

**Ecological Flows Science Advisory Board (EFSAB)**  
**Meeting Summary**                      **August 20 & 21, 2013**  
**Stan Adams Training Facility, Jordan Lake, Chapel Hill, NC**

**FINAL DRAFT—Approved for distribution**

**Attendance (for both days unless otherwise noted)**

**Members**

Hugh Barwick, Duke Energy (8/20 only)  
Mark Cantrell, USFWS (8/20 only)  
Bob Christian, ECU  
Tom Cuffney, US Geological Survey  
Linda Diebolt, NC League of Municipalities  
Chris Goudreau, NC Wildlife Resources Commission  
Jeff Hinshaw, North Carolina State University  
Amy Pickle, Duke University  
Judy Ratcliffe, NC Natural Heritage Program  
Jaime Robinson, CH2MHill  
Jay Sauber, NC Division of Water Quality  
Fred Tarver, NC Division of Water Resources

**Division of Water Resources**

Harold Brady (8/20 only)  
Tom Fransen  
Sarah Young (8/21 only)

**Alternates**

Rebecca Benner, The Nature Conservancy (8/20 only)  
Tom Gerow, NC Forest Svc. (8/20 only)  
Sarah McRae, US Fish & Wildlife Vann Stancil, NC Wildlife Resources Commission  
Tom Thompson, Duke Energy  
David Williams, Div. SWC (8/20 only)

**Guests:**

Kay Javers, Duke U.  
Jen Phelan, RTI (8/20 only)  
Gerrit Jobsis, American Rivers (8/20 only)  
Jim Mead, Environmental Defense Fund

**NCSU Facilitation Team**

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

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**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."

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**NOTE:** The EFSAB will meet **September 24 @9:00am until 4:30pm and @8:30-4:00pm for September 25** 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).

**August 20 and 21, 2013:**

# Summary of Decisions, Recommendations and Proposed Actions

## Decisions and Recommendations:

### 1. Regarding Flow Recommendations

- A. Recommendation 1: Statewide approach using simultaneously two tools:
- In the basinwide hydrologic models, use 80-90% flow-by as the ecological flow.
  - If the basinwide hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.
  - The Eco-deficit tool should be used to determine the current and future modeled biological condition of locations in the basinwide hydrologic models.
  - DENR should evaluate the change in current and future biological condition as a decision criterion. *A 5-10% change in biological condition is suggested as a threshold for further review by DENR. [section requires further discussion/review by EFSAB to determine if all members can live with/support this statement].*
    - a. The Board tentatively defined flow-by as: The percentage of ambient modeled daily flow that remains in the stream. For modeling purposes this is calculated on a daily basis. *[Need to define somewhere how daily flow is reached].*
    - b. The Board opted to continue fleshing out recommendations and let writers define terms, then address any concerns about that later.
    - c. RTI will provide an outline of the RTI report to the EFSAB by mid-Sept for a review by the EFSAB; include justifications of the 5, 10, and 15% thresholds to assist with discussion in Sept about the possible threshold.
- B. Recommendation 2: Headwater Streams  
There is limited biological and hydrologic data in headwater streams within North Carolina. These streams have a higher vulnerability to disturbance, and the broader statewide approach may not adequately reflect the potential for impact to ecological integrity. Therefore, DENR should identify the subset of headwater streams to receive alternative analysis. (Note for further explaining- examples of vulnerability, how and in what way. Less water to start could be converted to intermittent)."

### 2. Coastal Plain Strategy:

Linda Diebolt will work with Bob Christian to address the coastal plain strategy. This would include the changes that resulted from the Aug 21 discussion and any pertinent rationale/assumptions, citations, and references to justify what is being proposed in the coastal strategy. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive as this strategy.

## **Proposed Actions or Identified Decisions to be made:**

### **1. Regarding Flow Recommendations**

1. Another potential recommendation was proposed: The current SIMBASE2013 should be used as the prevailing condition from now forward.
2. Maybe we should advise DWR on how to assess condition of stream, and there are a couple different ways to do that.
  - a. Compare against unregulated flow
  - b. Use eco-deficit tool.
3. When we're saying to maintain ecological integrity, we'll at some point define what it is.
4. Whether or not to set a threshold for %biological change in the recommendation, and, if so, what that threshold should be.
5. How to move forward between now and September?
  - a. Address concerns about defensibility/validity
    - i. Seek report from RTI as documentation (needed)
    - ii. Seek additional supporting documentation from other studies, states that could provide references for using indices as evaluations and particular percent changes (would be helpful)
      1. MI paper with table that has water management zones
      2. Others?
6. Chris Goudreau will find the MI report to use as a possible reference for biological change threshold decision.
7. EFSAB members should share any references from other states, studies that could help with the biological change threshold decision
8. Mark will provide a presentation Sept 24 on how to evaluate the Oasis nodes.

### **2. Regarding coastal recommendations:**

- A. Use if/then statements? For example, if DWR wants to pursue scientific understanding of how to evaluate ecological flows in the coastal plain, then our advice would be to go through these options.
- B. A thorough summary of the coastal work should be included in the report because the coastal subcommittee's work has been so good, and it mirrors the work that the whole board has done.
- C. Put the research needs into a qualitative description of the if/then statements. State for your 3 or 4 approaches, how the research needs bolster those. That would help explain how/why this research is needed.

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## Executive Summary

### **TITLE: Presentation: Defining Stream Sizes and Discussion of Headwaters**

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#### **Presenter: Tom Cuffney (Aug 20, 2013)**

The EFSAB requested a presentation on the potential ways to define stream sizes and discuss the merits of each. The presentation was illustrated by the SALCC approach used by RTI/USGS. Tom Cuffney provided the presentation. The primary purpose of the presentation and discussion was to look at the issue of how well we're representing the various stream sizes across the state.

#### **Decisions and Recommendations:**

General agreement to have stream classifications in terms of size

Benefit in aligning to SARP and approaches others are using.

#### **Proposed Actions:**

Board wants additional data to determine if it's five classes or combined classes or some other alternative. Would like to see how the smaller streams fall out from the headwaters. Tom will separate out and provide new illustration to the EFSAB on Aug 21.

Mark will provide a presentation Sept 24 on how to evaluate the Oasis nodes.

### **Aug 21: Continued Discussion of Stream Size Classification & Headwater Recommendation**

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#### **Presenter: Tom Cuffney (Aug 21, 2013)**

On Aug 21, the EFSAB picked up from where they left off Tuesday in discussing stream size classification. The members were asked to review the latest Version of the SALCC drainage area distribution (a corrected version was reviewed on Aug 21 that separated the headwaters and the creeks (previously combined) and corrected minor miscalculations). Based on a random set of 900 points, the numbers of the very small basins – less than 3.6 square kilometers – are very under-represented in the DWQ data. Really small streams tend to become intermittent and thus more difficult to track and to assess water quality in those systems. These systems require a different set of standards. With respect to the headwaters, using the RTI, USGS regressions, this reinforces the notion that smaller and smaller headwater streams are less applicable because these systems become intermittent, and are totally different. This supports the argument from yesterday to handle these very small headwater streams differently.

#### **Major Discussion items/concerns/questions:**

1. Do headwaters have complete guild assemblages? Vann consistently found fish in ok size streams
2. Is it more appropriate to lump into larger group or keep separate and note the lack of data?  
(prefer not lumping)
3. There is data for the headwaters but not for the intermittent streams
4. If applying different criteria, state in the report for headwaters perennials that everything sampled by DWR/DWQ is proven.
5. What does vulnerability mean?
6. Oasis aggregates small withdrawals criteria; WaterFALL does better in small catchments.
7. If the break were closer to the creek, would that increase the # of creeks? The Geise and Mason report has a method to identify intermittent streams. [Facilitator's note: upon review of this

summary, Fred Tarver noted, "I believe Giese & Mason sets drainage areas for Hydrologic Areas (HA) above which the 7Q10 is not zero.

FOLLOW-UP: "Drainage area, in square miles, below which indicated low-flow statistic generally has a zero value." Low-flow statistics are 7Q10/Winter7Q10/7Q2/7Q30. Ten HA's are delineated in NC in the report.]

8. The EFSAB may not have enough information but to state small streams are vulnerable.
  - a. In what ways and how are those vulnerable?
  - b. Small streams that reach 0 flow experience extreme events naturally; withdrawals add stress
  - c. example: dead mussels in upper Tar/Sheldon Creek of the Uwharries as creek dries out.
  - d. Is the impact unnatural given the nature of long-run droughts in the state? What is the reference condition?
  - e. Adding a withdrawal factor to stressed systems, extends the period of time of extreme values. This can be demonstrated on the hydrograph as demonstrated in the Alberta method (a literature source to conceptually support this claim).
  - f. Use a different metric and if there is a decrease in flow from perennials – becomes intermittent – then flag. Another way to add protection.
  - g. What is the definition of intermittent flows ? 1 day of zero flows (whose definition and can it be supported?) Biological assemblage should define intermittent. Need to settle on definition.
  - h. If there is science that says a withdrawal of 100 mgd from most headwater streams would have a significant ecological impact, we should say that.
    - i. Could make statements about dewatering a small stream = impacts; therefore, they need protection. Though it is unlikely that they can support large withdrawals.
    - j. Does the EFSAB lump perennial headwaters with creeks?
    - k. Ecodeficit tool to investigate the potential increase in small streams.
    - l. Could recommend use of tools in >10km. List of nodes by drainage area to see if any nodes in <10km drainage? If anything is located in <10km drainage raise a flag?
    - m. There should be a lot of research showing impacts and vulnerability of small streams.
9. About hydro data and modeling in headwater streams <10 Km. Higher vulnerability therefore if there is a node in <10km drainage, flag as site specific for follow up. (no gages there to calibrate Oasis)
10. How to calibrate model and restrictions on OASIS?
11. Do exact same thing without #s – options for recommendations and hard #s where limited gages (Oasis data)
  - a. name the description with a range of #s
  - b. define vulnerability – continuous vulnerability as size increases
  - c. offer advice not numerical recommendations about relative vulnerability
12. Alternatives to an area
  - a. actions from perennial to intermittent raises flag
  - b. 1<sup>st</sup> or 2<sup>nd</sup> order stream raises flag (not popular)
  - c. Condition X triggers a flag if our recommendation doesn't allow a decision-flow chart....indicate where to add information if needed.
13. Important to reference impacts to ecology and support these claims.

**Decisions Made:** Chris, Judy, and Jeff agreed to develop a recommendation for Headwaters that the group could review and discuss in the afternoon.

Afternoon discussion resulted in the following Recommendation #2 on Headwater Streams:

"There is limited biological and hydrologic data in headwater streams within North Carolina. These streams have a higher vulnerability to disturbance, and the broader statewide approach may not adequately reflect the potential for impact to ecological integrity. Therefore, DENR should identify

the subset of headwater streams to receive alternative analysis. (Note for further explaining- examples of vulnerability, how and in what way. Less water to start could be converted to intermittent)."

**Proposed Actions or Identified Decisions to be made:** none

**TITLE: Framework of Proposed Recommendations for Coastal Streams and Rivers**

**Presenter: Bob Christian**

Bob Christian presented a framework for recommendations developed by the Coastal Subcommittee, which suggests four potential approaches to determining ecological flows for coastal streams, depending on the origin of the stream, the gradient or slope of the stream and whether the stream has wind or tidal driven flow:

Origin	Slope	EF determinant			
		EFSAB extension	Discharge & Habitat	Downstream Salinity	Overbank Flow
Piedmont	Medium gradient	X	X	X	
Coastal Plain	Medium gradient	X	X	X	
Coastal Plain	Low gradient		X	X	X
Coastal Plain	Wind or tidal driven flow			X	X

The subcommittee does not see these as recommendations at this point, but as potential approaches that could be developed. The subcommittee also developed a list of identified research needs for developing these into recommendations:

1. Determine correspondence of known discharge patterns with nearby coastal plain stream flow, stage and floodplain inundation patterns.
2. Evaluate juvenile abundance indices vs. flow and salinity/conductivity.
3. Map salinity distribution across coastal plain.
4. Determine the upper-most extent of tidal influence across coastal plain.
5. Quantify stream typology classes.
6. Evaluate Roanoke slabshell and other mussel distributions and abundance as informative of salinity and flow patterns.
7. Determine hydrologic metrics and characteristics of coastal streams.
8. Determine reference flow regimes for each river basin.
9. Assess the balance of withdrawals from and discharges to coastal streams.

**Major Discussion items/concerns/questions:**

- Looking at your stream classification and #5 of the research needs, what percent are covered by OASIS and not? What are the breakdowns within a class covered and not covered?
  - Almost all of it is not covered by OASIS currently.
- In the discussion of coastal rivers and streams, one concern is more about water going into surface waters after being pumped from an aquifer. An overabundance of fresh water going into surface waters in the coastal plain has importance for ecological flows, but that is outside the concern of DWR. [Facilitator's note: Upon review of the summary, DWR disagreed with the statement that this is outside the concern of DWR, stating that it is a concern if it affects ecological integrity].

- That's in our larger document.
- I'd suggest that the EFSAB would recommend that we push coastal concerns forward with what it requires. The research needs are appropriate and good for academic concern. But we have to put it into perspective regarding time and resources to be able to push a recommendation. It needs a magnitude analysis. I'm most comfortable stating it the way you (the subcommittee) have: In order to move forward, these are the things that are needed.
- Is the idea that you recommend all 4 approaches and that there would be some hierarchy for which approach to apply to a given type of stream?
  - I would leave these as parallel tracks. Where the statewide approach can comfortably be extended, that would be the first order approach. But then I think the next best step is to look at the effects on anadromous fish and other important species and develop the approaches from the biological point of view. Salinity would be almost a fallback. I see overbank flow as an add-on; in certain places, the overbank flow is an additional concern, not an alternate concern
- One of the challenges we are dealing with here is that slope and velocity are not the same; velocity is incredibly important. It is really the velocity that relates to ecological condition. The gradients may or may not be indicative of velocity.
  - In some ways, though, it is the depth of the stream that determines the amount of habitat, and in the coastal plain, that is disconnected from the discharge.
- In terms of practical application, if you take it at face value, everything in black, red or turquoise might fit into the rest of the recommendations.
  - Maybe the black and the inland red. I just don't know about the turquoise areas. It may be that when we look at how to extend the statewide recommendations, the distinction between inner and outer coastal plain may become a more critical factor.
  - Where you have the turquoise areas that are not contiguous with the coastline, they may be low-head dams or things like that.
- I'm very supportive of dealing with our coastal areas with if/then statements. If DWR wants to pursue scientific understanding of how to evaluate ecological flows in the coastal plain, then our advice would be to go through these options.
- I would advocate an integrated whole for the EFSAB report as much as possible. I think a thorough summary of the coastal work should be included in the report because the coastal subcommittee's work has been so good, and it mirrors the work that the whole board has done. I think of it as an integrated whole and encourage us to have a comprehensive report from the Board at the end of the day.
- I think as much as possible, put the research needs into qualitative description of your if/then statements. State for your 3 or 4 approaches, how the research needs bolster those. That would help explain how/why this research is needed.
- When I look at the map of the four classes of streams and the cover slide that shows the OASIS model area, I think a lot of those that are piedmont, medium-slope are going to be captured in the OASIS models. If that is the case, then those could automatically go into the statewide approach. It's not really additional research but rather a next step: overlay those and see what drops out already.

**Decisions Made: none**

**Proposed Actions or Identified Decisions to be made:**

- Use if/then statements? For example, if DWR wants to pursue scientific understanding of how to evaluate ecological flows in the coastal plain, then our advice would be to go through these options.
- A thorough summary of the coastal work should be included in the report because the coastal subcommittee's work has been so good, and it mirrors the work that the whole board has done.

- Put the research needs into a qualitative description of the if/then statements. State for your 3 or 4 approaches, how the research needs bolster those. That would help explain how/why this research is needed.

**TITLE: Presentation: Recommended Framework for Evaluating Ecological Flows in the Streams and Rivers of North Carolina**

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**Presenter: Jennifer Phelan, RTI**

There were 2 main components of the presentation:

- Flow Alteration – Biological (i.e., flow-biology) response curves for fish and benthos
- Ecological Flow (EF) Categories and Thresholds
  - Based on “Working Rivers” concept
  - Examples within the Upper Neuse River Basin
- Where do these curves apply?

The % change of biological condition allowed as a threshold changes based on the current condition of the stream -- the better condition, the less % change in biological condition is allowed before a flag is triggered. She showed how this applies in the two example sites within the Upper Neuse River Basin (*Eno River, Goldsboro*).

**Major Discussion items/concerns/questions:**

- Concerns were expressed about using the working rivers philosophy
- The concept is good for reason of discussion, whether or not the specific proposed categories and thresholds are used.
- Discussion about uncertainty values -- some would like to see them, others point out that the uncertainty is good for biological data.
- Regarding where this could be applied, it was suggested that it could apply everywhere but the tidal areas.

**Decisions Made:**

Provide an outline of the RTI report to the EFSAB by mid-Sept for their review; include justifications of the 5, 10, and 15% thresholds.

**Proposed Actions or Identified Decisions to be made:** none

**TITLE: Presentation: EFSAB Report: Draft 3 - Update**

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**Facilitator: Mary Lou Addor**

Chris Goudreau presented Draft 3 of the EFSAB report, which included a new section, titled, ***Literature Review and Presentations***, and presented additional research information that had been explored since the EFSAB began meeting. The writing team was comprised of Mark Cantrell, Tom Cuffney, Linda Diebolt, Chris Goudreau, Sarah McRae, and Jamie Robinson.

**Major Discussion items/concerns/questions:**

During the Aug 20 meeting, members of the EFSAB were asked for their reactions to the latest version of the report and specifically regarding the:

1. Level of detail required for the report
2. Organization of the report

**Decisions Made:**

Ensure Report leads with Findings/Recommendations.

**Proposed Actions or Identified Decisions to be made:**

Determine writing teams on Aug 21 once recommendations are developed.

**TITLE: Concepts and Principles Regarding Ecological Responses to Flows and Principles**

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**Facilitator:** Mary Lou Addor

The EFSAB had been asked to review the section of the DRAFT 3 Report titled, "Flow Regimes to Maintain Ecological Integrity" (pgs.12-14; this section also referenced a portion of the July Meeting Summary, pgs 74-78). Presented on pages 12-14, were concepts regarding ecological responses to flows and principals for maintaining ecological integrity of freshwaters in North Carolina. These concepts were derived from a list Tom Cuffney presented at the July meeting, titled: ecological responses to flows.

**Major Discussion Items/Concerns/Questions:**

During a discussion, several members of the board expressed concern about taking time to review and develop an agreement about the list versus spending time directly developing recommendations that would naturally offer context for the discussion.

**Decisions and Recommendations:**

For the most part, most members were comfortable with the concepts listed on pages 12-14.

**Proposed Actions:**

Revisit the concepts regarding ecological responses to flows and principals for maintaining ecological integrity of freshwaters in North Carolina following development of recommendations.

**TITLE: Process for Report Writing: Establishment of Writing Teams**

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**Facilitator:** Mary Lou Addor

Toward the end of the August 21 meeting, writing teams were established to expand/revise Draft 3 of the EFSAB report (Aug 16, 2013), in preparation of the Sept 24 and 25 meeting. The main goals are:

1. Provide a rationale for each recommendation developed by **Sept 6** (anywhere from 1-3 pages)
2. Ensure the completeness of the document as best as possible. Lou will combine any iteration into one document with support from Chris and Jamie.
3. Distribute Draft 4 by **Sept 10** to the EFSAB listserv so that all members can begin to identify gaps, areas where they are uncomfortable and why, raise questions, propose alternative language and additional edits, including how to increase the readability of the report.
4. Receive comments/questions/alternative language/proposals from all EFSAB members by **Sept 18 (request earlier return of comments by members working in tandem with their alternates)**
5. Provide marked up copy of Draft 4 with all comments to the EFSAB by **Sept 23 (earlier if possible)**
6. Proposal: set aside 2 hours onsite (**Sept 25**) to make changes to the report moving the EFSAB closer to one complete report.

**Major Discussion Items/Concerns/Questions: None****Decisions and Recommendations:**

The writing teams are:

1. Characterization Recommendation- Chris Goudreau and Linda Diebolt
2. EFlows Recommendation 1 - Statewide approach - Thomas Cuffney and Tom Thompson
3. EFlows Recommendation 2 - Headwaters approach - Judy Ratcliffe and Jeff Hinshaw
4. Coastal Plain Strategy - Bob Christian and Linda Diebolt
5. Glossary - Fred Tarver
6. Reorganization of Report – Jamie Robinson and Chris Goudreau

## Recommendations:

**1. Characterization Recommendation:** Chris and Linda with Tom Cuffney (Tom has an interest in this section and will do what he can to review). This includes any pertinent rationale/assumptions, citations and references to justify what is being proposed in the characterization recommendation. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive at the characterization recommendation.

**2. Eflow Recommendation 1:** Tom Cuffney and Tom Thompson will work on this section. This includes any pertinent rationale/assumptions, citations and references to justify what is being proposed in recommendation 1. Jennifer Phelan is sending a section of the RTI report that will assist in supporting the choice of 5%, 10% and the 15% thresholds early Sept. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive at recommendation 1.

Statewide approach using simultaneously two tools:

- In the basinwide hydrologic models, use 80-90% flow-by as the ecological flow.
- If the basinwide hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.
- The Eco-deficit tool should be used to determine the current and future modeled biological condition of locations in the basinwide hydrologic models.
- DENR should evaluate the change in current and future biological condition as a decision criterion. *A 5-10% change in biological condition is suggested as a threshold for further review by DENR. [section requires further discussion/review by EFSAB to determine if all members can live with/support this statement]."*

**3. Eflow Recommendation 2:** Judy & Jeff (Judy may look to Mark, and Sarah to assist). This includes any pertinent rationale/assumptions, citations and references to justify what is being proposed in recommendation 2. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive at recommendation 2.

"Headwater Streams – There is limited biological and hydrologic data in headwater streams within North Carolina. These streams have a higher vulnerability to disturbance, and the broader statewide approach may not adequately reflect the potential for impact to ecological integrity. Therefore, DENR should identify the subset of headwater streams to receive alternative analysis. (Note for further explaining- examples of vulnerability, how and in what way. Less water to start could be converted to intermittent)."

**4. Coastal Plain Strategy:** Linda Diebolt has suggestions for the Coastal section and would like to work with you, Bob, to address that section. This would include the changes that resulted from the Aug 21 discussion and any pertinent rationale/assumptions and citations and references to justify what is being proposed in the coastal strategy. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive as this strategy.

**Proposed Actions:** None

## **TITLE: Discussion on Characterization**

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**Facilitator: Mary Lou Addor**

Writing team, Mark Cantrell, Linda Diebolt, Jaime Robinson, and Chris Goudreau drafted a recommendation for characterization based upon the discussions from the EFSAB at the July meeting.

### **Major Discussion items/concerns/questions:**

- Unsure of the relevance of characterization in the way it's currently reflected in this draft of report, given that EFSAB did not focus upon it in this fashion.
- Make our recommendations and then back up and see what we need to include based on that. A lot of those answers may come after we have recommendations to provide justification.
- RTI and USGS did a lot of work on classification (as a means for characterization). Many various methods were tried that need to be reflected in the document, but it will be hard to include until the RTI report is written.
- The legislation calls for EFSAB to characterize ecology in the different river basins, so we somehow need to address that charge in the report, or explain how and why we did not address it.
- DWR staff characterizes the basins when doing basin plans, so we could say that DWR already does this, and we are focusing on the more critical piece, ecological flows.
- Suggest a different way to characterize ecology by basically discussing the relationships between different flow components and ecology. That stands on its own and we could do that now in a page or two rather than wait until the last minute. We could find this information in other documents.
- It needs to come out of findings and into a preface section. Its not a finding, but rather it sets stage for characterizing ecology

**Decisions Made:** none

### **Proposed Actions or Identified Decisions to be made:**

- Chris Goudreau and Linda Diebolt offered to work on the characterization section outside of the meeting.

## **TITLE: Approaches for Setting Protection Standards**

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**Presenter: Chris Goudreau**

As a lead in to the discussion around developing the flow recommendations, Chris Goudreau reviewed the general approaches that can be taken for flow recommendations as defined by Richter et al. (2011). The three approaches defined by Richter include:

1. Minimum flow threshold-- which might be a single value (e.g., 7Q10) or be seasonally adjusted (e.g., Tennant, South Carolina);
2. Statistically-based standard—this Board has not discussed this type of approach much, but it attempts to mimic as much as possible all the components of a flow regime, such as:
  - Critical low, low, high flow pulses, small floods, high floods
  - Wet, normal, dry years
  - For each, includes magnitude, duration, frequency, season
  - Tied to ecologically significant events
    - E.g., spawning, floodplain rejuvenation, fry/juvenile growth, migration, sediment movement, channel maintenance
3. Percent of flow standard (e.g., Alberta)

Chris then identified which of those approaches were employed by the various trial balloons that have been presented to the EFSAB. The RTI/USGS (ad-hoc) approach does not fit into Richter's scheme. Chris had put this presentation together to assess the various trial balloons in light of the principles that the EFSAB loosely agreed upon. He then showed how the various trial balloons could be applied to the various stream sizes used in the recommendations developed in July.

**Major Discussion Items/Concerns/Questions:** none

**Decisions and Recommendations:** none

**Proposed Actions:** none

## **TITLE: Continuing from July Discussions on Development of Flow Recommendations**

**Facilitator: Nancy Sharpless**

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Beginning by looking at the tentative recommendations agreed-upon in July, the EFSAB developed a new flow recommendation:

Recommendation 1: Statewide approach using simultaneously two tools:

- In the basinwide hydrologic models, use 80-90% flow-by as the ecological flow.
- If the basinwide hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.
- The Eco-deficit tool should be used to determine the current and future modeled biological condition of locations in the basinwide hydrologic models.
- DENR should evaluate the change in current and future biological condition as a decision criterion. *A 5-10% change in biological condition is suggested as a threshold for further review by DENR. [section requires further discussion/review by EFSAB to determine if all members can live with/support this statement].*
- The EFSAB discussed at length whether a numerical range for a threshold for %biological change should be recommended. This question will be further discussed at the next meeting

The EFSAB developed a list of remaining questions to be addressed and a proposed list of statements to accompany the recommendation in the report:

### Questions to address:

- Develop criteria for acceptable % change in biological condition (or do not define?)
- Determine if including seasonal differences
- How often does it have to drop below for a flag to go up (or let DENR decide?)?
- For eco-deficit, use fish or invertebrates?
- What level of ecological integrity are the recommendations protecting?
- Advise DWR on how to assess condition of stream?

### Statements to include in report:

- Limitations of data used to develop the eco-deficit tool
  - This is already in the report
  - When will the RTI/USGS report be published?
- PHabSIM could be used when flag is raised.
- Issue of it is all modeling—DWR is working in models. Everything is modeled. The assumptions are based on the models

- It should say it is calculated on a daily time-step
- What time step to use in flow-by
- How is flow-by calculated
- What is the index flow for calculating % flow by
- Define terms (%flow-by, eco-deficit)
- Include a description of where the high end of the flow-by range would be used.
- As data is collected and knowledge develops using the eco-deficit approach, eco-deficit knowledge might inform changing the % flow-by
- Describe where the range of % biological change comes from and authors provide examples of how it works.
- For headwaters, there may not be a node in OASIS. WaterFALL is probably the only tool available, and it did not correspond well with OASIS. You may not be able to use two tools in the headwaters because there may not be a node there.
- Explain that the model that was done was based on using unregulated flow and based on that we pick these numbers. Put in a statement that you look at the cumulative effect of withdrawals and take that into account.
- Justification of the flow-by range.
- In the Richter paper table 2, FL, MI, ME, EU, those percentages are 80-92.5% flow by. FL is based on their own information, 80-92%; MI is 85-94%; ME is 90%.
- Look at the cumulative effect of withdrawals and take that into account.

Another potential recommendation was proposed: The current SIMBASE2013 should be used as the prevailing condition from now forward.

The EFSAB had much discussion as to whether to provide a number or range as a threshold for % change in biologic condition or to not provide a number or range.

Why not to provide a number or range as a threshold?

- Is recommending a % change recommending a policy decision?
- As a group we have different understandings and interpretations of the threshold concept of the ecodeficit model.
- DENR should have the capacity to determine a threshold themselves
- Authors should be able to provide a recommendation and justify it rather than the Board setting that point.
- Is it defensible since there is no report from RTI yet, and no publication?

Why provide a number or range as a threshold?

- If saying DENR should consider change of biological condition between current and future as a decision criterion, without guidance on how to interpret what is allowable % change, nothing may happen with it.
- PHABSIM approach would also require an allowable % change to be used as a decision criterion.
- If x% is recommended as an initial threshold with some explanation of why we chose the #, it's at least a point of discussion. If it's ignored, at least we've gone down with some number and some reasoning.
- Would allow us to frame it as a risk of change if more than this % change happens, to say further review warranted when this threshold is crossed without defining a specific action of DENR.
- DENR needs some context for what a % change in bio condition would amount to, and risk of change in EPT class is most logical (criteria with which to evaluate the magnitude of change).

Board members present liked the biological index approach presented by RTI/USGS, but consensus was not reached on whether or not to set a threshold in the recommendation, or what that threshold should be.

#### Options

- If Board cannot reach consensus on a threshold, we can recommend DENR decide on a threshold
- Ask authors to provide a number recommendation and then Board refers to it rather than making the recommendation directly.
- Board can provide a number/range as an initial/starting point threshold for DENR to use.
- If we spent more time with it, with more examples may give us more confidence in a threshold (wait for RTI report?)

A range of 5-10% change in biological condition was suggested as an initial threshold.

- Include an explanation of where numbers came from within the report.
- Ask authors to provide examples, advantages, disadvantages of the numbers
- In report include language about when you may want a higher % change, when a lower % change may be appropriate
- A straw poll of a proposal to use 5-10% as a threshold resulted in one-1, seven -2's, and two 4's
- A straw poll of a proposal to use 5-15% as a threshold to reflect the RTI presentation was polled resulting in three-5s, so this was not further considered
  - It would not work to apply 15% across the board as a way to reduce risk

#### Decisions Made:

1. Recommendation 1: Statewide approach using simultaneously two tools:
  - In the basinwide hydrologic models, use 80-90% flow-by as the ecological flow.
  - If the basinwide hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.
  - The Eco-deficit tool should be used to determine the current and future modeled biological condition of locations in the basinwide hydrologic models.
  - DENR should evaluate the change in current and future biological condition as a decision criterion. *A 5-10% change in biological condition is suggested as a threshold for further review by DENR. [section requires further discussion/review by EFSAB to determine if all members can live with/support this statement]."*

[The EFSAB discussed at length whether a numerical range for a threshold for %biological change should be recommended. This question will be further discussed at the next meeting]

2. The Board tentatively defined flow-by as: The percentage of ambient modeled daily flow that remains in the stream. For modeling purposes this is calculated on a daily basis. [Need to define somewhere how daily flow is reached].
3. The Board opted to continue fleshing out recommendations and let writers define terms, then address any concerns about that later.

#### Proposed Actions or Identified Decisions to be made:

1. Another potential recommendation was proposed: The current SIMBASE2013 should be used as the prevailing condition from now forward.

2. Maybe we should advise DWR on how to assess condition of stream, and there are a couple different ways to do that.
  - a. Compare against unregulated flow
  - b. Use eco-deficit tool.
3. When we're saying to maintain ecological integrity, we'll at some point define what it is.
4. Whether or not to set a threshold in the recommendation, and, if so, what that threshold should be.
5. How to move forward between now and September?
  - a. Address concerns about defensibility/validity
    1. Seek report from RTI as documentation (needed)
    2. Seek additional supporting documentation from other studies, states that could provide references for using indices as evaluations and particular percent changes (would be helpful)
      - a. MI paper with table that has water management zones
      - b. Others?
6. RTI will share the proposed outline of their report to the EFSAB for feedback about what should be included, and will complete a description of the biological change threshold methods and reasoning before the September meeting.
7. Chris Goudreau will find the MI report to use as a possible reference for biological change threshold decision.
8. EFSAB members should share any references from other states, studies that could help with the biological change threshold decision

## I. August 20, 2013 Meeting Orientation and July 16 & 17, 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.

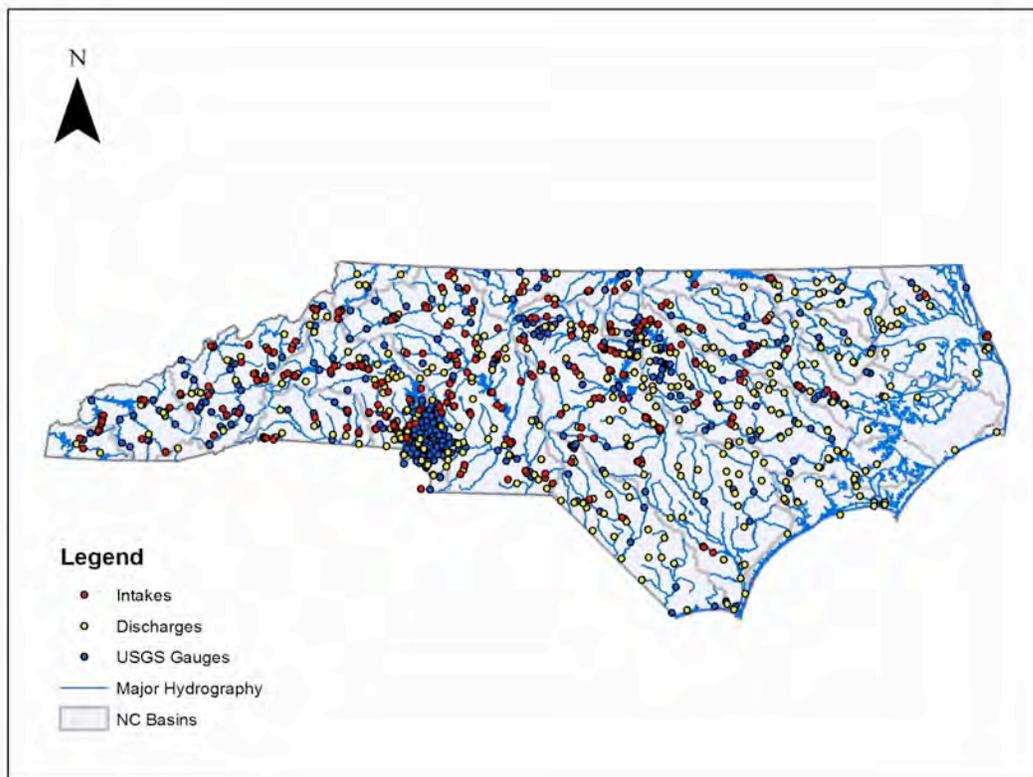
The EFSAB approved the July 16 & 17, 2013 meeting summary, and it has been posted to the NC Water.org website.

## II. Presentation: Defining Stream Sizes

**Presenter:** Tom Cuffney, USGS

The EFSAB requested a presentation on the potential ways to define stream sizes and discuss the merits of each. The presentation was illustrated by the SALCC approach used by RTI/USGS. Tom Cuffney provided the presentation. The primary purpose of the presentation and discussion was to look at the issue of how well various streams sizes are represented across the state.

Fred opened the discussion of stream classification by introducing a map that Ian McMillian had developed though it was not clear how this map related to stream sizes. The map displayed public water intakes, NPS discharges, and USGS gage sites, including the blue line streams in the state. Ian was demonstrating the distribution on the various intakes and discharges in relationship to the gage sites.



NC DIVISION OF WATER RESOURCES  
NC ECOLOGICAL FLOW SCI ADV BOARD  
08-28-2013

IAN McMILLIAN

In terms of stream size in headwater streams, the goal was to address the relationship of these registers at various intakes and discharges in relationship to discussions about headwater streams versus larger streams. Recall that the use of bug and fish data primarily comes from wadeable streams; that larger non-wadeable streams are probably going to be the existing intakes and discharges in the future and thus candidates for additional withdrawals. And so, in terms of intakes and placement of these intakes and discharges, the locations in these non-wadeable streams and lower reaches and to some extent the headwaters are not typical sites for proposed new intake due to dependability of water supply. The public water supply doesn't account for non-registered withdrawals such as with agricultural or other sources.

In terms of relationship to the OASIS models, DWR uses the USGS gage data to calibrate the OASIS models. In terms of location of the nodes placements in the OASIS model, they're placed in areas that try and capture registered water uses (registered with DWR in terms of greater than 100,000 gallons,

or those shown on the map here). Thus, we try to capture those nodes. In some of the other headwater streams, there are not nodes because there are no known withdrawals that meet the criteria of greater than 100,000 gallons.

With respect to discussions about headwater streams, DWR does not have that resolution in its use of OASIS to capture some of the headwater streams, because there are no uses, or are no known uses.

Question: Is there a way to analyze or augment the blue lines? Because the wadeable streams area is not necessarily so small; a few of these areas are staying full. Can we acquire concrete numbers?

Tom: In terms of how far up the headwater streams, maybe the Board can consider recommendations on evaluating headwater flows and headwater streams. But in terms of the OASIS model, the very upper headwaters are probably not captured.

Question: Does the legislation have a cutoff point for stream size? [No] For ecology or characterization?

Tom: No, it's very broad. The Board is free to make recommendations as it sees best.

Comment: Some of the best water supplies are in these smaller headwater streams and in multiple headwater streams. If there are limits on withdrawals in some waters, then it leaves open the door to the headwaters.

Tom turned the conversation toward what was currently available to the Board in terms of water or basin size classifications. He presented a distribution of streams pulled together by the SALCC and used by RTI and USGS. The distribution is comprised of headwaters, creeks and small rivers, medium rivers, mainstream rivers, and large rivers, which are greater than 10,000 square kilometers.

[Note: Tom had initially combined the class 1a – headwaters and 1b- small rivers].

**A question raised to the group was, “Do we agree to have stream classifications in terms of size?” [Yes].**

**The second question is whether 1, 2, 3, 4, 5 classes – are acceptable, or whether some should be collapsed similar to what Chris had, or some other alternatives.** Originally, the work TNC completed in the northeast involved extensive analyses, a panel of experts, and how different states in the northeast defined their sampling regimes. The results made sense from a data distribution and a utilization perspective. SARP and the South Atlantic LCC have picked up this work. Thus it's fairly widely used.

Tom further explained that the BEC analysis made use of the fish sites and the use of random points across the state to define basins. Random points were set up for comparisons to the biological, as opposed to gage sites; the biological sites do a very good job of reflecting the distribution of these streams across the state in terms of numbers. This was the point in using those random sites- to provide a level of criteria to look at. This random population helps to indicate how well we are doing at representing streams conditions across the state.

The argument about whether we're representing the mainstream sources where most of the water is being taken out – is a different question. It needs to be addressed both in terms of the biology, and in terms of the charge to the group, which does not necessarily say its drinking water withdrawal in large rivers. But it says basically, all streams in the state. So again, do people agree that this shows that we are representing the distribution of stream sizes across the state biologically?

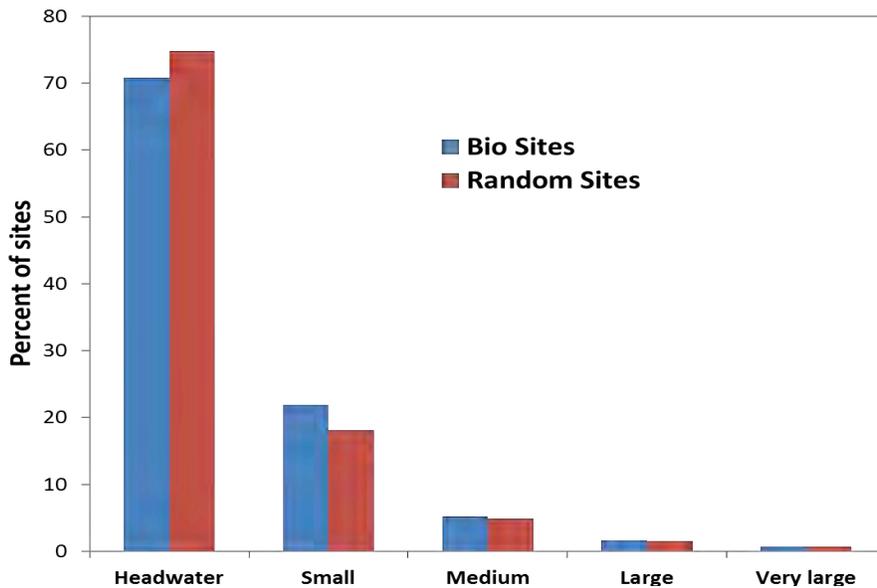
Comment: Yes, this seems reasonable. However, I'd be more comfortable if the headwater creeks were separated from the headwater streams. I'd like to see how they fall out in terms of biology. There's a bigger difference between a stream with average mean flow less than 10 CFS compared to one that might have average mean flow of 75. I'd like to see if it's representative. We may want to put them together or we may not. Are we trying to keep certain streams pristine? If so, we might be more inclined to say headwaters or creeks.

Additional comment: do not over focus on the adjective of headwater, creeks, small rivers rather than the numerical distribution. For example, you've got 5 categories which are 100% based on drainage area. (We could debate for a long while the adjectives that describe the drainage areas, as to whether that's really headwater or whether it's a small creek).

Response: when you include the really, really small creeks, you're including everything down to those that are ephemeral. I believe there's much greater difference perhaps in the biology of those compared to the biology of those that are not that small. Let's break them out and see what we get – Tom said he could do that after lunch [was unable to do this until the next morning].

Distribution of Stream Sizes				
Drainage area (km2)	No. fish sites	No. Inv sites	No. RndPts	All sites
Headwater & Creek: < 100	701	1124	778	2603
Small rivers: 100 – 518	154	409	67	630
Medium rivers: 518 – 2,590	3	130	36	169
Mainstem rivers: 2,590 – 10,000	0	42	12	54
Large rivers: >10,000	0	17	7	24
<b>Total</b>	<b>858</b>	<b>1722</b>	<b>900</b>	<b>3480</b>

Stream sizes: Biol. Vs. Random



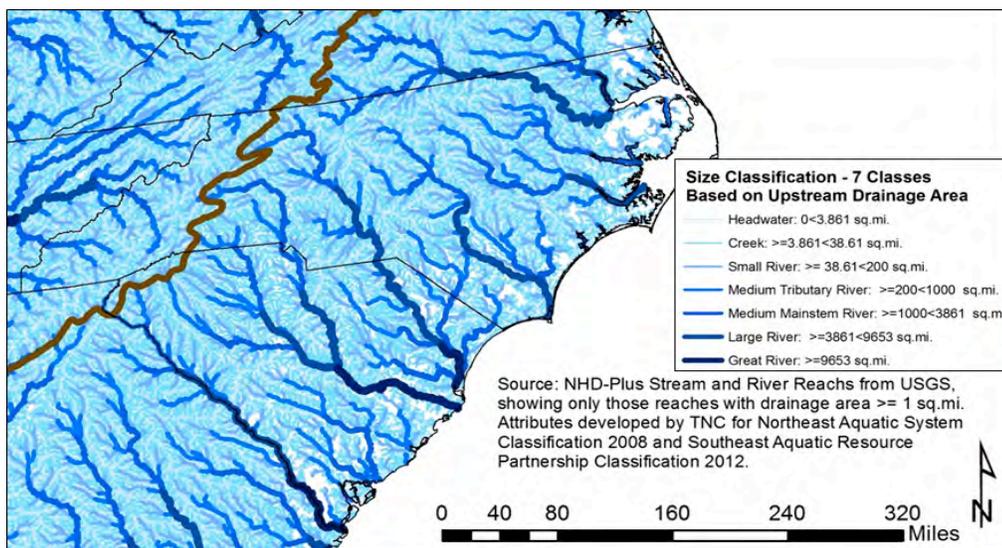
**The next issue, where does representing the OASIS nodes come in and how do we assess the importance of that?**

We may need to consider some type of analysis that we did with fish sites and say where are the nodes now? How many nodes fall where? Is that doable? Like where are they on these streams? Are they meaningful, or medium rivers or greater? I think that would match up with what we're going to hear.

Comment: The difficult part would be to geo-reference the nodes, because they capture a withdrawal or a discharge or a combination of such. So you have to kind of refer back to what the node's trying to capture in order to try and get a placement of it in general. So you'd have to go back and see what each node tries to represent in terms of the model. And then, based on the NPS permit for an intake that long, you'd have to say the node is here. Since we don't have weights and nodes for all basins, we'll just go back to the raw data, which are the intakes and the discharge ones.

What is the explanation as to why some of these categories are rolled together? When Mary Davis was doing the analysis for SARP, the northeast design was here's the stream and you can collapse or not based on individual needs. Jeff's point is a good one. They are ecologically different so it will be helpful to see if there are distinctions.

Size Class	Description	Definition: Upstream Drainage Area (sq.mi.)	Definition: Upstream Drainage Area (sq.km)	Definition: Mean Annual Flow (cfs)
1a	Headwaters	0<3.861	0<10	<= 10
1b	Creeks	>=3.861<38.61	>=10 < 100	>10 - 75
2	Small Rivers	>= 38.61<200	>=100 < 518	>75 - 400
3a	Medium Tributary Rivers	>=200<1000	>= 518 - 2590	>400 - 2,000
3b	Medium Mainstem Rivers	>=1000<3861	>= 2590 < 10,000	>2,000 - 6,000
4	Large Rivers	>=3861<9653	>=10,000 - 25,000	>6,000 - 20,000
5	Great Rivers	>=9653	>= 25,000	>20,000



For now, I think we are doing a good job spatially and have addressed the issues in terms of characterizing responses or ecological flow across the state. But we have another question, which DWR is really interested in. **What is the effect on these larger rivers that they're likely to increase**

**withdrawals from?** We don't really know what the overlap is between the sites the models were built for and the sites DWR is interested in. It's a supplementary question that may be a bit beyond the charge although it's relevant to DWR and their tasks.

The take home message, for me, is that the areas' classifications haven't been as important as a general response across all of the classes of rivers as- within an eco-region of some sort.

The BEC analysis said that we can't divide them by eco regions, need to conduct statewide. That's consistent with what we're seeing here, that the applicability of this model is over most of the state, though it may not be very applicable at the very low or very high end.

Facilitator: Mark has volunteered to try and pull the raw data together to determine where the Oasis nodes come into the analysis.

Some general comments about the stream size classifications:

- 1. General agreement to have stream classifications in terms of size**
- 2. Board wants additional data to determine if it's five classes or combined classes or some other alternative (Tom will provide this review).**
- 3. Benefit in aligning to SARP and in approaches others are using.**

[Concluded Aug 20 Discussion on Stream Size Classification]

### III. **Presentation: Framework of Proposed Recommendations for Coastal Streams and Rivers**

**Presenter:** Bob Christian, ECU

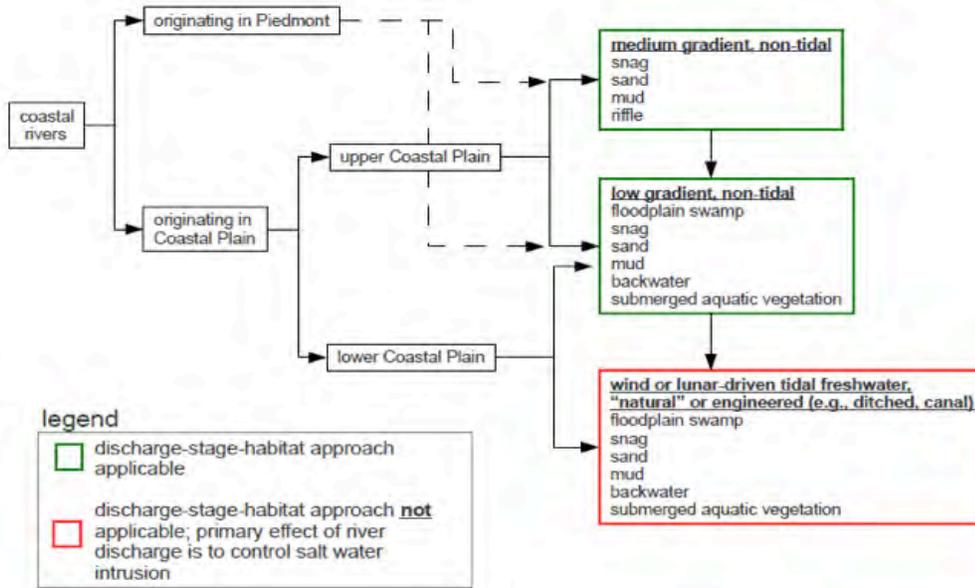
This power point presentation can be found [here](#)

Bob Christian reviewed the overall objectives of the Coastal Subcommittee, which include:

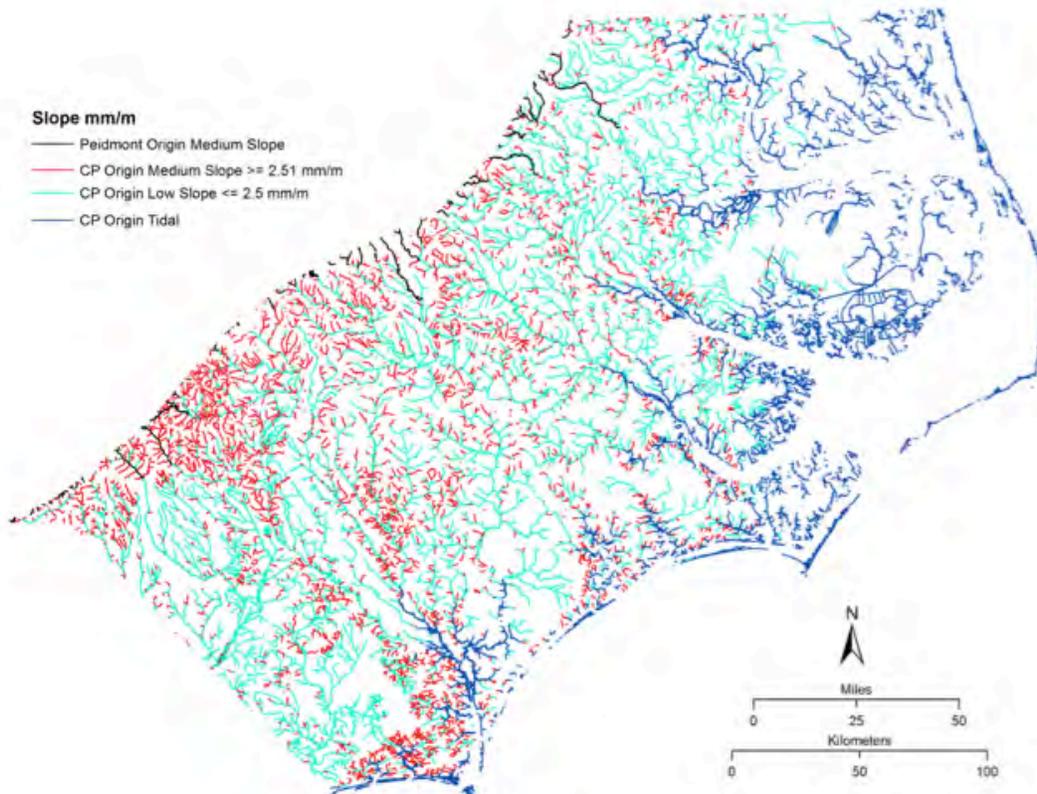
- Assessing applicability of previous coastal work (other states and Greenville)
- Developing a stream typology
- Advancing spatial modeling and mapping
- Establishing relevant ecological and biological dependencies on flow
- Developing frameworks for potential coastal ecological flow criteria and protocols if possible
- Identifying factors limiting coastal ecological flow protocols and needed research within coastal systems.

Bob showed the stream typology developed.

## GEOMORPHIC TYPOLOGY AND ASSOCIATED IN-STREAM HABITATS



The subcommittee concluded that whether a stream is in the upper or lower coastal plain was not significant in terms of determining ecological flows. Rather, the subcommittee determined that the important issues are: origin, by reach; gradient/slope, dividing streams into medium slope ( $\geq 2.51\text{mm/m}$ ) and low slope ( $< 2.50\text{mm/m}$ ); and tidal effect (below 1 meter elevation). The subcommittee mapped which coastal streams and rivers are in each of those categories:



They then developed a framework of potential approaches for determining ecological flows based on those:

Origin	Slope	EF determinant			
		EFSAB extension	Discharge & Habitat	Downstream Salinity	Overbank Flow
Piedmont	Medium gradient	X	X	X	
Coastal Plain	Medium gradient	X	X	X	
Coastal Plain	Low gradient		X	X	X
Coastal Plain	Wind or tidal driven flow			X	X

For the streams originating in the piedmont, the subcommittee suggests using the EFSAB recommendations developed for the rest of the state, applying those downstream as far as possible with the understanding that there is some regional correlation, noting that at this point the subcommittee can not define the % correlation between upstream and downstream flows.

A discharge and habitat approach could be developed for medium and low gradient streams. Information from fisheries and other agencies could be used to develop quantitative relationships between flow and habitat from which to make numerical recommendations. Several states have used downstream salinity as an approach to ecological flows in coastal areas. Actual numbers would need to be developed to apply in NC. Finally, Bob noted the importance of overbank flow in riparian wetlands.

Additional research is needed to develop quantitative approaches for determining ecological flows from this framework of recommendations. The coastal subcommittee identified the following research needs:

1. Determine correspondence of known discharge patterns with nearby coastal plain stream flow, stage and floodplain inundation patterns.
2. Evaluate juvenile abundance indices vs. flow and salinity/conductivity.
3. Map salinity distribution across coastal plain.
4. Determine the upper-most extent of tidal influence across coastal plain.
5. Quantify stream typology classes.
6. Evaluate Roanoke slabshell and other mussel distributions and abundance as informative of salinity and flow patterns.
7. Determine hydrologic metrics and characteristics of coastal streams.
8. Determine reference flow regimes for each river basin.
9. Assess the balance of withdrawals from and discharges to coastal streams.

Bob indicated that APNEP and Division of Marine Fisheries might be able and willing to carry this work forward.

Comments/Questions from the EFSAB included:

- There is a salinity map available
- There are models for Neuse, and Tar/Pamlico, that could be used that hydrodynamic models
  - That was used for the Greenville study
- Looking at your stream classification and #5 of the research needs, what percent are covered by OASIS and not? What are the breakdowns within a class covered and not covered?
  - Almost all of it is not covered by OASIS currently.
- The Lumber River has not been attempted, but there are some gages there.
- Some of the Cape Fear could be modeled.
  - There are gages on the system that are not being modeled?
  - Yes, there are some gages.
- NCSU has done correlations of flow at different water level stations along the Neuse.
- In the discussion of coastal rivers and streams, one concern is more about water going into surface waters after being pumped from an aquifer. An overabundance of fresh water going into surface waters in the coastal plain has importance for ecological flows, but that is outside the concern of DWR. [Facilitator's note: Upon review of the summary, DWR disagreed with the statement that this is outside the concern of DWR, stating that it is a concern if it affects ecological integrity].
  - That's in our larger document.
- So in terms of recommendations, at this point your group is recommending that we have a piece in the report that says, we don't have enough information to make a quantitative recommendation, but here are some options.
- I'd suggest that the EFSAB would recommend that we push coastal concerns forward with what it requires. The research needs are appropriate and good for academic concern. But we have to put it into perspective regarding time and resources to be able to push a recommendation. It needs a magnitude analysis. I'm most comfortable stating it the way you (the subcommittee) have: In order to move forward, these are the things that are needed.
- The process is beyond; here are the research needs.

#### **IV. Presentation: Recommended Framework for Evaluating Ecological flows in the Streams and Rivers of North Carolina**

Presenter: Jennifer Phelan

This PowerPoint presentation can be found [here](#)

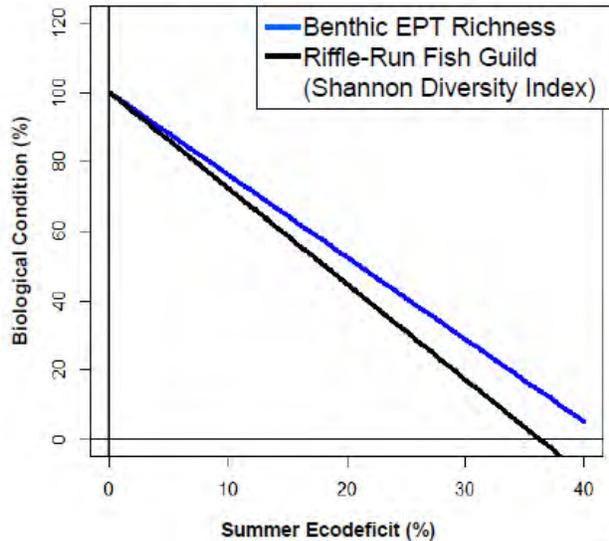
This presentation is to place those in a framework to recommend a setting for evaluating flows throughout the state.

2 main components of presentation:

- Flow Alteration – Biological (i.e., flow-biology) response curves for fish and benthos
- Ecological Flow (EF) Categories and Thresholds
  - Based on “Working Rivers” concept
  - Examples within the Upper Neuse River Basin
- Where do these curves apply?

These categories based on working rivers concept I'll explain. We had requests from you to see it on the ground to see it applied- we'll show the flow metrics there and translations into metrics that makes sense (million gallons per day or MGD), which may make more sense than ecodeficit. We used two examples in the Upper Neuse River Basin and will translate ecodeficit into units that may make more sense.

## FLOW – BIOLOGY CURVES



Second component, where do these curves apply.

Flow biology curves- here we show the curves for benthos and fish, reminder the biological response metrics for benthos is EPT Richness. The biological response metric for fish is the riffle-run fish guild characterized by the Shannon Weaver Index for species diversity and abundance.

Something else to get out of here is the fact that fish seem to be more sensitive to flow alterations than benthos, as least riffle-run fish guild.

Now putting this in a framework of ecological flow categories and thresholds onto the curves.

- Here are definitions to start off with, and then we'll put them on a curve.

EF Category = Current biological condition that determines EF Threshold

EF Threshold = Change in biological condition (caused by flow alteration) that triggers a "flag", meaning the biological component has been compromised.

This table outlines the 4 categories we're proposing- current condition is based upon the WaterFALL model that tries to look at change in biology that changed based on flow, current is the baseline. That varies across the state, the change in natural vegetative cover to current condition.

EF Category (current biological condition of stream/river (%))	EF Threshold (% change in biological condition before "red flag")
100 – 80	5
80 – 60	10
60 – 35	15
<35	Other or minimum flows standard

Q: what you're suggesting, the threshold is the greater the degradation of the stream, the greater the tolerance?

R: yes.

For each category, we recommend an amount of absolute change that can occur in each class. If you have a relatively good condition with respect to flows, the condition could be altered 5%, etc. This is a working rivers concept- we're proposing, and would like your feedback on this, that a greater level of protection to the streams and rivers that are in good condition. To put this framework onto these curves to see what it shows.

Q: the threshold is based on an arbitrary weighting decision based on a philosophy, rather than a tested model?

R: yes, the relationships are linear, there is no place on the curve where it drops off; it is an incremental change.

Q: You could have equally made those the same. Based on this threshold with the arbitrary value judgment, we could equally have made it 10 or 12% or any other figure.

C: To clarify, for the 80-60 category, that's not 10+ 5, it is a total amount (in the right hand column)?

R: Yes. Basically if you are saying the current condition is 70%, than it could go down to 60%.

Q: How do you reconcile working rivers concept of allowing additional degradation to existing condition when you have the Clean Water Act that requires... healthy balanced... (inaudible)

C: The concept is likely that this is an ecological flows decision and not a threshold of what meets or doesn't meet water quality standards. Those are 2 different models of planning and assessment. Nothing in the legislation is about water quality.

C: It's not the same metric of impairment used by DWQ. A 60% condition may not be an impaired.

Q: Aren't they related? The more water you take out the higher the concentration of any pollutants?

C: She is suggesting a tolerance of change, not a threshold of what's acceptable and not acceptable.

C: Planning not permitting is the mantra- this is not a regulatory decision, it will be up to DWR to determine the threshold of what the response is based on the category.

C: Legislation has nothing about working rivers in it, but maintaining ecological integrity. In terms of what our mandate is, there may be a problem with this.

C: It does say "prevailing eco condition".

C: Not necessarily the prevailing economic condition, but back to ecological integrity.

C: But the way it's proposed is appropriate but we would need to make sure the caveats are explained. The 3 categories could be for different levels of warnings for planning purposes.

C: We did discuss having the same number across, but for those in good shape now, would we want to give them extra protection?

C: You're dead on target, but that would be a different decision than a planning tool. That would be decision-making.

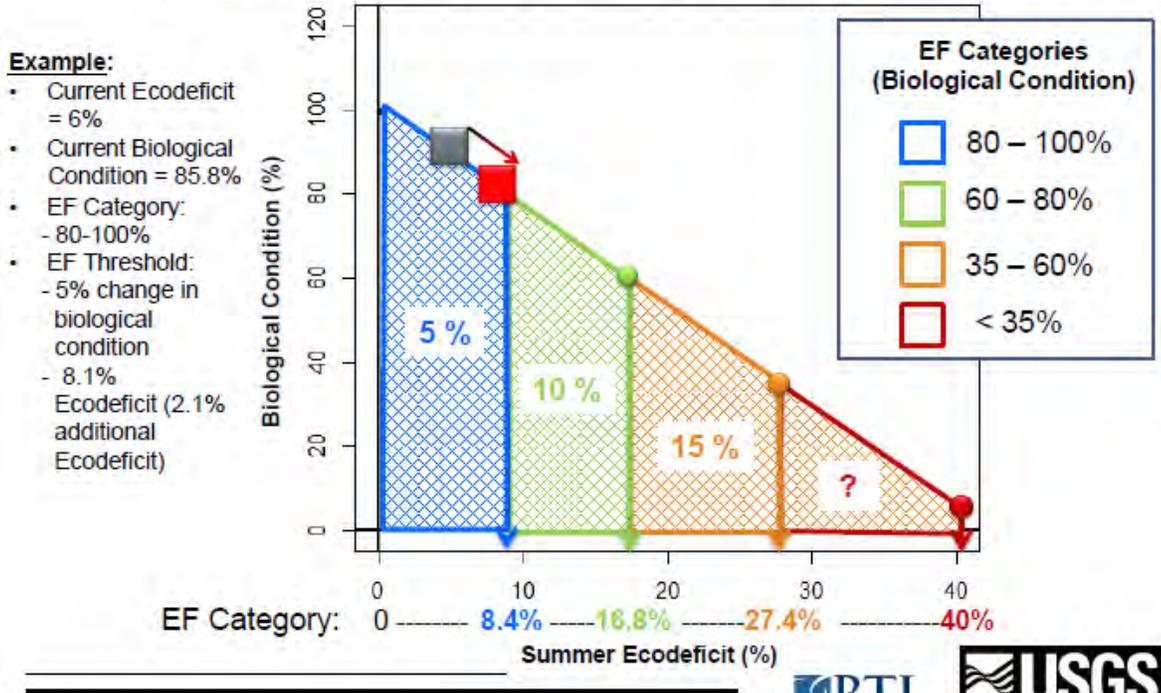
C: Whatever the numbers are would be dealt with at the next stage. The concept is good for reason of discussion.

C: In terms of thresholds, can we detect a 5% or 10% change? Are these measureable differences?

R: I'll show you and you can decide.

We're trying to apply these categories and thresholds to eco-deficit. Here are categories placed on the curve, the x-axis is % ecodeficit, current biological condition in y axis. If you translate what the categories correspond to in terms of ranges of ecodeficits, you can get these categories of conditions in the colored boxes.

## BENTHIC EPT RICHNESS IN RESPONSE TO SUMMER ECODEFICIT - EF CATEGORIES AND THRESHOLDS



Can you name a river or stream you'd expect to have minimum altered flow?

C: Lumber

R: Say for example the Lumber has a 6% current eco-deficit, using WaterFALL to see current level of flow alteration. The gray dot is where the Lumber falls. If it has current biological condition of 85.8%, then say if we allow a 5% change in biology going down the slope, which corresponds to an 8.1% eco-deficit (2.1% additional eco-deficit). Look at it and let me know if you have any questions. This is a direct translation of these 4 classes (shown in colored areas in SLIDE)

Q: it's not a 5% change in ecological flow, but in biological condition?

R: Right, and entirely determined by your flow biology curve.

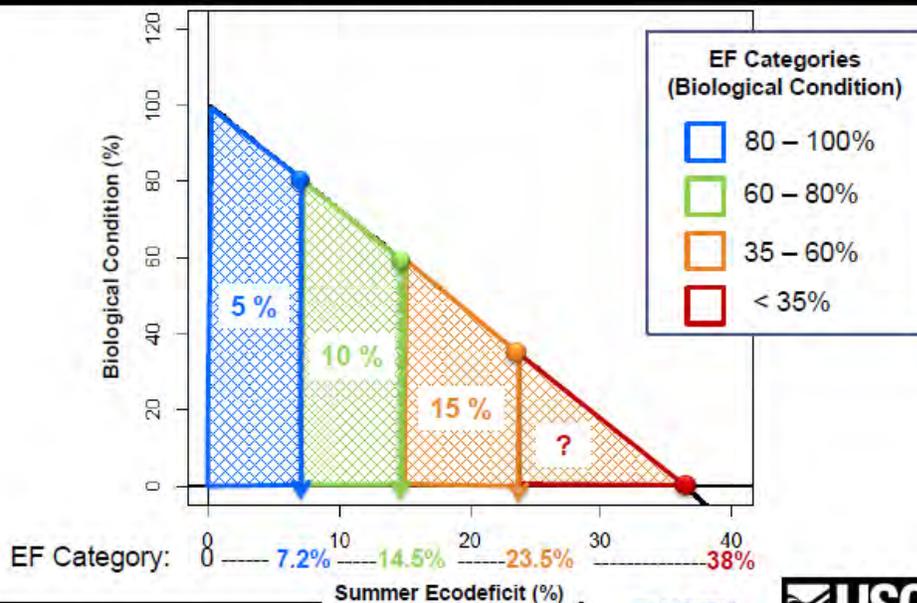
Q: Are you going to go further with your model river and translate that into the flow pattern that correlates with that change in threshold of eco-deficit?

R: You may get a glimpse of that when we start looking at the Upper Neuse River basins.

C: You go to 6% on the horizontal axis, which goes up to 85.8 current biological condition, which puts you in blue category. Then allow 5% change in bio condition, which brings you down to at 80.8 on the vertical axis, which translates to 8.1 on the horizontal, which is a net change from current to projected eco-deficit change.

R: Yes. This is for fish. Relationship is stronger (slope is steeper) with fish you can see the ranges for categories are slightly tighter due to more sensitivity to flow. The ranges for your categories are slightly tighter.

## RIFFLE-RUN FISH GUILD SHANNON DIVERSITY IN RESPONSE TO SUMMER ECODEFICIT - EF CATEGORIES AND THRESHOLDS



Question: Is it required to use WaterFALL to determine biological condition %?

C: Only thing is you have to have a way to determine baseline condition, and you could map the entire state using WaterFALL.

Q: Have you put in any uncertainty values? When those original regressions were made, the fit wasn't great, a pretty large uncertainty band. Have you looked at the confidence intervals? What might it be in this example?

R: yes, there is a large band, true.

C: no, important to remember this is your red flag tool, to red flag things you need to look at further. This is a planning tool, not predictive with absolute values. The confidence intervals are not bad for biological data.

C: I just like to see the uncertainty of the curves.

C: The confidence intervals are not that bad for biological data.

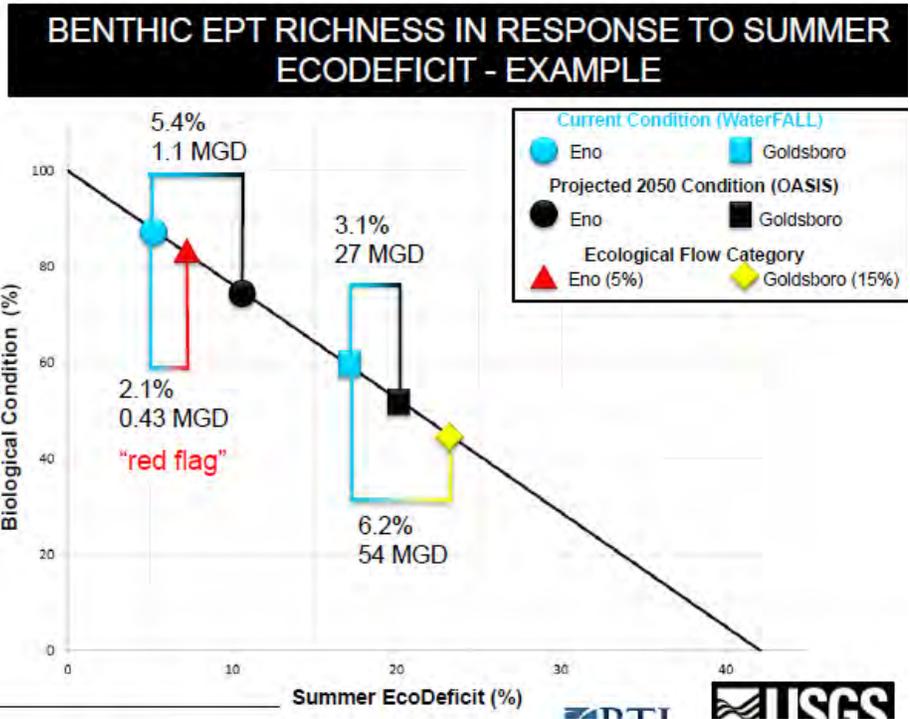
C: It's helpful to think it's about making comparisons on DWR's large planning horizons, 25-50 years out. It's not on a request-by-request situation. It's at such a high level in the planning, that this movement between EF categories will be at a high level. It will take potentially a high withdrawal to move it.

*Back to Jennifer's presentation:* Here are the examples.

- Locations:
  - Eno River State Park stream segment
  - Goldsboro river segment
- Scenarios (flow metrics and associated biological condition):
  - Current Condition = WaterFALL PNV (natural vegetation)– 2006
  - Projected 2050 Condition = OASIS current – 2050
  - EF Category and Threshold = determined by flow-biology curve

- Flow metrics and million gallons per day (MGD); Jennifer showed and explained slides - Applications given real world examples (see slide)

Putting the framework of EF category and threshold and putting them on the curve to show how proposed projects relate to the categories and see if they exceed our comfort level and raise red flags. Translate it to MGD.



Starting with Benthos- current condition, Eno segment is relatively pristine with respect to flow alteration; Goldsboro is quite modified. This is 2050 projection based on OASIS estimates, associated eco flow %'s, and MGD for summer season; keep that in mind. There is a big difference due to the size of streams. Plot the allowed biological change of 2.1% with Eno, a red flag goes up because 2050 projections will exceed allowable amounts of change in biology. In contrast with Goldsboro, it's in a different category, and does not cause a red flag.

The same thing happens with fish, though slightly more sensitive; again the red flag goes up for the Eno but not for Goldsboro. Any questions here?

- Q: just a reference point, at point where you measure Eno, what is flow typically there at that point?
- C: It's about 100 square mile drainage area, 1 cfs per square mile for flow for the year.
- C: so on the Eno, that .43 MGD, is about .75 CFS.
- R: these MGD, if you were to permit another withdrawal to occur, and how much you think a utility or facility would want to withdraw on a daily basis, and how these values equate to that.

Here is the summary of the different flow metrics that have been presented. The 4 eco-deficits based on season, the 30-day min flows. For Eno and Goldsboro, and biological condition (benthos on right). Idea is to contrast the 2 different river sizes and how minimum flows convert to MGD. There is a difference by season and river size. Here you can see for benthos this is current condition based on curves for benthos, and 2050 projections.

## ENO RIVER AND GOLDSBORO EXAMPLES – SUMMARY OF FLOW METRICS: BENTHIC EPT RICHNESS

### Eno River

Metric	Number of Days	Current EcoDeficit		Projected 2050 EcoDeficit - [Oasis]		Benthic Biologic Condition (%)	
		%	MGD	%	MGD	Current	2050
Winter	121	2.5%	2.0	4.2%	3.4	93.7	83.0
Spring	91	3.7%	1.6	2.8%	1.4	90.9	83.9
Summer	92	5.3%	0.9	5.4%	1.1	87.4	74.7
Fall	61	3.5%	1.1	3.0%	0.5	92.1	85.4
30 Day Min Flow	30	1.7%	0.0	13.1%	1.0	97.7	79.5

### Goldsboro

Metric	Number of Days	Current EcoDeficit		Projected 2050 EcoDeficit - [Oasis]		Benthic Biologic Condition (%)	
		%	MGD	%	MGD	Current	2050
Winter	121	12.8%	278	2.5%	57	67.6	61.1
Spring	91	12.5%	142	2.5%	32	69.2	63.1
Summer	92	17.1%	175	3.1%	27	59.4	52.0
Fall	61	21.1%	220	4.1%	23	52.5	43.3
30 Day Min Flow	30	NA	NA	NA	NA	NA	NA

Q: Help me to understand how you generate benthic condition?

R: Continue using the benthic curve relating the amount of flow to % change. Summarize all the curve condition, plot it on the curve, allow 10% change, plot it, and see where change is on the curve. This is entirely based on triangulation.

Q: This can design how well we're able to measure ecodeficit?

C: It's a function of your slope and your confidence in the slope (and assumption of linearity). They did look at it non-linear and the fit was similar.

C: I think it's straightforward. Only wording differences I'd make are that you're not really proposing thresholds, your proposing relative changes. DWR could choose something different, such as moderate change, minimal change.

R: Yes, the terms you use could be very loaded. This is a proposed framework, could put the flow biology curves, how you could translate them into some kind of recommendation for how you want to address thresholds.

C: The metric-- winter spring summer fall--those are all flow duration curves...it's the median flow duration curve.

C: Fundamentally it's a risk analysis (which makes sense)

R: Current eco-deficit is a relationship between current condition curves (using 40-year period of record, same as used in natural vegetation and current) so you only get curves based on human influence.

C: What I'm struggling with, I'm glad you used Eno, it's already a capacity use area, has been recognized as a flow vulnerable area, but yet it's coming out in the high category of good biological condition. It seems to be a mismatch and I'm having trouble reconciling it.

C: A couple things- you're right the Eno is a voluntary capacity use designation- it doesn't mean it's going to hell, it means there is a threat to it. There is concern about Eno due to the state parks; there are a lot of straws in it. You've got 2 reservoirs in headwaters, water supply, out of basin transfer, it's tiptoeing along the edge. But last time we were there was a DWR investigation to see if it qualified for high quality waters. That it comes out in the upper category isn't that surprising. It doesn't seem high on that graph but it is a lot for the Eno. There's not a lot of water, it doesn't take much for withdrawals to have an effect.

R: this is the same for fish. The eco-deficits don't change as it based on flows and landscapes, and these are the biological curves for fish.

Moving on to the next and final component. Anything else first?

C: if folks are getting wrapped around what we call these classes of existing condition, take that away, and say x%, you start here, you allow x% change, whether its different numbers. The concept is good, we could argue over details later.

C: We don't have to embrace the working rivers concept to use this. The management can decide their threshold; this provides a relative level of risk as a planning tool to describe this.

*Back to presentation:*

**Finally, where do these curves apply-** the distribution of the fish and benthos monitoring sites, exactly same as what Tom put up today, versus summary of what all the catchments look like for the state. It more or less represents distribution of drainage areas across the state. For fish it's not as well, but we recommend the framework for all rivers and streams until more data is available. Any questions?

## WHERE DO THE FLOW-BIOLOGY RELATIONSHIPS APPLY?

River Class	Drainage Area (sq miles)	# Fish Sites	% Fish Sites	# Benthic Sites	% Benthic Sites	# of Biological Monitoring Sites	% Biological Monitoring Sites
Headwater	< 39	701	81.7	1,124	65.3	1,825	70.7
Creek & small rivers	>= 39 < 200	154	17.9	409	23.7	563	21.8
Medium rivers	>= 200 < 1,000	3	0.4	130	7.6	133	5.2
Mainstem rivers	>= 1,000 < 3,861	0	0.0	42	2.4	42	1.6
Large rivers	>= 3,861	0	0.0	17	1.0	17	0.7
<b>Totals</b>		<b>858</b>	<b>100</b>	<b>1,722</b>	<b>100</b>	<b>2,580</b>	<b>100</b>

River Class	Drainage Area (sq miles)	Count	% NC catchments
Headwater	< 39	59,803	86.7
Creek & small rivers	>= 39 < 200	5,377	7.8
Medium rivers	>= 200 < 1,000	2,210	3.2
Mainstem rivers	>= 1,000 < 3,861	1,106	1.6
Large rivers	>= 3,861	509	0.7
<b>Totals</b>		<b>69,005</b>	<b>100</b>

**RECOMMENDATION: Apply framework for fish and benthos to all rivers and streams in NC until more data become available**



C: It could equally be altered to represent if/then scenarios. If you exceed 15% or whatever risk

threshold, it could require site specific evaluation. Jordan Lake is about 1400 square miles for reference.

Q: could this be applied about crossing a category, so if you had a system like Eno and the red flag went up, could you look at it if you are going to move that system further into next category, could you backtrack what threshold will cause us to shift into the next condition?

R: You can make it so it jumps into next category, but the problem is you can get so close to the point is so close to the threshold, you don't have to have much change in flow to jump into the next category. That's the problem with absolute categories. We didn't want to make absolute categories, but rather base it on current condition. It doesn't matter where you start, you can always add more on. Do we want to apply 10% to rivers in good condition? Determine where you are initially, and then apply a value to the current condition (a % change). Allows an acknowledgement of where you stand, and then based on that you allow a certain percent change based on current condition.

C: It would be nice to calculate what an error value would look like. How much of a change to have statistically significant. Example, a 10% change, how many standard deviations is it, what would be confidence limit.

C: A more relevant question, is it a significant difference. It's probably more like a 50 or 40% chance you'd have that change.

C: The actual amount is less important than knowing whether a difference that you see is related to some level of variation within the population, right?

C: Expressed another way, you could say we're 90% confident that we'll alter the biology.

C: Exactly, rather than just saying a 10% difference. Another way of wording the 5- 10- 15% change in the proposal.

R: We debated probabilities, too.

C: We need to get away from the 95% confidence interval. If you can prove 50%, you are responsible to that. We do a disservice by sticking to the 95% confidence interval, then you have drastic change. Think about the risk instead. To give you an idea of variability of slope for EPT Richness, slope is 2.35, standard of error is 4.199...it's not that bad (similar to fish too). There's no R-squared.

C: Recommendation was for all streams, based on Bob's presentation in terms of coastal waters, that would answer if this applies to coastal. Do the curves apply for streams where we don't have data?

C: We do have data. The majority of the actual difference of ecological deficits is in the coastal plain.

C: It might apply to medium gradient.

C: Question for DWR, what are the boundary conditions for the models you're working on in terms of the coastal area? Is that question even relevant?

C: The terminal node is associated with lowest gauge that is non-tidal.

C: Most of coast would not be included in the model.

C: The statute is more expansive than the modeling efforts.

C: Here's a situation, if you have a gauge downstream of where OASIS ends but there is good correlation to discharge factor, you might be able to apply it downstream. Wouldn't be able to apply it to additions of freshwater (reducing the ecodeficit).

R: That would be part of your modeling effort to account for. Example here, for 30-day minimum flow metric for Goldsboro was not applicable because there wasn't a reduction, but was an increase.

C: Regarding applicability, a lot of streams are ungaged. We don't have the hard-core gauge data for them, so if it's a physical characteristic like size and you can guess basin size, why wouldn't you apply it? There are some pieces of information we have, we may not have biological data or gage data, we could say this is a medium river, and apply it because we don't have any information saying it wouldn't apply. All the mapping you did it sounds like  $\frac{3}{4}$  of streams fit into the basic size classes. Tidal could drop off.

## v. **Presentation: EFSAB Report – DRAFT 3**

### **Facilitator: Mary Lou Addor**

A writing team composed of Chris Goudreau, Mark Cantrell, Tom Cuffney, Linda Diebolt, Sarah McRae, and Jamie Robinson developed Draft 3 of the EFSAB report. Chris Goudreau presented Draft 3 of the EFSAB report, which included a new section titled, ***Literature Review and Presentations***, and additional research information that had been explored since the EFSAB began meeting. The drafting team also included a section on Characterization that they were asked to write from the July meeting.

This section will focus on the discussion about the report. During the Aug 20 meeting, members of the EFSAB were asked for their reactions to the latest version of the report and specifically regarding the:

1. Level of detail required for the report
2. Organization of the report

### **Comments regarding *Organization of the Report* included:**

1. In general, organization of the report is fine
2. Ensure report leads with what people care about – the Findings/Recommendations
3. Discussion ensued about ensuring the main body was concise and relevant to the outline, that supplementary details are provided in the Appendices or linked to the appropriate materials on the DENR Water.org website.
4. The EFSAB will consider the value of an external reviewer before submitting a report to DENR (Linda Diebolt can recommend an external reviewer).
5. Consider how the report can use 21<sup>st</sup> Century technology and make use of the DWR website as an accompaniment to the report (take report into the 21st century)

### **Comments regarding *Level of Detail Required for the Report* included:**

1. Audience is DENR the institution; DWR is expected to produce the reports required by the end-users like the EMC, the General Assembly, or the public. Therefore, the report from the EFSAB should be of sufficient length to present the rationale behind the recommendations presented by the EFSAB. This includes all of the information examined by the EFSAB, and specifically what information laid foundation for the current recommendations and what information was not included in developing that foundation and why.
2. Current format may not support nor ensure the competence of the findings (there is little to no information about the process the EFSAB used to arrive at the current recommendations nor how the EFSAB evaluated their choices for recommendations and the selection of the current recommendations).
3. Where the recommendations are described, provide citations and/or links to the literature – particularly peer-reviewed materials.

4. Link the report in general to materials located on the Water.org website for further explanation of the description in the report or to provide a basis for how the EFSAB chose to move forward with its investigations.
5. Increase the level of clarity around the technical information including reducing the use of technical jargon or explaining it in the report. Increase the readability of the report and therefore the reader's ability to understand the charge of the EFSAB, the path the EFSAB took to address the charge, and the how, what, and why of deliverables chosen by the EFSAB.
6. Include a glossary to the report.
7. Other discussion points:
  - a. Limit to the # of pages
  - b. Rationale and assumptions included- determine what is enough
  - c. Drafting process – occur using writing teams
  - d. Edit process – a team of EFSAB members and external reviewer

## **VI. Presentation: Concepts and Principles Regarding Ecological Responses to Flows and Principles**

Facilitator: Mary Lou Addor

The EFSAB had been asked to review the section of the DRAFT 3 Report titled, "Flow Regimes to Maintain Ecological Integrity" (pgs.12-14; this section also referenced a portion of the July Meeting Summary, pgs 74-78). Presented on pages 12-14, were concepts regarding ecological responses to flows and principals for maintaining ecological integrity of freshwaters in North Carolina. These concepts were derived from a list Tom Cuffney presented at the July meeting, titled: Ecological Responses to Flows.

The current list of concepts is divided into five main categories in the Report:

1. Stream Ecology
2. Many studies that change in flow results in impact to aquatic and riparian biota
3. We have few tools that directly assess the biological effects
4. There is uncertainty in the science and the models, so we need to be risk adverse in recommendations
5. Adaptive Management

If the EFSAB considers these principles and/or criteria, they may guide decision-making toward recommendations for ecological flows for the remainder of the afternoon. How would the board like to proceed?

During a discussion, several members of the board expressed concern about taking time to review and develop an agreement about the list versus spending time directly developing recommendations that would naturally offer context for the discussion. For the most part, members were comfortable with the concepts listed on pages 12-14.

Comment: My concern with using our time to review this list of concepts is we do not know if any or all of these listed on pages 12-14 will be pertinent in the decision-making process for the flow recommendation. So, there may be a lot of these that are true statements though they may not drive a direction toward recommendations. My preference would be to develop recommendations and then discuss and describe the fundamental principles.

Comment: In the main, I think these concepts are fine. I can pick out several of them that I have questions about; some I believe are overstatements. I'd prefer to develop the recommendations and then come back to these concepts if we need them.

Members of the EFSAB discussed their general agreement with the concepts regarding ecological responses to flows and principles for maintaining ecological integrity of freshwaters in North Carolina. These statements may later serve to as part of the supporting documentation for the recommendations with additional clarity and rationale.

The decision was made to use the remaining meeting time to discuss and develop recommendations for ecological flows.

**[Following the Aug 20 meeting, Tom Gerow provided his perspective on pages 12-14]:**

**SECTION 1:**

I could see all of these statements as "Findings", maybe with statement (e) being a Guiding Principle.

**SECTION 2:**

The initial statement "Many studies show that changes in flow...." could itself be a Finding.

Findings: Items a,b,d.

Item (c) could be a Guiding Principle.

Item (d), the statements that starts with "Streams must have access to floodplains....." could be a Recommendation.

Item (f) could either be a Finding or Guiding Principle.

**SECTION 3:**

I see all items as Findings. (items a through d).

**SECTION 4:**

I see all of these items as Recommendations (items a through g).

**SECTION 5:**

I could see both items as a Guiding Principle.

Alternatively, I could also see item (a) as a Recommendation.

Proposed definitions for terms:

**A "Guiding Principle" should explain:**

1) How to approach this task; 2) Assumptions that are being made; and 3) What this report is.... and what this report is not.

**A "Finding" equals a statement that says:**

1) Our observations are \_\_\_\_\_.: 2) The literature review revealed \_\_\_\_\_.3) Evidence and data indicate or leads us to conclude \_\_\_\_\_.

**A "Recommendation" should:**

1) Be a direct, actionable statement (either a tangible or intangible); 2) Include methods on how to measure its progress, success, or failure.

## VII. EFSAB Report Writing Process – Establishment of Writing Teams

**Facilitator: Mary Lou Addor**

Toward the end of the August 21 meeting, writing teams were established to expand/revise Draft 3 of the EFSAB report (Aug 16, 2013), in preparation of the Sept 24 and 25 meeting. The main goals are:

1. Provide a rationale for each recommendation developed by **Sept 6** (anywhere from 1-3 pages)
2. Ensure the completeness of the document as best as possible. Lou will combine any iteration into one document with support from Chris and Jamie.
3. Distribute Draft 4 by **Sept 10** to the EFSAB listserv so that all members can begin to identify gaps, areas where they are uncomfortable and why, raise questions, propose alternative language and additional edits, including how to increase the readability of the report.
4. Receive comments/questions/alternative language/proposals from all EFSAB members by **Sept 18 (request earlier return of comments by members working in tandem with their alternates)**
5. Provide marked up copy of Draft 4 with all comments to the EFSAB by **Sept 23 (earlier if possible)**
6. Proposal: set aside 2 hours onsite (**Sept 25**) to make changes to the report moving the EFSAB closer to one complete report.

The writing teams are:

1. Characterization Recommendation- Chris Goudreau and Linda Diebolt
2. EFlows Recommendation 1 - Statewide approach -Thomas Cuffney and Tom Thompson
3. EFlows Recommendation 2- Headwaters approach - Judy Ratcliffe and Jeff Hinshaw
4. Coastal Plain Strategy - Bob Christian and Linda Diebolt
5. Glossary - Fred Tarver
6. Reorganization of Report – Jamie Robinson and Chris Goudreau

### Recommendations:

**1. Characterization Recommendation:** Chris and Linda with Tom Cuffney (Tom has an interest in this section and will do what he can to review). This includes any pertinent rationale/assumptions, citations and references to justify what is being proposed in the characterization recommendation. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive at the characterization recommendation.

**2. Eflow Recommendation 1:** Tom Cuffney and Tom Thompson will work on this section. This includes any pertinent rationale/assumptions, citations and references to justify what is being proposed in recommendation 1. Jennifer Phelan is sending a section of the RTI report that will assist in supporting the choice of 5%, 10% and the 15% thresholds early Sept. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive at recommendation 1.

Statewide approach using simultaneously two tools:

- In the basinwide hydrologic models, use 80-90% flow-by as the ecological flow.
- If the basinwide hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.
- The Eco-deficit tool should be used to determine the current and future modeled biological condition of locations in the basinwide hydrologic models.

- DENR should evaluate the change in current and future biological condition as a decision criterion. *A 5-10% change in biological condition is suggested as a threshold for further review by DENR. [section requires further discussion/review by EFSAB to determine if all members can live with/support this statement]."*

**3. Eflow Recommendation 2:** Judy & Jeff (Judy may look to Mark, and Sarah to assist). This includes any pertinent rationale/assumptions, citations and references to justify what is being proposed in recommendation 2. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive at recommendation 2.

"Headwater Streams – There is limited biological and hydrologic data in headwater streams within North Carolina. These streams have a higher vulnerability to disturbance, and the broader statewide approach may not adequately reflect the potential for impact to ecological integrity. Therefore, DENR should identify the subset of headwater streams to receive alternative analysis. (Note for further explaining- examples of vulnerability, how and in what way. Less water to start could be converted to intermittent)."

**4. Coastal Plain Strategy:** Linda Diebolt has suggestions for the Coastal section and would like to work with you, Bob, to address that section. This would include the changes that resulted from the Aug 21 discussion and any pertinent rationale/assumptions and citations and references to justify what is being proposed in the coastal strategy. Writing teams are asked to include other research and literature that was reviewed and rejected to arrive as this strategy.

## VIII. Discussion on Characterization

**Facilitator: Mary Lou Addor**

A draft section on characterization was completed by a small writing committee composed of Mark Cantrell, Linda Diebolt, Jamie Robinson, and Chris Goudreau and presented to the EFSAB for discussion as part of the revised report that was sent to them before the meeting, and provided as a handout. The key points of discussion follow.

- What was the value of discussing the public ownership of land in the mountains?
  - Intent was to describe the vegetative state of the watersheds and got into public lands managed with vegetation as a goal.
  - Better to describe the land cover rather than ownership.
  - We had said we might reference basinwide plans or other documents that include more details, those included land use and ownership within them.
  - Could add "sparsely developed" to flesh out why public ownership is relevant
- Unsure of the relevance of characterization in the way it's currently reflected in this draft of report, given that EFSAB did not focus upon it in this fashion.
- The distinction between the piedmont, mountains, coastal plain may not add value for characterization.
- If we're going to put these statements in, they need to add something to the discussion of our conclusions. For example forested cover is too broad, x% forested is better.
- Other reports spent considerable pages on characterizing watersheds and streams. We should either say we didn't get around to it, or we improve upon what we have.
- Current draft attempts to address characterization in terms of hydrology, biology, geomorphology, and water quality, connectivity.
- Make our recommendations and then back up and see what we need to include based on that. A lot of those answers may come after we have recommendations to provide justification. (Many

comments of this type were made)

- If recommendations are classification dependent, then there should be more detail there to support the recommendation.
- It's possible the flow recommendation will be purely hydrologically based, in which case we won't need to characterize the ecology.
- If we go with something USGS/RTI proposed then it makes a difference and we need to get something in there.
- We need to include ecological integrity and characterization as basis for making ecological flow recommendations.
- RTI and USGS did a lot of work on classification (as a means for characterization). Many various methods were tried that need to be reflected in the document, but it will be hard to include until the RTI report is written.
- The legislation calls for EFSAB to characterize ecology in the different river basins, which we tried to do through classification.
  - If we don't have a recommendation, we need to be clear about how we're addressing the charge in the legislation.
- The current level of detail is enough, though the content may need to change.
- If an EFSAB member has a suggestion for what to include, they should write it down (edit the document)
- DWR staff characterizes the basins when doing basin plans, so we may not need to do it but rather say that DWR already does this, and we are focusing on the more critical piece, ecological flows.
- Suggest a different way to characterize ecology, regardless of the recommendations, that can be done by talking about high flows important for this reason, base flows are important for this reason, overbank flows are necessary because of x, basically the relationships between different flow components and ecology. That stands on its own and we could do that now in a page or two rather than wait until the last minute. We could find this information in other documents: Texas, Alberta, Susquehanna reports. (Agreement expressed from another)
- It needs to come out of findings and into a preface section. Its not a finding, but rather it sets stage for characterizing ecology

Based on the group's interest in focusing on the ecological flows recommendation, they set characterization aside and moved on.

**Action item:** Chris Goudreau and Linda Diebolt offered to work on the characterization section outside of the meeting.

## IX. **Presentation: Approaches for Setting Protection Standards**

Presenter: Chris Goudreau

This power point presentation is available [here](#)

As a lead in to the discussion around developing the flow recommendations, Chris Goudreau reviewed the general approaches that can be taken for flow recommendations as defined by Richter et al. (2011). The three approaches defined by Richter include:

1. Minimum flow threshold-- which might be a single value (e.g., 7Q10) or be seasonally adjusted (e.g., Tennant, South Carolina);
2. Statistically-based standard—this Board has not discussed this type of approach much, but it attempts to mimic as much as possible all the components of a flow regime, such as:
  - Critical low, low, high flow pulses, small floods, high floods
  - Wet, normal, dry years

- For each, includes magnitude, duration, frequency, season
  - Tied to ecologically significant events
    - E.g., spawning, floodplain rejuvenation, fry/juvenile growth, migration, sediment movement, channel maintenance
3. Percent of flow standard (e.g., Alberta)

Chris then identified which of those approaches were employed by the various trial balloons that have been presented to the EFSAB. The RTI/USGS (ad-hoc) approach does not fit into Richter's scheme. Chris put this together to assess the various trial balloons in light of the principles that the EFSAB



## Approaches of Proposals

Proposal	Threshold	Stat-Based	POF	Other
Modified SC	20/30/40 MMF 30/40/50 MMF			
NC			80% Flow-by (daily)	
Alberta	20%-tile EBF (monthly)		85% Flow-by (daily)	
TNC	~10%-tile pass-by (monthly)	?	90% Flow-by (monthly) 95% Flow-by (monthly)	Headwater cutoff; Wet/dry year values
Ad-Hoc				Regression of ecodeficit with fish diversity or EPT richness

loosely agreed upon. Chris showed some graphs depicting what these would look like. He then showed how the various trial balloons could be applied to the various stream sizes used in the recommendations developed in July.

# Application of Proposals

Proposal	Headwater	Wadeable	Large River	Coastal Non-Tidal	Coastal Tidal
Modified SC	✓	✓	✓	✓	
NC	✓	✓	✓	✓	
Alberta	✓	✓	✓	✓	
TNC	No withdrawal	✓	?	?	
Ad-Hoc	✓	✓	?	?	

## X. Discussion: Continued July Discussions on Development of Flow Recommendations

**Facilitator: Nancy Sharpless**

The Board then looked at the tentative recommendations that had been developed in July, which were based on stream size:

- Small stream protection draft recommendation in July
  - Make sure that whatever methods are used in the recommendations for wadeable streams address the issue of extra protection for small streams.
  - Define small stream.
  - Clarify what site-specific evaluation means.
- Large rivers draft recommendation in July
  - Define large rivers
  - Use a flow-by approach
  - Use some type of floor/cut-off/ environmental base flow (EBF)
  - Address cumulative effects
- Wadeable streams draft recommendation in July
  - Use a flow by approach
  - Apply EBF/South Carolina (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
- With additional recommendations developed in July
  - Endangered/threatened species
  - Adaptive management
  - Site specific follow up from DWR

The facilitator asked the Board if this was still the approach they wanted to take since several people were not present when these recommendations were developed and given the RTI/USGS presentation this morning.

Comments included:

- What would catchment size be for small streams? <100km?
- Is a flow-by based on instantaneous flow, daily, monthly...needs definition
- With the new RTI/USGS tool, we could go with a minimum threshold; it is not my choice, but with what Jen presented, you wouldn't ask how much is coming out; you're asking where is this node on the linear relationship, then calculate to see if you cross the threshold.
- **The RTI/USGS tool is a method for assessing the impact of any method you choose. Once you make a decision in how you handle the flow, then you can measure the ecodeficit and determine a priori what the risk is. It's not a method for setting eco-flow but for evaluating any decision you make. That should be clear.**
- I thought it would preclude the need for establishing e-flows if you put in the water here now and for 2050.
- Those numbers were arbitrary to start a discussion. The numbers have to be set by somebody.
- It is a measuring tool.
- Threshold approaches do not address the natural flow paradigm.
- Fransen looked at it as you not only need to protect an eco-flow but essential uses. Either e-flow is a flat line or people are cut off from using water. This is different from a % flow approach, where both portions are getting something all the time; it is reduced but not flat line.
- If you do a % flow and a threshold, you will still come up against that (but for a short time). % of flow without that you'd have natural flow extended down beyond the natural. That's why combine them.
- Stick with this classification of the streams, so we address the concerns that are size related. That is the fundamental thing- we frame recommendations because size of stream will be an important factor about how you maintain ecological integrity. Small streams are more vulnerable. With large rivers we are making somewhat of a reach because the data are from wadeable streams. I agree personally that the threshold approach alone is probably not protective enough of ecological integrity. We have to decide what that number is.
- Acknowledge that small streams/headwaters are vulnerable and document why.
- We have the same approach, with 3 sizes, with different levels of protection. With larger streams we probably need more data.
- Headwaters, you're talking about 90% of impounded farm pounds in the state are headwaters.
- We've kicked around that we can make the recommendation of importance of protecting headwater streams; science suggests they are the most vulnerable and maybe leave it like that. I'm not sure I would say no touch, but recognize vulnerability.
- If there is science that says a withdrawal of 100 mgd from most headwater streams would have a significant ecological impact, we should say that.
- That's fine but if we then say that it shouldn't be allowed...
- We can say we think if you withdraw 100k mgd then you violate eco integrity, but then not recommend policy of not allowing that.
- It's DENRs policy call to determine
- What is a recommendation vs. just a statement? I think that is just a statement, not a recommendation.
- We recommend that DWR take that into consideration. We're presenting all this info and we hope you take it into consideration as you make policy

- It is not realistic to think a lot of straws will go into the small streams. Its really really important that we make decisions about the likely locations of withdrawals.
- My point was the policy statement of saying hands off of headwaters, where already people are using them for impoundments. The straws are often already in place.
- My concern about the RTI/USGS tool is the original fit of data. The data was not a clear straight line, but they made it fit.
- The larger the stream, the more permitted withdrawals, the smaller, then the more unpermitted withdrawals.... it behooves us to be more conservative in the headwaters because there are a lot of unpermitted uses.
- We could look at what permitted withdrawals are on what size streams.
- OASIS does not include withdrawals less than 100,000gpd. Less than 100,000 will be aggregated.
- There are two ways to get at headwater streams: 1) percent flow-by, which could be different from other sizes; or 2) use some flow-by and if using USGS/RTI, have a different allowable percent change in the biological condition. You could combine the 2.

**At this point the Board developed 2 draft recommendations using a statewide approach to e-flow with a different criterion for headwaters:**

Recommendation 1: Statewide approach using simultaneously two tools:

1. Use [x percentage] of flow-by as the flow regime
2. Use eco-deficit tool to identify the effect on the ecological integrity.
  - a. Combine eco-deficit tool with the criteria to be used as a flagging tool

Recommendation 2: Use the two tools with different criteria for headwaters.

This draft recommendation received full support with the understanding that a list of statements (caveats) would need to be developed to include in the report. **These recommendations were subsequently refined further the next day.**

The EFSAB developed a list of questions to be addressed and a proposed list of statements to accompany the recommendations in the report **[some of these were added on 8/21; the issues in italics are from 8/20]:**

Questions to address:

- *% for flow-by*
- *Develop criteria for acceptable % change in biological condition*
- *Determine if including seasonal differences*
- *How often does it have to drop below for a flag to go up*
- For eco-deficit, use fish or invertebrates?
- When using SIMBASE, does that change over time?
- What level of ecological integrity are the recommendations protecting?
- Advise DWR on how to assess condition of stream?

Statements to include in report:

- *Limitations of data used to develop the eco-deficit tool*
  - *This is already in the report*
  - *When will the RTI/USGS report be published?*
- *PHabSIM could be used when flag is raised.*
- Issue of it is all modeling—DWR is working in models. Everything is modeled. The assumptions are based on the models

- It should say it is calculated on a daily time-step
- What time step to use in flow-by
- How is flow-by calculated
- What is the index flow for calculating % flow by
- Define terms (%flow-by, eco-deficit)
- Include a description of where the high end of the flow-by range would be used.
- As data is collected and knowledge develops using the eco-deficit approach, eco-deficit knowledge might inform changing the % flow-by
- Describe where the range of % biological change comes from and authors provide examples of how it works.
- For headwaters, there may not be a node in OASIS. WaterFALL is probably the only tool available, and it did not correspond well with OASIS. You may not be able to use two tools in the headwaters because there may not be a node there.
- Explain that the model that was done was based on using unregulated flow and based on that we pick these numbers. Put in a statement that you look at the cumulative effect of withdrawals and take that into account.
- Justification of the flow-by range.
- We can point to other places, and we can add qualitative descriptions of reasons of where you'd want the flag to be triggered earlier, for example less resilient lands, or where you have cumulative effects. If we were talking about a regulatory program I'd articulate it differently, but if we're talking about when do you want to take a closer look, I think it is more appropriate for certain streams that may be more vulnerable, to have a higher percentage to trigger a closer look.
- In the Richter paper Table 2, FL, MI, ME, EU, those percentages are 80-92.5% flow-by. FL is based on its own information, 80-92%; MI is 85-94%; ME is 90%.
- Look at the cumulative effect of withdrawals and take that into account
- **When we're saying to maintain ecological integrity, we'll at some point define what it is.**

**Another potential recommendation was proposed: The current SIMBASE2013 should be used as the prevailing condition from now forward.**

## August 21, 2013

### I. August 21 Meeting Orientation

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

The facilitator reviewed the revised agenda. The meeting would start with a discussion of headwater streams, followed by a discussion about the framework of recommendations in Coastal Streams and Rivers, then moving into spending the majority of the day continuing to develop flow recommendations. The day would end with developing writing subcommittees and developing the agenda for September.

## II. Continued Discussion of Stream Size Classification and Headwater Streams

Facilitator: Christy Perrin

On Aug 21, the EFSAB picked up from where they left off Tuesday in discussing stream size classification. The members were asked to review the latest version of the SALCC DA Distribution (a corrected version was reviewed on Aug 21 that separated the headwaters and the creeks (previously combined) and corrected minor miscalculations). Based on a random set of 900 points, the numbers of the very small basins – less than 3.6 square kilometers – are very under-represented in the DWQ data. Really small streams tend to become intermittent and thus more difficult to track and to assess water quality in those systems. These systems require a different set of standards. With respect to the headwaters, using the RTI/USGS regressions, this reinforces the notion that smaller and smaller headwater streams are less applicable because these systems become intermittent, and are totally different. This supports the argument from yesterday to handle these very small headwater streams differently.

### ***Do headwaters have complete guild assemblages?***

The EFSAB discussed the biological assemblages of these very small streams. Tom made the point that these streams would have EPT, but of a different kind. Vann offered that he consistently found fish in ? size streams.

### ***Is it more appropriate to lump into larger group or keep separate and note the lack of data? (preference is not to lump)***

What is the interpretation? Is it more appropriate to lump together in the next larger group? Or more appropriate to retain that separate group and simply state, we don't have the information. Or is there even enough information to propose anything specific other than if we have literature that suggests the need for treating them separately -what's the best approach?

If we're trying to retain these classes in some way, relative to the RTI data, do we lump them with the next larger group or separate with a caveat that, within this group there is information in some areas and in others there is not information.

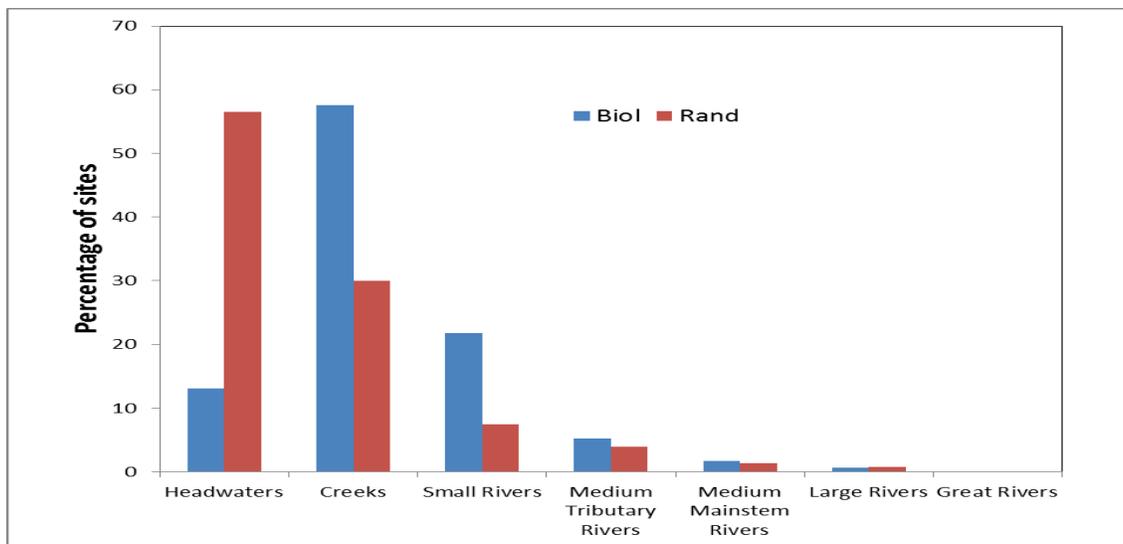
### ***There are data for the headwaters but not for the intermittent streams***

We do have information for headwater perennial streams; we don't have information for the intermittent streams since the state does not monitor them. We could apply a different criteria for intermittent from perennial headwater streams (and may need to set a different criteria flowby).

Class	DA km2	Inverts	Fish	Rand
Headwaters	<=10	85	255	509
Creeks	<100	616	878	270
Small Rivers	<518	154	411	67
Medium Tributary Rivers	<2590	3	133	36
Medium Mainstem Rivers	<10000	0	43	12
Large Rivers	<25000	0	17	7
Great Rivers	>25000	0	0	0
		858	1737	901

## Percentage of Sites

Class	DA km2	Inverts	Fish	Rand	Biol	Rand
Headwaters	<=10	9.9	14.7	56.5	13.1	56.5
Creeks	<100	71.8	50.5	30.0	57.6	30.0
Small Rivers	<518	17.9	23.7	7.4	21.8	7.4
Medium Tributary Rivers	<2590	0.3	7.7	4.0	5.2	4.0
Medium Mainstem Rivers	<10000	0.0	2.5	1.3	1.7	1.3
Large Rivers	<25000	0	1	1	1	1
Great Rivers	>25000	0	0	0	0	0
		100	100	100	100	100



***If applying different criteria, state in the report for headwaters perennials that everything sampled by DWR/DWQ has record of evidence.***

Someone mentioned that the headwaters and creeks are set at 10 square kilometers that one gets more biological samples with random for creeks and a lot fewer biological samples of random for headwaters. If one slides that break 10 kilometers down a little bit, one might pick up some of the larger headwaters. This would provide better representation for the creek. And thus reduce the number of headwater streams to be treated differently. May even consider setting aside non-perennial streams. The older USGS report by Geise and Mason (USGS report) had relationships by basin on what drainage area produced a 0 flow stream during a year [or something like this]. They had a relationship of how to figure out what size stream in each basin in the state was from 0 flow stream. Perhaps this would be a way to draw the line between intermittent and perennial streams and which ones that might or might not be covered by hydrologic area and not by river basins? OASIS aggregates small withdrawals criteria; WaterFALL does better in small catchments.

***What does vulnerability mean? How best to convey it? What is the reference condition?***

A discussion about vulnerability ensued. The board may not have much information at this time to address the extremes – except to convey vulnerability. Perhaps focus on small river, medium tributaries where there is enough information, and for the headwaters say they are extremely vulnerable.

In what way are these vulnerable? What are they vulnerable to? Are they vulnerable to it at some percentage flow-by reduction, therefore making them from perennial to intermediate? Is that the idea of their vulnerability? Or are they biologically more vulnerable than a larger stream? What do we know about that?

Vulnerability can be considered when these streams seasonally reached a 0 flow; even though there's volume, there's not protectable flow. Or in some cases they may be drying out completely, seasonally, or experience extreme events in their hydrologic cycle. And even in the natural condition. For example: upper Tar (Sheldon Creek) over the past 3 or 4 years, every summer you go up there and there's hundreds and hundreds of dead mussels, because there's no flow in creek and thus is not a good candidate for a withdrawal proposal. Given the 5 years of drought, the creeks have dried out completely and turned into giant sidewalks. There are ecological impacts when there is no water at all.

### ***How to test/support vulnerability?***

How do we know that? Can you test the difference between something that is dry for 0 times, versus 5 days a year, versus a month a year? Is this due to a natural cycle, or is there a withdrawal that's causing that?

Think back to the Alberta and the environmental base flows. If you add a withdrawal factor, conceptually this will extend the period of time extreme values are being experienced. This can be demonstrated on the hydrograph. That's the concept that they're looking at in Alberta and something we can consider for all streams.

### ***Extremes that are beneficial; extremes that are not beneficial – what is the reference condition?***

Need referenced information. The risk is that on the flip side, we may try to justify and make the point that extremes in terms of flooding and over bank flow are beneficial. An extreme in one case is a negative, and an extreme in another case is a positive, like flooding.

Someone else mentioned that all flooding is not created equal. There are very unnatural flooding scenarios in which streams are inundated for a much longer period of time or in seasons when it's not appropriate for them to be inundated. That causes a significant shift in the ecology. It is happening this year and it happened last year.

But is this unnatural? It is happening because of the change in the precipitation pattern. Whatever goes into the report, it needs to be referenced and justified.

One possible way of talking about exception for headwaters may be a different kind of metric. Not sure how this could work in OASIS, because there are not many nodes in these areas. But given a basin with a node in this kind of situation, if a natural scenario changes the stream from a perennial stream to an intermittent stream then this is pretty extreme change.

What is being explored is the use of Tom's numbers. The smallest class is not going to change based on class boundaries here. So those 10 square kilometer headwater streams, if only 25% of them essentially have biological data in them, and the rest of them don't – either because they're intermittent or they're just too small to sample, in terms of these protocols. Thus a large portion of those is already probably intermittent. So the question is, does that push the remaining bunch of 25% or whatever from perennial to intermittent? That is a big change, but it's another way of dealing with protection to headwaters. Still will have criteria of changes in the eco-deficit numbers.

### ***Definition of Intermittent Flow***

Intermittent means you have 1 day of zero flow. Whose definition is this? The term 'intermittent' is used in different contexts by different people. In the board's previous work of the hydrologic classification

piece, there was the use of a term, intermittent. That pushed away to whether there was any measurable flow. Though (to me) that's not the definition of intermittent; there is the need to look at the long-term pattern of that stream. Biological assemblage should define intermittent. There is a need to settle on a definition of intermittent.

### ***Do we need to mention headwaters in smallest systems?***

Is there a need for this level of concern about what to say about headwaters in the smallest systems, since they are almost out by the bounds, if it's not completely out of the bounds by what is currently tracked by DWR? Because at 100 kilometers, is there going to be 100,000 gallons per day withdrawal? [Some said – the point is, it could be].

Do you all want to spend a lot of time trying to refine a specific recommendation in the absence of this information? On the other hand, if one causes a stream to be de-watered that is not normally de-watered, it's a safe statement to state that there likely will be an impact on the ecology of the stream. Therefore these streams need a high level of protection in the absence of that kind of information. But the reality is, it's unlikely these are going to be capable of supporting large amounts of withdrawal, or permanent withdrawals anyway. Or, they'd be willing to issue a permit for withdrawal. The question is: do we lump the remaining part of these- the perennial parts of the headwater streams in with the larger category? Or do we leave them separately? Do we lump them together with the creeks, and state that everything from whatever the size was – less than 75 square kilometers should also be treated similarly? Or do they need something separate?

### ***Ecodeficit tool to investigate the potential increase in small streams***

On Aug 20, when RTI presented, I was struck by the comparison of the Eno River and the Neuse, and what percentage, what amount was being withdrawn before it shifted. If the board had that tool, perhaps the board could see how much of a withdrawal is observed for these small headwater streams and the change involved. If that happens, and dependent on where it occurs, that might capture how to examine the headwaters.

Considering the recommendation from Tuesday regarding statewide percentage of flow-by and what Jeff is talking about, one way to deal with this is to use that approach for nodes and drainage areas with greater than 10 square kilometers. Then, if there's a node in a drainage area with less than 10 square kilometers, slide those out. This would provide more detail than the analysis needs because there's not going to be many of those to start with. Right up there where there are nodes in drainage areas smaller than 10 square kilometers up there.

Question: do we have OASIS models, summaries that show all the nodes and their drainage areas of the ones that are done so far?

There are nodes in models where there are existing gages.

Think there is a lot of research that will support the vulnerability of small streams for water withdrawal. I'm certain that there is information in the literature we have reviewed that describes the vulnerability of small systems.

### ***Beginning to Generate a Recommendation for Headwaters***

The morning discussion began to generate a recommendation for headwaters and how smaller creeks are handled, including a statement of vulnerability. One is a boundary condition; that there is uncertainty about hydrology data and modeling in headwater streams. Specifically, there are no gages to test, calibrate the model. Second, is the high likelihood of greater vulnerability to the streams if withdrawals happen. Therefore, if there were a proposed withdrawal, specifically less than 10 square kilometer drainages, then this would flag DWR to follow up and determine how to proceed.

Can we go greater than 10 to 100 square kilometers? Thinking of Virginia and the confidence we had in their model would give the board the ability to make a numerical recommendation. Less than 10 kilometers, we're not going to make a numerical recommendation. [Recommend to avoid getting bogged down in debating the confidence of the probability of 10 versus 12 versus 20, but establishing kind of threshold here].

In the OASIS model when it first was started, the smallest drainage area in the model at that point was about 100 square miles or 100 square kilometers. That's big; there are two things going on in here. One is the restrictions on the OASIS, and the other is the restriction on the water supply here, which would be related to the availability of calibration gages. Which may be much smaller than 100. But there are kind of two different things going on here. One is how to evaluate the model – the RTI, USGS model – that is depending on what you can use to calibrate it. And the other is if you plot it using the OASIS, what are the restrictions on that? And they're two separate things. And I think that maybe we need to leave that up to DWR to determine what they need to address it, based I think on what we decide.

There are two ways to get at headwater streams: 1) percent flow-by, which could be different from other sizes; or 2) use some flow-by and if using USGS/RTI, have a different allowable percent change in the biological condition. You could combine the two.

### ***Numeric Thresholds: Narrative, Range or A Numeric Number***

A member put forth the suggestion to avoid establishing numeric thresholds and substitute narrative descriptions of headwaters and creeks, or small streams. Consider combining statements 1 and 2, without a numerical threshold given without providing some security in those numbers.

1. One is perennial streams where the action is likely to make them intermittent. This would be one flag to address as the categories change from perennial to intermittent.
2. Second is to consider the headwater streams now. That if it's a first order stream, or second order stream, the flag goes up. Thus, do not about whether that's 12 acres or 20 acres.

The board is struggling with the number of intersect and continuance; with the smaller the drainage area, the greater the vulnerability. But then we talk about the continuum of how much a withdrawal of percent flow-by. These are intersecting continuums and have different numbers depending on how these areas are taken from minor to severe. As a Science Advisory Board, my proposal is to offer advice but not necessarily numerical recommendations. In our report, let's discuss relative smaller systems without quantifying them. If somebody was to take out a gallon in a small system, we're not going to worry too much about that. But if they want to take out 80% of the flow and divert for use on a trout farm that might not be a good idea. In fact, it might not be a good idea to take out 20% of the water for trout farms in part of the systems. We want to offer a high degree of caution for those kinds of planning and migrations. We could go from a vertical analysis to a second or third or where moving site specific. I think if we try to go down the path of doing that type of quantitative definitions, as a scientific advisory board we should be highly confident in what our recommendations are. And I don't believe we are. That's why I'm suggesting some sort of language advice rather than a quantitative debate. Numerical trigger point either has good scientific confidence based on real information, or we have to insert our own value judgments in establishing the trigger point. It's trying to avoid those value judgments, which I think are best done by commissions and divisions. Even though we have spent three years learning this new language of ecological flow related terminology and issues, we likely more knowledgeable than most other science board who could provide value judgment bodies. Is that our job? I think our job is to find scientific advice and not establish uncertain thresholds. We do not want to get bogged down here into philosophical difference because we're way too close in agreement here.

Another said, I understand the problem with hard thresholds. Though not clear how we can substitute narrative descriptions of headwaters and creeks, or small streams. Maybe this means we consider a range of numbers or better criteria, by which we can define vulnerability.

Perhaps we don't have to put a number limit to the point of excluding any particular size of headwater stream. If we say small headwater streams, and then we can give examples, or use RTI's limits of utilization or the data that RTI has available for their models. Provide justification of what they found, that they had this information for calibrating their model below a certain size, or above a certain size. Those would be descriptors, but then leave to DWR to determine specifically where that line pops up.

Another option is that at some given known condition, x, a flag is raised. If we don't, then our description of that condition, x that triggers the flag is arbitrary and capricious, or too vague for planning purposes. But our recommendation, putting aside a hard size limit, is for a particular action. That particular action is the need for more information – such as a site-specific evaluation.

If you're going to propose a node into small drainage basins - that is a recommendation for a specific action. That's different than describing a continuum of vulnerability through different sized drainage basins. I'm hesitant to go down a road where we are not recommending and instead are performing primarily a scientific descriptive function rather than having actual recommendations on where additional information is needed. I'm not at all advocating that our recommendations should disallow a withdrawal or prohibit or restrict. I'm not interested in any of that language. But I am interested in having clear demarcations where we think additional information is needed. Where the basic flow-by standard that whatever percent it could be agreed on is appropriate for DWR's use as the flag. Those are recommendations for trigger points and it is challenging to have a trigger point that is tied to the art of hydrology, rather than simply making a couple of them.

May want to consider 4 options on what to do in areas where there is limited gage data, limited OASIS information:

1. Narrative description
2. Narrative description that includes hard numbers or range of numbers.
3. Skip narrative and put in a range.
4. Develop criteria around vulnerability that may include a stream size dependent

Other considerations:

Do exact same thing without #s – options for recommendations and hard #s where limited gages (OASIS data)

- a. name the description with a range of #s
- b. define vulnerability – continuous vulnerability as size increases
- c. offer advice not numerical recommendations about relative vulnerability

Alternatives to an area

- a. actions from perennial to intermittent raises flag
- b. 1<sup>st</sup> or 2<sup>nd</sup> order stream raises flag (not popular)
- c. Condition X triggers a flag if our recommendation doesn't allow a decision-flow chart....indicate where additional information is needed.

Chris, Judy, and Jeff agreed to develop a recommendation for Headwaters that the group could review and discuss in the afternoon.

### **III. Discussion: Framework for Recommendations in Coastal Streams and Rivers Coastal Subcommittee**

After a brief review of the framework of recommendations that Bob Christian presented to the Board on August 20, the facilitator solicited comments and suggestions from the Board for Bob in drafting this section of the EFSAB report. Those comments and suggestions included:

- Is the idea that you recommend all 4 approaches and that there would be some hierarchy for which approach to apply to a given type of stream?
  - I would leave these as parallel tracks. Where the statewide approach can comfortably be extended, that would be the first order approach. But then I think the next best step is to look at the effects on anadromous fish and other important species and develop the approaches from the biological point of view. Salinity would be almost a fallback. I see overbank flow as an add-on; in certain places, the overbank flow is an additional concern, not an alternate concern
- It sounds like you are saying that the EFSAB is not in a position to provide recommendations for the coastal areas, but here is a list of options and advice for making a path forward.
- The recommendation is to develop this framework.
- The gradient cut-offs are somewhat arbitrary, based on professional judgment.
- One of the challenges we are dealing with here is that slope and velocity are not the same; velocity is incredibly important. It is really the velocity that relates to ecological condition. The gradients may or may not be indicative of velocity.
  - In some ways, though, it is the depth of the stream that determines the amount of habitat, and in the coastal plain, that is disconnected from the discharge.
- In terms of practical application, if you take it at face value, everything in black, red or turquoise might fit into the rest of the recommendations.
  - Maybe the black and the inland red. I just don't know about the turquoise areas. It may be that when we look at how to extend the statewide recommendations, the distinction between inner and outer coastal plain may become a more critical factor.
  - Where you have the turquoise areas that are not contiguous with the coastline, they may be low-head dams or things like that.
- I'm very supportive of dealing with our coastal areas with if/then statements. If DWR wants to pursue scientific understanding of how to evaluate ecological flows in the coastal plain, then our advice would be to go through these options. I'm not comfortable with going forward with those as recommendations; I distinguish between advice and recommendations because I don't think we know enough about how to get to an ecological flow in the coastal plain to make recommendations, but I am very comfortable with what Bob has presented and the attributes he has talked about. If DENR is interested in developing that, we have given them ways to move forward with it. Frankly, I think it would be wonderful research to pursue.
- I think this subcommittee has done the absolute best job possible on this.
  - In such a short time.
  - Highly commendable.
- We should decide the link between the EFSAB report and this subcommittee's report.
- I would advocate an integrated whole for the EFSAB report as much as possible. I think a thorough summary of the coastal work should be included in the report because the coastal subcommittee's work has been so good, and it mirrors the work that the whole board has done. I think of it as an integrated whole and encourage us to have a comprehensive report from the Board at the end of the day.
- The committee's 3-page report or the 12-page report?
- That goes back to whether we have a 10-page EFSAB report with appendices or a longer report, which we have not yet resolved.
- I think as much as possible, put the research needs into qualitative description of your if/then statements. State for your 3 or 4 approaches, how the research needs bolster those. That would help explain how/why this research is needed.
- When I look at the map of the four classes of streams and the cover slide that shows the

OASIS model area, I think a lot of those that are piedmont, medium-slope are going to be captured in the OASIS models. If that is the case, then those could automatically go into the statewide approach. It's not really additional research but rather a next step: overlay those and see what drops out already.

#### IV. Discussion: Statewide Flow Recommendations

The facilitator invited the Board to look at the draft recommendations as they were at the end of 8/20 and the list of remaining questions to address. Comments included:

- On the third bullet [2a above in recommendation 1] of recommendation 1, what criteria? % change criteria?
- It should be flow-by regime to maintain ecological integrity
- % of what flow? What is the index flow?
- Are there seasonal differences that might be applied?
- Use x% of flow-by calculated on a daily time step
  - In Fred's proposal, baseline hydrograph today is x, multiply it by .8, then works it through the spreadsheet. People want to know how many days its over.
  - Isn't it averaged into a daily?
  - The withdrawal amount is a seasonally or monthly adjusted value, but the number, even if constant for a month, you want it contrasted vs. a daily number. The metric that goes into an eco-flow is calculated daily.
  - The flag goes up when violated once?
  - Regardless, we're not making that decision...I'm not convinced it needs to be done on a daily time step. I think it is fine on a weekly time step.
  - It would give you a different outcome, probably wouldn't send up any flags.
  - Calculate using a specific period of record?
  - They generate a period of record that is used for the entire basin.
  - It is different from how eco-deficit is calculated in the RTI work, which uses natural vegetation; it needs to be specified.
  - It is good to have two different approaches.
- Include a calculation of unregulated flow for comparison
  - Publications that have proposed a % of flow-by use a reference point, index flow, on which to base % flow. What we are talking about that index flow. Is it based on natural flow, current condition, etc? The percent tool will be a % of that index
  - Advise DWR to assess current alteration compared to unaltered.
- The time step is also factored in. We don't necessarily need to specify that. It will need to be decided by somebody.
- We need to define flow-by before I can agree on a recommendation.
  - We could just Richter's definition.
  - What is currently used as the index flow? Period of record for a particular day?
  - For PHabSIM it was .85 times every daily flow in the record—80 years x 365 flows x .85.
  - Richter paper didn't have NC data set.
  - His paper uses it as a presumptive standard. You could remove up to x % of the ambient flow.
  - The baseline condition as determined by Fransen? SIMBASE? SIMBASE is the current condition using 80 years of record.
  - For the purpose of calculating when to raise the flag, we need a point of reference. You're suggesting SIMBASE be used.

- OASIS is based on historical record and assumes that history continues. Year 2050 projected flows take historical flows and bolt onto those the projected alterations. They assume 1930- 2010 record of flow based on gauge data is the pattern that will continue into the future but with projected withdrawals and discharges, and you can do % increase or decrease based on climate change.
- The Board tentatively defined flow-by as: The percentage of ambient modeled daily flow that remains in the stream. For modeling purposes this is calculated on a daily basis. [Need to define somewhere how daily flow is reached].
- The Board opted to continue fleshing out recommendations and let writers define terms, then address any concerns about that later.

The Board decided that the first decisions to be addressed should be 1) what the x is in x% flow-by; and 2) biological impact.

The facilitator suggested that the Board start with the X% flow-by and start by narrowing in on a range for that number. She pointed out that several of the trial balloons had suggested similar percentages. Comments included:

The only ones in the trial balloons were 80 and 85%.

- Didn't TNC have 90%?
- It was 90-95%, but it was on a monthly, not a monthly time step...it was on a monthly statistic, which is different from what we are talking about. It's hard for me to figure out.
- Wasn't it mostly an average monthly average that would account for the seasonal issues?
- Let's use 80-85%.
- We're saying that % of flow by is going to be done in concert with knowledge of biological deficit as well. We can use biological deficit to determine what that % would be.
- The eco-deficit tool is just a tool to measure the change in eco-deficit, but if somebody comes up with what % change would raise a flag it could also raise a flag.
- So if you have a flow by of 80% and it gave you a 20% change in biology and we had flow-by of 85 % and it gave you 2% change in biology. That larger change gives you a bigger bang for you buck and would inform your selection.
- But you would have to do it node by node by node, and I don't know if that is practicable. We need to set our statewide flow-by and it can raise a flag, and at the same time we are going to use the eco-deficit piece and that gives you a more precise numerical impact that you can show how big a shift you are going to get. You might not get a flag at 80% but see a huge change in the biology.
- What I hear is that you want two separate flagging mechanisms rather than one.
- I think the original intent of RTI was to use it as an evaluation too. You flag with an x% flow by then you use the eco-deficit tool to evaluate how much change you get in the biology. But once you get enough data down the road, you can also use that eco-deficit tool as another flagging tool.
- So you're suggesting that your first order review is under the flow-by percentage; your 2nd order review is under the biological impact.
- That's where you have the 3 steps. You can come up with a flow-by and assess the impact of that, but unless you decide what that criterion is that thing is nothing more than a number.
- So you are saying they are combined, not in parallel.
- In Jennifer's presentation there was a proposal for setting the biological, then from the biological you get the eco-deficit and with the eco-deficit you could assess what that meant in terms of setting your flow. It's tougher to see it going that way.

- It's also tough to accept the answers she gave us on where those numbers came from.
- If you raise a flag, with the current knowledge, it [eco-deficit] may be a good indicator of how much change you might see. But I don't have a lot of confidence in looking at those numbers and using those numbers as any kind of limiting criteria, positive or negative with the current state of what the models and how much variability they account for. It is a good tool to evaluate, but I think the level of confidence involved is so broad that it would be really difficult to set a threshold based on the tool.
- I agree with that at this point in time, but it could be refined as we move forward in time and get more data. Then it could be used as a tool to develop those criteria.
- I think you are underestimating how good this model is, and you are equating it with a linear regression model. The significance of the slopes and y-intercept are very very high; the confidence is high. What you are uncomfortable with is the ceiling that it is predicting. We see a response of eco-deficit change along the slope. It is less variable than our hydrology estimates. It is the best thing, only thing, we have.
- In terms of applying it, it is an indicator, not a fixed point, and frankly we still haven't seen the final report and gone through it. I accept what you are saying but other than using it to indicate level of impact, establishing a boundary is difficult to justify at this time.
- I don't know why there's such consternation over talking about a % biological change from that curve, the two curves from yesterday for fish and benthos, any more than there is about what % hydrologic number? It's the same concept in my mind. That % flow-by is not based on any statistic, we say others are using these numbers and that's a good starting point and as more data is gathered they can change that number in the future. We're putting too much cold water on the eco-deficit analysis.
- We are for invertebrates using EPT Richness. The state has criteria for EPT rRichness. Your condition classes have a range of about 10% wide [Jennifer countered this later, saying it was 20%], so the 5% we are talking about is half of a class. It has some basis. As to whether it is protective or not is a different question, but it wasn't entirely arbitrary. It was based on some degree of alteration.
- I was impressed with RTI/USGS presentation. I'm not sure about this % change; it's a little bit arbitrary.
- Let's talk about the flow-by numbers. We started with 80 and 85%. Kimberly's stuff is hard to figure out as how to put into a percentage. She is doing it totally differently from what we are talking about here.
- The curves give a solid basis for developing planning tools; it's good work. I'm not entirely confident in the threshold values, but I am confident in the tool as a means for moving forward with pursuing eflows concepts.
- Whatever number we put into that box will be reviewed or altered over time. We shouldn't worry about whether it's 80 or 85.
- I'm fine to say 85% and be done with it.
- We could use a range, or pick 80%. We could reference everyone else using 80%. When you use the eco-deficit piece, it may raise the flag. It may show 80% will cause significant change at this node or not.
- If you look at PHABSIM results, the 80-85% is actually a pretty good choice as flow-by. While it's a small sample size of NC data, it supports the general literature. I think we have support within the state's work for that.
- FL uses 15% loss of habitat, based on most limiting factor.
- My feeling, based on PHABSIM, is that the strength of 80-85% is a pretty good range. I think we have pretty good support within the state to go ahead with that.
- Facilitator: So it sounds like there has been a proposal to make the x in flow by 80-85%. Is that a proposal?

- Based on the PHABSIM work the strength of that work was that it was based on an unregulated model. Removing 20% of unregulated flow was low impact, but the SIMBASE could already be a 20% change so you could end up with a 40% change. That would be predicting impacts to those guilds.
- I think you adjust that. We're working within the bounds of the Legislature's prevailing conditions. I think we just explain that the model that was done was based on using unregulated flow and based on that we pick these numbers. **Put in a statement that you look at the cumulative effect of withdrawals and take that into account.**
- In a system with a significant amount hydro alteration, I'd pick 90 or 95%.
- We did use unregulated as baseline for PHABSIM; that was one of the things we wrestled with while evaluating the RTI/USGS analysis. Where do you set lines between categories? Maybe setting your flow-by at 80-85 will have more impact on streams with some alteration. If you're working on a stream with no or minimal alteration, 80-85% is pretty good. Do you want to steer potential withdrawals to streams with less alteration?
- Like the working rivers approach?
- By allowing 20% flow-by you're not shifting emphasis on those with no impacts.
- I don't know if the legislation has paid enough attention to language; prevailing conditions is not unregulated.
- We absolutely need to use SIMBASE. We're not precluded from also including unregulated flow so we can characterize a node with degree of alteration.
- Knowing prevailing condition means knowing where it falls on the spectrum. To know how much you want to move, it helps to know where you are now.
- IF DWR chooses not to use eco-deficit as a tool, I'd feel more strongly about using unregulated flow, to factor in how altered the system is. **Maybe we should advise DWR on how to assess condition of stream, and there are a couple different ways to do that.**
- Under a planning strategy, we are not compelling anyone to go anywhere; it is an evaluation of a future state.
- Make the range of flow-by 80-90%.
- An advantage of using a little wider range is that you give opportunity for constituency groups to comment on where you think the final should be.
- How do we justify the range? What do we have from other areas?
- The advantage of a little wider range, the midpoint is something used in other places. We can point to other places, and **we can add qualitative descriptions of reasons of where you'd want the flag to be triggered earlier, for example less resilient lands, or where you have cumulative effects.** If we were talking about a regulatory program I'd articulate it differently, but if we're talking about when do you want to take a closer look, I think it is more appropriate for certain streams that may be more vulnerable to have a higher percentage to trigger a closer look.
- I think that is true. We don't have data to support 80 or 85 or 90% exactly. Give DWR a range and let them use discretion.
- In the Richter paper Table 2, FL, MI, ME, EU, those percentages are 80-92.5% flow by. FL is based on its own information, 80-92%; MI is 85-94%; ME is 90%. We're in the same ballpark. UK has seasonal- larger % in high flow months. I think we can reference Richter and other papers and support 80-90%. He's done the summary but there are other papers.
- **When we're saying to maintain ecological integrity, we'll at some point define what it is.** PHABSIM used the most sensitive guild, etc. In the Richter paper, what are they saying they are protecting? In MI they say excellent ecological condition; UK had 2 levels of protection. Do we need a modifier in there or would it confuse things?
- These are often in site-specific applications. They are identifying a location where they want to maintain a certain condition. We're saying we want to maintain a resilient eco community, and don't need to get more specific than that.

- **If the eco-deficit piece is fleshed out, that may be where we put some qualifiers on it.**
- If you read the statute, it says the intent is to maintain ecological integrity. Current is assumed to be maintaining ecological integrity and what we are talking about is the amount of disruption that allows recovery. So is this 80-90% the amount of disruption from the current condition?
- If current is maintaining ecological integrity, deviation must still maintain ecological integrity.
- It's to maintain ecological integrity and allow a small amount of disruption.
- Judy's language would work: "to maintain a resilient ecological community."
- We didn't really address recovery, but we can imply it.
- These permits are not going to change. The permits are permanent, so the notion of coming back to it is a fallacy.
- They could be nonpermanent if used for drought use permits. This is not the purpose of this long range planning, but I can see scenarios where there could be temporary drought supplies.
- I'm not hyped up on resilient ecological community versus ecological integrity.
- **Does it trigger it if it hits it once or twice, or how many times? We don't necessarily want to put that number in there.**
- To that, maybe we want to put in there that DWR will determine at what frequency this value is exceeded will trigger a flag.
- Maybe we could cover that by saying that if the hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.
- How many times in this report will we refer to this in any other application? If not, we could define it in a broad sense elsewhere and refer to in general here.
- I think we want to lead off with this. It doesn't have to be in great detail, but the rest of the report explains why.
- After wordsmithing, **the Board developed the first two bullets of recommendation 1:**
  - **In the basin wide hydrologic models, use 80-90% flow-by as the ecological flow.**
  - **If the basin wide hydrologic models indicate that there is insufficient water available to meet all needs, essential water uses and ecological flows, then further review is recommended.**

#### **Further Discussion about setting biological change criteria:**

After discussing and agreeing upon an ecological flow recommendation, the group discussed how the ecodeficit tool might be used, particularly focusing on the idea of setting biological change criteria using the method that was presented by RTI/USGS on Aug. 20.

The main discussion points of the conversation follow.

- We need more conversation to pick the percentages as offered by RTI, or say the tool could be used in this way, here's a starting point that Division could refine based on additional data, peer review of RTI work.
- The presentation was for the % that represented half the change in EPT Richness associated with a change in condition class.
- We don't have a comparable thing for fish.
- Two ways to set thresholds- a fixed percentage (10% is half of the change of the condition class), or the percentage varies depending on the starting point of ecological condition
- Using benthos AND fish?
  - Shannon Weaver Index for fish is more sensitive than benthos
  - Could use both, and choose the more sensitive of the two for a trigger
- We could recommend we use this ecodeficit tool, and ask the authors of this approach to recommend these thresholds rather than EFSAB naming the thresholds
  - The authors were offering this as a straw man approach

- Documentation for it is not immediately available (with Sam in TN)
- Could authors be specific about their recommendation about numbers that should be used in our report
- How to establish validity of this approach?
- The group discussed how the method was developed in order to try to get an understanding of it. Ad hoc group members shared ideas that were raised- a recovery-based approach vs. a working rivers approach, for example.
- Using a straight 5% would allow you to get rid of the category (working rivers)
- What does a 10% change represent?
  - 10% seems extreme for a change in EPT Richness or Shannon Weaver Index.
  - The starting point seems relevant.
- Using a working rivers concept is beyond the EFSAB charge.
  - A 5% change in biological condition is tolerable and has potential to be protective of resilience.
  - 15% on an already impacted system would not protect resiliency.
  - The concept gets into values and policy
- The amount of flow that equates with a % change is site specific
- How comfortable in the large/great streams are we in using both (tools?)
  - There is some data in some of the bigger rivers; it's reflective of the frequency of streams of particular sizes (fewer larger rivers, fewer data)
- Ways to use eco-deficit tool:
  - To determine current/relevant biological condition (current eco-deficit)- what is your current prevailing condition
  - To then determine additional biological impact of a proposed flow (future eco-deficit)
  - To convert the flow-by using biology to flag
  - To use if 80-90% flow-by indicates a big change
  - The flow regimes that can be evaluated are endless as long as you can create a flow duration curve (any proposal can be plugged through tool to see if flag pops up)
- If using ecodeficit tool to figure out a flow if you have a target eco-deficit, it would be an average over an extended period.
- We should be clear that we're recommending using both in parallel; both tools get used every time the basinwide models are run. This is important since you could maintain 80-90% flowby and still see a significant biological change.
- Previous concern about using EPT categories was that using excellent, fair, good-fair, etc. for describing existing biological condition would tie it to language from an existing regulatory program that was not relevant here.
- Is it relevant if there are few or many species at a site, when looking at a certain % change?
- 5% change is 50% chance of moving to a new class. On average, if done 100 times, 1/2 will probably move out of a class, 1/2 will not. How much of a risk of moving to a new class are we comfortable with?
- Why not to provide a number or range as a threshold?
  - Is recommending a % change recommending a policy decision?
  - As a group we have different understandings and interpretations of the threshold concept of the ecodeficit model.
  - DENR should have the capacity to determine a threshold themselves
  - Authors should be able to provide a recommendation and justify it rather than the Board setting that point.
  - Is it defensible since there is no report from RTI yet, and no publication?
- **Why provide** a number or range as a threshold?

- If saying DENR should consider change of biological condition between current and future as a decision criteria, without guidance on how to interpret what is allowable % change, nothing may happen with it.
- PHABSIM approach would also require an allowable % change to be used as a decision criterion.
- If x% is recommended as an initial threshold with some explanation of why we chose the #, it's at least a point of discussion. If it's ignored, at least we've gone down with some number and some reasoning.
- Would allow us to frame it as a risk of change if more than this % change happens, to say further review warranted when this threshold is crossed without defining a specific action of DENR.
- DENR needs some context for what a % change in bio condition would amount to, and risk of change in EPT class is most logical (criteria with which to evaluate the magnitude of change).

Board members present liked the biological index approach presented by RTI/USGS, but consensus was not reached on whether or not to set a threshold in the recommendation, or what that threshold should be.

### Options

- If Board cannot reach consensus on a threshold, we can recommend DENR decide on a threshold
- Ask authors to provide a number recommendation and then Board refers to it rather than making the recommendation directly.
- Board can provide a number/range as an initial/starting point threshold for DENR to use.
- If we spent more time with it, with more examples may give us more confidence in a threshold (wait for RTI report?)

A range of 5-10% change in biological condition was suggested as an initial threshold.

- Include an explanation of where numbers came from within the report.
- Ask authors to provide examples, advantages, disadvantages of the numbers
- In report include language about when you may want a higher % change, when a lower % change may be appropriate
- A straw poll of a proposal to use 5-10% as a threshold resulted in one -1, seven -2's, and two 4's
- A straw poll of a proposal to use 5-15% as a threshold to reflect the RTI presentation was polled resulting in three -5s, so this was not further considered
  - It would not work to apply 15% across the board as a way to reduce risk

### How to move forward between now and September?

- Address concerns about defensibility/validity
  - Seek report from RTI as documentation (needed)
  - Seek additional supporting documentation from other studies, states that could provide references for using indices as evaluations and particular percent changes (would be helpful)
    - MI paper with table that has water management zones
    - Others?
- Find out absent EFSAB members' views on the proposal

**Everyone present agreed on this part of the recommendation:**

*DENR should evaluate the change in current and future biological condition as a decision criterion.*

**More information is needed before determining support for this part of the recommendation (in September):**

*A 5-10% change in biological condition is suggested as a threshold for further review by DENR.*

Mary Lou Addor called Jennifer Phelan who provided the following explanation of how they arrived at the threshold numbers:

The numbers are the ecological flow thresholds assigned to the individual ecological flow categories. The numbers are not documented specifically in the literature; we used a circuitous route originally based on the benthic site condition classes that have been adopted and used by the state of NC. There are 5 site condition classes based on benthos (excellent, good, good-fair, fair, poor) that are used as indications of quality for benthic health.

We found through an evaluation of EPT Species Richness at each of the monitoring sites across the state, on average, each site condition class represented a 20% change in benthic biological condition. From the top to bottom of a class was ~20% change (20% for each class add up to 100%). We then tried to see if we were to go to a site, and we allow a 20% change in condition would that cause a jump in site condition class. Would that be too much? The ad hoc group thought, yes it would be too much of a change in condition, and a half of a site condition class would be good number to recommend, which would be a 10% change in biological condition. That is where 10% came from. We considered that we could apply the 10% change to every location, but perhaps that is too much across the board, maybe it would be better to recommend a greater level of protection to good condition streams. So that's where half of the 10% was suggested, which represented a 5% change in biological condition for the higher-level category. The 10% was meant to apply to the middle condition. Then we followed the 5% gradient going down into the ecological flow categories. That's the logic behind those 5, 10, 15% percentages. The 4th category was 20%, which was another base flow standard. It's founded within a preexisting classification system based upon benthic condition, however its gone through several stages of judgment calls, and is not necessarily supported by flow ecology relationships.

**Action item:** RTI will share the proposed outline of their report to the EFSAB for feedback about what should be included, and will complete a description of the biological change threshold methods and reasoning before the September meeting.

**Action item:** Chris Goudreau will find MI report to use as a possible reference.

**Action item:** EFSAB members should share any references from other states, studies that could help with the biological change threshold decision.

## V. **Revisiting Headwaters Recommendation**

Presenter: Chris Goudreau

A Headwaters Steams Recommendation was developed and presented by Chris Goudreau, Judy Ratcliff, and Jeff Hinshaw. After a brief discussion, the recommendation was refined as follows.

Recommendation 2:

There is limited biological and hydrologic data in headwater streams within North Carolina.

These streams have a higher vulnerability to disturbance, and the broader statewide approach

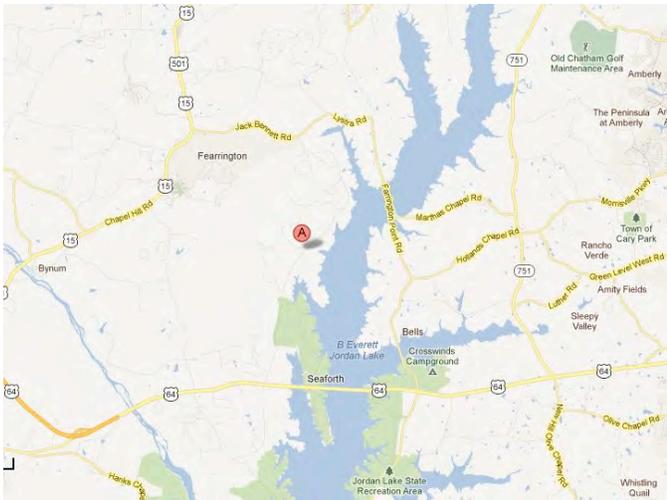
may not adequately reflect the potential for impact to ecological integrity. Therefore, DENR should identify the subset of headwater streams to receive alternative analysis. (Note for further explaining- examples of vulnerability, how and in what way. Less water to start could be converted to intermittent).

This recommendation was supported by a straw poll with eight members or their alternates supporting the proposal at a “1” –meaning they were in full support of the recommendation; and two members supporting the recommendation with a “2” – meaning they had a minor reservation.

## VI. September Agenda Items

Proposed agenda items for the September 24 and 25 include:

1. Recommendation 1: revisit the discussion on the 5, 10 and 15% thresholds assuming RTI provides the justifications on the thresholds to convene this discussion.
2. Review all recommendations: Ecological Flow Statewide Recommendation, Headwater Streams Recommendation, Characterization (using stream hydrology) and Coastal Strategy Recommendations.
3. Review justifications provided by writing teams
4. Discuss SIMBASE and recommend that DWR move forward with SIMBASE of today 2013 for future use.
5. Mark Cantrell will present a table on how to evaluate OASIS nodes.
6. Chris Goudreau will find MI report to use as a possible reference.
7. EFSAB members should share any references from other states, studies that could help with the biological change threshold decision.



The next meeting of the EFSAB is scheduled for **September 24 and 25, 2013** at the Stan Adams Educational Center from 9:00am until 4:30pm on the 24<sup>th</sup> and 8:30- 4:00 on the 25<sup>th</sup>. 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>