biological communities. I know that both USGS and Weyerhaeuser have been tracking those data on the Roanoke intensively for decades. There may be very strong salt intrusion and flow DO curves and literature available for the use of your committee. My second observation is that what you have or don't you have to get it written up in 2.5 months. Be thinking about how to frame this as advice to DENR for finding the missing pieces of the puzzle and coming up with some sort of strategy for conserving ecological integrity in the coastal plain. It has to be based on flow. I know that stage may be the most important thing to track, but flow is what makes it and that is where we have to get vis a vis the legislation.

Bob: In response, I am glad that Dean is here because APNEP and its comprehensive management plan has ecological flows for the Albemarle/Pamlico as a priority item. Dean intends to continue the work of this group beyond the length of this EFSAB. You're right; we have an immediate goal, and there is a longer-term opportunity through APNEP.

C: Maybe the most important thing in the coastal section of the EFSAB's advice to DENR is to hand the ball off to APNEP. Here's where we need could get, and here's where they need to take us.

Bob: I could write that up today.

C: That Greenville study was really interesting. When we first went into that, we were dealing with both the freshwater component upstream of their intake and the transitional area down below where the salt wedge was. We tried to come it initially with the traditional approach of flow studies and, essentially, got nowhere because with the stage issue, for example, you can have very widely varying flows yet the stage will change only a little bit. It has nothing to do with flow; it is all dealing with tide and wind. Where you have ended up with your path so far is very much where we came to in that study that went over several years.

Bob: That study was influential, at least to me, in terms of how to approach this.

C; Along those lines, I would find a way to highlight the importance of wind and climatological events in

the coastal plain a bit more strongly than we have elsewhere.

C: Another thing, in the table that had the species represented, I wonder, for the resident fish you have it down for the lower coastal. Is that the estuarine assemblage that you were talking about?
Bob: Yes, those animals in the sort of tidal freshwater. Again, we were thinking more about fish. It think one of the things that has come out of this is that a little more thought needs to be given to the benthos.
C: We did discuss resident fish as in striped bass and some other species did come up. They would be of interest in both the upper and lower coastal plain. We were thinking about data sets and what could be mined in relationship to the types of features that we identified - the direction we were thinking of going with salinity and so forth.

Q: Did you all do any geographic discussions on northern versus southern and the significant differences there are between those?
Q: In the fish assemblages?
R: No, more in general, in flows...
R: Yes, we did because I am so centric on the Cape Fear system; it is different from the Tar/Pam or Roanoke. So we did discuss that there are variations between the basins. We need to be basin-specific when we look at these things.
Bob: This is buried in the one sentence fragment. We do have to look at the north and south differences.

C: I want to get back to the mechanics of the slope and differentiation, that threshold between low and really low gradient streams or what you call medium and low. At what point can you measure flow in these? Is there a threshold for flow measurement that is noticeable, visible in a surface type of velocity or directional velocity or even measurable with a flow meter? I have fooled around with some of these and I want to make sure we have that building block there to make a meaningful dichotomy between flat and really flat streams, and is there a threshold that has something other than the numeric coefficient that we can point back to.
R: The way to handle this in a document would be that this represents a potential threshold, but obviously we need more information to deal with how that geomorphological gradient relates to flow itself. Somebody may know. That's a very good point. The idea of a threshold here is in some ways artificial. The relationship between flow and gradient probably would be even more artificial in terms of setting it as a threshold. But there is something that, from the point of view of flow, it doesn't matter if it is this or twice or 5 times higher. You make a good point.

C: I'm going to sort of state the obvious. On the Cape Fear where you have a very strong flow-dominated system, if you are talking about the lower coastal plain, you are going to be subject to some pretty wide swings between years for some of these estuarine species depending on what flow does during the recruitment period. I don't know how you handle that.
Bob: Yes, again, that makes that area particularly difficult to deal with. You're talking about the tidally driven?
R: Yes.
Bob: I don't know. I don't have a solution.
C: We (Duke Energy) have some extensive historic data on the lower Cape Fear. The down side is that is that it is probably too far down into the estuary for what you need, but if you want to get with me, I can share what we have.
Bob: Okay.
C: To carry on with some of that, my old agency has a lot of information above Wilmington. The estuarine-dependent species, many of them, spend their first three or four months in fresh water: blue crab, white shrimp, southern flounder, and spot. Also, when you talk about estuarine dependent species, you are talking about their resident time in the fresh water.

C: I understand that this is the EFSAB, but I think also it is about water quantity. If you are in a very low flow system, like a zero flow system, you are going to be concerned about quantity, and water quantity is going to be influenced by water extraction. Like what Amy was saying, we don't need to just tie our hands and say well, we can't talk about flow if there is no flow to begin with. We can say that in some of these areas we need to talk about fresh water quantity in its simplest form if we have to, if we are limited to. There just may not be current. It's still an issue, and I don't think we can ignore it.

Bob: The coastal group is not meeting again. I will try to have something still more developed next month.

C: I just wanted to add since in all these basins DWR is focusing on OASIS modeling and given the fact that we are not going to be doing OASIS modeling in these reaches, that's going to require some other methodology for other monitoring or planning for those areas so the post-processing we talked about in the other part of the basins where OASIS is going to be used, it is going to be another modeling effort that can handle tidal and variations in flows or some sort of spreadsheet post-processor type of thing. Since it is DENR that is the main recipient of this, there are sister agencies within DENR that can offer expertise in this regard. DWR is certainly willing to partner with sister agencies once we figure out how we want to proceed.

XIII. Review of EFSAB Charter

Presenter: Mary Lou Addor

TITLE: Presentation: Review of the EFSAB Charter
Presenter: Mary Lou Addor

Mary Lou Addor reviewed the Charter with members of the EFSAB. The EFSAB did not make any major changes to the Charter who serves as a working document for the EFSAB.

The EFSAB would like members and their alternates who served the EFSAB but are no longer serving for various reasons to be listed in order to recognize their participation and contributions. In addition, the full list of EFSAB members and alternates will be included on the Report to the EFSAB.

There was request for DENR to continue to inform the EFSAB about the status of their recommendations for at least one year following their Report to DENR.

The EFSAB decided to list the EFSAB members and alternates who served previously but are no longer serving for various reasons in the Charter Appendix and the Report Outline. The list of former EFSAB members and alternates are:

- Jessi Baker, NC Division of Marine Fisheries (Alternate to Bob Christian, Eastern Carolina University)
- Donnie Brewer, Environmental Management Commission – Water Quality and Water Allocation Committees
- Cat Burns, The Nature Conservancy (Alternate to Sam Pearsall, Environmental Defense Fund)
- Vernon Cox, NC Dept of Agriculture and Consumer Services (Alternate to Dr. Jeff Hinshaw, NC State University)
- John Crutchfield, Progress Energy Carolinas
- Jim Mead, Division of Water Resources

- Steve Reed, Division of Water Resources (Alternate to Jim Mead, Division of Water Resources)
- Arlene Roman, City of Gastonia (Alternate to Linda Diebolt, Local Governments)

XIV. EFSAB Report outline discussion

Presenter: Mary Lou Addor

TITLE: Presentation: Review of the EFSAB Report Outline
Presenter: Mary Lou Addor

Mary Lou Addor reviewed the most recent EFSAB Report Outline that was distributed to the EFSAB in July (hard copies of the document were provided at the July meeting).The document was labeled:

Preliminary EFSAB Report Outline and Discussion Points - DRAFT 2 – 7/10/13.

The Report Outline is introduced as follows:

All working documents are included in this document except aspects of a source document "guidelines to aid recommendations" as may be appropriate.

Note: *The research assumptions enclosed are currently limited to the RTI and USGS research as well as sections of the recommendations. The report from the EFSAB to DENR will eventually include a comprehensive view of what has transpired particularly with respect to the research assumptions and a more comprehensive set of recommendations. Thus others may be involved in drafting these sections.*

This document and its contents will require a full review by the EFSAB before it is endorsed by members and submitted to DENR.

The Report Outline is still divided into four sections: Preface, Research Assumptions, Recommendations, and Summary and Conclusions. The EFSAB Framework for Recommendations is listed as an attachment and it is recommended by the facilitators that this section is move to the Recommendation section once additional changes are made to the Report Outline.

The drafting subcommittee met prior to the July 16 and 17 meeting to make minor edits to the Preface section and major changes to the RTI/USGS section.

Major Points of Discussion
During the July 17, members commented that the Report Outline is too RTI/USGS centric and that other research that has transpired, been conducted and considered, and should be included in the Report to DENR, in part to demonstrate the thorough examination that the EFSAB has conducted. The EFSAB is currently focused on providing recommendations at the July and August meeting, and intends for the writing to occur in an iterative fashion between the August and October meetings.

Members of the EFSAB would like 3 to 4 sentences to describe the other presentations, literature and/or research that has been examined by the EFSAB and as requested in the legislative Charge, listed in the Report. It was not decided who would conduct this work.

Members of the EFSAB generally support the idea of referencing in the Report to DENR, weblinks to the NCWater.org (DENR site) or other information, when discussing supporting documents, research, and larger research documents.

The EFSAB was informed that the Report to DENR will be due by the end of October. Members were still asked to hold the Dec 3 meeting which could be readily cancelled at the October meeting.

Lastly, it was mentioned that the T&E subcommittee's recommendation on T&E species has not been added to the Report Outline. [Note: Mary Lou Addor has added the recommendation to the Report Outline – Draft 2 – 7.20.13].

The Report will continue to be updated; the EFSAB will be apprised of any updates and the Report Outline will be distributed for their review when the next round of major changes are made.

XV. Proposal: Afternoon Agenda Discussion

Nine recommendation topics were proposed by an EFSAB member to the EFSAB for the afternoon session. The objectives for the afternoon was to discuss the common threads of the 5 Methods presented on July 16, including what each method offered as a way to develop recommendations. Other data would be incorporated as appropriate.

The 5 presentations of proposed recommendations included:

1. Alberta Desktop (presenter - Chris Goudreau)
2. Decision Support System for Environmental Flows (presenter - Kimberly Meitzen)
3. 20/30/40% and 30/40/50% of Annual Mean Flow (AMF) and Mean Monthly Flow (MMF) (presenter – Hugh Barwick)
4. 80 Flowby (presenter Tom Fransen)
5. Establishing Ecological Thresholds (Ad Hoc Water Coordination Group)

The afternoon agenda included nine topics for the EFSAB to discuss and develop into recommendations. The nine topics were:

1. Characterization
2. Maximum Allowable Withdrawals
3. Flow-by Goals for larger river
4. Seasonally –stepped Minimum Flows
5. Method for predicating bio-responses to Altered Flows
6. Listed species trigger
7. PHABSim as strategy for site-specific follow up
8. Coastal Plan Strategy
9. Adaptive Management – Future Research

Note that some of these topics changed as a result of discussion.

XVI. Discussion of key concepts about ecological responses to altered flows

At the beginning of the day, Tom Cuffney asked if the group could talk about: ***What are key things that we know about ecological responses to flows? (from the literature and our investigations).*** This item was added to the agenda.

Comments from EFSAB members about this suggestion:

- That to me is a very broad point of discussion. Given our timeline, I don't know if it's a critical need.
- In expanding discussion in report in talking about stream class etc., that we can't do it there.
- There are general things we can cover in 5 minutes that can serve as templates for evaluating methods for allocating flows. I've noted them and can share them (list follows).

Tom shared his list. Following is that list of concepts regarding ecological responses to flows. The list has been edited based on comments by the group that follows the list in this summary, and also comments made after lunch.

Concepts regarding ecological responses to flows

1. It's important to maintain as natural a flow as we can, (changes in frequency, duration, timing and rate of change, magnitude cause damage).
2. To do #1 requires small time step (such as daily). An annual value will not capture the flow regime.
3. Urban studies show and increase in frequency and duration at low flows creates degradation.
4. Droughts and drought conditions are natural, but are extremely high stress events in the ecosystem. Increasing frequency or duration of drought flows will lead to degradation.
5. High flows are important. Streams must get at their floodplains (with consideration of frequency, duration, timing, magnitude). If that doesn't happen you'll change biology. In coastal and lower piedmont streams, high flows also needed for salt and dissolve oxygen management.
6. Size matters- the smaller the system the less it can stand if water is taken out of it.
7. Minimize distance between removal and return. The smaller the gap is the smaller section of stream affected by flow. Interbasin transfers are undesirable.
8. We have few tools that directly assess the biological effects.
    - All the tools point to adverse affects even at relatively low levels of withdrawal. (biological response begins at the origin of the graph and changes continuously- there is no threshold.)
    - Models are all highly variable. There may be a high probability that the models currently do not offer enough protection to the resources.
    - The models will continue to improve over time if thoughtful studies are funded (adaptive management approach).
    - PHABSIM is not a direct but is an indirect measure of effect. But probably will be the best site specific method that we have.
9. All this leads to uncertainty, so we need to be risk adverse in recommendations, and narrow those over time as more data is available.
10. It is possible that a watershed may not currently be supporting stream flow requirements for the ecology of the system.
11. There may be additions to this criteria list based on review of reports & presentation.
12. Impacts to biology when small amounts of flow are withdrawn may be attributed to water quality (though benthos are more affected by water quality than fish).

    Comments (C) about the list included:

    C: In reference to word conservative (risk adverse, models do not offer enough protection to the resources). Err on the side of caution.

    C: I'm pretty simpatico with everything mentioned. But words matter and our word-smithing of how those statements are conveyed will take some effort.

    C: My primary purpose of doing this is to capture the science in the literature and the stuff we've

done, but also assessing the different approaches, which are the same approach but with different flow recommendations, in terms of whether they are producing these types of results.

C: These are things that would go in research assumptions; we need to communicate this within the board and beyond the board.

C: Amendment to the original list- high flows in floodplain are also critical in coastal plain and lower piedmont for salt and dissolved oxygen, and frequency, duration, timing and magnitude are also important and should applied to accessing the floodplain. Biological response to flow alteration begins at the origin of the graph, there is no such thing as a lower limit to biological response based on flow alteration (in all literature we've seen).

C: These should go in the preface of the report, as the foundational concepts that research shows, that recommendations are built upon- we need to communicate this within and beyond the board.

Facilitator: What I heard is that these might be of value in helping to evaluate the trial balloons. These can be discussion points right now, though people need to be comfortable with the list before we can talk about having them go external..

C: To address the models being too conservative, we're providing the science and we're not taking care of the policy. If you look at the state of Washington, they have flow requirements in 26 watersheds. They are primarily driven by anadromous fish, though they do not have enough water in watersheds due to natural or manmade impacts. They are taking it off the table for intake for water supply- you need more water than that is in there now. Where that state is dictated by anadromous species, it may be different than T&E species, it may be that a given watershed may not have enough water as currently exists. If industry wants to take water out, they don't want to hear it but it may be the case.

C: Something that would be helpful- going back to some of other reports that have been shared, they have similar stuff. I can go through those and see if there are some other concepts to add to this list. This list is a great start. We may want to spend a little time to see if there are other thoughts we've overlooked.

Facilitator: To be clear, this list was a way to assess the conversations about the 5 proposed methods/trial balloons?

C: yes but it also fits into report as a nice synopsis here's the state of our understanding of what the effects of flows are on fish and invertebrates, and then here is the research we did that is consistent with that (like the RTI stuff). I think fleshing it out is helpful.

Facilitator: So we could use it today to frame the discussion, AND more concepts could be added to it, and we could continue to present those?

C: Yes

C: To follow up as a devil's advocate, what I have seen in graphs, if this is a discussion of what data shows us, if you have condition of the community (not ecological function) or habitat, then 2 factors that control it are flow and water quality. Flow may have linear relationship to condition of community, but I've seen it gets hidden when you have flows very close to natural flow, hidden by water quality issues. It's difficult when talking about looking for boundaries that are 5 or 10% away from natural flow, to identify those changes as flow related, when compared to 20,30,40% away from natural flow. the control over variation in community it seems that you see the evidence of

flow impact when flow is further away from natural. Do people see it that way? (please restate it) Restated- the condition of the community is much more driven by water quality when flows are close to natural. Saying that flow is linearly related or that any small change in flow has an impact on community is difficult to say when approaching natural conditions when water quality may have impact.

C: Grossly overstated, that is probably accurate based on our benthos work, based on our fish work it's more related to habitat than water quality. The major issue I have with that, is our marching orders are not to evaluate a measureable effect on biological communities, but to look at ecological integrity as defined including goods and services. This is one of the dilemmas I've had. I'm fine with statement that flow alteration yields a biological response. Does that meet definition in legislation of impunity on ecological integrity, I'm less confident with that. Harmonious with what you're saying with low flow withdrawals and water quality and habitat things. I'm good with saying on one hand, any flow alteration we expect to see biological respond. But at minor withdrawals (5, 10, 80% flow-by whatever) we are more comfortable or less uncertain that they will have impact on ecological integrity. That's why I said the way we word it is important. I agree with everything on the list, but don't want to come across that we as various bureaucrats changed the basic driver we've been asked to work on from definition of ecological integrity including goods and services, into alteration of the community structure.

Action: Chris Goudreau offered to look through reports to see if there are other concepts that could be added to the list.

The list was typed up over lunch and shared on an overhead after lunch. The facilitator said she wanted to see if the list was acceptable to the group, and to see if any additional criteria are needed, and if people were comfortable using the list as potential criteria. The following comments were made.

C: High flows are needed for salt and DO management, not accessing the floodplain.

C: Since we don't have proxies representing who is absent, there is some ambiguity over whether we're meeting everyone's comfort level.

C: The important thing is not comfort level but does this represent the state of the literature. That is what we're trying to capture

C: That seems like a weighty decision if we're putting that level on it.

Facilitator: If it's not something that everyone feels they need to agree to, then the other way to go is to simply add on to the list, but then we need the opportunity for people who have different views to share.

C: Then are these the only criteria for reviewing? I don't know that these were intended as criteria, but as some fundamental concepts related to this process. I've never seen them, there is some truth but how accurate they are or if they are universally applicable, I don't know. We're shifting gears from what I thought we'd do today.

Facilitator: then what do we want to do with these.

C: Our goal is to look at flow vs. ecology. This is the current understanding of flow vs ecology.

C: I'd disagree with #7 from the point of what our task is.

C: I'd use these, as I address issues under list of possible recommendations, I'd ask if what we're

recommending align with what we believe is true. This is a fair summary of what we think is currently known in literature of biological response to flow.

C: I see that, this should be a rough list to be considered. We will recognize some weaknesses if there are any.

Facilitator: That would come out in the discussion of recommendations.

C: Probably take out language in 7 that interbasin transfers are undesirable.
C: If we're offering a science basis to consider, #7 is true.
C: This is a list of things to keep in mind, if you don't keep them in mind, no one will know.
C: At the coastal meeting, it came up that if a withdrawal is groundwater and a return is surface water, that is a problem.

Facilitator: We'll characterize them as things to consider, though not agreed upon by group at this point.

C: As we look at scenarios it's important to evaluate them with these considerations.
C: Amend 9D to say best site specific.
C: May be better to use different word than conservative. Risk adverse.
C: Good choice.

Facilitator: so we accurately captured those? (head nods)

XVII. Discussion of Topics for Recommendations

Assessment of the Trial Balloons/Proposals

The Board used the framework of 9 topics suggested earlier by an EFSAB member to discuss the 5 methods/trial balloons/proposals that had been presented on July 16. These discussions and draft recommendations follow. Topics of discussion are underlined, with the discussion and decisions following them.

Characterization Discussion

The following includes suggestions for how to approach characterization and discussion surrounding those suggestions:

1. The work of the Ad-hoc Working Group of the NC Ecological Flows Science Advisory Board informs characterization. On pages 6-7 of their preliminary Report Outline and Discussion Points, that characterization is outlined as follows:
    a. For comparison purposes, biological data must be normalized. The EFSAB recommends normalizing fish data to trigger basin (HUC 8) and benthos data to Omernik Ecoregion Level III; and
    b. Characterize each modeled stream segment according to the record of flows and the biological or habitat response curves for the biota most sensitive to changes in flow.

Q: What about non-wadeable streams, which were not covered by the data used in the RTI/USGS work? What needs to be done there?
R: I expect that under the Further Research topic at the bottom of our list [of discussion items for the

afternoon] we will have things to say about improving all of the other items on the list, so we don't need to do it as we go.
R: Okay

2. The TNC proposal addressed characterization. Discussion highlights included:
    a. That work suggested that size should influence our level of protection.
    b. Precipitation and temperature were significant, although I have concerns about the confidence level of TNC's results. Their r-square values were so low (0.05).
3. There are a gazillion things you can say about watersheds. How many of them do we need to address in our stipulation about characterization? I'm thinking known hydrologic characteristics and known aquatic biology gets it.
4. Two things come to mind: What are the metrics you are going to use? We recommend Shannon Index for characterizing the community or species richness or the percentage of the community that has effective tropic level above primary carnivore. There are different ways to characterize the biology. Along the same lines, there are different ways of characterizing the flow, including eco-deficit, etc. How detailed do we get in terms of our recommendation for what should be characterized, what are the metrics of characterization? The second point, does any of this deal with cumulative impacts, and should that be part of the characterization? A third thing is that this is all based around the TNC approach. Do any of the other approaches require a characterization that is different from the TNC approach?
5. Items 1. And 4., above, are based on the RTI/USGS approach.
    a. What RTI/USGS recommended was pretty general. That work recommended normalizing fish data and normalizing benthos data in two different ways and said that biological responses should be determined for flow alterations. That's what the draft currently says. What that work did was calculate flow based on PNV then calculated flow based on current land use and looked at the delta and said that that is the baseline eco-deficit. How much additional eco-deficit do you get if you change the flow and how does biology respond? The work showed that for fish we need to use the Shannon diversity index because it give us more data to work with. For benthos, we did not need to; we used the EPT species richness. There is a little bit of difference between what RTI/USGS recommended and what they did. We took what we recommended and refined it when we did it. I don't know if this group wants to get that far down into the weeds with the recommendation, or not.

    One thing we can do in writing this up regarding the characterization, we can characterize by hydrology, biology, geomorphology, and other aspects. We can make that statement then say that we are focusing in on the hydrology and biology. Then it is clear that we acknowledge that these other aspects are out there, but they are not necessarily central to where we are going. Then give the explanation and the details about what we are focusing in on.
    One research group did.
    The presentation on the 30/40/60 approach characterized according to general fish communities and physiographic provinces. Someone could say that it is biological characterization approach. If we put the bigger picture out there we can say that we could look at all this stuff but it is not necessarily germane to where we are going and say where we are going specifically.
    I want to add to the magnitude of that. For the invertebrates, we looked at over 1700 sites and calculated over 105 metrics for each site. We can list the table of metrics but I don't put all that data in a table somewhere but that is what the characterization was. Then we boiled it down from that to finally get into a recommendation for EPT, which was most relevant.
    I think that is the way to capture that. We did all this other stuff but here is we ended up and why we ended up there.
    We could just include a table showing all the things we considered, and here is where we want to go.

I think we need a subgroup to make a separate fresh look at independently characterizing the ecology of each and all of the basins just in descriptive terms that we can pull out of basin plans and that sort of thing just to characterize the ecology.
By look at you mean write.
Yes, look at and write in a document.
You said a fresh look?
That may not be a reasonable approach given the timeframe. Could we just direct our audience to those basin plans?
I tend to think we might be able to bring it down to the 60,000-foot level that would be compliant with the charge and the legislation and then lend itself to the rest of the recommendations.
One of our approaches dug really deep on the data. After doing that, I am a little reluctant to say and you should go read the basin plans.
So what details would we pull?
We can say here are all the gazillion bugs; here's the communities; we have Atlantic slope basins; we have Tennessee basins; we have different fish communities in some; we have different bug and aquatic conditions; we have cold water communities down to warm water communities; small streams, big streams.
To some extent, I don't know how much coverage there is, but that is what SALCC was trying to do with their GIS technique. We might generate a map. It doesn't cover the mountains, Appalachians. I think there is a good deal of information that we could cobble together of the distinguishing characteristics of groupings. I don't think we need a fresh look at it; I think we could synthesize what is out there.

Mark Cantrell and Chris Goudreau agreed to work as a subgroup to propose a draft for characterization, and Linda Diebolt and Jaime Robinson agreed to serve as a subgroup to review the product. The reviewed draft will be presented at the August meeting.
It's not necessarily what else, but we should use discussion of characterization to set the stage. Why do we think seasonality is important? Because the ecology needs it. Why do we think high flows n the spring are important? Because the ecology needs it. Through highlighting those things through the characterization can set the stage for what are our recommendation assumptions. Highlight those key features so that they carry forward into the recommendations.
That was listed yesterday and the facilitators can provide that to the subgroup.
The complexity of what my fisheries colleagues are proposing for the invertebrates is a little daunting. We have almost a thousand taxa in this descriptive database. I don't know how many fish you have. There is a lot more work than one individual can do.
I was suggesting just general statements with some specificity as needed to get across the concepts.

General description and maybe some examples, some astounding numeric statements about the numbers of species.

Say this is what we recommend and this is what we did. Not to belittle the magnitude or the importance of this task, but this is the least important thing on the list.
If it takes more than a page, we have too much in it.
To a certain extent, the Board can punt because it does say that DENR is supposed to characterize, and you are supposed to assist them.
I would like to add that we do have some characterization of the Coastal Plain. Of the sites we have, about 1/2 are in the piedmont, a quarter in the mountains and a quarter in the coastal plain.

Small Stream protection (original topic was maximum allowable withdrawals

Moving down the list of proposed items to address, the group then considered what the trial balloons offered regarding maximum allowable withdrawals.

Comments and discussion points included:

1. Only the TNC recommendations proposed maximum allowable withdrawals; they did a comprehensive job of it, recommending none in catchments below 25 square miles, 1 million gallons per day (MGD) in catchments 25-50 square miles and then drought or wet/moderate limits for all other catchments. I recommend that we throw this category away. I don't think it is in the brief of this committee to recommend maximum allowable withdrawal. I think that exceeds our brief [several nods and comments of "yes" among Board members]. I included it in this list because it was recommended.
2. That would fall into the site-specific or project-specific study category.
3. I think the part of this worthy of discussion is the small basin protection. There was a specifically outlined recommendation. for protecting smaller watersheds. The 30/40/60 approach also mentioned that there might be trout streams or other small catchments that need protection. I would like to ask how we could go forward with a recommendation on how to protect the smallest drainages.
   - My observation on that is that we may not have been asked to provide a numeric maximum allowable withdrawal rate by drainage area or otherwise, but certainly, our recommendations should include a significant emphasis on the need for identifying some threshold for which no more water should be withdrawn and also note that in some cases existing withdrawals may already exceed that threshold I think we should provide that framework with emphasis on its needing to be done. Providing information about when there is no more water to be taken is probably the most important aspect of any recommendation that we could provide.
4. I agree that the tiniest streams should not have withdrawals, but the fact is that DENR needs to make that call, not us. We can recommend that DENR should make some sort of determination of that, but we should not tell them what it is.
5. It has to be put in terms of ecological integrity.
6. Our strategy for predicting biological response to altered flows is going to show huge changes in small catchments. The smaller the catchment, the bigger the change.
7. That statement demands that we make a recommendation of some kind associated with that. If we don't put something like that in there, then people won't draw that conclusion.
8. I would say regarding the small stream discussion that small streams with high flows with a small withdrawal would have a low impact, as opposed to a large stream with a large intake during drought conditions could have more impact. I don't think it is necessarily the size of the stream; the issue is the size of withdrawal relative to flow.
9. But we also said, and I know this is true from the PHABSIM results, that the smaller the stream, typically the higher the flow recommendation needs to be to cover all the aspects of the habitat. The further down you go you can get by with less water to maintain the same percentage of habitat. There is something to it. I think we do need to capture this concept as a recommendation. Now how we word it, whether small watersheds or some combination of that and other metrics, we can discuss, but it seems it is an important concept we don't want to lose.
10. I agree with the concept, but shouldn't our toolbox we come up with address it?
11. I agree. I think that one of the 9 or 10 scientific facts that we have is that size matters. To ignore that in our recommendations is doing a disservice to the science. My thinking is that we should at least say there is a red flag if a small stream is being considered. Before using TNC's

numbers I would want to go back and look at their data and their report, but I do think there should be a flag for small streams.

12. I agree that on these small streams that is probably going to raise a red flag anyway, and hopefully, whatever toolbox we come up with will help shed light on the potential impacts on those small streams.
13. I just don't know which of our tools is going to do that.
14. I'm not sure which toolbox is going to do that especially when Fred is saying that DWR won't even use that tool, or they don't want it coming from us. But as a scientific advisory board, I think it is incumbent on us to say that on every stream in NC there is a point at which withdrawing an additional increment of water will change the ecological integrity of that water body. There is a point in every stream, large or small. It may be sooner in smaller ones; it may be sooner in some of the flashier streams; or later in some of the bigger rivers. But there is a point. That can be defined by any of these approaches as a threshold.
15. I think I phrased what I said in a bad way. If we write a guideline that says that for catchments smaller than some size extra caution should be used when evaluating biological impacts from flow alteration, and then somebody among us figures out what that size should be, that probably is okay [not outside our brief]. The wording "maximum allowable withdrawal" suggests a form of regulation, which is why I said we should not do it. Regarding there being a point at which taking water out of a river violates its ecological integrity, I disagree. What we have learned in our work is that if you take any water out of a stream, you will affect its ecological integrity and taking more water out of a stream will further affect its ecological integrity. What we have not arrived at is a conclusion about how much change in ecological integrity, measured however you want to measure it (and at the moment there is really only one site-specific and one statewide approach to that on the table) that is a different story. We'll come to that later. I think a general statement, a short paragraph, will probably do the trick.
16. Of the recommendations that have been mentioned here, my take-away message is that there is this small stream concern that was brought up in the TNC proposal and of the recommendations brought up in that proposal I would want to see that move forward into our final suite of final proposals--not the exact numbers that TNC is proposing.
17. Basically what we are creating is a set of triggers for site-specific evaluation. Perhaps what we need here is a recommended trigger that says if the watershed is smaller than x amount, you should automatically go to site-specific evaluation. What I don't know is what the threshold should be. TNC said 25 square miles and 50 square miles. I see nothing in their data to make those numbers real for me.
18. The reason for this effort was to avoid having to go around to every stream in NC to do an in-stream flow study. I don't want to raise the specter of unrealistic expectations that every time DWR has a flag raised because some threshold is violated, that we are going to run out and do an in-stream flow study. That is not going to happen.

Facilitator: That raises the question of what site-specific evaluation means. Does site-specific evaluation mean in-stream flow study?

19. It just means that we have raised the flag on this. All we are saying from the planning perspective is that further investigation is recommended. Whether that is a site-specific study in the field or something else is at DENR's discretion.
20. I would tend to say that those are places you would not entertain withdrawals unless the applicant provided information to demonstrate that it was not going to harm the ecological integrity.
21. Again, this is going to go to DWR. If this is a recommendation from the Board and DWR, once it is in hand, says we can't or won't implement that, which is their discretion.

22. Don't forget that 3 clicks down the list, we have a strategy for determining biological responses to changes in flow, and it works really well in small watersheds.
23. **I propose that we make a note to double check that the issue of small streams is addressed in the section on biological response and if everyone agrees, that we go forward.**

No one expressed disagreement when agreement was tested, and the Board moved to the next item on the list.

Flow by goals for larger rivers

Following are the comments, proposal, and consensus recommendations from the EFSAB in relation to flow by goals for larger rivers.

1. When this list was originally proposed, I don't think this was exclusive to large rivers. I think in our conversations over the course of the day yesterday, we got the feeling that if we don't need to use a flow-by approach anywhere else, we may need to recommend that approach for larger rivers because the data used for other approaches was from wadeable streams.

2. The flow-by goals and the seasonally stepped minimal flows were simultaneously presented. They were presented as the same thing in the modified SC proposal and the 80% flow-by proposal. In the Alberta proposal they were combined so you get a flow-by goal and a minimum flow, but I don't recall that it was seasonally stepped. What I did was parse that stuff and said that the flow-by goals for larger rivers and the seasonally-stepped minimum flows for all rivers were how I separated those 2 things.

Facilitator: Perhaps we should step back and look at how we want to address the remaining items on this list. Rather than taking each item individually, do you want to step back and address how you want to approach making recommendations on flow?

3. These were just listed to parse them out. What Judy was alluding to is that there was a thought that we have this wonderful biological data set in wadeable streams and that comprises 88% of the catchments, but it does not include the main stem rivers where the water withdrawals are likely to come from; therefore, maybe we should use a different approach for main stem rivers and use the RTI/USGS approach for wadeable streams.

4. That was why I parsed it the way I did.

5. For me, then I think about what are our options for large rivers then. There were a couple of different proposals that could potentially deal with those, right? Alberta, the 30/40/60% Approach, and the 80% flow-by approach would be relevant. The way I was thinking of it was where would we use this tool; where is this tool applicable? Of these tools which ones would we recommend? All of them? None of them?

Facilitator: That is how I was thinking we could approach this. You have these various tools; it sounds like there is interest in using different tools in different places potentially. Is that what you are suggesting?

6. So for the second item, maximum allowable withdrawals, we changed that to something about small watershed protection. I think it makes sense to change the 3rd item to "Large River

Approaches", which would include the flow-by percentages, the modified SC approach, and the Alberta method.

7. What I had in mind was that the RTI/USGS approach works for the 88% of North Carolina catchments that are characterized by wadeable streams. The seasonally stepped minimum flows represent a wonderful safety net we ought to consider for all catchments. For the larger streams that are not characterized by wadeable streams (12%, but they are the biggest ones) we need some other strategy, and perhaps the flow-by goals that were presented by TNC and the Alberta Model and the DENR proposal should be considered. The TNC flow-by goals were complicated, but DENR's goal was 80%; the Alberta Model's goal was 85% and TNC had a sort of stepped flow-by strategy. So the question do we want to adopt flow-by goals for catchments that are not characterized by wadeable streams and if so, what should it be?

8. Another question is if the Board supports the idea of having a minimum flow recommendation and whether that would be the SC-modified approach or what was used in the Alberta Approach, the ecological base flow.

9. The flow-by approach is a target; the minimum flow is something else.

10. Right.

Facilitator: So how do people feel about, as a broad approach for large rivers, using one of the flow-by approaches with a minimum base flow?

11. My thinking right now is that we need to go back and characterize the distinction between a large river, a small catchment, and a wadeable stream. That is now a characterization step.

Facilitator: The wadeable streams include small catchments, right, but with the additional comment about the need for extra protection for the smallest watersheds.

12. I guess we can get into the details of wording later, but regarding minimal base flow, I'm not sure if that minimum refers to when the flags start flying because in terms of restricting withdrawals, that's more of the permitting arena, not the planning arena. Also, during droughts I hate to see mother nature violate our base flow so during drought I don't know where we are going to set that base flow.

13. That's why Alberta deals with both. You may want to call that cut-off flow or low-flow cutoff or EBF.
14. Also, if we are going to consider the SC-modified as an option in developing that number, I think what was brought up yesterday was to use the modified-SC approach to set the conceptual bounds.

15. For clarity, base flow is flow fed by ground water. We should not use the term base flow. We should be talking about minimum recommended flow. It will be up to DENR what to do with that recommendation.

16. Let's not get into semantics right now;

17. The Alberta paper says there are about 5 different terms that are used for that concept. You can choose what term to use given whatever baggage each term has to you, but they use ecological base flow and list the others.

18. Use EBF and SC modified for now.

19. I hesitate to do this, but how much are we backing up if we think about the % flow-by things and how are we are going to work in the cumulative nature of those and where is the baseline? Eighty-five % past a point then another point, then another point, then another point can reduce that cumulatively downstream.

20. Right, so there is another bullet to add to our recommendation, and that is to include that concept of that cumulative effect.

21. That is all part of riparian water use. You have to leave something for that next user. If you are leaving 85% of what flows by you, pretty soon, somebody downstream, including the ecological integrity could have very much less than whatever the flow-by goal was.

22. Whatever the % is, I favor using it only in the larger rivers, and it is cumulative. In other words, you can't do 85%, 85%, 85%...It has to be 85 for the basin, if 85% is the chosen percent.

23. Or it can be done cumulatively or it can be done with the baseline concept and just set it up river-wide and say this is where it is now, and with whatever percentage, that is the baseline at your point.

24. 85% at whatever point.

25. It's not 85% of inflow; it is 85% of the hydrograph, the flow duration curve.

26. That's an entirely different strategy.

Proposal:
For large rivers, acknowledging that we need to define large rivers, use a flow-by approach using some type of floor/cut-off/EBF [need to determine term] and address cumulative effects.

Comments on the proposal:

- With a flow-by approach, that could but does not have to have a seasonal component, right?
- At this point, we haven't talked about that. The ones that have been presented do have that.
- We are agreeing that flow-by is a good idea and then we can get into a discussion of flow-by that is seasonal or not.
- Minimal flows that should apply to all rivers should be seasonally stepped. For the larger rivers, the flow-by goal, no one presented a seasonally stepped proposal.
- The flow-by, percentage of flow concept, in all of them, in Richter's paper, is not seasonal, it is instantaneous, and it is daily. So it is 85% of what is happening. So in the model that is how you would do it, right Tom [Fransen]?
- We would use the daily data. The way I presented it is that we would basically be following the hydrograph so it is seasonal from that perspective.

- But you are not changing the percentage by season. You would use the x%.

- In the example, we would use the same percentage. There is not any reason you couldn't change it by month or season.

- The flow-by goal is a percentage of instantaneous flow-by. The seasonally stepped minimum flows may or may not be.

- We haven't gotten there yet.

- Part of the charge is to try to predict water usage down the road. Are you going to be able to do this with a daily, instantaneous flow-by?
- Can we predict what future flow-by's are going to be?

- It's not predictive in terms of what is going to happen 6 months from now, but you're basing it on the hydrology data set.

- Right. So we can get an idea of what our water withdrawals statewide might be 15 years down the road and we'll have some idea, based on our historic hydrology data set, of that. Our flow-by's are going to be [inaudible]

- DWR plugs in this future demand and they'll test against that daily, instantaneous flow-by.

The Board members present accepted the proposal with six votes of one [meaning Endorsement (I like it) and four of two [meaning Endorsement with a minor point of contention (basically I like it)].

The Board opted to continue with developing the framework of broader concepts, give the people not present an opportunity to weigh in, and then delve into specifics at the next meeting.

Wadeable Streams (topic seasonally –stepped minimum flows)

The following discussion occurred among the group around seasonally stepped minimum flows.
Facilitator: So this is essentially a subset of the flowby approach, right?

C: In theory it might have been applied elsewhere, but I feel it's applicable in these larger river systems, applied to wadeable streams.

C: We've talked about small stream protection, large river approaches, wadeable stream approaches is left. We have that as an option- wadeable rivers, we have the RTI/USGS approach, if we're just throwing things up at this point by these categories of large, wadeable, and small.... we've diverged from where we started.
C: Seasonally stepped minimum flows may have application for larger rivers, but not in the shape its in now would need tweaking, may need to look at monthly mean flow.

Facilitator: Chris is proposing deviating slightly from the list by addressing wadeable streams and options for addressing them.

C: I think all 5 of them (trial balloon approaches) should be on there to start with.

C: The RTI method, listed species, PHABSIM are all ways of evaluating the decision that you've made. Now we're talking about the process of making that decision. Are we going to use that to establish what the flow deficit would be, then back out of it…

C: Like the previous one we haven't determined numbers yet.

Facilitator: we shifted gears from this list as some were elements of proposed recommendations, and moved into discussing larger rivers, small streams, wadeable streams.

C: Any of the approaches can be used in the wadeable streams, do we have a preferred approach?

C: I was thinking of a seasonally stepped minimum flow as a safety net, and the RTI/USGS approach is a way for predicting the biological response to an altered flow, not necessarily a decision made but any altered flow you might want to evaluate for any reason. Could be an altered flow based on any change. What you have in the list is a large river flow by goal, a seasonally stepped minimum for a safety net, and a strategy for evaluating biological responses to all altered flows that we know works pretty well in 88% of the catchments.

C:I thought RTI/USGS approach worked towards a prescriptive number, so if we agreed there were a 10% decline in species assemblage, then there would be an ecodeficit associated with each node that you'd not want to cross, and not crossing it would be the prescription. Ultimately a flow would need to be derived.

Q: The RTI/USGS method predicts biological response for altered flows. Having worked hard to pick the right variables and treat the data respectfully. We also recommended that a 10% diminution in biological condition as result of altered flows should raise a flag. I don't have a reason to back away from the 10%, I realize it is hypothetical at this point, but we're talking generalities at the moment, not numbers, right?

C: True, but each of these other (trial balloon) recommendations can provide a flow recommendation. Isn't that the final objective?

C: Our goal is to tell DENR how to determine if ecological integrity will be violated if you alter flows. Tom nailed it, so far we have generalized strategies based on literature. When you get to RTI/USGS methods it tells you how those strategies will perform. It's a pretty good way of how an additional alteration will produce an additional affect.

C: We don't dispute that, we're looking at all the trial balloons that have been thrown up at this point. We're talking about what would work for wadeable streams. We haven't said anything about which one we like best, just which ones should be on the sheet to start with.

C: I misunderstood. If we're trying to figure out how to address wadeable streams, then there are 3 seasonally stepped minimum flow proposals on the table plus the USGS/RTI approach (an alternative strategy).

C: We're not just talking about seasonally stepped minimum flows though.

C: We're talking past each other. I'm suggesting that the Alberta method is a combination of % flow and an EBF. That is not seasonally stepped minimum flow. That's one method. The NC 80% flow by is another one that does not have that second component. The SC method, whatever the numbers, is a seasonally stepped min approach, it's another approach to dealing with wadeable streams. Then the TNC approach is a percent of flow with a cut off component.

C: I'm resisting throwing all options in the pot and picking one, I think something would fall through the cracks. I think there is merit to all the options. I'd hoped to see a stepwise strategy in which we have some sort of flow by target, some sort of minimum flow recommendation, and some strategy for measuring the approach.

C: Our previous one just did that for larger river approaches? I understand where you're coming from but these methods were developed with components for a purpose. We can talk about numbers later, but if you want to call flow cut off as a minimum flow thing, the SC method is in that ballpark but doesn't include % minimum flow component. It's still on the list as a viable option. They weren't intended to work as separate components. Everything is still up there.

Facilitator: It leaves me wondering how to best approach this. My thinking was what do we have that's applicable to wadeable streams, what from that is important to include in the recommendation? But sounds like they can't be separated from their components, or maybe from looking at each one we can identify a lit of what should be included in wadeable streams

C: What I see as different on that list, if you start with the SC or Alberta approach that could be the end of it. If you start with the RTI approach, you may want to include some aspect of one of the other approaches.

C: RTI/USGS approach, you can say you want a 10% limit of degradation and find out the deficit, it doesn't tell you how to achieve that deficit. That's the problem I have with starting with the RTI/USGS approach. It doesn't help you in determining what set of parameters of the model to put in to produce that deficit. If you go the other way, it doesn't tell you how to manage the resource in order to produce that deficit. Even if you use it for guidance, you still have to go back to these other components and decide how you're going to produce that deficit, and whether that deficit is significant. There are multiple ways to produce a deficit.

Facilitator: Are you suggesting coming up with an approach, then RTI/USGS work would tell you what the damage is of that approach?
C: Possibly. That's one way. Do these scenarios produce that deficit or is it better than that deficit. You could use it as a criteria. To me its easier to say 90% flow by, then see if it produces a deficit. If not you don't worry, if it produces a small deficit then you can look up whether its significant or not. It's easier to go that route than come up with scenarios.

C: That's very important. The RTI strategy cannot be used to prescribe a flow. It can be used to test a flow and what it does to the biological condition. What I had in mind was a target/minimum flow strategy, that we would know what it does in terms of biological impact relative to baseline condition, than any proposed additional alteration from any source can be evaluated.

C: How do you recommend how to get the numbers that go into the model? The 85% from Alberta? 90%?

C: We could give those numbers, whatever the low minimum flows would be, apply it to a few places with projected water uses and see what it produces in 2050.

C: For each node that Tom runs, you'll have to punch in a few scenarios and evaluate ecodeficit for each scenario?

C: That's why the value is the ability to project the effects based on future management decisions for water withdrawals.

C: In other words, where the other ones could be stuck into Tom F's model, say the Alberta one. He could put that or the 80% flow by you showed yesterday, that is the measuring stick against which to determine whether you're violating the flow on any given day. In a sense it's the recommendation and the measuring stick. Tom C. is saying you can use any of those in the model, and use USGS/RTI as measuring stick. If a flag goes up then it's probably PHABSIM type of analysis. (another measuring stick)

C: You're getting into layers of approaches, if you past this test, then this.

C: There a model missing in our work- one that relates the flow characteristics to eco-deficit.

C: That's Tom Fransen's model.

R (Tom F.): We have a flow model…

C: We need that link that allows us to look at the variety of scenarios and whether they produce ecodeficits.

C: So you can calculate a flow duration curve right?

R: It's programmed in to develop a flow duration curve (DWR).

C: Then you can do ecodeficits.

C: IF DENR adopts an 80% flow by or series of seasonal min flows and test with RTI/USGS model and it shows an unacceptable level of biological change, DENR can adjust those strategies on a basin by basin basis. We can recommend 80% as a starting point, DENR may decide that needs to change based on basin. That is the scientific way to do it. They should then continue to look at data as they come in from DWQ monitoring sites, if it determines biology changes more than predicted, model can change, for iterative adaptive changes.
C: How much change in biological condition is going to be acceptable, whether 5, 10, 15%. We'll need to hammer that out later.

C: Starting numbers for % are easy, but need to figure out how much biological change do we recommend that DENR should accept.

C: Right.

C: If you have no seasonality, and you have a flow by of 80%, in your planning method its reducing flow by 20%, then the ecodeficit (if constant throughout the year in a planning phase), the ecodeficit is 20% linear?
C: Not necessarily, depends on water use throughout year.
C: Ok. Planning tool says if someone uses 3 mgd more per year, we're saying does that reduce it more than 20%.

C: RTI/USGS approach is an evaluation tool for DWR to use. They can plug in flow reductions, any number, we don't need to give them 80% flow by, as long as it doesn't provide more than 10% decrease in biological response it gets approved without further evaluation? Is so, then why prescribe a number like 80% if we don't know yet if an 80% flow by will cause 10% reduction.

C: Good point, if we can agree on how much degradation in biological condition we can tolerate, we

can leave it up to DENR to determine what they want to do with target flows, minimum withdrawals, etc. The problem is it's a tall order for DENR to do that for everything all that at once. It's probably be good to look at literature to look at guidelines for target flows, minimum flows, so DENR has reasonably safe place to work while they get to evaluating biological results that they probably will have to do case by case.

C: Going back to the ecological principles we just introduced, we need to maintain that variability (frequency, duration), and easiest way to do that is with a flow by. That argues for that. About droughts- you don't want to push it down there, that argues for minimum levels. You've already got some pretty rigid standards, what's left is to decide the % flow-by (80% for large rivers? 90% for wadeable to start with until we have better knowledge?). I don't think DENR has the flexibility to make any change they want and match the criteria we've suggested are important.

C: I think we should start with safe standards and give DENR an excellent measuring tool.

C: RTI/USGS technique as a measurement tool in wadeable streams then?

Facilitator: Had you decided as a group if maintaining variability was important? Possibly was a consensus agreement earlier, but is in our concept list from today too.

C: So what we've got whether it's a large river or wadeable stream, the flow recommendation approaches are essentially the same that we came up with, the only difference is for wadeable streams we have this additional measuring stick with which to assess the tool that might be recommended. Is that a fair statement?

C: If you use it in the other 12% of catchments you will get a conservative (protective) answer. If it fails in the larger catchments it will be because it is too conservative.

Facilitator: My interpretation is what Chris said, is there general agreement on that? We're looking at basically the same as we had for larger rivers with addition of this tool for assessment?

Q: Can we agree that min flow should be seasonally stepped? Since there is one proposal (Alberta) that has it uniform?
C: No, its monthly not seasonally, or could be weekly. The number itself is 20% but it could be 20% of monthly flow, whatever month you're in. The 20th percentile flow.

C: TNC proposed 2 seasons, Hugh has proposed 4 seasons, the Alberta approach could go monthly (% doesn't change).

C: SC proposal changes seasonally and its expressed either as annual or monthly. TNC is attempting same as Alberta, to do that she changes the % by month. Two seasons for the % of flow component.

Q: How comfortable are, instead of having a flat percentage, are we with a stepped percentage? Without looking at the numbers do we think we need to have some variance in there?

C: Are we talking about percent of flow…(inaudible)

C: We're talking about percent of monthly mean, just for the low flow cut off.

C: If we use the SC strategy as a low flow cut-off it's as % monthly mean.

C: If working in range of 30, 40 50 percent, then adjusting seasonal percent makes sense. If you go to

80, 85, 90% I don't think we have the resolution to have an adjustment of that percentage.

C: Not talking about trigger flow, but the low flow cut off.
C: Kim's bottom percentile ranged from 40-60, Hugh's ranged from 30-60, Alberta monthly proposal was constant 20%. We don't have to pick a percent now, do we want to recommend a constant percentage or seasonally adjustable?
C: Constant is related to the month. A % of mean monthly flow

Chris made a table and shared with group to test what people think the proposals provided: TNC approach as % flow and cutoff component. Her % of flow was ~90% in normal to wet years, and 95% in drought years. Her base flow cutoff was complicated but boiled down to about 15 percentile flow. NC approach was 80% flow by with no low flow component. Alberta is 85% and 20th percentile that you implement by calculating by month. The SC approach doesn't have a % of flow component, I wouldn't call it an EBF, but the (20-30-40, whatever the numbers are) numbers are the low flow. Is that how others understand it?

C: With an exception, Kim's handout said her recommended EBF is 50-60% depending on whether it's a wet or dry year Jan- April, and 40-50% depending on whether it's a wet or dry year from May- Dec.

C: So the number may be a different range than 15% but her objective is to get above 10%. Seems like a complicated way to say stay above 15%.

C: The reasons for 40% in drought years was because it's a lower flow in the drought year and you're only withdrawing 5% so it give you a lower floor.

C: She's presented it more as a policy instead of a planning thing. Tom's not going to know in the model if it will be a drought year so he should use this percent.

Q: With the SC proposal, when initially proposed, it was there wouldn't be a % of flow that goes along with it, it would be the lowest flows that would be tolerable as opposed to other 3 systems are talking about how that water will stay in the stream in any given day.(did not have a daily percentage flow by). When the % was bumped up it didn't apply to the EBF, low flow, feature any more. It was moving more to a very low % flow concept. Where do you feel it's going? We co-opted it as a base flow.

C: I still consider it to be a stepped seasonal minimum.

C: Reason why is its not necessarily maintaining hydrologic pattern.

Q:Going back to my original question, do you prefer a flat rate for minimum or a seasonally adjusted minimum? Details of how to adjust can be done later. I prefer a seasonally adjusted, acknowledging its harder to come up with and justify. Do you want to try for a single or something complicated?

C: In some respects a seasonal step is to accommodate spawning season giving higher flows then.

C: But the pass by take care of that. The importance would be to protect the low flows and not to increase frequency of drought condition.

C:The 20-30-40 approach, what seasons were those?
C: With the Tar River example, June-Oct was 30%, Nov- Dec 40%, Jan- Feb 50%, Mar-May 60% based on not dropping any habitat approach below 80% except for one (the deep fast).

C: Sam are you asking if that approach is used with % flow by as well?

C: I'm suggesting it could be used with POF target.
C: If you use numbers that high, you've done away with half the hydrograph. If you took the hydrograph and laid on those high monthly percentages, you cut off bottom half of hydrograph. So that means you only use the % of flow when above the median flow. That is essentially doing away with most of your water availability.

C: the numbers, you take the inverse as POFs? Of 60% at that time of year you'd have 40% of available water?

C: If I have a pipe in the river I can take up to 15% flow by year round, in Jun-Oct., I'm also restricted from lowering the flow below 30%. I think there is a significant gap between the numbers I don't think I've taken the hydrograph away at all. In Mar- May, when 60%, there is only 20% wiggle room.

C: But your flows were mean annual flows.

C: What I presented with PHABSIM was mean annual flows. They didn't have PHABSIM data for mean monthly flows. In original proposal, we suggested mean monthly flows were more similar to the normal hydrograph than mean annual.
C: I modify my proposal, I propose we use mean monthly as baseline and not mean annual if we use the SC approach. You can take down to 80% instantaneous flow, but you can't drop below 50% monthly annual mean.

C: For all users, that's multiple pipes that can't go below a certain amount.

C: Remember we're not balancing users, we're recommending to DENR what should happen in a catchment.

C:Tom F- one point I tried to make yesterday, it seems we're mixing percentiles and % means and they are not the same. In the modified SC, 30-40% of time the flows are falling below that. If you pick any of these EBF, we need to think is that base, what will you do if flows drop below that point. If we tell people we can't pump anymore, that is a problem.

C: I'm suggesting the high end target is a % of mean of instantaneous flow by, the bottom cut off proposal is percent of a % of the monthly mean. When you looked at it, you looked at the annual mean. At monthly mean half the time they were below the line?
Tom F: It ranged anywhere from 3%- 41% with average 16% of monthly mean. Based on last month's presentation 20-30-40, depends on mountains or piedmont.

C: To follow up on that, that's why Alberta approach only applies that cut-off to a portion of the hydrograph, if you get below that and the natural flow is less than that, then it's the natural flow so you don't restrict further. It's not that nobody can take water below that point, you try to extend the portion of the hydrograph.

Tom F: if you put some kind of floor there, you have to address where withdrawals stop. We don't cut people off.

C: For planning purposes, we're looking at when we hit that threshold. For planning, that's when we say we need to seek other sources. We're not saying you're cutting anyone off.

Tom F: How I interpret that is if you're saying you're not trying to stop withdrawals, that's fine. IF you're planning withdrawals based on your drought plan, that works.

C: The only thing we're trying to say is that if you go below that, the ecosystem suffers. We're not saying anything about what you can or can't do, our responsibility is simply to tell you if you cross that threshold, the ecosystem suffers.

C: Or it suffers but it has to recover, according to the legislation.

C: The Alberta method then makes sense, it says that ecology would naturally survive a drought cycle if you have a resilient system with ecological integrity. The Alberta approach makes sure the duration is closer to the natural. I don't know about duration though.

Facilitator: We started by trying to decide the various parameters to include for wadeable streams. We discussed a potential flow by approach, with some sort of approach to a minimum, and then RTI/USGS work as a tool for assessing the impacts. Right? Are there additional items /parameters to include in the approach taken for wadeable streams? Do you want to narrow the parameters that you want to include?

Q: Was one of the early statements that possibly the larger and wadeable streams recommendations are going to be based on the same pieces, that there would be these 2 components to the recommendations, and they might vary based on the size of the stream? Not saying wadeable vs larger streams?

Facilitator: Right, with distinction was that we did not include the RTI tool.
C: so the revelation is it's not going to prescribe any of these features, it's simply a post-processing evaluation tool.

Facilitator: So you would say the same as for larger rivers with addition of RTI/USGS as a tool for analysis of the effect of it. The other thing you had for large rivers was the comment about cumulative. (Head nods.)

Wadeable streams approaches

- **Flow by approach**
- **Apply EBF/SC modified, for when a flag goes up**
- **Characterize difference between wadeable, small catchments, large rivers**
- **Address cumulative effects**
- **Use the RTI/USGS tool for assessing biological responses to altered flows**

Test for alignment on that through show of fingers: **10 ones**

Listed Species Strategy

The EFSAB will use the proposed recommendation developed by the T&E subcommittee and approved by the EFSAB at the June 2013 meeting. That recommendation was and is currently included in the Report Outline:

> T&E subcommittee review suggests that flow-habitat relationships for these species are broadly addressed by the PHABSIM approach. Rather than further evaluate the developing research on T&E species' flow requirements, the SAB recommends that specific, potentially more limiting, flow needs for resident T&E species should be considered on a project specific basis by the DWR in addition to the more generic recommendations offered by the SAB. For planning

purposes, portions of basins (e.g., nodes) that include listed species should be treated by DWR as needing additional analysis.

Follow up for situations where ecological flows are flagged

Site Specific Follow up Recommendation:

If DENR evaluates a catchment for a larger basin and a flag goes up as a result of that analysis, that catchment or basin would be identified vulnerable and any proposed flow alteration would be evaluated more closely.

When in planning mode and a flag goes up, the PHABSIM and field work is not normally conducted unless there is a permit application. As Fred mentioned earlier, just because a flag goes up does not mean that DENR is off to automatically conduct field studies. *Rather we might want to say for planning purposes in the Report is that when a flag goes up, further analysis is required and that might mean anything from field studies, to talking to water users in the basin about other ways that they can meet their water needs [at that future point] or x,y,z. [Chris - include this section in the recommendation?]*

Initial discussion occurred on whether to recommend PHABSIM as a strategy for site specific follow up (trigger is site specific):

Right now, PHABSIM is the only strategy before the EFSAB for site specific follow up.
C: One approach is if a flag is raised, do your analysis on the deficit, then look at the RTI work and decide whether it passes or fails, and if it fails, then you use the PHABSIM.
Q: Do we need to tell DENR to use PHABSIM?
R: What else would you use? Or, do we have to recommend anything when the flag goes up including some other SIM (simulation)?
C: Maybe what the EFSAB can say to DENR in the report is when the flag goes up, you should do site specific analysis.
C: This came up yesterday when Tom Fransen said that SEPA minimum criteria is not going to change in the near future and that is the current rigor for site specific evaluation. Thus is it our responsibility to recommend an approach for site specific follow up?
C: When in planning mode and a flag goes up, the PHABSIM and field work is not normally conducted unless there is a permit application. As Fred mentioned earlier, just because a flag goes up does not mean that DENR is off to automatically conduct field studies. Rather we might want to say for planning purposes in Report is that when a flag goes up, further analysis is required and that might mean anything from field studies, to talking to water users in the basin about other ways that they can meet their water needs [at that future point] or x,y,z.
C: May I try an alternative phrase: if a flag goes up for a watershed in which no withdrawals are proposed and that watershed is identified as vulnerable, then any future plans for water withdrawals need to be evaluated very carefully.
Q: Is a site specific evaluation going to undertaken with individual requests or simply as a result of long-term planning or both? Will it be a result of a 60 year plan or withdrawal by withdrawal?
R: We could do it on individual request but also if are a number of flags going up in a particular basin, we may want to say that this basin we may want to consider for capacity use. So both types of "evaluations" may be considered.

Proposal: if DENR evaluates a catchment for a larger basin and a flag goes up as a result of that analysis, that catchment or basin would be identified as vulnerable and any proposed flow alteration would be evaluated more closely.

C: My concern is we are talking catchments' here not sites on a stream. In addition, DWQ is assessing watersheds – are we stepping into this area?

R: If DENR decides to evaluate an area in which there is no node, then a node will need to be made and then watersheds evaluated upstream.

Coastal Area Strategy

The NC Coastal Working Group will provide information that they are proposing be included in the EFSAB Report outline at the August meeting.

Adaptive Management – Future Research

A suggestion was made to use language in report which is:

Ongoing Validation - DENR should adopt/design/develop strategies for:

a. validating ecological thresholds. Strategies should be informed by new data or research.
b. tracking the impact of flow changes when they occur.
c. modifying characterizations, target flows, and thresholds based on new data, changing conditions, and lessons learned.

Discussion: the word threshold must be qualified. We are using threshold to mean a value that is important not to cross; a flag is not a statistically defensible number. Example: 80% flowby as a threshold; may be a value DENR sets because of this and that but there is no statistical basis for this number and we need to clear about this.

May also need to define various kinds of thresholds and what do you mean by them for example:
a. minimum flows thresholds
b. percent of flows thresholds
c. biological diminution thresholds

XVIII. August Agenda discussion

In planning for the August 20 and 21 meeting, what are the next steps for the EFSAB?

It was decided that a new draft writing team composed of:

Chris and Mark would initiate a draft of the recommendation topics that had been discussed for most of the afternoon of the July 17 meeting including any recommendations that the EFSAB supported. The draft generated by Chris and Mark would be reviewed by Jamie and Linda. This process would be completed within two weeks and then distributed to the entire EFSAB for their review. This draft would be incorporated into the existing report outline with sections identifying where a range of numbers or numbers could be inserted.

Chris and Mark requested the meeting notes from the facilitation team which will be sent to them by next Tuesday, July 23.

Mark also made a request to the EFSAB that if anyone had suggestions about items that needed to be

included to send an email with those specifics to Mark and Chris.

The information being sent to Mark and Chris will be distributed to EFSAB members who were not at the July 17 meeting which included: Jeff, David, Amy, Jamie (late afternoon), Becca, Fritz, and Sarah (late afternoon).

Discussion ensued regarding the August meeting about what the next steps would be. The facilitator asked the group to help determine specific actions and/or questions that the EFSAB could focus on in August. A brief list of ideas was generated. At the August meeting, the EFSAB should agree to a discussion template for the meeting.

Suggestions for specific actions and/or questions the EFSAB can address at the August meeting:

1. Characterization: what are the specific variables? and what condition are they in?
2. Flowby goals for larger rivers: what are those options- 80, 85, and 90? And what should they be?
3. Seasonably stepped minimum flows: there are four proposals that range from 30 to 60% based on monthly mean.
4. Method for predicting bio-response to altered flows: there are numbers to plug in here until you get to the end and ask what is the percentage of biological diminution that should raise a flag.
5. Listed species triggers: no numbers
6. Site specific Analysis: no numbers for PHABSIM
7. Coastal Plain strategy being proposed by coastal working group
8. Adaptive Management: members may want to revise the language in the report outline.

Additional comments:
The draft team may want to consider:
1. How cumulative effects fit into the discussion
2. Propose specific actions and/or questions that EFSAB should address in August
3. Ensure to the range of proposals is described where there is missing information or where information needs to be considered.
4. Begin to include reference information for the recommendations/sections

Additional Agenda Items for August:

1. Review notion of large and small streams: what is a large stream? What is a small stream? The SALCC and Northeastern classification effort is being used by the BEC approach to generate stream divisions (5 stream class sizes). The Ad Hoc Water Coordination Group has a model it is using. May also want to consider the TNC Susquehanna method for discussion.

Tom C. emailed a stream distribution to Christy to distribute to the EFSAB.

2. Coastal Plain information for the report outline

3. Two Neuse River scenarios in terms of available water provided by the Ad Hoc Water Coordination Group

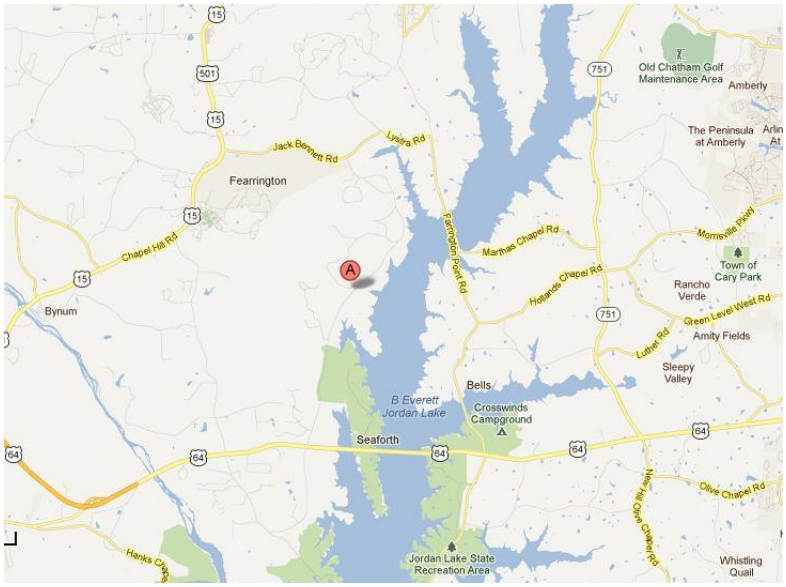
4. Review and discuss the new recommendation framework developed by Mark, Chris, Jamie, and Linda.

5. Discuss the remaining questions and issues proposed by Mark, Chris, Jamie, and Linda, and other questions and issues identified by others.

6. Explore the question: are additional writing teams required? If so, what sections? And who will write those sections?

a. identify what transpired along the way that led the EFSAB to their current conclusions
b. how does what transpired contribute to the larger body of research and discussions about Ecological Flows?
c. what information needs to be included in the Appendices? Are large reports included or posted online at ncwater.org

The next meeting of the EFSAB is scheduled for **August 20 & 21, 2013** at the Stan Adams Educational Center from 9:00am until 4:30pm on the 20th, 8:30- 4:00 on the 21st. Please remember to bring lunch and refreshments with you. Coffee will be available on site and soft drinks are ($1). **Webinar:** If you cannot attend the meeting in person but would like to join us via the webinar, you can watch the presentations and listen to the live streaming audio of the meeting by accessing the link and typing your name in the space labeled "guest":
https://denr.ncgovconnect.com/sab/



Meeting Location & Directions: The meeting location is the Stanford M. Adams Training Facility at Jordan Lake Educational State Forest. Directions are: 2832 Big Woods Road, Chapel Hill, NC 27517. From Rt 64 and Big Woods Road, it will be the first Forest Service sign on the right. Pass the office building and continue on through the gate to the education center. For Map link:
http://go.ncsu.edu/stanadams