

Ecological Flows Science Advisory Board (EFSAB)
Meeting Summary **Sept. 24, 25, 2013**
Stan Adams Training Facility, Jordan Lake, Chapel Hill, NC

X **Final approved on Oct. 22, 2013**

Attendance (for both days unless otherwise noted)

Members

Hugh Barwick, Duke Energy
Mark Cantrell, USFWS (online)
Bob Christian, ECU (online 9/25))
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, EMC, Duke (9/24 only))
Sam Pearsall, Environmental Defense Fund
Judy Ratcliffe, NC Natural Heritage Program
Jaime Robinson, CH2MHill
Fritz Rohde, Natl. Marine Fisheries Svc (9/24
only)
Bill Swartley, NC Division of Forest Resources
(9/24 only)
Fred Tarver, NC Division of Water Resources

Alternates

Sarah McRae, US Fish & Wildlife
Vann Stancil, NC Wildlife Resources
Commission
Tom Thompson, Duke Energy
David Williams, Div. SWC

Guests:

Shannon Deaton, NCWRC (9/24 only)
Jennifer Phelan (9/24 only)
Kay Towers, Duke Nicholas School (9/24
only)

NCSU Facilitation Team

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

Division of Water Resources

Harold Brady
Ian McMillian (online)

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 is new as of August 2013)

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

NOTE: The EFSAB will meet **Oct. 22 @9:00am until 4:30pm and October 23 @8:30-4:00pm** 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).

September 24 & 25, 2013: Summary of Decisions, Recommendations and Proposed Actions

Decisions and Recommendations:

1. The EFSAB decided by consensus to use $\leq 10 \text{ km}^2$ (3.9 sq. mi) as the threshold for deviating from their statewide flow recommendation. The language for their headwater recommendation is as follows:

There are 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, for streams with a drainage area $\leq 10 \text{ km}^2$ (3.9 sq. mi), DENR should conduct additional analyses to determine the potential for impacts on ecological integrity.

2. As the last sentence in statewide flow recommendation, say: **A 5-10% change in biological condition is suggested as a criterion for further review by DENR**
3. Define baseline as the management regime, whether it was modeled or not, extant at the time the legislation passed on 7/22/2010. (language was written on Sept. 25)
4. Put the description of what raises a flag into the recommendations [as opposed to putting it into the text following the recommendations]. (language was written on Sept. 25)
5. Use Tom Fransen's method for defining flag raising. (language was written on Sept. 25)
6. Use the same language regarding what "further analysis" means as was developed for headwaters (language was written on Sept. 25)
7. Use the language in lines 134 through 136 in the current master draft, which say:
"Statewide Ecological Flow Evaluation"

"To evaluate flow scenarios in most North Carolina streams, the following two tools are recommended to assess whether ecological flows are maintained:" [9 ones; one 2];

The Board also reached consensus on changing the word in line 145 from "change" to "reduction".

Proposed Actions

1. Add a descriptor in the report where the mountain PHABSIM information is earmarked (language was written on Sept. 25).
2. Consider a recommendation that NCDWR georeference the nodes for OASIS (language was written on Sept. 25)
3. Consider adding an outcome criteria in the report [for further analysis], that doesn't get into the suite of tools that DWR may or may not use.
4. Ensure we say that the eco-deficit tool is not only for the exceptions in the statewide recommendation.
5. Justify in the report why the Board went with 5-10% based on the RTI report but did not use the 15% or the working rivers approach (language was written on Sept. 25)
6. Write a section to include in the report accompanying the statewide flow-by recommendation. This should include:
 - 1) Context for why a range for flow-by (or bio response)
 - (such as the numbers in the range are found in the literature,
 - PHABSIM results,
 - lack of consensus on a single value) and

- 2) Implications for how that range plays out. (language was written on Sept. 25)
- 7. In the report, explain EFSAB's concern about very low flows; Alberta uses 20th percentile adjusted monthly; more in the literature; DENR should investigate the literature and refine the numerical value. (add to paragraph 167-173) (language was written on Sept. 25)
- 8. Sam will ensure the RTI report addresses the baseline question and documents the date of the eco-deficit calculation.
- 9. Link the conditions for flagging to everything else we are doing in the report.
- 8. Say in the recommendation that we think it is important to understand the frequency and magnitude of how long, how often you go below the recommended 80-90% flowby.
- 9. Include a paragraph explaining why the Board has emphasized community structure and species richness and not other aspects of the ecology in determining ecological integrity. Include discussion of resiliency. (language was written on Sept. 25)
- 10. **Decisions and Recommendations for version 4.1 of the EFSAB DRAFT Report (from small groups on Sept. 25):**

- 1. The following tables and figures in version 4.0 are to be updated by RTI:
 - Pg. 9-10. Figs. 5A - Quantile Regression showing relation between summer ecodeficit and Shannon-Wiener Diversity Index and 5B - Quantile Regression showing relation between summer ecodeficit and Macroinvertebrate EPT richness
 - Pg. 10 Table 1 – Statewide quantile regression models
 - Pg. 22 Fig. 3 – Example of flow – ecology relationships for fish and aquatic insects.
- 2. Decisions and action items from Sept. 25 EFSAB meeting
 - Locate Glossary and Acronyms to front of report
 - Glossary: provide definitions in body of report as well as include in glossary
 - Acronyms: ensure when incorporating into report that acronyms are placed correctly depending on when they first appear
 - Consider hyperlinking sections of the report to the EFSAB website where appropriate
 - Capitalization rule: mountains, coastal plain, and piedmont are lower caps; if it's a physiographic provinces - Appalachian mountains, the Piedmont, and Mid-Atlantic coastal plain – these provinces should be capitalized. If discussing geographic features in the mountains, the piedmont, and the coastal plain – none of which should be capitalized. The piedmont is the one of those that has the same name either way you go.
- 3. Ensure the PHABsim and IFIM sections are complete with all figures and tables is complete (Fred)
- 4. Ensure when the flag is raised scenarios are described completely (Jamie, Fred, Chris, and Jeff with Fransen)
- 5. Ensure all sections of the report are completed such as:
 - a. Additional narratives and sections to complete:
 - (1) Other Recommendations – review for missing narrative
 - (2) Tools to Support Ecological Flow Recommendations –requires narrative or remove this Section
 - (4) Glossary –all terms identified and defined
 - (5) Acronym – all abbreviations are listed and identified

- (6) Reference -all references in the report are listed in Reference section
- b. Thoroughly review
 - (1) all recommendations to ensure support
 - (2) entire report for remaining edits
 - (3) for ease of reading

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I. Executive Summary

TITLE: PHABSIM on Mountain Sites

Presenter: Fred Tarver

Fred provided a presentation on results of running 10 mountain sites using PHABSIM, including similar methods and metrics as used for piedmont sites that EFSAB viewed previously. Differences between the piedmont and mountain sites analyses include the use of WaterFALL to develop a period of record since there are no completed OASIS models in the mountains, and different guilds and species (EPT was transferred to the mountains). He presented stacked bar charts for each site, showing weighted usable area (WUA, unit is square feet per 1000 feet of stream) for both the % species with <80% WUA under various flow scenarios, and for % species with >120% WUA under various flow scenarios. The 80/120 thresholds are represented by “0.0%” on the respective graph.

Major Discussion items/concerns/questions:

- Discussion centered around the slides that showed great increase of species with >120% WUA

under lower flow scenarios.

- Fry and young of year had better response at low flows like 7Q10
- Literature shows in high grade areas, that would likely reduce flow to usable velocity
- Concern that many streams showed little effect at 75% flow-by, which could raise challenges
- If the deep and shallow guilds weren't combined, you could see a shallow group benefiting
- Sensitivity is lost in the graphs because deep and shallow are combined. Looking at other graphs could help look at specific responses to 80% flow-by in more detail.
- Results still point to more sensitively when you get below 80% flow-by.

Decisions Made: none

Proposed Actions or Identified Decisions to be made: Address how to include this information in the report when the group discusses the report.

Title: Assessment of OASIS Nodes in headwaters and discussion of how to address headwaters

Presenter: Mark Cantrell

Mark provided a presentation on his analyses of location of existing surface water intakes across NC. He presented maps showing where the permitted intakes were located, where associated NPDES discharges were located, and graphed the intakes by stream order and drainage size, and by flow and drainage size. The EFSAB discussed the data and how it related to their headwaters recommendation, and then determined a threshold for where to apply a statewide recommendation.

Major Discussion items/concerns/questions:

- Surprise at the number of intakes on first order streams
- OASIS nodes are not georeferenced- this could be a recommendation
- The analyses emphasizes the importance of headwater streams for surface water intakes
- Using $\leq 10 \text{ km}^2$ as a breakpoint for the statewide flow recommendation makes sense given it captures more of the first order and $1/3^{\text{rd}}$ of the second order streams.
- Moving up to the next break in stream size used by TNC and SARP (75 km^2) would create many more evaluations by DWR staff
- Exactly what further evaluation by DWR that the threshold triggers has not yet been fleshed out by the EFSAB.

Decisions Made:

The EFSAB decided by consensus to use $\leq 10 \text{ km}^2$ as the lower drainage area limit of their statewide flow recommendation. The language for their headwater recommendation is as follows:

There are 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, for streams with a drainage area $\leq 10 \text{ km}^2$, DENR should conduct additional analyses to determine the potential for impacts on ecological integrity.

Proposed Actions or Identified Decisions to be made:

- Consider a recommendation that NCDWR georeference the nodes for OASIS

TITLE: Remaining issues to address for EFSAB Statewide Flow Recommendations

Facilitator: Nancy Sharpless

The facilitator presented the list of issues to discuss relating to flow recommendations, which was developed by the EFSAB at the last meeting as they developed recommendations. That list included:

- Develop biological thresholds for % change in biological condition. 5-10%?
- Discuss hydrologic recommendation for when to use lower or higher end of range of % flow-by
- Use a critical low-flow as part of the flow recommendation?
- Define headwater streams?
- What to use as prevailing condition—use Simbase x as current prevailing condition and as comparison flow as move forward?
- Recommend how often for how long the projected flow drops below the e-flow in order to raise a flag?
- Recommend what further analysis would be if flag raised (PHabSIM?)?
- What level of ecological integrity are the recommendations protecting?

Major Discussion Items/Concerns/Questions: none

Decisions and Recommendations: None

Proposed Actions: none

TITLE: Biological Threshold discussion

Major Discussion items/concerns/questions:

- Why use the 5-10% rather than the 5-15% range
 - Using the working rivers approach would enter into policy
 - 15% too great a risk
 - if at least half the biological condition is based on micro-invertebrate species richness, and species richness is about 20 different species in an area, then a 5% change would be a loss of 1 species, and a 10% loss would be a loss of two species. Is that the way to interpret it?
 - For a good site it's probably twice that--a loss of Loss of 2 species or 4 species, when talking about richness but not diversity.
 - The thing to keep in mind is that you could have the same EPT taxa richness and not have any of the same taxa. So you could have a total community change and not detect it with this metric.
 - The species you lose are more vulnerable to hydrologic alteration? Response: Yes, that's why EPT was chosen.
 - I don't want to confuse the 2 uses of the word threshold. They mean two different things, the way we are talking about using the 5-10% and no threshold for biological change. I don't want misinterpretation.
 - Use criterion? [Head nods]
 - So we're not going with the suggestion from the RTI/USGS work to have the highest quality streams triggered at 5% and the rest at some other number, like 10%?
 - Whether there should be greater protection on an excellent stream, my impression was that that would be a policy board type of decision. It's a good question but we may not be the ones to make that decision.

- We're basically providing a bracketed recommendation that any change of 5-10% or more should trigger additional, or more than 5% or greater than 10%?
 - I thought we were giving it to DENR and the policy Board that does not yet exist to make the call for a single criterion, and we are recommending that that single criterion fall between somewhere between 5 and 10%. It might be based on quality of streams, trout, classification, social evaluation. There are many scenarios for setting that policy.
 - My reservation is the worst case scenario where the most pristine stream is evaluated in the context of some future scenario, and DENR decides for some reason that a 9% impact is not of concern.
 - I can live with 5-10 but not good with applying it universally. I think that there is a group of streams that should be looked at more aggressively. That was the working group's concept.
 - the other side of that argument is that for streams with lesser conditions you can't withdraw any water because 10% of a small number is less than 1 so you can't have any change.
 - On a good stream you could have 60 taxa and lose 6 taxa. On a degraded stream you might only have one or even if it has 10, which would be a moderate one, you could only lose 1. There's a pretty good chance that under this criteria you would trigger a flag every time.
 - If we are accepting of a range or some recommendation that is different from what is in the RTI report, we need to make sure we can justify that.
 - The deviation seems to be that in their report they took the working rivers strategy, which is where the 15% may have come from. As a Board we're saying we don't entirely agree with that. Is that what we are saying?
 - We are saying that there is a trigger and it is somewhere between 5 and 10%, regardless of the stream's present condition.
 - What we are trying to do is say that the eco-deficit tool is not only for the statewide.
 - Fifteen percent is too much; somewhere between 5 and 10% is okay; it came from RTI; the 15% question is too great a risk from my standpoint. So what else do we need to say about that? It may be that the working rivers concept comes back through DENR's decision process.
- What do we mean when we say "raise a flag"
 - If there is a biological response, DENR should investigate.
 - DENR needs a step-wise approach.
 - We should tell them when ecological integrity is at risk. We're using "flag goes up" because we're trying to avoid words like "allow, prevent" and leave it in DENR's hands to make decisions about what happens when ecological integrity appears to be at risk.
 - Does it mean that we are really saying site-specific evaluation, or are there other options?
 - There is also the piece of having conversations with the users in the basin as part of the planning.
 - I do think that creating a phrase that puts intended outcome for the alternative analysis in this paragraph would be useful. Even something as general and broadbrushed as "alternative analysis to further evaluate ecological impact" even, so we're clear that the reason for the alternative analysis is because we have insufficient data to utilize the statewide approach, and that the outcome we intend for the alternative analysis is to generate that data and have sufficient information for DWR to do whatever it is that it is going to do.

- Our charge is to tell DENR what they should do about evaluating loss of ecological integrity, how to tell when it happens. If we confine our interest to any given specific place where a future scenario is being modeled, then the question about using working rivers or distributed impact strategy becomes irrelevant. If our question is how to maintain the ecological integrity of the state's aquatic systems writ large across the state, then the question of whether we recommend evaluation based on a working rivers concept versus a distributed impacts concept really matters. Maintaining ecological integrity can't be done using a distributed impact strategy. It drives all rivers towards mediocrity.
- We just say further study; some people say site specific, some say going into the field? I don't think any of those are necessarily accurate.

Decisions Made:

1. As the last sentence in statewide flow recommendation, say: **A 5-10% change in biological condition is suggested as a criterion for further review by DENR? [4 ones; 9 twos]**

Proposed Actions or Identified Decisions to be made:

1. If we can add an outcome criteria in the report [for further analysis], I think that would be useful and doesn't get into the suite of tools that DWR may or may not use.
2. What we are trying to do is say that the eco-deficit tool is not only for the exceptions in the statewide recommendation.
3. Justify in the report why the Board went with 5-10% based on the RTI report but did not use the 15% or the working rivers approach.

TITLE: Context regarding the % flow-by range

Facilitator: Christy Perrin

Major Discussion items/concerns/questions:

- Some members pondered why wouldn't a single value be best for the reasons:
 - PHABSIM showed that 80% works fairly well.
- Board discussed why the range was chosen:
 - PHABSIM used unregulated flows; OASIS uses a possibly altered prevailing flow (SIMBASE) so using 80% could end up with more degradation.
 - a range is more appropriate to allow DENR to hone in on a number.
 - we felt 80-90% bracketed work done by DWR, others
 - It gets harder to get agreement on a specific number.
 - in literature which refers to numbers in this range
 - no obvious threshold can be associated with biological degradation.
- Implications for choosing a range were discussed
 - If we go with a range, it's the same as subdividing streams in some way.
- The report was discussed
 - explanation needed for why those numbers. There's no explanation in there yet.
 - should say that we couldn't agree on a specific number. The recommendation is not to use different numbers in different streams.
- the idea of classifying streams based on condition was revisited- merit was found in the idea, time limits ability to reach agreement on which ones need more or less protection.
- We don't need to solve it, we need to state it in the document- here are the consequences.

Decisions Made: None

Proposed Actions or Identified Decisions to be made: Write a section to include in the report accompanying the statewide flow-by recommendation. This should include:

- **Context for why a range for flow-by (or bio response)**
 - such as the numbers in the range are found in the literature,
 - PHABSIM results,
 - lack of consensus on a single value and
- Implications for how that range plays out.

TITLE: Critical low-flow component discussion

Facilitator: Christy Perrin

The issue of including a critical low-flow component in the flow-by recommendation was raised since it had been included in the last draft of the report but had not been agreed upon by the group yet. The following points were discussed.

Major Discussion items/concerns/questions:

- This was thrown out by one of the report writers as a strawmen proposal since it came up but we had not discussed it.
- The idea came from the Alberta approach.
- Tom Fransen's presentation showed that if it's not included, it presents more problems for some water uses.
- Concern was raised about cutting off users in drought flows, though it was pointed out that it is just another way flag is raised during planning, not cutting off users.
- Reasons for another tool to raise flags- to not extend a critical low flow (frequency, duration)
- Regarding whether DWR addresses this, drought plans incorporated into the OASIS model, triggering events vary by situation.
- Would this be captured in the biological response model, would we see a drastic response in biological condition?
- Ecodeficit may not be adequate to flag- it's an average number.
- Does EFSAB have time to define those low flows?
- Low-flow events are the most critical for determining biological condition- it's important to incorporate it.
- Alberta approach of using 20th percentile flow as critical low flow was suggested as starting point, but other literature should be consulted as well.

Decisions Made: none

Proposed Actions or Identified Decisions to be made: In the report, explain EFSAB's concern about very low flows; Alberta uses 20th percentile adjusted monthly; more in the literature; DENR should investigate the literature and refine the numerical value. (add to paragraph 167-173)

This action was provided to a small group to write first thing Wednesday morning. This was incorporated into language provided for the flow-by recommendation.

TITLE: What to Use as Prevailing condition?

Facilitator: Nancy Sharpless

The facilitator initiated the discussion by reminding the Board that at the end of the August meeting

another potential recommendation had been identified: Use SIMBASE for a particular year (perhaps SIMBASE 2013) as the prevailing condition to be carried forward for comparison. It had also been mentioned at the August meeting that SIMBASE 2013 might not yet be available.

Major Discussion items/concerns/questions:

- Baseline conditions will be compared with natural and future conditions to assess how much hydrology has been altered and to determine the effects of future withdrawals and returns. DENR should use this information to identify areas that have undergone substantial hydrologic change and that warrant additional attention when considering further water withdrawals. As the hydrologic models are updated with new withdrawals and returns, baseline (i.e., 2013) conditions should continue to be used as a benchmark to avoid comparisons to a continually shifting "current" condition."
- [without a fixed baseline] As you keep updating the model with more withdrawals and more alterations and that is your new baseline, then you can take 20% more of that, or 10% more biological alteration to that, then you end up driving everything to mediocrity.
- it could be the date the law was enacted.
- But for calculating eco-deficit you want to track changes.
- Yes, that's why you have all three of those points in there. You can continue to track all of those, but don't lose what I called the baseline condition. You have unaltered, baseline, and projected.
- We probably shouldn't use the word SIMBASE in this conversation because that suggests one way to run the model.
- What happens when there is a new license issued? Do you change the baseline at that point or not?
- That would be incorporated into the future projection. So you have your baseline management regime. Then just one component of the future condition would be that particular license.
- What happens if things get better? How do we handle that?
- If it gets better, the deficit should decline. If that becomes less, you wouldn't say don't do that project; it's getting better. The flag would not be raised then because your eco-deficit is going to be reduced.
- It's not a true baseline because they would do unregulated also. You would have unaltered, your baseline and the future, so when you look at all three of those collectively, you will see the relationship between the improvement over prevailing and any costs of the future withdrawal.
- A suggestion is that we put more specificity to that if you don't do an OASIS model until 2016, the first time it is up and running, is that the baseline condition? In other words, in my mind, the first time you use it is the baseline condition. If you don't create the model for another 5 years, that's the initial baseline.
- Then let's run with the management regime as modeled in OASIS in 2010. The problem is that ½ of the basins in NC were not modeled then.
- You address that by, in theory, when you plug in that withdrawal, you are deriving those numbers from 2010 data submissions, water plans that were viable in 2010, not water plans that were constructed after that date.
- Does that affect the RTI baselines? Are they using the same definitions in calculating impact in the RTI information?
- Their strategy starts with unregulated river flowing through a landscape with potential natural vegetation growing on it.
- That would be the first starting point. Those would be the same. I'm suggesting that the language could be unified in our report so it fits both, or is there a difference in the way it was applied?
- Current eco-deficit is NOW? Is it based on 2013 number, 2010?
- It's based on the period of record with average values.

- Will that be a moving target if calculated in 5 years, or does that need to have a baseline too?
- The RTI report deals with a baseline established in 2012 (I think), and the assumption is that we would continuously know current eco-deficit is by continuously recalculating it, which requires using waterfall which means continuously spending money, and I don't think that is going to happen. I'm now realizing for the first time that the RTI report creates an eco-deficit baseline of 2012 that likely won't be updated for a long time.
- That's okay. **I just think we need to define that, at least in the report.**

Decisions Made:

1. **Define baseline as the management regime, whether it was modeled or not, extant in 2010 at the time the legislation passed.**
Consensus poll: 14 ones.

Proposed Actions or Identified Decisions to be made:

1. **Sam will ensure the RTI report addresses the baseline question and documents the date of the eco-deficit calculation.**

TITLE: Discussion on Conditions that Raise a Flag

Facilitator: Nancy Sharpless

Major Discussion items/concerns/questions:

- While this is important for protecting ambient, instantaneous flow, and it is important for the critical low-flow events, it is not a critical question for calculation of eco-deficits.
- Tom [Fransen] addressed that. If the period of record has no days with flows less than 80%, then it is green. If at least one day has an occurrence of below 80% and no times in the Index B (model run with top and bottom 10% extremes chopped off) analysis, then it is yellow. A red flag goes up if there is both one day below 80% and one in index B (with top and bottom extremes chopped off).
- Can biology tell us anything?
- Some of the biological changes would occur within minutes; some will get up and move in minutes if flow falls outside of their range. Others will stay there until they die. You have to approach it on a species by species basis.
- You're skimming 10-20% of hydrograph, so you want to maintain the shape of the hydrograph. Are we also saying you can deviate from that periodically?
- Then it becomes how much can you deviate? It's the same question, just re-worded.
- We're just saying, does the flag go up when one time in the entire period of record drops below, or does it have to be something more stringent than that in order for a flag to go up. That's essentially what we are talking about.
- My concern is extremes. Some of us think low-flow extremes are the ecological driver, are going to cause the greatest shifts. If we go with index B I feel like we may be missing the most critical low-flow events. We might be able to drop off the high flow 10% and not sweat it, but if it is driven through the low-flow extremes, I think we need to pay attention. It seems like water users would benefit in understanding that crises are in drought extremes, not during standard situations.
- It's not a hammer, saying you are exceeding your allowable amount. It's saying it's time to sit down and talk about options and alternatives for management regimes given that this particular approach under review shows you're tripping the flags.
- Tom's [Fransen's] strategy for interpreting it makes sense. I suggest we adopt them.

- It's pretty conservative. A yellow flag goes up if one day in a period of record you drop below that 80 or 90% line. It doesn't mean you'll necessarily change anything but you're keeping an eye on it. The other one is the warning flag goes up if you have both of those criteria are not met, and that's when you talk.
- I think this is a good place to start. Once DWR has more of these models and starts running them, they are going to figure out if they are getting way too many flags, or if it is extraneous or whatever, and they can revise it over time. But I think this is a good place to start.
- Then the only thing left for discussion then is whether chopping off that 10% at each end how is that protecting or not protecting ecological integrity as opposed to chopping off 5% at each end or something else. At this point it would be a shot in the dark to say some other number.
- when you are looking at it at a watershed scale like this, a whole bunch of yellow flags add up to red downstream.
- If we don't use the index B component, then we're back to how many times you violate the 80%, and then it gets messy (how many days, what times of year?) in a POR of 50 years.
- I thought this was part of the whole purpose of the biological response model, that they could actually plug that in here. Am I missing something here? If you violate the 80% flow-by then you look at the biological response model to help evaluate it.
- That depends on what effect it has on the deficit.
- The deficit might be zero because you have a bunch of high flows offset by lower than expected flows.
- Wouldn't we say in the recommendation that we think it is important to understand the frequency and magnitude of how long, how often you go below the recommended 80-90% flow-by. We have limited experience with it, and we did not evaluate very many options but that a place to start would be the approach currently utilized by DWR. The recommendation part of it is that it's important, that you need to think about it.
- Tom seemed to interpret it as when both criteria are met, and then we really need to talk. That seems reasonable (right, I agree). These others you could still take a look in a desktop manner at some of these to determine why they are getting tripped. It starts you down the road of inquiry; it's not something where we would lay out a full spectrum of what we expect them to do.
- I think it needs to be in the recommendation [as opposed to the description following the recommendation statements], as well as the part about the baseline.
- I would deviate from the yellow flag, red flag [language].
- In the recommendation say something about targeting flows to 80-90% flow-by, and if there is one day of deviation from that in the POR a flag goes up; if there is, if there is one day of deviation in the POR AND at the same time Index B is violated, then flag requires extra weight.
- Regarding what further analysis would be when a flag is raised, Amy, you were going to undertake including in the writing, using further analysis or evaluation with a statement of intended outcomes.

Decisions Made:

- 1. Put the description of what raises a flag into the recommendations [as opposed to putting it into the text following the recommendations].**
- 2. Use Tom Fransen's method for defining flag raising. [Fred and Jaime will write a recommendation on this for review by the Board]**
- 3. Use the same language regarding what "further analysis" means as Amy and Jeff developed for headwaters.**

Proposed Actions or Identified Decisions to be made:

- 1. How do we put this in our report and link that to everything else we are doing. We are interpreting it in the context of trying to apply an impact on the stream biology and**

maintaining ecological integrity. This is a way to trigger a flag or not. We have to link it somehow.

2. Wouldn't we say in the recommendation that we think it is important to understand the frequency and magnitude of how long, how often you go below the recommended 80-90% flow-by. We have limited experience with it, and we did not evaluate very many options but that a place to start would be the approach currently utilized by DWR. The recommendation part of it is that it's important, that you need to think about it.

TITLE: What Further Analysis Would Happen If Flag Raised

Facilitator: Nancy Sharpless

Decisions Made:

1. Use the same language regarding further analysis as was developed for headwaters.

TITLE: What level of ecological integrity are the recommendations protecting?

Facilitator: Nancy Sharpless

Major Discussion items/concerns/questions:

- On the eco-deficit strategy, that answer is embedded in the strategy.
- Isn't it current conditions less 5-10%?
- The way the eco-deficit strategy would work is that additional eco-deficit above the baseline eco-deficit that would result in a 5-10% diminution of fish diversity or bug richness would constitute a flag.
- Fish diversity or bug richness?
- We recommended that DENR use the more sensitive of the two measures so if the bug richness is more sensitive than fish density in a particular instance, they should base their response on bug richness.
- Whichever one appears to be more sensitive becomes the one that raises the flag, and that will vary from place to place.
- I don't think we can answer this question for the 80-90% flow-by strategy, nor can we address it for the extreme event strategy. For both of those strategies we are relying on the professional opinion of authors and/or best professional judgment. We don't have biology to fall back on.
- I think there is consensus around that region from PHabSIM data that we have. If you look at the information that Jim had developed from PHabSIM, 80-90% is a reasonably protective zone of flow-by.
- That is habitat, but habitat is directly related.
- We really have not addressed the resilience aspect of ecological integrity, and **we have really put most of the emphasis of what ecological integrity is on the basis of community structure and species richness of two assemblages, and not on other aspects of the ecology. I think that is justifiable, but to me it would require a paragraph or two explaining why it is justifiable on the basis that you had these two assemblages that have been monitored, and the data are much more abundant than anything else we could get for the ecosystems we are addressing.**
- I agree we do need a paragraph like that. I disagree a little bit with your assumption. The eco-deficit strategy actually does take resilience of species in that guild and the EPT into account because eco-deficit is measured over the POR. So their ability to recover and show up in the successive samples indicates resilience.

- Only in so far as the numbers of species, not necessarily the same species, right? [yes]
- **I would add that we best addressed resilience by using a % of flow-by, as opposed to some other measure. By using % of flow-by, you address that duration, frequency, and magnitude that for the most the pattern of the hydrograph should remain the same. By doing that we are trying to address resilience and substrate structure and all those processes that we are not explicitly capturing with the biological data.** That's true, but remember, if you take 20% of the water out of the river, that will produce a biological result.

Decisions Made: none

Proposed Actions or Identified Decisions to be made:

1. **Include a paragraph explaining why the Board has emphasized community structure and species richness and not other aspects of the ecology in determining ecological integrity. Include discussion of resiliency.**

Title: Discussion about How DENR should Implement the two strategies for Maximum Benefit

Facilitator: Nancy Sharpless

Major Discussion items/concerns/questions:

- We're recommending to DENR three distinct strategies: % flow-by, eco-deficit, and low-flow incident strategy. We are recommending that DENR use all three of these to evaluate future scenarios. In each case, we have made some recommendations about how they should also evaluate the results. I think we need to stipulate something about how to balance the use of these strategies and when to pay attention to which one. If we offer something simple, like just use the strategy that produces the scariest result, then one of them (probably the % flow-by with the one-day flag) is going to show up every time, and the other strategies, which may be more informative and are actually based on data, may be set aside.
- It's hard to think about how they would work synergistically since I haven't seen any of them employed in OASIS.
- I'm confused about what the third strategy. To me that is part of the flow-by recommendation. With that said, the point is still there about how you use the two approaches.
- Yes, two approaches.
- I don't see that there are two strategies. You have flow-by that determines what your hydrographs are, and that determines what the eco-deficit is. Eco-deficit goes into the model to determine what the biological effects are.
- To do eco-deficit you have to have a hydrograph. The flow-by gives you one; projecting into the future gives you another. Until you have done that, you cannot apply the eco-deficit. They are linked.
- You can use the first one without the second, but to use the second one, you have to have two different hydrographs (current and future) to compare to come up with an eco-deficit number.
- The first one does not have a direct link to biologic effects. We are saying that because we preserve the hydrograph we preserve the biology, which is a good place to start. The second one has a direct link to biological data in NC.
- I am inclined to think that the answer may be in "scale", but there may be watershed sizes or HUC scales that are more appropriate for one or the other.
- I think as I understand your point, we would use the flow-by strategy at the point of a proposed management action, and we would use the eco-deficit strategy at the pour point, which is the lowest point topographically for a HUC 10. So the eco-deficit gives you cumulative results whereas the flow-by produces a result at the point of a proposed action.

- But the statistical models for the biological response are based on reach data, right? In other words, you have a sampling point for the biology and then the reach associated with that sampling point for the hydrology. That model you are basing the eco-deficit relationships on is a small scale-dependent model, is it not?
- Well, they are derived from point data, and we accumulated them NHD catchments, right? [yes]
- But then we accumulated those to whole basins for the final analysis.
- Well, there are different locations along basins, so in some cases they are cumulative.
- I'm trying to understand this in light of the OASIS model. Won't these things be done at nodes? Is this necessary?
- I don't see that there are two strategies. You have flow-by that determines what your hydrographs are, and that determines what the eco-deficit is. Eco-deficit goes into the model to determine what the biological effects are.
- Flow-by is not a proposed future hydrograph; it's a test for proposed future scenarios. This is the confusion I was having; are we proposing to implement a future hydrograph that looks like current but with 10-20% lower, OR whether we were going to use that 10-20% line to test future scenarios to see how often they cross that line. As it turns out, it is the latter, which makes more sense, so we have 2 tests for future scenarios. I have 4 alternatives:
 - Give them both to DENR and say use them how you see fit
 - Use them in a prescribed order: we recommend you use the flow-by strategy, and then test the results with the eco-deficit strategy. IF you don't like results, you have further work to do.
 - Always use them both, and rely on the most sensitive one. That is essentially the same as alternative #2, phrased a little differently, and it implies a little more conservative approach.
 - Apply these two strategies at different scales. One approach would be to use the flow-by strategy for site-specific evaluation, and then try to maintain a cumulative roll-up of all site-specific decisions using an eco-deficit measure somewhere, like pour points of 10 digit HUCs.
- If 80-90% flow-by were used, and flag went up when a single day were violated in the POR, then that would be by far the more sensitive. I'm worried DENR will rely on that one only, and not use the eco-deficit tool which is based on a very deep dive of the data. I don't want to create a situation where DENR doesn't use the eco-deficit tool as a way to look at whatever decision they are making to make sure that their decision has some sort of cumulative evaluation over time and perhaps also space.
- Running the two models is equally easy after set up. Setting the eco-deficit tool is hard on the front end but then easy to run. If you run the 80-90 strategy and most of the time a flag will go up, the eco-deficit strategy will give you some comfort, as it's less sensitive.
- You haven't heard yet what we put together about the flagging. Our approach for our writing task was to kind of flip it and in the recommendation we followed the recommendation from Tom Fransen's approach where you pursue a certain strategy of further analysis whenever you found at least one day in the POR where you drop below the threshold AND you fell outside index B. Whenever that happens it would trigger additional evaluation, which presumably would include the eco-deficit model wherever it is applied (either at that point or at the appropriate location in space).
- I like option 4 since it would incorporate use of information that DENR would have readily available, and then applying eco-deficit approach on an appropriate scale because it seems that if you apply it, where you apply it would make a big difference.
- I like 2 and 4 a lot better than 1 and 3. Perhaps they should both be used: DENR should check the results on a project by project basis, starting with the flow-by test, then use the eco-deficit test, which may in fact give some relief to their conclusion. Then I think DENR should experiment at different scales for doing roll-up analysis and find the scale that works best for #4.

- To do eco-deficit you have to have a hydrograph. The flow-by gives you one; projecting into the future gives you another. Until you have done that, you cannot apply the eco-deficit. They are linked.
- Is there some reason to not only check at the management node you insert in the model, but to also accumulate that somewhere down the watershed?
- The nodes will be done no matter what. The question then is what is the relationship of those nodes to some other layer of hydrologic accumulation (HUC 8 or 10 whatever). If it's in the middle of one of those HUC units, it's still accumulating to that point. The next node down you accumulate to that point. If you do away with the different HUC levels, you still are answering what is happening accumulating to that point.
- We've made the assumption that 80% flow-by is fine. We haven't tested that. Does eco-deficit provide the ability to test that assumption? We have PHABSIM and eco-deficit to test that assumption?
- That's basically what I am suggesting, to test using eco-deficit every time.
- I think any time you use those tools it is cumulative impact because you are looking at everybody's action at that point. I don't think you are ever not looking at it from a cumulative perspective.
- OASIS is set up watershed by watershed. So every OASIS model actually produces an outflow at the bottom of the model. Is that the appropriate scale for looking at cumulative impacts?
- Is it appropriate for us to say that DENR needs to do this exact prescriptive approach everywhere or something specific but less prescriptive?
- DENR should test the future flow scenario against both the flow-by standard and the eco-deficit model.
- I think it makes sense to not go beyond that with more specificity because until they have actually done it for a while, to know how many flags or what kind of flags go up in the flow-by test against how many and what kind of impact from the eco-deficit test, until they get experience with that it is hard for us to give more detail on whether to use the more sensitive or any other permutation.
- This is a statewide recommendation. This is what we have determined what we think ecological flows are. That's where we started; now we are getting into the implementation. We need to be very clear that the testing concept...
- What we are really doing is testing our recommendations and whether they are sufficient. That's what the tools are doing.
- I don't agree that 80-90% of ambient mean flow-by is a statewide ecological flow. I think that what we talked about yesterday afternoon is that we could test management actions and see if they violate an 80-90% ecological flow as a test for whether those management actions are ecologically sustainable or not. There is a big difference.
- We are not making an across the board ecological flow recommendation. What we are saying is that it is going to be different in every stream and these are the tools to evaluate that.

Decisions Made:

1. **Use the language in lines 134 through 136 in the current master draft, which say:
"Statewide Ecological Flow Evaluation"**

"To evaluate flow scenarios in most North Carolina streams, the following two tools are recommended to assess whether ecological flows are maintained:" [9 ones; one 2];

2. **The Board also reached consensus on changing the word in line 145 from "change" to "reduction".**

Proposed Actions or Identified Decisions to be made: none

TITLE: Discussion: Nine New Written Sections for the EFSAB DRAFT Report

Facilitator: Mary Lou Addor

In order to discuss the nine new written sections of the EFSAB DRAFT Report 4.0, a review process was proposed and accepted.

Major Discussion Items/Concerns/Questions: discussed and proposed revised language as appropriate to each of the nine new written sections of the EFSAB Report 4.0

Decisions and Recommendations:

1. Add a descriptor in the report where the mountain PHABSIM information is earmarked.

Fred will make the following changes to introduce the PHABSIM section:

- submit a section titled “Physical Habitat Simulation (PHABSIM) & Time-Series Analysis” and determine where to insert into EFSAB Report 4.0
 - replace PHABSIM figure with map of analyzed site for piedmont and mountains (figure 1 in version 4.0 of EFSAB)
 - replace site, stacked bar charts (figure 2, EFSAB Report 4.0)
 - include figure for the mountains (figure 3, EFSAB Report 4.0)
 - provide definition of Index B in glossary
 - place species info in appendices section
 - provide an intro paragraph following line 625 –just after Flow-habitat Relationships
- Lou will integrate Fred’s section into EFSAB Report 4.0

2. Headwater streams recommendation written as and inserted in page 11 of the EFSAB Report 4.0:

There are 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, for streams with drainage basins ≤ 10 km², DENR should conduct additional analyses to determine the potential for impact.

3. Recommendation that “DWR should georeference nodes to facilitate analysis” was included on page 14 of the EFSAB Report 4.0 following the Ongoing Validation Using an Adaptive Management section.

4. Tom drafted two new paragraphs for insertion into the report that described why the EFSAB recommendation deviates from RTI’s recommendation for biological thresholds (justification for using 5-10%), implications for using the range without the stream categories. Reference page 64 of summary for full narrative.

5, 6, & 7: Chris and Hugh developed a narrative to respond to items 5, 6, and 7. This information was based on an early narrative Chris had developed. This section replaces line 147 -198 in EFSAB Report 4.0. Sections bolded are recommendations. At some point, instead of using the phrase 80 to 90% flow-by, we need to define it as: the flow-by recommendation, or the flow-by criterion, or flow-by strategy or flow-by threshold. And then use that phrase throughout rest of document. The report will read a lot better. Reference page 65 of summary for full narrative.

(5) In the flow-by recommendation statement, describe why the range was chosen (based on range seen in the literature, PHABSIM results, range chosen versus a number based on ability to reach consensus, other?), and implications of choosing the various percentages. Note that implications are not clear cut, there is a continuum.

(6) Critical low-flows- flesh out the statement that is currently in the report. Language in the flipchart notes to draw upon- the increased frequency and duration of drought is a concern. Low-flow events are most critical for contributing to biological impacts. DENR should consider identifying a critical low-flow component. Alberta, CA uses 20th percentile flow adjusted monthly as a critical low flow. DENR could consider Alberta's and other examples in the literature for setting a critical low flow for planning.

(7) Prevailing flows- use as baseline the management regime extant used when legislation passed on 7/22/2010

8. Incorporate a narrative about what happens when the flag is raised (consider Fransen approach).

Jamie, Fred, and Jeff discussed a proposal during the meeting but determined that they needed to meet with Tom Fransen in order to work through their ideas. They will present a new narrative prior to the Oct 22 and 23 meeting. Chris will join their group (anyone else is invited).

Some of the ideas that they discussed included:

- Inserting their section after line 141 of EFSAB Report 4.0
- Weave this section into the narrative Hugh and Chris developed to replace lines 174-198.
- Ensure critical low flow is defined in glossary and main body
- For Index B, determine another term to use
- Provide an explicit description of what it means when the flag is green, yellow, and red
- Fred, Jeff, Jamie, Chris meet with Tom Fransen
- Proposed language developed and team will revisit includes:

For evaluating potential impact of reduced flow when critical low flows [not just when below critical low flow but when below 80%] are encountered, the EFSAB recommends DENR undertake additional analyses of potential for impact to ecological integrity. We recommend these additional analyses be conducted whenever flows are predicted to be below the (threshold) and also below the Index B value [determine less confusing term than Index B] for one or more days as calculated daily for the period of record.

When the modeled flow falls below the threshold level for any day but has no days that fall below the threshold for the Index B record, flows at the associated river reach should be given additional scrutiny.

9. Add paragraph about how EFSAB addressed ecological resiliency (Using ecodeficit approach)

Bob and Sam developed a narrative to report how the EFSAB addressed ecological resiliency. Lou integrated section at line 636 in section on Flow-Ecology Relationships and added reference to Reference section. Reference page 71 of summary for full narrative.

TITLE: Review of Requested Edits to EFSAB Report 4.0

Facilitator: Mary Lou Addor

Members present were divided into 3 teams in order to review the most recent EFSAB report (4.0) (dated 9.10.2013), and the edits that had been requested to be made to the latest version (using document labeled “Complied and Reviewed – Aug 22 – Sept 16”).

The responses of the three teams are being distributed with the new version of the EFSAB report, version 4.1.

Decisions and Recommendations for version 4.1 of the EFSAB DRAFT Report:

1. The following tables and figures in version 4.0 are to be updated by RTI:
 - Pg. 9-10. Figs. 5A - Quantile Regression showing relation between summer ecodeficit and Shannon-Wiener Diversity Index and 5B - Quantile Regression showing relation between summer ecodeficit and Macroinvertebrate EPT richness
 - Pg. 10 Table 1 – Statewide quantile regression models
 - Pg. 22 Fig. 3 – Example of flow – ecology relationships for fish and aquatic insects.
2. Decisions and action items from Sept. 25 EFSAB meeting
 - Locate Glossary and Acronyms to front of report
 - Glossary: provide definitions in body of report as well as include in glossary
 - Acronyms: ensure when incorporating into report that acronyms are placed correctly depending on when they first appear
 - Consider hyperlinking sections of the report to the EFSAB website where appropriate
 - Capitalization rule: mountains, coastal plain, and piedmont are lower caps; if it’s a physiographic provinces - Appalachian mountains, the Piedmont, and Mid-Atlantic coastal plain – these provinces should be capitalized. If discussing geographic features in the mountains, the piedmont, and the coastal plain – none of which should be capitalized. The piedmont is the one of those that has the same name either way you go.
3. Ensure the PHABsim and IFIM sections are complete with all figures and tables (Fred) is complete (Fred)
4. Ensure when the flag is raised scenarios are described completely (Jamie, Fred, Chris, and Jeff with Fransen)
5. Ensure all sections of the report are completed such as:
 - a. Additional narratives and sections to complete:
 - (1) Other Recommendations – review for missing narrative
 - (2) Tools to Support Ecological Flow Recommendations –requires narrative or remove this Section
 - (3) #8 new written section on critical flow/flag raised scenarios by Jamie, Jeff, Fred, & Chris.
 - (4) Glossary –all terms identified and defined
 - (5) Acronym – all abbreviations are listed and identified
 - (6) Reference -all references in the report are listed in Reference section
 - b. Thoroughly review
 - (1) all recommendations to ensure support
 - (2) entire report for remaining edits
 - (3) for ease of reading

II. September, 2013 Meeting Orientations and August, 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 Aug 22 & 22, 2013 meeting summary, and it has been posted to the NC Water.org website.

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

Presenter: Fred Tarver, NC DENR

Fred's powerpoint presentation can be found at <http://www.ncwater.org/?page=366>

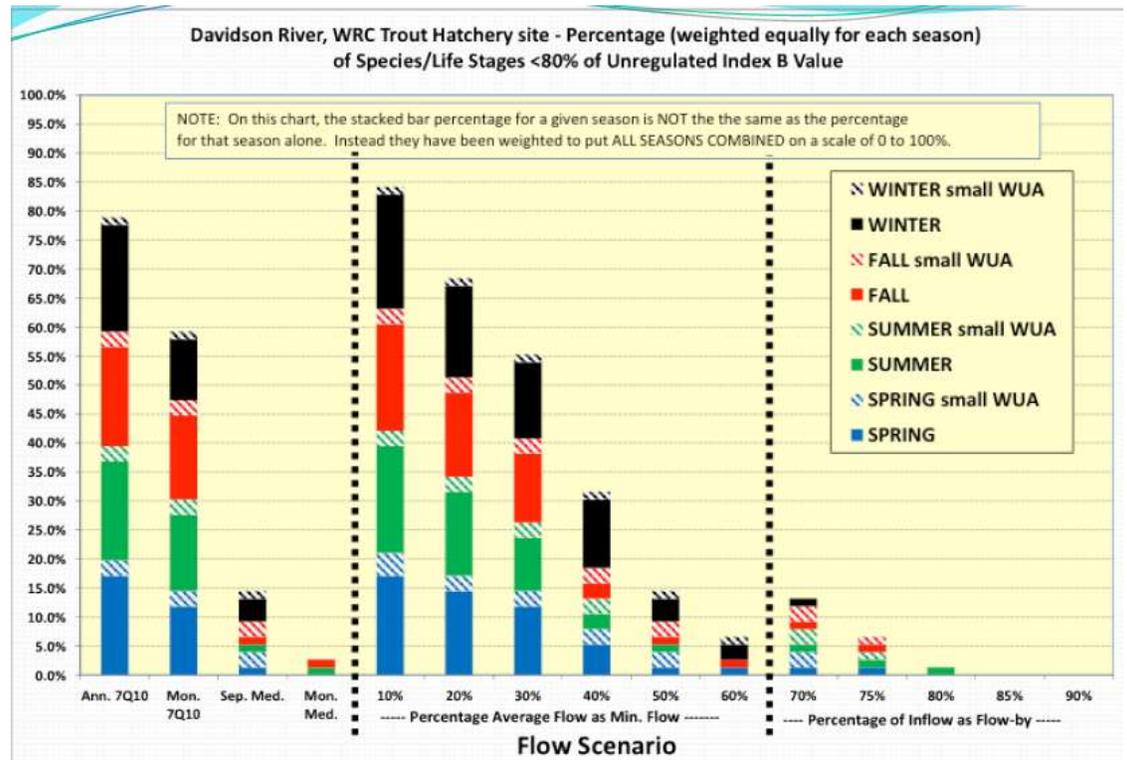
Fred began by saying that presenting the mountain PHabsim sites may give a little confidence in addition to the piedmont sites Jim did. As a review, Fred showed sample bar charts from piedmont sites, including % of number of guilds with less than 80% of unregulated index B Value. He showed the 3 types of flow scenarios. He showed a map of sites from piedmont, then a list of mountain PHABSIM sites. See Fred's July 2013 presentation (and July EFSAB meeting summary) to review complete details about the mountain sites. These sites were done during hydropower relicensing, as well as water supply. On the map of mountain sites, yellow dots were sites not chosen as suitable based on difficulty to rehash the sites. He showed a list of guilds used in piedmont sites. There is a divergence of analysis used in piedmont and mountains- different guilds and species were used. The EPT guild that was transferred from the piedmont sites to the mountain sites. Fred showed the list of species used for mountain sites.

DEEP	SHALLOW
Caddisfly (TRIC)	Mayfly (EPHEM)
Mottled Sculpin (adult/juvenile) (MTSX)	Stonefly (PLECO)
Northern Hogsucker (adult) (NHSA)	Northern Hogsucker (juvenile) (NHSJ)
Rainbow Trout (adult) (RBTA)	Rainbow Trout (fry) (RBTF)
Rainbow Trout (spawning) (RBTS)	Blacknose Dace (juvenile) (BNDJ)
Brown Trout (adult) (BRTA)	Longnose Dace (adult/juvenile/spawning) (LNDX)
	Creek Chub (adult) (CRCA)
	Blacknose Dace (fry) (BNDF)
	Blacknose Dace (spawning) (BNDS)
	Brown Trout (fry) (BRTF)
	Brown Trout (juvenile) (BRTJ)
	Creek Chub (young-of-year) (CRCY)

For most sites there were transferring curves from one site to the next since they weren't used at all mountain sites, and updating coding. Grouped by deep and shallow based on preferences of species. Quick rehash- take the preference curve, have velocity, depth and substrate cover, and the curves that should correspond with preferences of species, take field data and run it to generate flow preference curve, then look at period of record to generate the amount of habitat over time. The other difference was without OASIS models in mountain sites, I had to use OASIS/WaterFALL to get a model-generated period of record at specific drainage areas. Most mountain sites did not have a proximal gage, so generating POR would require the use of data from different watershed.

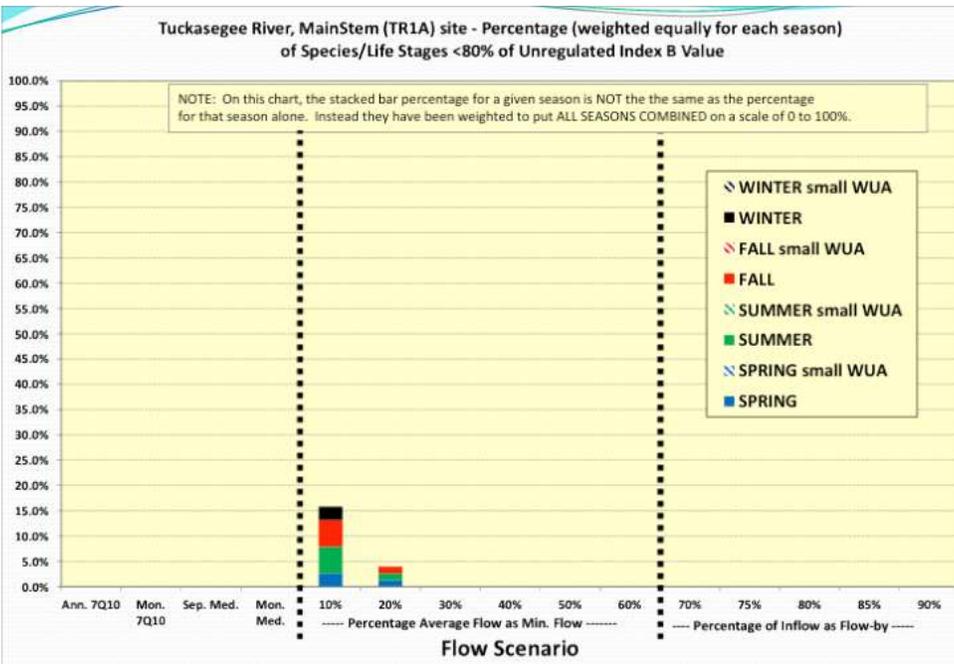
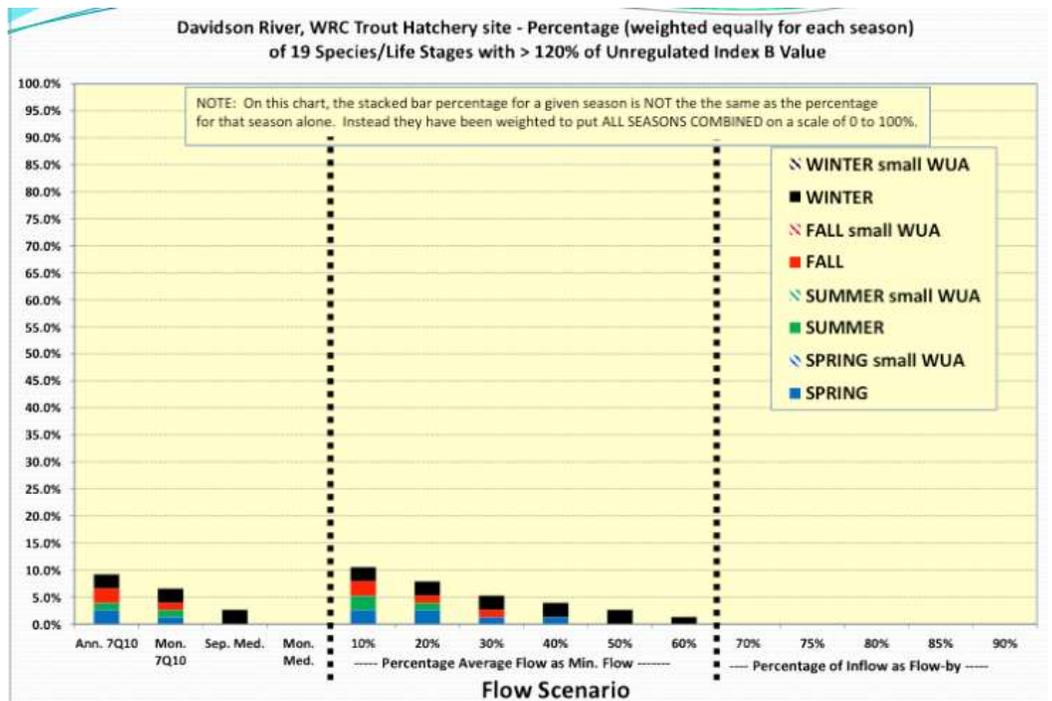
Results:

Fred showed slides for all of the sites. For all sites I separated scenarios into the 3 categories of flow regime: traditional flow requirements of Annual and monthly 7Q10, Sept. median, Monthly median; the percentage annual average flow as minimum flows; and percentage of inflow as flow-by. This was how the piedmont sites were presented as well. Recall you asked to see weighted usable area. There was interest in looking at sites that produced small amounts of WUA, we set it at 1,000 WUA. Striped bars are representing the smaller <1,000 WUA. A few representative slides will be shown here.



The first slide was Davidson River <80% unregulated Index B. Bars represent by season when you have the various flow scenarios, the % of the 19 species and life stages (shallow and deep are lumped together). Index B is if you take the average of the WUA values between 10 and 90 percentile. Of the species we looked at, 80% had less than 80% WUA under the Annual 7Q10 scenario. Under these flow scenarios, as you move across the spectrum you have an improvement in the weighted area. On the Davidson River bar chart for >120%, 10% of the 19 species/guilds had greater than 120% of the unregulated Index B value. For % flow-by, none of the species are showing an increase of >120% WUA.. I get the impression this is more of a valley type river, doesn't have the high gradient of some of the other sites.

Tuckasegee River mainstem- 287 mile drainage, 7Q10 of 280 cfs. These flows were all generated by WaterFALL from 1967-2006, this was with no alterations and 70's landcover. 19 species that had deviations from 100%, very few of the species were <80%. It was a little confusing in this regard. For the >120% chart there are a lot of changes. I was trying to interpret what was happening, such a great increase, maybe WaterFALL period of record was trying to push a lot of water through, maybe a 7Q10 flow requirement removed a lot of water, reducing the flow, it would be interesting to compare WaterFall to gage data. Interesting relationship, 10% of mean annual flow up to 60%, there was a peak in the middle.



Nantahala- 143 mi² drainage area, mean of 603, pretty high, the lowest part of that river where whitewater rafting takes place. Sort of same affect with the >120% as well. Compare it to the <80%, not a lot of change. A lot of habitat between 80% to beyond 120%. It's quite a deviation from some of the sites we've seen elsewhere.

West Fork Tuckasegee- One of the bypass reaches, which are the sites where they take water around the dam- being

diverted to the powerhouse. For the >120% bar chart you get the same sort of scenario, a whole lot of species and life stages showing weighted area >120%, liking the far end for some reason.(left end, 7q10). All the seasons seem fairly well distributed in terms of amount. For the <80% bar chart, again all the weighted usable areas are compressed above 80% and through >120%.

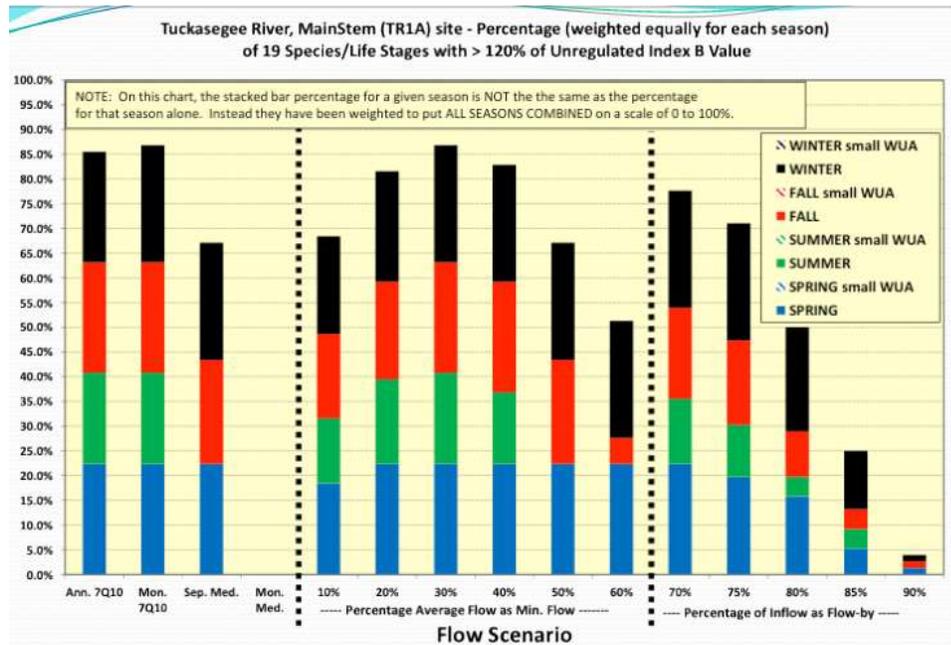
West Fork Tuckasegee Peaking reach- below the powerhouse so you get the effect of power generation, more dramatic fluctuations in flows

Q: in this analysis you've stripped that out? R: yes, that is right. This is unaltered flow.

So you see the same sort of impact here.

Jonathan Creek- Maggie Valley, fairly small drainage 13 mi², 7Q10 of 4 (don't have mean).

Shows opposite, very few life stages exceed 120% of WUA. Strangely they are over on the left and middle. On the right a few responses of <1,000 WUA, but probably a factor of stream size.



Whiteoak Creek on the Nantahala River- 13 mi², 7Q10 of 6 cfs, mean of 63 CFS. Comparable to Jonathan Creek but more slope to it. Fred showed the slides and pointed out where the impacts were.

Nantahala River- another bypass reach upstream of Whiteoak Creek. Same sort of look to it.

N. Fork Mills River, around Asheville area, Forest Service area, water supply for Hendersonville. Drainage area is 10mi², 7Q10 of 2 cfs, small drainage area. The <80% bar chart shows quite a bit of impact on left side of ledger, a little on the right.

Tuckasegee River called the "East Fork" - The Tuckasegee and Nantahala river drainages are sort of interesting results.

From the work Jim did, next step was to take all the bar charts and do an all sites conglomeration. I will try to get it done and post it on our site.

Q: Bar charts are for deep or shallow?

R: Think they were all combined.

Q: I'd think those liking the >120% would be the shallow or slower species?

R: yes, the fry and young of year were having the better response at the low flows, 7Q10 flows.

C: That should be appropriate from literature that in high grade areas it would be more likely to reduce it to a usable velocity.

R: That makes sense. My question was if WaterfFALL was trying to push too much water through the cells.

C: It only happens on those streams that are the hydro power streams. You're not seeing that pattern on the North Fork Mills or some others.

C: But the others have really small drainages.

C If you didn't have a bypass, I'd expect nothing above 120%. The Tuckasegee drainage sites are a little screwy.

Facilitator: questions, reactions, thoughts on how this informs your recommendations?

C: I think what we have in the report is a placeholder figure in there somewhere for the mountain results. Depending on how that will be written or rewritten it will have to take it into account, if it stays in there, to incorporate these results.

C: My concern is that many of the streams showed very little effect of a 75% flow-by, if I were an outsider trying to challenge this, I'd say it doesn't have an effect on these particular streams at this level. Why have you set the recommendations more stringently?

C: I think given that these are the combined life stages, deep and shallow, if you pulled those out to see there was a shallow group seeing a benefit.

R: There's a whole suite of charts with the 19 by month, season, you could tease out those individuals. You lose some of that resolution by lumping them.

C: Yes, I think sensitivity is lost in this particular graph. If we wanted to look at the 80% flow-by in more detail it could be done with other graphs.

C: What also makes it a little hard is that you can take these 10 and add to the existing 9 in the piedmont and there may be some overall trend, however we had to use WaterFALL and a different suite of species. There are not OASIS models available in the mountains. It's another complicating factor to try to compare.

C: If you compare within the evaluation you could have a trend in the mountains, a trend in the piedmont. You still won't compare apples and oranges. It still points towards sensitivity when you get lower than 80% flow-by.

R: Would you include it in your report as supporting evidence for your decision-making? Would it be couched in that regards?

Facilitator: Do you want to address that when we talk about the report later in the meeting? (nods, yes.)

IV. Presentation and discussion: Assessment of OASIS Nodes in headwaters and how to address headwaters

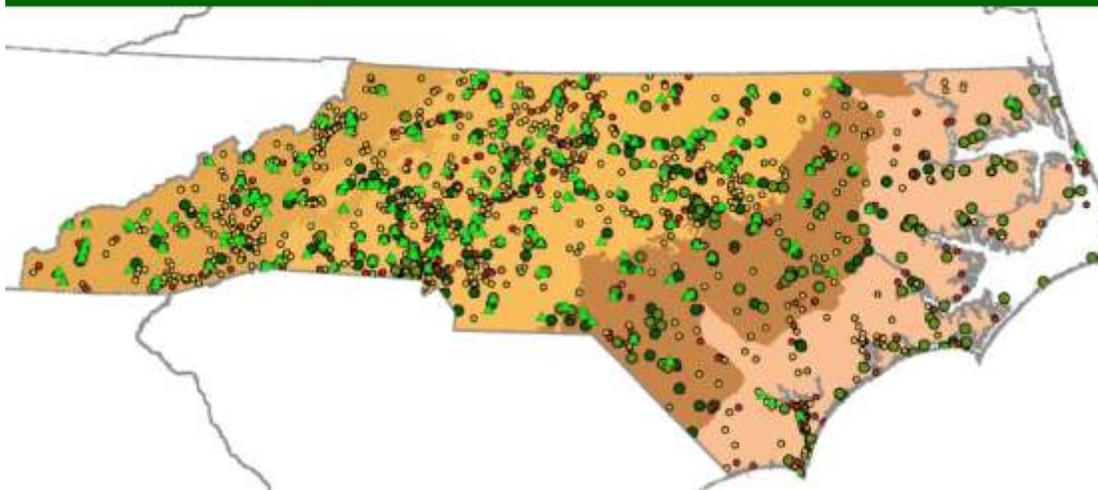
Presenter: Mark Cantrell

This power point presentation can be found at <http://www.ncwater.org/?page=366>

At the last EFSAB meeting, Mark decided to look at how existing water supply intakes are distributed across the state, to help inform the group's discussion about headwater streams.

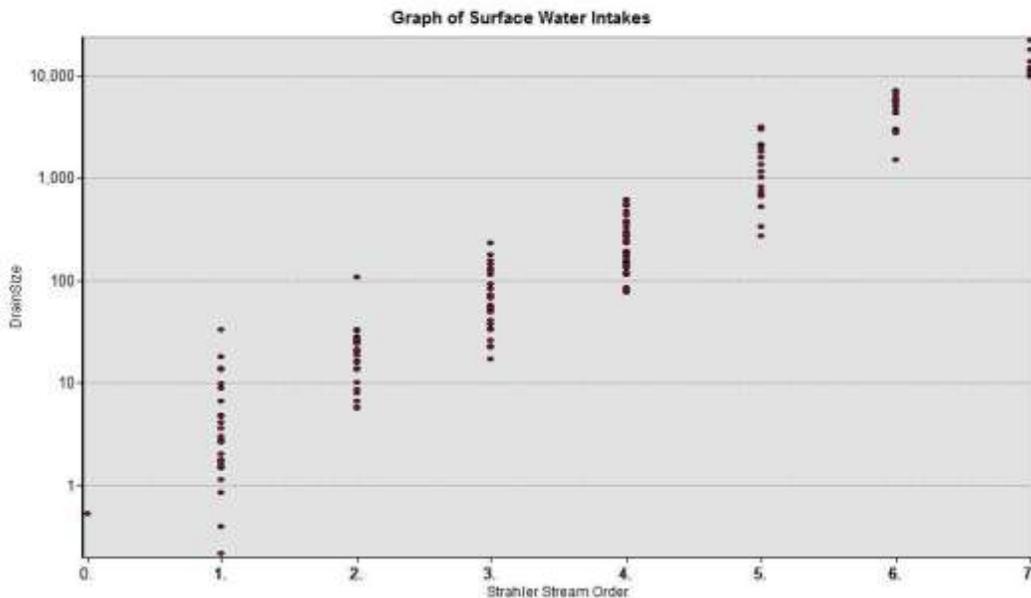
I've plotted a graphical illustration of the location of each of the NC surface water intakes from NC One Map, and then overlaid those with the Omernick ecoregions including mountains, piedmont, coastal plain, inner and outer. Also combined with intakes are discharges. Another slide shows NPDES discharges, big dots are the large municipal discharges making big returns back to surface waters.

Existing Surface Water Intakes



mary

Existing Surface Water Intakes



I plotted intake drainage areas with stream order (slide not shown here but is in his presentation).

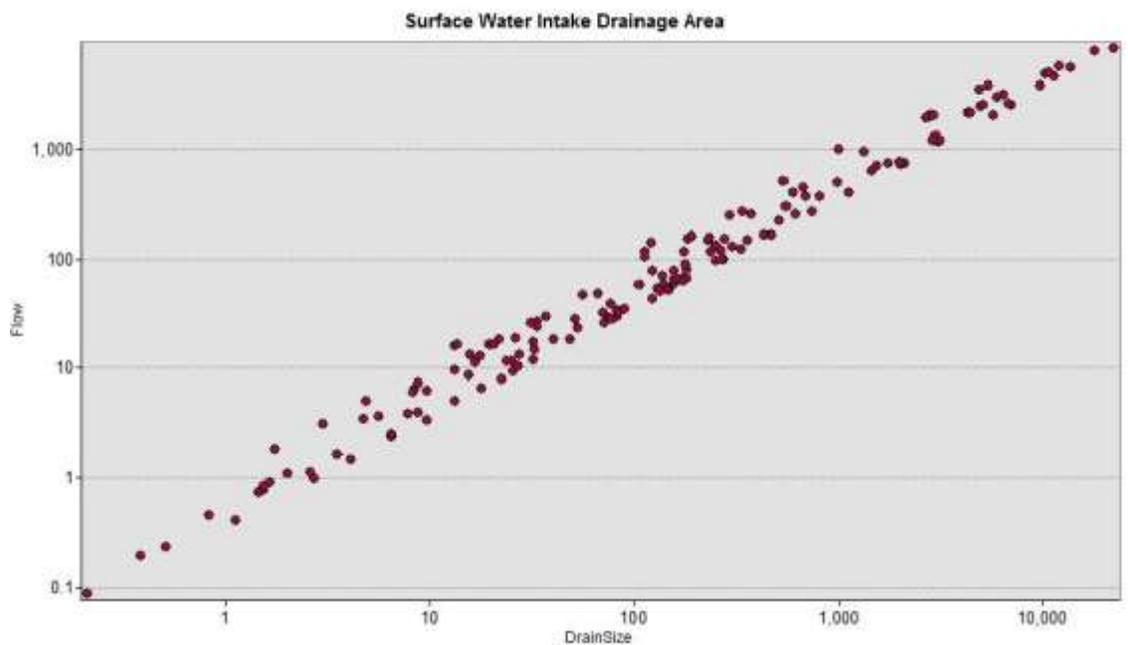
Essentially you see intakes on first order streams that range from very small drainage size this is log scale by the way, to 60 km², some first order streams get large. Then I plotted estimated mean annual flow of these streams against drainage size. We've seen the relationship in a lot of the other work that has

contributed to the ecological flows. As drainage size increases, flows increase. So that's as far as I've been able to take this. I'd like to look

at the capacity of our existing water intakes, to compare the surface water intake, drainage area and discharge relationship and look at where we are. Stream size, flow, order, are correlated in NC with physiographic and other variances across the state. Because my data were limited, I didn't look at intake individual capacities or permitted withdrawals, though I was interested in

doing it. I wanted to plot so that looking across this chart, creeks, small rivers, medium tributaries, up to great rivers, shows where surface water intakes are with regards to drainage size and withdrawal. This was to see current practices for siting withdrawals and potentials for eco-deficits and drought effects on surface water intakes. Something that we've seen with extended drought in a number of basins. It's not just a means for identifying ecological flows issues, but could be a red flag for surface water withdrawals, this would give them an idea of how to better balance expectations for water withdrawals in these streams. It could inform our recommendations or how to implement our recommendations.

Existing Surface Water Intakes



Comments/questions

- I'm surprised at # of intakes in 1st order streams (some are as large as 60km²)
- Would be good to know about data set Mark used.
 - It's NC One Map database of permitted intakes from DWR (Source Water Intake, or SWI layer from Public Water Supply)
 - Does not include agricultural or other intakes
 - Not the same data layer as used for OASIS, as OASIS nodes are not georeferenced.
- Potential future recommendation for OASIS nodes to be georeferenced.
- I looked at same question using stream size data from Olivero, TNC. Some intakes are in small reservoirs near streams but not on the stream. This is a very rough cut; with SWI not being georeferenced, it's hard to determine what is going into OASIS, but it's still informative and other data that should be evaluated geographically. There are other aspects that should be evaluated geographically.
- Is another use of this to help determine the cut off for headwater streams, as scheduled for discussion?

Headwaters	<10
Creeks	<75
Small Rivers	<400
Medium Tributary Rivers	<2000
Medium Mainstem Rivers	<6000
Large Rivers	<20000
Great Rivers	>=20000

Facilitator: If you want to get into the discussion now, you are welcome to go there. How do you think this informs that decision?

Headwaters discussion:

- We need to have a threshold for when statewide recommendation applies and when it does not. I wrote this section in the report and included the ≤ 10 sq km (3.9 sq. mi) threshold as a strawman for board consideration. The SARP and TNC use this (northeast and southeast) and it makes sense to me. I used the smallest (10km²) as breakpoint for when use statewide v. further analysis. In my evaluation, a lot of streams and intakes fall in the 10-75km² size (creeks). You pull in many public water supply, and would possibly create for DWR many more further analyses if the headwaters include "creeks" subset and headwaters subset in break point. I definitely think <10 should get special consideration.
- Would Mark change his definition of headwater streams from 10km² based on his analysis?
- No, but would emphasize the importance of headwater streams for surface water intakes.
- Seems like this class break of 10km² would capture almost all of 1st order and 1/3rd of 2nd order streams, and that is a pretty small drainage area.
- Beyond that, 75 km² would be the next break, and that would include a lot of evaluations. Because discharge increases with drainage area, you are getting those streams that have low discharges, and the subset with more variable.
- I propose 10km² (3.9 mi²) as the threshold for moving from statewide recommendations to recommendations for headwaters.
- So anything under 10km² would get further analysis? What is that analysis?
- It would automatically trigger a closer look by DWR. How, is not fully sorted out.
- Less than or equal to? (yeses from EFSAB members- SARP and TNC used less than equal to)

The facilitator read the headwaters recommendation developed by EFSAB in August:

There are 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)."

Consensus check: Use less than or equal to 10km² as threshold for deviating from statewide
○ 9-1's; 4-2's;

The EFSAB supported this proposal. They recognized that the text of the last sentence of the above recommendation needed to change based on this new recommendation, so a small group re-wrote the recommendation during lunch and presented it to the EFSAB after lunch for a consensus check. Later in the morning, the topic of headwaters came up and the following discussion occurred:

- This discussion talked about headwater streams; there are no red flags in the headwater streams since the model doesn't apply.
- OASIS has some capability of generating flows at nodes that are not in immediate vicinity of a gage, right? There is capacity for that in the model; there are not necessarily a lot of gages for them to calibrate it against, but they do generate flows.
- I spoke wrong when I said the model doesn't do that. I meant our recommendation for headwater streams is that the statewide recommendation doesn't apply.
- I wonder if we should evaluate that more closely. It could be that a 80% flow-by in a given headwater would work and not necessarily impact the ecological integrity. It would need to be evaluated. We feel relatively confident that for streams with drainage areas greater than 10square km, then 80% flow-by will protect ecological integrity over time. We are not as certain about that in headwater streams and, therefore, we need to more closely evaluate whether the 80% flow-by would be sufficient to protect ecological integrity or not.
- That's why the last sentence was written in that way.

Facilitator: So is it essentially that headwater streams are innately a red flag?

- First test of potential withdrawal: is drainage < or =10square km? If yes, it automatically moves into this question of whether 80% and eco-deficit evaluation is adequate; then with anything greater than 10 square km, then is it throwing flags there; then you throw the eco-deficit tool in, is it throwing a flag there?
- To wordsmith, take last statement from headwater streams...Do we want it to be "to evaluate eco-flow requirements", or "to protect eco integrity"? What is our modifier?
- We need to evaluate whether or not the statewide approach would adequately protect ecological integrity of those streams. To me it's about sensitivity and vulnerability.
- Right. I'm trying to put something in that provides direction without begin prescriptive.
- We don't need to measure for headwaters streams against the statewide approach. It could end up being that the statewide approach we decide on could work. or another technique entirely could be used. We shouldn't exclude the statewide approach.
- We're saying don't automatically apply the statewide approach.
- Can the eco-deficit tool be used in headwater streams?
- Yes.
- So once a stream is in the pile of headwater streams, would we not want to use the eco-deficit tool?
- That was not decided. The 80% was our question.
- So we use the eco-deficit tool in headwater streams.
- I want to be sure that everybody knows that the eco-deficit tool would potentially be part of the

evaluation of the headwater streams.

- I don't think anything we have said prevents them from doing that.
- A critical piece for headwaters is that the water removal could be very different than in these other situations so that even if you had the same eco-deficit, maybe they took a tanker and pulled out water for 12 hours. In a bigger stream that would not make such a difference. Important thing for headwaters is that they have a different sensitivity to the way water is removed. That's one of many reasons for special consideration.
- So the eco-deficit tool could be considered one of the additional analyses to use in headwaters?
- We need to say that the eco-deficit tool is not only for the exceptions to the statewide.

Consensus check was made after lunch to use the following language for the headwaters recommendation:

There are 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, for streams with a drainage area $\leq 10\text{km}^2$, DENR should conduct additional analyses to determine the potential for impacts on ecological integrity.

- All 1's, the group unanimously supported the recommendation.

V. Remaining issues to address for EFSAB Statewide Flow Recommendations

The facilitator presented the flow recommendations developed as of 8/21/13 and a list of issues to discuss relating to flow recommendations, which was developed by the EFSAB at the last meeting as they developed recommendations. The flow recommendations were:

Statewide Recommendations (8/21/13)

The following two tools are to be used simultaneously to determine ecological flows in most North Carolina streams:

1. In the basinwide 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.
2. The Eco-deficit tool should be used to determine the current and future modeled biological condition of locations in the basin wide 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]."*

Recommendation for Headwater Streams (8/21/13)

There are 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.

That list included:

- Develop biological thresholds for % change in biological condition. 5-10%?
- Discuss hydrologic recommendation for when to use lower or higher end of range of % flow-by
- Use a critical low-flow as part of the flow recommendation?
- Define headwater streams?
- What to use as prevailing condition—use Simbase x as current prevailing condition and as comparison flow as move forward?
- Recommend how often for how long the projected flow drops below the e-flow in order to raise a flag?
- Recommend what further analysis would be if flag raised (PHABSim?)?
- What level of ecological integrity are the recommendations protecting?

She then asked the Board if they could identify additional substantive issues that still needed to be addressed.

C: The Coastal recommendation was not clear to me in the report. I think we need to come up with a clear sentence or two on that.

Facilitator: Yes, I did not include that in this list because it does not require substantive decisions. It just needed a more concise statement of the recommendations in the report.

C: Did you see I put together a short few sentences to put in the next revision of the report?

Facilitator: Yes, it should be in the report that was sent this morning, We can review it when we get to the report. Any other substantive decisions to add to this list? [None]

The facilitator provided handouts including: the statewide recommendations as of 8/21/13; the headwaters recommendation as of 8/21/13; questions to answer and issues to address in the report that the Board had developed in August; the section of the Executive Summary of the August Meeting Summary regarding setting a threshold for % change in biological condition, or not. The facilitator then invited the group to take a minute to review the discussion points about whether or how to set a % change in biological condition threshold, since the Board would start with that question first.

Q: Can we revisit headwater streams? The recommendation as of 8/21/13 read: "Therefore, DENR should identify the subset of headwater streams to receive alternative analysis." I think the Board is recommending that headwater streams receive this alternative analysis; headwater streams are streams that are less than or equal to 10 km².

Facilitator: You are identifying that the last sentence in the Headwater recommendation needs to be changed?

C: Yes.

Facilitator: I think maybe the way to handle that is to make a note of that and ask someone to redraft that at lunch for approval.

The group agreed, with Judy and others agreeing to work on it.

VI. Discussion: Thresholds for % change in biological condition

Facilitator: As if I recall from the last meeting, you were close to agreement on the 5-10% threshold for change in biological condition, but there was concern about how to document or justify that. Jen Phelan sent out an outline and a draft section of the RTI report.

C: For the record, the original proposal and the supporting document from RTI suggested a 5-15% range.

C: That was discussed at the last meeting, which was addressed in a straw poll. The 5-15% range did

not get the level of consensus within the group- some felt 15% was too great a risk associated with that particular evaluation. We had better consensus around the 5-10%.

Q: Was there a discussion about where to use 5 and where to use 10?

C: I don't think we got that far. I think that is the gist of today's conversation.

C: Rivers and streams that have between 40 and 65% eco-deficit, we still wanted to retain 90% of the biological condition.

Q: That was the RTI [ad-hoc group's] recommendation?

C: Yes.

Q: Where streams were at the higher degradation level you still wanted to use no more than 10%?

C: yes

Facilitator: One concern was the ability to justify. How has the added information addressed this?

C: What do we mean when we say "raise a flag". We're talking about establishing thresholds that say to alert DWR that they need to take a quick look at what is going on. In some sense we're trying to set a conservative guideline for them to just take a look. These can be adjusted over time. I don't think we should get caught up too much in trying to say we have to be absolutely precise in what we are doing. We should probably agree that we need to start on the conservative end and then allowing experience to inform DWR in making adjustments as needed.

C: I agree. It seems to me that what we have can be divided into findings, recommendations, and suggestions. The difference between the two latter may end up being important after all. The finding is that any eco-deficit results in a biological diminution. We weren't able to find a lower threshold where some change did not produce a biological response. With radiation there is a lower threshold below which it is harmless, but not for smoking. It's the same with reducing flows; reducing flows reduces biological integrity. Acknowledging that condition will be reduced and people will use water, we came up with a strategy for measuring bio response vs. flows and suggesting that our recommendation should be that when DENR detects biological response to a proposed future scenario, DENR should evaluate further. The finding is that the line goes to the origin; there is no lower threshold below which the biology does not respond. The recommendation is that if there is a biological response, DENR should investigate. The suggestion is that DENR should have a stepwise strategy for deciding how much additional investigation they should do in what circumstances because we know that they are not going to be able to do field investigations for every possible future scenario. These break points of excellent, good, good-fair, and poor just constitute priorities for DENRs' action. Where you draw the line between excellent and good or good and fair; where you say 4% and 8% or 5% and 10% is much less important than that DENR get the message that there is no lower threshold and the more biological response you predict, the more imperative is the need for DENR to get out and do evaluation of the site with reference to the proposed scenario. I will say that I'm getting some feedback from the environmental community that they don't like 5% as the low threshold. They want it to be 1%, any biological change should warrant additional attention by DENR. I have pointed out that that is not feasible; there is a lower threshold below which the change is not measurable, and there is also a lower threshold, which we can't reasonable expect DENR to drop everything and get out in the field. There needs to be some sort of stepwise strategy for triggering further investigation.

C: The reason not to use 15%, we felt we were going into a policy arena when we went into working rivers concept and that was not where the Board should go. That was beyond the scope of what we're doing here. The working rivers concept may have merit but should be considered in a different group. Another thing that has been on my mind is how and when these are evaluated. If you evaluate eco-deficit at a node with withdrawal, but you don't take into account when and if the return comes in, you may not have as substantial an eco-deficit if the return follows shortly distance-wise within a given reach, and also if there is major tributary contribution between that and the next node. We need to think about where we'll recommend the eco-deficit be evaluated in this scheme. There are a lot of non-consumptive uses that will result in eco-deficit being perceived at a node if the future return is not taken into account.

C: Eco-deficit is where you measure it, so if you measure it between the withdrawal and the return you get a different answer than if you measure it after the return. DENR should evaluate future scenarios at an ecologically appropriate scale. Your question about policy is one I lost sleep over. Our charge is to tell DENR what they should do about evaluating loss of eco integrity, how to tell when it happens. If we confine our interest to any given specific place where a future scenario is being modeled, then the question about using working rivers or distributed impact strategy becomes irrelevant. If our question is how to maintain the ecological integrity of the state's aquatic systems writ large across the state, then the question of whether we recommend evaluation based on a working rivers concept versus a distributed impacts concept really matters. Maintaining ecological integrity can't be done using a distributed impact strategy. It drives all rivers towards mediocrity.

C: I think its well in the policy arena for decision-making. I haven't seen consensus for a hands off policy for headwaters streams. I have not seen consensus building around more restrictive recommendations.

C: We haven't asked those questions specifically.

C: But Kimberly's recommendations had a lot more restrictive approach, and we haven't seriously brought them forward. I wasn't anticipating thorough discussion about going with the working rivers approach, or try to recommend that rivers classified as excellent would automatically get additional evaluation or anything like that.

C: A couple things. We're away from Tom's original question and suggestion. It [what does it mean when we raise a flag] does play into where this discussion has gone, but it's important to frame this: 1) What is raising the flag? When? We have a feeling from Tom Fransen's presentation a couple of meetings ago, at least how he was thinking about it. That's still a gray area. 2) What does it mean when a flag is raised; what will DWR do? We just say further study; some people say site specific, some say going into the field? I don't think any of those are necessarily accurate. I don't think anybody really knows what is going to happen when the flag is raised. We need to address those points. We can recommend what we think should happen. To the latter discussion, I think the whole issue of working rivers or not, the way we dodged that question was by saying if we put a range on those numbers then people feel comfortable with it. We have not given direction as to 5% goes with this part of the curve and 10% goes with this or 15% goes with that. We ran out of time last time, and we left it hanging. My sense of what happened was that if we don't talk about it too much and the numbers look okay, people will vote for it, and we'll just close our eyes on what that really means. It is back before us. I think we need to go back to the questions Tom raised.

C: Our charge is to advise DENR when we think ecological integrity is violated, how to tell when that happens. Our charge is not to tell DENR what to do when they think it is. We've been using the euphemism of a flag goes up when there is a higher probability that ecological integrity is at risk in certain circumstances. I'd hope DENR would take these flags very seriously and would do what they can to offset those effects using whatever research, policy, advice and in some cases regulatory tools they have. I don't think that's our business. We should tell them when ecological integrity is at risk. We're using "flag goes up" because we're trying to avoid words like "allow, prevent" and leave it in DENR's hands to make decisions about what happens when ecological integrity appears to be at risk.

C: My perception is different. I think we're making progress on defining the range of what is acceptable, the limits of a threshold within which we are willing to make a recommendation that certain processes should go forward. Outside that range it gets beyond what we are comfortable with as far as our knowledge base. Either it has a higher level of reduction of ecological integrity, or we don't know. There's a subtle difference in how that affects our charge. If we're in agreement that within a certain boundary we think the degree of change is acceptable, or as long as we are working within that boundary, we think we are comfortable that DENR can go forward without exceptional actions. I agree that what they do outside of those boundaries is DENR's charge.

C: I agree. We are not in the business of telling DENR what to do when a flag goes up. I think we have a finding. I think our recommendation should be that DENR should respond to any detectable

diminution by some increased level of concern, and my suggestion is that we have some ranges for those actions (which were considered at last meeting with whatever we want to modify today). I just don't think we are in the business of telling DENR what to do when the flag goes up.

C: We can't tell them what to do; if we don't tell them what to do, it makes me wonder what pile of stuff are we giving them. You know, headwater streams do something else. That might affect where I think that threshold ought to be set. That's why I think we ought to have that discussion. Maybe DENR is not in a position to speak to that. If it means we can ignore it, that leads me to take one kind of action; if it means they are going to do x, y, and z, then I might be willing to adjust that pile of stuff.

C: Good point.

C: I've been operating on the assumption that when the flag goes up DENR gets worried, takes the situation more seriously, does more in-depth evaluation, and is more cautious with how it proceeds. Those are descriptors of policy. If we don't at least say that much, we're leaving the door open to misinterpretations of our intent.

Facilitator: It seems that we have several themes going on: Is it appropriate to define what actions should be taken or what further analysis means if there is a flag raised--whether you even go there? Issue of setting threshold- sounds like setting a range is appropriate? Where do you want to take this now? Chris's point was that to be able to discuss the threshold issue, you need to decide as a group to what extent you are going to address what DENR would do if a flag is raised, and how you would do that if you did.

C: it would be helpful to have an understanding of the scope of DWR's evaluation tool set. I'm aware of site specific evaluation when greater than 20% 7Q10 is surpassed. I'm aware of an OASIS modeling effort that can already tell them some things about the system, and we'd be adding a component into the evaluation through the OASIS model. What is the scope of what DWR has to further evaluate? Does it mean that we are really saying site-specific evaluation, or are there other options? If those are really the only two choices, then we need to understand that.

C: I think the other piece that occurs before a lot of that is talking to all water users in that catchment and say is this really what you think is going to happen; you all should be concerned, not just one applicant saying they want to withdraw here. Everybody in the basin recognize concerns and we all need to work together, are you really being realistic. You have those kinds of conversations; it is not necessarily all on the ? side. It is also on the planning side. There is a two-fold approach.

Q: And that does happen?

C: Yes, it does, with or without DWR. Jordan Lake, Catawba users, that is going on. They sort of themselves realized that we are getting to the critical mass of available water supply. There are two pieces to that.

C: To a certain extent that voluntary capacity use area on the Eno, those people came together to come up with a voluntary use of waters of the Eno.

C: Maybe the way to deal with this, looking at headwater recommendation, and we had already talked about having to rewrite it, that last phase , "DENR should identify the subset of headwater streams to receive alternative analysis", maybe we may need to say something more specific than "receive alternative analysis", maybe that DWR works with the water users in the basin, etc, so we understand what alternative analysis means.

Facilitator: Do others have thoughts about what should go into that; what do you mean by further analysis?

C: I don't agree. I think something like "alternative analysis" leaves it open. Hopefully DWR will do a great job of what everyone expects them to do, but if we put something more prescriptive we may be limiting what they can do, which may or may not be the most appropriate fool for a particular endeavor, watershed or whatever. I am concerned that if we get into that, we may get bogged down trying to figure that out. Conceptually it sounds good, but I think it is risky to go back and try to be too prescriptive.

C: I agree. If this conversation had happened a year ago, we could have pursued it, but we're up against a deadline. We need to move on the things we can move on; I don't think anything DWR would say would change how I would address the 5-10% or 10-20%, the issues that are really foremost for us

C: I also agree that providing a list of what alternative analysis might be could be problematic. I do think that creating a phrase that puts intended outcome for the alternative analysis in this paragraph would be useful. Even something as general and broad-brushed as "alternative analysis to further evaluate ecological impact" even, so we're clear that the reason for the alternative analysis is because we have insufficient data to utilize the statewide approach, and that the outcome we intend for the alternative analysis is to generate that data and have sufficient information for DWR to do whatever it is that it is going to do. If we can add an outcome criteria to that I think that would be useful and doesn't get into the suite of tools that DWR may or may not use.

C: I agree with almost all of that. The one phrase about not using the statewide approach, that's the case in headwater streams. In all other cases we're asking for further evaluation because we have determined that the risk of biological degradation is high.

C: Amy very eloquently stated what I was thinking. Put something in there about the effects of the proposed withdrawal. It may be something like "evaluating alternative withdrawal strategies"

C: I'm not sure we're evaluating individual withdrawals.

C: We're not...

C: That would be permitting.

C: They run the basin wide models every couple of years.

C: We're saying this watershed has problems.

C: So that part about whether you are going to do alternative evaluation of the effects of a proposed withdrawal..

C: Projected withdrawals, not proposed.

C: I like the way Amy phrased it. It encompasses what others have said. Add a modifier at the end that directs what they will be looking towards. That would work.

Facilitator: Some of you are working towards a proposal for using alternative analysis and including a statement about intended outcome.

C: To reduce ecological impact.

C: or to evaluate it.

C: this would be applied to both the headwater recommendation and the eco-deficit tool evaluation?

C: Remember the reason DENR is charged with caring about ecological integrity is because it is one of the things for which they are charged with knowing how much water is required--the big question in the act. Further evaluation should be towards answering that question- how much water does the ecosystem in this particular river require?

C: we've had a lot of terms tossed about. What we're talking about includes an initial analysis. Should we say "additional" or "further" analysis, not "alternative".

C: This discussion talked about headwater streams; there are no red flags in the headwater streams since the model doesn't apply.

Q: OASIS has some capability of generating flows at nodes that are not in immediate vicinity of a gage, right? There is capacity for that in the model; there are not necessarily a lot of gages for them to calibrate it against, but they do generate flows.

C: I spoke wrong when I said the model doesn't do that. I meant our recommendation for headwater streams is that the statewide recommendation doesn't apply.

C: I wonder if we should evaluate that more closely. It could be that a 80% flow-by in a given headwater would work and not necessarily impact the ecological integrity. It would need to be evaluated. We feel relatively confident that for streams with drainage areas greater than 10square km, then 80% flow-by will protect ecological integrity over time. We are not as certain about that in headwater streams and, therefore, we need to more closely evaluate whether the 80% flow-by would be sufficient to protect ecological integrity or not.

C: That's why the last sentence was written in that way.

Facilitator: So is it essentially that headwater streams are innately a red flag?

C: Yes. First test of potential withdrawal: is drainage $<$ or $=$ 10 square km? If yes, it automatically moves into this question of whether 80% and eco-deficit evaluation is adequate; then with anything greater than 10 square km, then is it throwing flags there; then you throw the eco-deficit tool in, is it throwing a flag there?

Facilitator: So we have a proposal, essentially, although it is not written out yet. Are people comfortable with the idea of yes, set thresholds for headwaters and thresholds for the % change in biological condition (and come back to actual numbers), then the idea of having a statement like what Amy suggested, where you decide on the term (additional analysis, further analysis, or whatever) and add a statement of the intended outcome of that RATHER than defining site specific or exactly what steps DENR would take. Anyone NOT like that idea? If you like the idea, maybe Amy and a small group could draft that concept. Then we could move on as a group to decide what threshold you want the change in biological condition to be, for example. Anyone object to that approach?

C: To wordsmith, take last statement from headwater streams...Do we want it to be "to evaluate eco flow requirements", or "to protect eco integrity"? What is our modifier?

C: We need to evaluate whether or not the statewide approach would adequately protect ecological integrity of those streams. To me its about sensitivity and vulnerability.

C: Right. I'm trying to put something in that provides direction without begin prescriptive.

C: We don't need to measure for headwaters streams against the statewide approach. It could end up being that the statewide approach we decide on could work. or another technique entirely could be used. We shouldn't exclude the statewide approach.

C: We're saying don't automatically apply the statewide approach.

C: Lets postpone this- you draft this at lunch (Amy, with Jeff), then bring back for review?

Facilitator: Looking at our list, there are a couple of things that sort of relate to that- the question of what level of ecological integrity are the recommendations protecting is relevant to that. Do we want to discuss that before we get back into numbers?

C: That's a Pandora's box. Is there something easier to nail down before lunch?

Facilitator: Okay, then let's go back to the thresholds then. Where we left things the last time was with using 5-10%, but without full consensus.

Q: Question of clarification for Tom--if at least half the biological condition is based on micro-invertebrate species richness, and species richness is about 20 different species in an area, then a 5% change would be a loss of 1 species, and a 10% loss would be a loss of two species. Is that the way to interpret it?

C: For a good site it's probably twice that.

C: Okay, so a loss of 2 species or 4 species?

C: Yes.

C: When talking about richness but not diversity.

Q: What does 5% loss of Shannon-Wiener Index mean?

C: The thing to keep in mind is that you could have the same EPT taxa richness and not have any of the same taxa. So you could have a total community change and not detect it with this metric.

C: Do we make the assumption that species you lose are more vulnerable to hydrologic alteration?

R: Right. That's why EPT was chosen.

C: One species being lost is a big deal! But...

R: To get to that level you'd have to identify the species that was lost.

C: This fits the idea that Sam said earlier that we don't find a threshold. The 5-10% says there is a change in the species richness. If there is not a threshold then that change is a significant loss.

C: All measureable loss is significant.

Facilitator: There have been some positive comments about the 5-10% range.

Q: Are we moving forward with a range or a specific threshold. I'm still comfortable with a range of 5-10% going into the recommendation. I don't need to debate the guts to go forward with that range.

Q: Do we want to get rid of the word threshold in there? Otherwise, we keep saying that's when the flag goes up.

C: So we could say something like "DENR should consider an allowable range of 5-10%"?

C: I don't want to confuse the 2 uses of the word threshold. They mean two different things, the way we are talking about using the 5-10% and what Sam's point has been. I don't want misinterpretation.

C: Use criterion? [Head nods]

Q: Did we have 5% assigned to most excellent stream classes and 5-10% assigned everywhere else, or is it a 5-10% range to be applied everywhere?

C: I thought that was a decision point for DENR and a future policy board to make the specific criterion 5% or 10% or 8%, or 7.5%.

C: So we're not going with the suggestion from the RTI/USGS work to have the highest quality streams triggered at 5% and the rest at some other number, like 10%?

C: I think it was whether we were comfortable making decisions based on evaluated quality of streams.

C: That was the baseline condition of the eco-deficit, the prevailing condition.

C: Right. So whether there should be greater protection on an excellent stream, my impression was that that would be a policy board type of decision. It's a good question but we may not be the ones to make that decision.

C: We're basically providing a bracketed recommendation that any change of 5-10% or more should trigger additional, or more than 5% or greater than 10%? How are we phrasing it?

C: I thought we were giving it to DENR and the policy Board that does not yet exist to make the call for a single criterion, and we are recommending that that single criterion fall between somewhere between 5 and 10%. It might be based on quality of streams, trout, classification, social evaluation. There are many scenarios for setting that policy.

C: OK

C: My reservation is the worst case scenario where the most pristine stream is evaluated in the context of some future scenario, and DENR decides for some reason that a 9% impact is not of concern.

C: You are talking about ecological integrity vs hydrologic [?--recording inaudible].

C: If we don't have environmental flow categories, and we are just going to have headwater streams, lower coastal plain streams, and everything else, and we are going to write a statewide strategy for everything else, and we tell DENR that if biological degradation is 5-10 % that you should look harder, then I am worried that 10% is a very high number for just looking. Some of the streams in this large category of everything but headwaters and outer coastal, there are some pristine streams where a diminution of biological condition of a few percent ought to raise some flags. I can live with 5-10 but not good with applying it universally. I think that there is a group of streams that should be looked at more aggressively. That was the working group's concept.

C: That is a battle that you could hopefully fight on this other Board.

C: To muddy the waters, the other side of that argument is that for streams with lesser conditions you can't withdraw any water because 10% of a small number is less than 1 so you can't have any change. So if you apply the same percentage everywhere, that is the situation you end up with.

C: So in a degraded system the flags will go up because there's not a lot of play, not enough species.

C: On a good stream you could have 60 taxa and lose 6 taxa. On a degraded stream you might only have one or even if it has 10, which would be a moderate one, you could only lose 1. There's a pretty good chance that under this criteria you would trigger a flag every time.

C: We aren't even evaluating the number of taxa in a given stream. What we are doing is try to evaluate the hydrologic change and then make an educated guess based on the hydrologic change that this most likely will rate as degraded stream, and therefore we will apply this criterion.

C: No. -If you apply what we've done with eco-deficit, you'd get an estimate of taxa richness under the scenario.

C: But also under the existing scenario, it is a hydrologic evaluation.

C: It is a link between hydrologic and the ecology.

C: Right, but even with degradation you might still get high richness because there might be 67 animals that have a really high tolerance for hydrologic alteration. It's unlikely, but it could be.

C: It would certainly not be consistent with the data we have.

C: It's important to understand that eco-deficit was the flow variable most correlated with biological response, that we used biological data. Predicted biological diminution as response to increased eco-deficit is not guesswork; its based on some pretty intensive and expert statistical relation building. EPT benthos and riffle run guild of fish were selected because they are the best indicators, most responsive to flow changes, and they are ubiquitous.

Facilitator: So we have the 5-10% range; do you want to use the range? If or how to describe how DENR should work with this range? There has been discussion about whether that is policy or not. I'm wondering if one way to get at that is the "suggestion" idea. Are there some conceptual ideas here to capture, but not to the extent of entering into the policy realm? It seems there are concepts that are important to convey. Do they need to go into the recommendation?

C: I'd give a 1 or 2 to the 5-10% range, and a 2 or 3, leaning toward 3, to the decision not to categorize streams according to condition.

Q: In our minutes, there was an item that RTI will provide an outline including justification of the thresholds. I got here a little late; have we discussed that?

Facilitator: Yes, those were sent out, but we have not discussed that. That's where we left off last time, and I mentioned to start this conversation, should we discuss that?

Q: Shouldn't we go through this first?

C: It's 7 pages. We've been discussing the two principle components of that. Their recommendation is there, encompassed on table 1 page 2. I think there is emerging consensus to do away with first column, then to limit the second column to 5-10%, and that that 5-10% applies to all rivers and streams, other than headwaters and outer coastal plain. Jennifer, is there anything we ought to be discussing that we ought to be.

R: No, you are capturing it. We're providing it to you for support. We could include specific, very detailed information in our report if you have suggestions for us. We did include a detailed description of how we came up with the 5, 10, and 15% changes and where they were founded. That might worth discussing where those came from.

C: I'm just wondering if the discussion of the RTI summary was on our agenda, and if we should discuss it before moving forward.

C: The way I approached that, once I received the document, I reviewed it, and it explained what I needed explained. I assumed we could jump into whether we are building consensus around these specific numbers or not. But if you have specific questions...

C: I don't, except to insure that if we are accepting of a range or some recommendation that is different from what is in here, we need to make sure we can justify that. Why are we picking something that may or may not be there. I just wanted to make sure we can do that. C: The 15%, if I am not mistaken, would apply to an already impaired system. Is there room for a 15% loss? That was my problem, to me it exceeds a tolerable risk for any system.

C: That depends on where you are in the condition.

Facilitator: Does the report that RTI provided give basis for the 5-10% range, and what you may be asking, Jeff, is if what is being proposed by Board is not exactly what is proposed by RTI, why would you deviate?

C: Correct.

Facilitator: So the first question: Does the report give justification for 5-10%? Given that we do now have the report, let's revisit the 5-10%. Are people comfortable using the 5-10% in the statement in the recommendation: **5-10% change in biological condition is suggested as a criterion for further review by DENR [to replace the section in red in the recommendations as of 8/21/13]?**

4 ones

9 twos

C: The deviation seems to be that in their report they took the working rivers strategy, which is where the 15% may have come from. As a Board we're saying we don't entirely agree with that. Is that what we are saying?

C: We are saying that there is a trigger and it is somewhere between 5 and 10%, regardless of the stream's present condition.

Q: Can the eco-deficit tool be used in headwater streams?

R: Yes.

Q: So once a stream is in the pile of headwater streams, would we not want to use the eco-deficit tool?

C: I wasn't here when you decided not to use the eco-deficit tool in headwater streams.

C: That was not decided. The 80% was our question.

C: Right.

C: Good. So we use the eco-deficit tool in headwater streams.

C: I want to be sure that everybody knows that the eco-deficit tool would potentially be part of the evaluation of the headwater streams.

C: I don't think anything we have said prevents them from doing that.

C: Part of the recommendation in the coastal plain was that there is potentially a subset of those that use the eco-deficit tool.

C: I think a critical piece for headwaters is that the water removal could be very different than in these other situations so that even if you had the same eco-deficit, maybe they took a tanker and pulled out water for 12 hours. In a bigger stream that would not make such a difference. Important thing for headwaters is that they have a different sensitivity to the way water is removed. That's one of many reasons for special consideration.

C: As clarification, in the coastal plain...

C: The decision is a matter of stream gradient and influence of tides.

Facilitator: So we have several different themes going again. So the eco-deficit tool could be considered one of the additional analyses to use in headwaters?

C: What we are trying to do is say that the eco-deficit tool is not only for the statewide recommendation.

C: Whoever is writing that over lunch can work on that.

Facilitator: In the flow recommendation and the headwaters or general statement on both?

C: I think we don't put anything in there that precludes that from being used as an evaluation tool, I don't necessarily think that is the one and only evaluation tool we would recommend. I think the main thing is to avoid anything to suggest that we don't want them to try that as a tool.

Facilitator: We still have the remaining question of using the RTI work as justification for the 5-10% while deviating from the rest of their recommendations, which would be addressed through statements in the report?

C: That's the only option we have.

Facilitator: Are there comments on why that is? Is the group in agreement as to why that is and we ask that somebody write that up, or is there more we need to decide as a group to be able to do that because it sounds like you are not going with the working rivers idea.

C: Here's my thought on it. Fifteen percent is too much; somewhere between 5 and 10% is okay; it came from RTI; the 15% question is too great a risk from Heritage's standpoint. So what else do we need to say about that? It may be that the working rivers concept comes back through DENR's decision process.

Facilitator: I'm just trying to find out, before someone rewrites this, if there is additional information people feel strongly about having included, or if there is another decision to make around this right now. Seems like answer is no additional decision making.

The group then had lunch.

VII. Discussion: Context regarding the % flow-by range

The facilitator pointed out that in August, EFSAB members identified the need to address when to use the higher or lower end of the 80-90% flow-by range in their state recommendation. As this has not yet been added to the report, this topic was added to the agenda for discussion. Is this something to be included in the report somehow? Thoughts from the group on how to address this? The purpose of bringing up this topic is not to ask you to rehash the numbers, but to respond to the interest for further explanation of the range.

Comments/discussion

- Board thought we should let DWR decide what to use in that range; we felt 80-90% bracketed work by DWR, others
- Why wouldn't a single value be best? PHABSIM showed that 80% works fairly well.
- It gets harder to get agreement on a specific number.
- If looking at PHABSIM for basis, it is done using unregulated (unaltered) flows; the modeling uses prevailing flow (SIMBASE) that is already altered so in places so using 80% could end up with more degradation. Thus, a range is more appropriate to allow DENR to hone in on a number.
- Leaving the range is fine for reasons mentioned, another line of evidence is what is in literature which refers to numbers in this range; in report we should write out the explanation for why choosing those numbers. There's no explanation in there yet.
- If we go with a range, it's the same as subdividing streams in some way.
- We should say that we couldn't agree on a specific number, and state that in report and leave range and explain where range comes from. The recommendation is not to use different numbers in different streams.
- I feel more comfortable with range because is no obvious threshold that can be associated with biological degradation.
- It's like the 5-10% that we discussed before lunch. Since we aren't classifying streams based on condition, then not comfortable as group with specific number; should give similar reasoning for using ranges for both (ambiguity, differences).
- Did we dismiss the idea of classifying streams based on condition?
- We have been discussing whether or not to offer different responses based on condition and I thought we decided not to because it would be suggesting policy.
- There is some merit for using exc/good/fair. Let's put it in our suggestions pile.
- We can acknowledge that stream conditions should be characterized by condition, as it could provide context, but we don't have time to reach agreement on which ones need more or less protection. We may have different perspectives on this.
- Makes it seem more arbitrary to say that we need to have grades of protection without applying it.
- That criteria is already out there. Doing away with the classes and using one number, 10% (for biological threshold) says giving less protection to more pristine streams. The stepwise approach was to provide more protection to pristine streams, doing away with it does the opposite.
- Over time all the streams will go toward middle.
- So we are making a policy decision whether we want to or not.

- By not saying how the proposed system accumulates over all the streams in North Carolina. That is a policy recommendation.
- We don't need to solve it, we need to state it in the document- here are the consequences.
- So we need to spell out the consequences.

Facilitator: that still needs to be written. Is there any other direction a writing team will need to write this?

- Discuss the implications of using the lower or higher percentage of flowby.
- Two issues to address:
 - 1) Context for why a range for flow-by (or bio response)
 - a. (such as the numbers in the range are found in the literature,
 - b. PHABSIM results,
 - c. lack of consensus on a single value) and
 - 2) implications for how that range plays out.
- The statement made captured well: the level of change in biological integrity is a continuum; there is no clear threshold above which is large impact, below which is low impact. So we used a range.
- RTI report is going to be an appendix and explains how arrived at range.

Action item: Write a section to include in the report accompanying the statewide flow-by recommendation. This should include:

- **Context for why a range for flow-by (or bio response)**
 - (such as the numbers in the range are found in the literature,
 - PHABSIM results,
 - lack of consensus on a single value) and
- **Implications for how that range plays out.**

This action was provided to a small group to write first thing Wednesday morning. This was incorporated into language provided for the flow-by recommendation and supporting explanation.

VIII. Discussion: Including a critical low-flow component as part of flow-by recommendation

The issue of including a critical low-flow component in the flow-by recommendation was raised since it had been included in the last draft of the report but had not been agreed upon by the group yet. The following points were discussed.

- This was thrown out by one of the report writers as a strawman proposal since it came up but we had not discussed it.
- Didn't the idea come from Tom F's presentation?
- It came from the Alberta approach. Tom showed that if it's not included, it presents more problems for some water uses.
- He pointed out if there is a flat line at some basement level, then you can't investigate consequences of really low flows.
- Tom didn't like idea of turning off spigot at some point- cutting off users in drought flows.

- But it is not a basement; it is just another way flag is raised; a visual cue to aid planning so it won't go below.
- We are already saying we don't want to plan to go below 80%. Why do you need another tool for raising a flag?
- It's a question of can you meet all needs, essential, ecological. It's also a timing thing- are you extending this critical low flow.
- It really comes down to frequency and duration of that flat line.
- Most critical question is whether DWR is already accounting for that. If something supersedes or addresses the need to have this, we don't need to.
- Drought plans are incorporated into the OASIS model. The actions that are imposed when they get to certain levels are incorporated.
- What levels trigger drought plans?
- They are set by the water user in discussion with DENR. It could vary. Storage, elevation, depending on where they get water from.
- Would this be captured in the biological response model, would we see a drastic response in biological condition?
- I don't know, we haven't simulated it. If there was a short period of time with drought conditions, then came back up, eco-deficit might not show it. This is trying to get at the fact that you don't want to extend the period of time in a drought- when we hit this level we need to think carefully about what we're doing. Eco-deficit is an average number.
- I don't doubt those times exist, but are we prepared to say what those low flows are and what is meant by a severe drought.
- RTI report suggested 6 variables including 4 seasonal ecodeficits, annual ecodeficits, and 30-day low-flow. You look at biological response to that.
- Discussion occurred regarding what the 30-day low flow was- several members suggested that it is the lowest 30-day running average in the period of record.
- How about use same approach as used for quality issue (exc, good fair): *increased frequency and duration of drought is a concern. Due to lack of time, EFSAB couldn't determine an approach. DENR should address this issue.*
- Low-flow events are the most critical for determining biological condition- it's important to incorporate it.
- Alberta uses 20th percentile (adjusted monthly) as critical low flow.
- That's regardless of duration, it's instantaneous flow?
- In the model, each month would have low-flow criterion put into the model in addition to % flow-by.
- What do we have to back up the comment that low-flow events are the most critical for determining biological condition?
- Literature says it.
- We could say in report "Alberta, CA uses 20th percentile flow. DENR could use this as a starting point".
- I'm not comfortable with going with that because the issues are different due to freeze/thaw cycles. What else do we have rather than going with one study and one number? I don't disagree with it but don't want to go with one number without evaluating other examples.
- Literature is replete with examples.
- We could say that Alberta uses 20% as an example, and DWR should investigate the literature and refine that.
- It is not a turn off the taps recommendation. It's saying you need to look at this. Not only are low flows a problem for ecology but also potentially for some types of water uses. Extended periods of low flows are a problem for people with unpermitted straws in a stream.
- Does MI have something? No

Facilitator: Should the language go in the supporting documentation or in the recommendation?

- Currently report does say flow-by plus a critical low flow. We just need to add a short paragraph in that part of the recommendation.

Action item: In the report, explain EFSAB's concern about very low flows; Alberta uses 20th percentile adjusted monthly; more in the literature; DENR should investigate the literature and refine the numerical value.

(add to paragraph 167-173)

This action was provided to a small group to write first thing Wednesday morning. This was incorporated into language provided for the flow-by recommendation.

IX. Discussion: What to use as prevailing condition

The facilitator initiated the discussion by reminding the Board that at the end of the August meeting another potential recommendation had been identified: Use SIMBASE for a particular year (perhaps SIMBASE 2013) as the prevailing condition to be carried forward for comparison. It had also been mentioned at the August meeting that SIMBASE 2013 might not yet be available. Comments and questions included:

- Each model has a SIMBASE?
- I think this is a non-issue.
- Nooo.
- This is why I think it is a non-issue. When calculating Ecodeficit it's based on a strategy spelled out in the RTI/USGS paper. It's the difference between current conditions and what would happen under a PNV condition. In eco-deficit strategy, current conditions constitute the current calculation of eco-deficit using that strategy. When doing the instantaneous 80-90% flow-by, current conditions are what? Instantaneous flow-by, right? DENR will continuously update OASIS. SIMBASE is nothing more than a framework for running the OASIS model according to current conditions. OASIS is periodically updated with new data as USGS processes those data and make them available. OASIS typically runs 16-18 months behind since it takes USGS, actually it is the Corps of Engineers, that long to process data from USGS. DWR runs whatever model they've got. For eco-deficit it's calculated present condition versus what it would have been with PNV. For 80-90%, it is the flow-by.
- So what if they don't take the recommendation to use the RTI approach, and they just want to say, we'll run 80% flow-by. I took a crack at this to try to explain this in a 2-page explanation. In that I wrote, "To the extent possible, flow regimes representing natural conditions (flow regimes without withdrawals or returns), baseline conditions (flow regimes incorporating current withdrawals and returns), and projected conditions (flow regimes incorporating current and future withdrawals and returns) should be estimated by basin wide hydrologic models. Baseline conditions will be compared with natural and future conditions to assess how much hydrology has been altered and to determine the effects of future withdrawals and returns. DENR should use this information to identify areas that have undergone substantial hydrologic change and that warrant additional attention when considering further water withdrawals. As the hydrologic models are updated with new withdrawals and returns, baseline (i.e., 2013) conditions should continue to be used as a benchmark to avoid comparisons to a continually shifting "current" condition."
- And presumably declining.

- As you keep updating the model with more withdrawals and more alterations and that is your new baseline, then you can take 20% more of that, or 10% more biological alteration to that, then you end up driving everything to mediocrity.
- I agree, but law says current prevailing condition.
- It says a loss of biological condition on this date. Chris says don't move the goal post. You're going to keep updating the model. We're just saying that when you make comparisons, don't keep changing...
- The degree of change with projected withdrawals in 2025 or 2050 or whatever is going to be contrasted to a SIMBASE condition on a particular date. You could argue it could be the date the law was enacted, not now we are going to contrast 2025 to 2015, thereby showing that there is not much change and think it is okay to add more withdrawals.
- But for calculating Ecodeficit you want to track changes.
- Yes, that's why you have all three of those points in there. You can continue to track all of those, but don't lose what I called the baseline condition. You have unaltered, baseline, and projected.
- So SIMBASE is just a way to run the model. If you run the model on the one-year that the law passed it will be a very different answer.
- SIMABASE is the withdrawals and returns at a given time plugged into the model through any period of record you want to use.
- So what you are suggesting is that the prevailing current conditions are the management regimes in place on the day the law passed.
- We probably shouldn't use the word SIMBASE in this conversation because that suggests one way to run the model.
- I didn't. That's why I used baseline.
- Let's talk about the baseline management regime on the day the law passed. That is a very sensible thing to include in the conversation.
- So you agree with the concept but we need to use a different term?
- Now that I understand the concept, yes.
- What happens when there is a new license issued? Do you change the baseline at that point or not?
- As I understand it, we're referring back to the management regime as it existed on the day the law passed.
- That would be incorporated into the future projection. So you have your baseline management regime. Then just one component of the future condition would be that particular license.
- I'm a little troubled still. This prevailing conditions terminology only shows up in the definition of ecological integrity, serving as a non-degradation component to that definition. What was originally proposed in that language was natural condition. What happens if things get better? How do we handle that?
- If it gets better, the deficit should decline. If that becomes less, you wouldn't say don't do that project; it's getting better. The flag would not be raised then because your eco-deficit is going to be reduced.
- If 2010 was the baseline management condition, and something happens to improve like a textile mill goes out of business and all of a sudden there is a smaller withdrawal upstream. And therefore eco-deficit is reduced. Then say you have a new project projected to happen in your future water use, if you are trying to compare that projection to 2011 the incremental change will not be as big as the incremental change with the new and improved situation. You may be underestimating the increment of change if you see improvements but some projected increase in withdrawal.
- All improvements are vulnerable.
- Wouldn't the improvements be included in the future evaluation, so there would be a net reduction because it is collective? Granted, you had improvements, so it doesn't throw a flag,

then you add a new proposed withdrawal, you will still have that wiggle room because it's combined. You are not evaluating an individual withdrawal. It's always evaluating that collective quantity of withdrawal.

- But your baseline, if you keep it fixed, never improves.
- But the cost at any individual time you are evaluating is going to be balanced.
- Stated simply, Chris was concerned that the baseline not deteriorate over time, that we have a baseline that corresponds with the day the law was passed, and that's the baseline they continually refer back to, not some future deteriorated condition. My point is that it can go the other way. If things get better, you are still going to be referring back to that same 2010 baseline if you freeze the baseline at 2010.
- So which is the more...
- It's not a true baseline because they would do unregulated also. You would have unaltered, your baseline and the future, so when you look at all three of those collectively, you will see the relationship between the improvement over prevailing and any costs of the future withdrawal. I also don't think it is likely that things are going to significantly improve.
- Even if it does, the implications of not having this language in here, is that you're not protecting ecological integrity. In most cases you'll let it continually decline. Some streams may get better, but which is the bigger risk? It seems like you'd want to prevent the continual drive down into the dirt.
- I'm okay with the idea that we should describe current condition as the current management regime, or the 2010 management regime. It does not constitute the baseline against which eco-deficit is calculated, nor does it constitute the baseline from which instantaneous flow is derived. I'm trying to understand what DENR would do with it.
- When they run a future projection right now, it doesn't do anything about unaltered condition. They use current condition and future condition. We're already recommending that they look back at unaltered as another point of reference to see how much things have already changed. What they do with it or don't do with it is up to them. We're suggesting that in 20 years from now and they do this again on a particular river basin, keeping that original point of reference is important. If you don't, and you use 2030 as your starting point and you've lost that previous point, that is not what you want to be doing.
- Eco-deficit will look pretty small if you shift from this time forward.
- You just don't want a shifting management regime, basically.
- You are just referring back to that point. It's not like you are precluding any future management decisions.
- So as I understand it, we are recommending that DENR consider the management regime modeled by OASIS in 2010 as the current/prevaling condition. They need that information for reference purposes, although we do not incorporate it in either of our two strategies for managing future scenarios.
- Point of clarification for Fred- if you were to evaluate the 80-90 % flow-by, wouldn't you model that based on a prediction. In your evaluation of a proposal, you would be modeling it based on a predicted curve, so to some extent that is a moving baseline. It's just a long-term average.
- You mean the 50-year projection?
- Yes.
- Yes, it's based on all those projected future projected uses and needs in the future, and it's a little fuzzy.
- Do we need a prevailing condition for those projections, too?
- When evaluating a flow-by strategy, you build that management into the model, and you run it on the period of record, whatever is available, and you compare that with the current management regime run on the period of record.
- I'm not talking about a specific one. If they are looking at their 50 year projections, and they are running the models not based on one specific point on a stream, but looking at a variety of

basins, they are going to base that on a period of record and based on some reference point in time at the starting point and a 50-year projection. Would it make sense to also put some reference point into that model as well, to correspond to what you are suggesting

- They run it 3 times- 2010. Current, projected.
- Is that what they do? I don't think so.
- Now they run it twice- current and projected.
- So you are suggesting that for e-flow comparison you would run two separate conditions--one for current and one for projected?
- I'm asking Fred. What we are proposing is that we define a baseline. Then DWR is evaluating their projections for you based on a 30 or 50 year projection, and that baseline is based on period of record through the current time; it doesn't stop at 2010. We are suggesting that for a baseline we want the model to be based on 2010 as a predictor, so we have something to measure against. So if those 30 and 50-year plans are going to be meaningful in the context of what we are suggesting, should they also be run against the 2010?
- I'm certainly not objecting to it, but at some point they stop being 30 and 50 year models and become 40 or 60 year models, or whatever number.
- Documenting the condition in 2010 is easy, and there is no harm in it. Is our tendency that we'll tell DENR to calculate it and figure out what they want to do with it?
- Facilitator: I don't have in front of me what you wrote, Chis. It sounds like you gave context for this point. [The Board had been sent Chris's language and could look at it.] It is a whole section in the report, and we might want to look at it as part of the report review, but it sounds like the decision to be made is do we want to define the baseline condition?
- I used the terms natural, baseline, and projected.
- By natural you mean unregulated?
- Unregulated, whatever that is.
- And future is whatever you are trying to understand.
- Projected.
- Facilitator: So the question is do you want to define the baseline?
- The way I defined it was the flow regimes incorporating current withdrawals and returns. Sam's suggestion is that we put more specificity to that...2010, or...if you don't do an OASIS model until 2016, the first time it is up and running, is that the baseline condition? In other words, in my mind, the first time you use it is the baseline condition. If you don't create the model for another 5 years, that's the initial baseline.
- That is when the SIMBASE line in the sand starts; the old modeling it was 2003, when the model is completed and approved.
- So you are saying that SIMBASE isn't a moving target? It really is sticking with 2003?
- My understanding is that SIMBASE is set whenever a model is completed and approved.
- No, I think you are wanting to use most current available information submitted by the water systems in OASIS. You want it to be current and up to date as much as possible.
- I assume you can go back and enter all the old information that was entered from previous water supply plans to get an idea of what the past conditions were if you wanted to. I don't know if DWR would do that; I'm not sure what that would provide for our planning purposes.
- You understand what we are getting at, right? If the original Cape Fear model was 2003, then you have a new SIMBASE of 2013, and it has a lot of added impacts to it, then you run it again in 2023 and that's your new point of comparison, your understanding of the impacts of projections are continually moving along with you. We can work on the language of what I called "baseline conditions", but somehow we don't want to lose that touch point.
- Then let's run with the management regime as modeled in OASIS in 2010. The problem is that ½ of the basins in NC were not modeled then.

- You address that by, in theory, when you plug in that withdrawal, you are deriving those numbers from 2010 data submissions, water plans that were viable in 2010, not water plans that were constructed after that date.
- I agree with having a fixed baseline against which to measure. It could be defined with three baselines. Does that affect the RTI baselines? Are they using the same definitions in calculating impact in the RTI information?
- Their strategy starts with unregulated river flowing through a landscape with potential natural vegetation growing on it.
- That would be natural.
- That would be the first starting point. Those would be the same. I'm suggesting that the language could be unified in our report so it fits both, or is there a difference in the way it was applied?
- The RTI strategy goes from that to another baseline, which is the current eco-deficit, and you take the current eco-deficit and compare a future eco-deficit to decide how you feel about your scenario.
- Current eco-deficit is NOW? Is it based on 2013 number, 2010?
- It's based on the period of record with average values.
- Will that be a moving target if calculated in 5 years, or does that need to have a baseline too?
- Good question; I don't think we addressed it. The RTI report deals with a baseline established in 2012 (I think), and the assumption is that we would continuously know current eco-deficit is by continuously recalculating it, which requires using WaterFALL which means continuously spending money, and I don't think that is going to happen. I'm now realizing for the first time that the RTI report creates an eco-deficit baseline of 2012 that likely won't be updated for a long time.
- That's okay. I just think we need to define that, at least in the report.
- **I'll ensure the RTI report addresses that question and documents the date of the eco-deficit calculation. (SAM)- ACTION ITEM**
- It may be useful in the future because it is in itself is a baseline.
- Yes, it is.

Decision: I move we define baseline as the management regime, whether it was modeled or not, extant in 2010 at the time the legislation passed.

**Consensus poll:
14 ones.**

X. Discussion: Conditions that raise a flag

The facilitator introduced the topic, and the following comments/questions were made:

- While this is important for protecting ambient, instantaneous flow, and it is important for the critical low-flow events, it is not a critical question for calculation of eco-deficits. Because eco-deficits are an average, as the period of record gets longer, you're calculating it over a larger and larger period. Eco-deficit is a measure of how far you wander from the mean.
- Facilitator: That's part of why I asked the question I did, because does the critical low flow and having eco-deficit satisfactorily address that?
- I don't think we have. I don't think the critical low flow piece addresses this. If DENR takes it up, it will be related to this; it will be another flag event, but we haven't come to a conclusion of what a flag raising means in the 80-90% flow-by piece. I think it is really relevant to DWR.

- Tom [Fransen] addressed that with the green, yellow, and red flags. He incorporated Index B. His green flag was if it was between 10 and 90%, and there were no violations on a daily time step. Yellow was if you violated the daily time step once. Red was violating the daily time step plus the Index B thresholds. That's just something he was looking at, but it is one kind of approach.
- Is there anything from the life histories or biology of the insects or fish about how long it could go below 80%? Can biology tell us anything?
- Some of the biological changes would occur within minutes; some will get up and move in minutes if flow falls outside of their range. Others will stay there until they die. You have to approach it on a species by species basis.
- Will they come back when the water comes back?
- No, they do a really lousy job of going up stream.
- We're talking about the 80% flow-by. Presumably it's a protective level of water. Is the deviation from 80% the question? 60 vs 70
- If the goal is to maintain 90% of the ambient flow-by, instantaneous flow, and we set it as a management standard for whoever puts a pipe in river, why wouldn't we also say that deviation from that must also mimic natural conditions? Say you can't go below that 80 or 90% more frequently than the record says you would go below the 80 or 90%.
- Looking for the average?
- You're skimming 10-20% of hydrograph, so you want to maintain the shape of the hydrograph. Are we also saying you can deviate from that periodically?
- Then it becomes how much can you deviate? It's the same question, just re-worded. How often and how long can you either have a drop in flow below the limit, or how much variation can you withstand?
- What this really boils down to is that you can take 10%, but sometimes you can take 15, and sometimes you can take 5, OR are we saying that you can take 10?
- So I don't understand. What Tom showed us was that if you plug in the 80%, for whatever reasons, there are times when you can't meet that expectation. The pipe is withdrawing the 10 or 20%, and yet the hydrograph is showing a dip below that.
- How does he model that? Is he basing that on the previous week's average or the previous two days average?
- Pipes take out a known quantity, and we are talking about percentages. So when the flow is low, that quantity then becomes a larger percentage of the flow. Isn't that where you run into the less than 10 or 20%?
- Yes.
- The model does not change what people take out. It evaluates whether with whatever the withdrawals and returns are, did it force the hydrograph to go more than 10 or 20% below the "unaltered" condition. I am looking at his presentation from July. If the period of record has no days with flows less than 80%, then it is green. If at least one day has an occurrence of below 80% and no times in the Index B (model run with top and bottom 10% extremes chopped off) analysis, then it is yellow. A red flag goes up if there is both one day below 80% and one in index B (with top and bottom extremes chopped off).
- We are basically debating permit condition.
- [Several no's at once].
- We're just saying, does the flag go up when one time in the entire period of record drops below, or does it have to be something more stringent than that in order for a flag to go up. That's essentially what we are talking about. He gave an example of what sounded reasonable to him.
- My concern is extremes. Some of us think low-flow extremes are the ecological driver, are going to cause the greatest shifts. If we go with Index B I feel like we may be missing the most critical low-flow events. We might be able to drop off the high flow 10% and not sweat it, but if it is driven through the low-flow extremes, I think we need to pay attention. It seems like water

users would benefit in understanding that crises are in drought extremes, not during standard situations.

- Modeling a future where 10-20% ambient flow is removed, or modeling where future use is a fixed rate of water withdrawal is compared with 10-20% line that is a completely different question with a different result. I thought we were thinking about modeling a future in which one could take a 10 or 20% of ambient flow, but if we are talking about is a future in which fixed rates of water withdrawal are to be compared for some purpose with a line drawn 10 or 20% below the hydrograph, that's a completely different question and it will produce a completely different result. In the latter case we get close to a permitting scenario whereas in the former, we are talking about a future scenario of available water.
- That doesn't tell you anything. That's just saying we will assume everyone's going to do this so you're never going to raise a flag.
- I don't disagree.
- Jaime's point of what tools DWR has when a flag is raised. It's not a hammer, saying you are exceeding your allowable amount. It's saying it's time to sit down and talk about options and alternatives for management regimes given that this particular approach under review shows you're tripping the flags.
- Tom's [Fransen's] strategy for interpreting it makes sense. I suggest we adopt them.
- It's pretty conservative. A yellow flag goes up if one day in a period of record you drop below that 80 or 90% line. It doesn't mean you'll necessarily change anything but you're keeping an eye on it. The other one is the warning flag goes up if you have both of those criteria are not met, and that's when you talk.
- Was Tom's intent for us to embrace it whole-heartedly or as a straw man?
- Facilitator: comments on the approach Tom proposed?
- [Harold pulled up Tom's presentation slide 14 from July 16 on the projector.]
- Instead of 80% it would say "80-90%".
- I think this is a good place to start. Once DWR has more of these models and starts running them, they are going to figure out if they are getting way too many flags, or if it is extraneous or whatever, and they can revise it over time. But I think this is a good place to start.
- This is what he currently does, based on a hydrologic approach. How does it relate to our interpretation of biological impact? Other than our thinking he's making a reasonable approach, how to we justify that based on ecological integrity?
- Extreme low-flow events produce almost instantaneous...
- I agree, but how do we put this in our report and link that to everything else we are doing. We are interpreting it in the context of trying to apply an impact on the stream biology and maintaining ecological integrity. This is a way to trigger a flag or not. We have to link it somehow.
- The 80% is already linked to the biology.
- Given the fact that we established that there is no biological threshold and we've been working toward being conservative, so limiting it to one day is being as conservative as we can be. That is justification in the way we've been developing our thoughts.
- Then the only thing left for discussion then is whether chopping off that 10% at each end how is that protecting or not protecting ecological integrity as opposed to chopping off 5% at each end or something else. At this point it would be a shot in the dark to say some other number.
- At least we have to go with what he is doing having no more justification than we do.
- You can also use the biological response model along with the Index B.
- True.
- I like the way he worded it here: "The number of days with potential adverse impacts." It's not guaranteed, but the potential and the risk is there.
- Since Index B cuts off the lower 10%, if you violate that, does that mean that you are violating the POR 10% as well, or not?

- The number of times it is violated is going to exceed 10% of the time.
- If you cut off that lower 10%, does it automatically mean that? If you are below that once, does it mean that 10% you cut off are you always below that value as well?
- It depends on the shape of the duration curve. Look at the King's Mountain Reservoir, the one in red [in Tom's July presentation]. 290 days with the full POR and 282 under Index B. So there is only 8 days different when you chop off 10% of the data. To me that suggests it's not 1 to 1.
- It's more meaningful if it is not an automatic thing, and it looks like it is not.
- Is the yellow a violation of either one or just one day in the POR?
- At the bottom it says you have 16 in the yellow, and only four additional ones in the red. That's down to 90% exceeded. That's pretty low flow.
- Yes, but I think the watch requires a little more action than just watching. It does let you know where the priorities are.
- Yes, don't start with the yellow, start with the red ones.
- The way he has it arranged, it is a cumulative distance downstream. You might want to try to address some of the watch ones and some of the red ones might be alleviated. Flags are "look at it more closely".
- And I think it is important that when you are looking at it at a watershed scale like this, a whole bunch of yellow flags add up to red downstream.
- As a group do we want to make a suggestion to incorporate this, should we ask Fred to write it up in a way it makes sense and can be implemented?
- So far we've just used the 80% flow-by. He proposed the index B to have a different statistic. We could use the 80-90% and use a different statistic. So far the only thing we have run is an 80% flow-by.
- Facilitator: I was going to suggest going back to the other slide of how he described it because it's being proposed that the Board recommend continuing with this approach. Is there anything you want to change in that?
- If we don't use the Index B component, then we're back to how many times you violate the 80%, and then it gets messy (how many days, what times of year?) in a POR of 50 years. It just really gets messy.
- You could always look at a smaller period of record.
- I thought this was part of the whole purpose of the biological response model, that they could actually plug that in here. Am I missing something here? If you violate the 80% flow-by then you look at the biological response model to help evaluate it.
- That depends on what effect it has on the deficit.
- The deficit might be zero because you have a bunch of high flows offset by lower than expected flows.
- The eco-deficit strategy as a variable is amazingly predictive, but it misses the outliers.
- Facilitator: So it sounds like you are suggesting not altering what is here.
- Yes, based on what Harold just said, right now they just run the POR without the second part of it, we get into the hornets' nest of trying to figure out how many days or how many consecutive days, what time of year...
- In that case you get 21 out of 28 instances where it would require additional evaluation on that one basin, which would get really messy.
- Facilitator: The other question raised was whether those are the terms you want to use if you go with this approach because there was some question about "watch" being the term you would want.
- My only reservation is that there are bright people at DWR, and they may have an even more reasonable approach. I think this is a reasonable approach. I may be at a 3 if we test

consensus since we haven't considered any other options, and we don't have time to. Is there a way to leave the door open for DWR staff to evaluate other metrics within this context?

- Facilitator: What was proposed was "Use Tom's approach as a starting point, (using 80-90%) and refine over time."
- Is this to incorporate as a potential option or are we recommending that they do it?
- Roll it into the number 1 recommendation. We have made little tweaks, and it would be rolled into that.
- Facilitator: You are thinking to roll it into the statements, not into the actual recommendation, or...
- That would go into that implementation piece, not into the statement of recommendation.
- Wouldn't we say in the recommendation that we think it is important to understand the frequency and magnitude of how long, how often you go below the recommended 80-90% flow-by. We have limited experience with it, and we did not evaluate very many options but that a place to start would be the approach currently utilized by DWR. The recommendation part of it is that it's important, that you need to think about it.
- They are not using it. It is just a demo that Tom came up with.
- So what might go into the actual recommendation #1 is something like how long, how often, the frequency are important criteria for evaluating.
- That we think it is important for the flag to go up even on the first day because biological response can happen even at day one. And then recommend that this is a way to approach the flagging, as a starting point.
- So in the example he showed, you would trigger evaluation 21 out of 28 times on every one of those nodes.
- We are not explicitly stating what that evaluation is. It could be a desktop...
- I don't think it is 21 separate evaluations. It could eventually be, but the starting point is not.
- Facilitator: I am trying to capture here how you said it. "As part of the recommendation, acknowledge that frequency and duration of flows below the ecological flow are important..."
- I thought it was that significant impacts...How did you say it?
- The ecological response can occur in one day so a flag should go up the first day.
- Based on this, it is hard for me to grasp the idea that one day in a period of record at that point is something we can actually, with some certainty, say that there is significant biological impact.
- It reveals the potential for impact. Because it is all a modeling exercise, it reveals potential adverse impact because at least once in the period of modeled record, we can see that the flow is driven below that 80 or 90%.
- I understand what the statement is; I am having a little difficulty wrapping my head around our drawing that fine red line in the sand and trying to make that clear statement. It could happen. It could happen whether or not they encounter that one day in the POR. It seems like a pretty broad brush.
- But what is the alternative? One day is as protective as you can get. Anything less is less protective. Then you get into whether it is 10 days, 20 days, or whatever. We have no justification for that.
- He's suggesting a 3-tiered system. We are condensing that into a 2-tiered system.
- I don't think we are. We are just saying that at a minimum... he already has a watch flag.
- In his case, I'm not sure what that means. What we are doing is condensing the lower two categories into one. So anything other than the top category...
- No, we are not.
- I thought we kept the three categories.
- So what will they do with tier #2?
- Simultaneously they can evaluate 2 factors at once.

- In our other verbiage, we stated it would require additional evaluation, appraisal, etc. In this case, are we not making that same recommendation?
- Yes.
- We need to come up with a word besides “watch”
- Will this trigger extra work for 80%? 90%? What is this going to mean? Is it a reasonable approach when they are faced with doing these kinds of evaluations? Or are we being so protective that we are calling wolf by triggering it in 90% of the instances: I don't know.
- You have a total of 27 nodes, you know you'll trigger it at the lower level, with a yellow flag we're also triggering it. This is all one basin, so it's one evaluation?
- That's the first step. In reality, when you first run the model and this table comes up, it would also have eco-deficit analysis; you're not likely to see only one 1 and zeros everywhere else.
- But will it look like this for every basin?
- DWR will have to look at it with their other basins and amend it as needed.
- I think having that verbiage about its being a starting point...
- Tom seemed to interpret it as when both criteria are met, and then we really need to talk. That seems reasonable (right, I agree). These others you could still take a look in a desktop manner at some of these to determine why they are getting tripped. It starts you down the road of inquiry; it's not something where we would lay out a full spectrum of what we expect them to do.
- We should leave it as it is. We can get into a whole other issue of guessing how they are going to use this. For example, this is a fairly small basin, only 27 nodes. If you have a basin with 55 nodes, do you have to have yellow in more than 15 of those 55? You can get into all kinds of scenarios of what are we going to do about it. Being conservative by having the flags go up at any hint of a problem, just means that they start looking at, and they are going to figure out whether most of them are yellow or red, or there is only one of them red. They are going to have to deal with it based on their expertise and the amount of time they can throw at it.
- Facilitator: Where we were was deciding whether this language goes into the recommendation or in the statements clarifying the recommendation?
- If we are going to have language in recommendation about frequency and magnitude of deviations from our other recommendations, than this should go into the recommendation.
- Then what is the recommendation- is it a single sentence? When I wrote my adjustments to that part 1, I tried to pull out in bold a number of sentences that are recommendations. To me the recommendation is not just to use 80-90%. All the other stuff with it is the recommendation. I'm not too worried about whether it goes here in bold and italics or if is in the paragraphs...
- If some of it is in going to be in italics and some is not...
- What I am saying is that then the recommendation is going to be about 2 pages long, in italics.
- For example, using the 80-90% flow-by, we have that as a recommendation. Right now, the minimum flow component is not up there so is that a recommendation or not? Or does it need to get added to that top part in italics?
- I think it needs to be in the recommendation, as well as the part about the baseline.
- Those are critical pieces of why 80-90% is our objective. If you take those away, it is not a full recommendation.
- Facilitator: if you can decide whether you want it in the upper part as part of the recommendation, or not, then vote on is this what you want to use, and then have somebody write it up afterwards for you to review.
- I say yes to the recommendation part.
- Facilitator: We have a proposal: Use Tom Fransen's method for defining flag raising.
- Question of clarification: You're suggesting that however we write up the previous slide, it go into the recommendation in its entirety?
- So it would say a yellow flag goes up when the POR has...

- I would deviate from the yellow flag, red flag. Basically, in the recommendation say something about targeting flows to 80-90% flow-by, and if there is one day of deviation from that in the POR a flag goes up; if there is, if there is one day of deviation in the POR AND at the same time Index B is violated, then flag requires extra weight.
- Facilitator: Let's test for consensus on putting it into the recommendations. [11 ones, 1 two, 2 threes]
- I'd like to see the rationale before knowing where it goes.
- Facilitator: I think it is easier to get basic agreement, then to write it up, and then we have something to look at it.
- Facilitator: Jaime and Fred will write it up.
- Facilitator: Looking at the list, regarding what further analysis would be when a flag is raised, Amy, you were going to undertake including in the writing, using further analysis or evaluation with a statement of intended outcomes.
- What Jeff and I did was what I had agreed to.
- Facilitator: So just on the headwaters?
- Use the same language for each one, for additional analysis.
- Facilitator: Harold was pointing out that as far as the baseline, the legislation was passed on July 22, 2010.

XI. Discussion: Ecological Integrity

Returning to the list, do you want to discuss more about what further analysis would be if the flag were raised? [no]. The other thing remaining on the list was whether you want to address what level of ecological integrity the recommendations are protecting.

- On the eco-deficit strategy, that answer is embedded in the strategy.
- Isn't it also in the legislation since we are not allowed to do anything more than what current conditions are? So the level we are protecting are the current conditions by definition?
- Isn't it current conditions less 5-10%?
- The way the eco-deficit strategy would work is that additional eco-deficit above the baseline eco-deficit that would result in a 5-10% diminution of fish diversity or bug richness would constitute a flag.
- Fish diversity or bug richness?
- Yes.
- Is that an "or"? Is that how that calculation is made? Is it an "or" or an "and" in making a calculation? It seems that the index is a consolidation of those things.
- We recommended that DENR use the more sensitive of the two measures so if the bug richness is more sensitive than fish density in a particular instance, they should base their response on bug richness.
- So you are running two eco-deficits--one for fish and one for bugs, and if either one of those...
- Whichever one appears to be more sensitive becomes the one that raises the flag, and that will vary from place to place.
- Facilitator: You suggested that the 5-10% change is the level being protected. Do people agree with that? Does it need to go in the report, or is it implicit?
- It's already there. Now, I don't think we can answer this question for the 80-90% flow-by strategy, nor can we address it for the extreme event strategy. For both of those strategies we are relying on the professional opinion of authors and/or best professional judgment. We don't have biology to fall back on.

- I think there is consensus around that region from PHabSIM data that we have. We saw that today. If you look at the information that Jim had developed from PHabSIM, 80-90% is a reasonably protective zone of flow-by.
- That is habitat, but habitat is directly related.
- That brings up something I kind of hesitate to bring up, but I am going to. We really have not addressed the resilience aspect of ecological integrity, and we have really put most of the emphasis of what ecological integrity is on the basis of community structure and species richness of two assemblages, and not on other aspects of the ecology. I think that is justifiable, but to me it would require a paragraph or two explaining why it is justifiable on the basis that you had these two assemblages that have been monitored, and the data are much more abundant than anything else we could get for the ecosystems we are addressing. I think that paragraph is missing from this document.
- I agree with your reservation. I agree we do need a paragraph like that. I disagree a little bit with your assumption. The eco-deficit strategy actually does take resilience of species in that guild and the EPT into account because eco-deficit is measured over the POR. So their ability to recover and show up in the successive samples indicates resilience. So there is some resilience built into bugs and fish species in those suites we evaluated.
- Only in so far as the numbers of species, not necessarily the same species, right?
- Correct.
- And the same would hold for the Shannon-Weaver Index.
- The thing I would add is that I think we best addressed resilience by using a % of flow-by, as opposed to some other measure. By using % of flow-by, you address that duration, frequency, and magnitude that for the most the pattern of the hydrograph should remain the same. By doing that we are trying to address resilience and substrate structure and all those processes that we are not explicitly capturing with the biological data.
- That's true, but remember, if you take 20% of the water out of the river, that will produce a biological result.
- We don't anticipate that it will be a consistent 20%.
- Facilitator: So you are suggesting adding a paragraph with some discussion about how you addressed ecological resiliency? [yes]
- Facilitator: Anything else you want to add about the level of integrity you are maintaining? [no] That finishes the list.

XII. How Will DENR Implement the Two Ecological Flow Strategies For Maximum Benefit?

In addition to the items on the list, we're recommending to DENR three distinct strategies: % flow-by, eco-deficit, and low-flow incident strategy. We are recommending that DENR use all three of these to evaluate future scenarios. In each case, we have made some recommendations about how they should also evaluate the results. I think we need to stipulate something about how to balance the use of these strategies and when to pay attention to which one. If we offer something simple, like just use the strategy that produces the scariest result, then one of them (probably the % flow-by with the one-day flag) is going to show up every time, and the other strategies, which may be more informative and are actually based on data, may be set aside. How do we want to advise DENR on using these three tools in some synergistic way so that they add up to a lot of useful information and serve in some way beyond just waving a flag every time they run the model? This is not a rhetorical question. I do not have the answer.

- It's hard to think about how they would work synergistically since I haven't seen any of them employed in OASIS.

- I'm confused about what the third strategy. To me that is part of the flow-by recommendation. With that said, the point is still there about how you use the two approaches.
- Yes, two approaches.
- I am inclined to think that the answer may be in "scale", but there may be watershed sizes or HUC scales that are more appropriate for one or the other.
- I had been considering if you could use eco-deficit at one of the HUC divisions to evaluate as a cumulative tool.
- I think as I understand your point, we would use the flow-by strategy at the point of a proposed management action, and we would use the eco-deficit strategy at the pour point, which is the lowest point topographically for a HUC 10. So the eco-deficit gives you cumulative results whereas the flow-by produces a result at the point of a proposed action.
- But the statistical models for the biological response are based on reach data, right? In other words, you have a sampling point for the biology and then the reach associated with that sampling point for the hydrology. That model you are basing the eco-deficit relationships on is a small scale-dependent model, is it not?
- Well, they are derived from point data, and we accumulated the NHD catchments, right?
- Yes.
- But then we accumulated those to whole basins for the final analysis.
- Well, there are different locations along basins, so in some cases they are cumulative.
- I can't think of any reason why it wouldn't work at some small-scale watershed like HUC 10, can you?
- They are valid there as they are anywhere else.
- It's deciding on a catchment or drainage size that seems like the most appropriate scale to evaluate it. HUC 10s seem to be a nice fit. I looked at the Cape Fear and there are 45 10-digit HUC drainage units in the Cape Fear. Running eco-deficit 45 times seemed reasonable. HUC 12s would be many more. HUC 8's may be too few in a basin like Cape Fear. Trying to get a grip on eco-deficit, maybe highlight a unit that may be of concern.
- Are HUC 10's entities? Do they show more internal ecological consistency than other scales of HUC?
- Back to classification?
- They drain to that point; they have a shared physical history. Depending on flooding, overland flow, there could be exchanges.
- Studies of ? flows and migrating is...
- If we use flow-by statistic as strategy for evaluating future management strategies, and eco-deficit strategy for accumulating those impacts across space, is 10-digit HUC a logical place to do that?
- No clue.
- I'm trying to understand this in light of the OASIS model. Won't these things be done at nodes? Is this necessary?
- If you use nodes strictly derived from water users, you won't be able to address the distance between whether there is a return or not. Even a downstream node captured as a user, wouldn't be able to...
- Wouldn't you want to know where impacts are greater?
- Facilitator: Given the time, perhaps we should take up this question tomorrow: We have two strategies on the table; how do we want DENR to implement them for maximum benefit?
- The meeting adjourned.

September 25, 2013

I. Orientation to the Sept 25 Meeting

The agenda for the Sept 25 meeting was:

- Introductions
- Draft Writing Assignments for the EFSAB Report
- Discussion: How Will DENR Implement the Two Ecological Flow Strategies (80-90% Flow-by and Eco-deficit) For Maximum Benefit?
- Present/Discuss Nine New Written Sections for the EFSAB DRAFT Report
- Review/Edits of Requested Changes to DRAFT EFSAB Report
- Develop October Agenda
- Adjourn until Oct 22 and 23 Meeting

II. Draft Nine Written Sections for the EFSAB Report

Facilitator: Mary Lou Addor

During the first 2 hours of the meeting, EFSAB members drafted the following written sections of the EFSAB report.

1. Add a descriptor in the report where the mountain PHABSIM information is earmarked. = *Fred*
2. Include the re-written recommendation for headwater streams (done- decide where to include in report) = *Jeff and David*
Therefore, for streams with drainage area ≤ 10 km², DENR should conduct additional analyses to determine the potential for impacts on ecological integrity.
3. Potential recommendation- DWR should have nodes georeferenced to enable analysis = *David*
4. Add description in report about why EFSAB recommendation deviates from RTI's recommendation for biological thresholds (justification for using 5-10%), implications for using the range without the stream categories. = *Tom*
5. In the flow-by recommendation statement, describe why the range was chosen (based on range seen in the literature, PHABSIM results, range chosen versus a number based on ability to reach consensus, other?), and implications of choosing the various percentages. Note that implications are not clear cut, there is a continuum. = *Chris and Hugh*
6. Critical low-flows- flesh out the statement that is currently in the report. Language in the flipchart notes to draw upon- the increased frequency and duration of drought is a concern. Low-flow events are most critical for contributing to biological impacts. DENR should consider identifying a critical low-flow component. Alberta, CA uses 20th percentile flow adjusted monthly is used as a critical low flow. DENR could consider Alberta's and other examples in the literature for setting a critical low flow for planning. = *Chris*

7. Prevailing flows- use as baseline the management regime extant used when legislation passed on 7/22/2010 = *Chris*
8. For raising flags, use Tom Fransen's suggested approach (*Jaime and Fred and Jeff*)
9. Add paragraph about how EFSAB addressed ecological resiliency (Using ecodeficit approach) = *Bob and Sam*

III. Discussion: How Will DENR Implement the Two Ecological Flow Strategies For Maximum Benefit?

Facilitator: Nancy Sharpless

The EFSAB spent the first hour and a half of the Wednesday meeting working in writing teams to revise report sections. The facilitator then invited everyone present to introduce him or herself and reviewed the agenda.

The EFSAB then undertook to answer the question: We have two strategies on the table. How do we want DENR to implement them for maximum benefit?

Comments/questions included:

- I don't see that there are two strategies. You have flow-by that determines what your hydrographs are, and that determines what the eco-deficit is. Eco-deficit goes into the model to determine what the biological effects are.
- Flow-by is not a proposed future hydrograph; it's a test for proposed future scenarios. This is the confusion I was having; are we proposing to implement a future hydrograph that looks like current but with 10-20% lower, OR whether we were going to use that 10-20% line to test future scenarios to see how often they cross that line. As it turns out, it is the latter, which makes more sense, so we have 2 tests for future scenarios. I have 4 alternatives:
 1. Give them both to DENR and say use them how you see fit
 2. Use them in a prescribed order: we recommend you use the flow-by strategy, and then test the results with the eco-deficit strategy. IF you don't like results, you have further work to do.
 3. Always use them both, and rely on the most sensitive one. That is essentially the same as alternative #2, phrased a little differently, and it implies a little more conservative approach.
 4. Apply these two strategies at different scales. One approach would be to use the flow-by strategy for site-specific evaluation, and then try to maintain a cumulative roll- up of all site-specific decisions using an eco-deficit measure somewhere, like pour points of 10 digit HUCs.
- I honestly don't have a strong preference for any one of the four; if we had to vote now I'd vote for #2.
- Which one would be more sensitive?
- If 80-90% flow-by were used, and flag went up when a single day were violated in the POR, then that would be by far the more sensitive. I'm worried DENR will rely on that one only, and not use the eco-deficit tool which is based on a very deep dive of the data. I don't want to create a situation where DENR doesn't use the eco-deficit tool as a way to look at whatever decision they are making to make sure that their decision has some sort of cumulative evaluation over time and perhaps also space.

- My sense is that the flow-by strategy would be an easier first screen, although I may be wrong. If it were to raise flag with even one day of exceedance, then look harder with the second tool as a validation or to see if it's a site of concern or not. To me the flow-by strategy is a more straightforward initial screen and less time-intensive to do.
- Running the two models is equally easy after set-up. Setting the eco-deficit tool is hard on the front end but then easy to run. If you run the 80-90 strategy and most of the time a flag will go up, the eco-deficit strategy will give you some comfort, as it's less sensitive. But I also think it is the more true. A few yellow flags from flow-by might not matter as much as results from eco-deficit.
- You haven't heard yet what we put together about the flagging. Our approach for our writing task was to kind of flip it and in the recommendation we followed the recommendation from Tom Fransen's approach where you pursue a certain strategy of further analysis whenever you found at least one day in the POR where you drop below the threshold AND you fell outside Index B. Whenever that happens it would trigger additional evaluation, which presumably would include the eco-deficit model wherever it is applied (either at that point or at the appropriate location in space. When you have the occurrence of one day where the flow drops below 80-90%, we are not saying whenever that occurs they apply everything. We didn't say what they apply, but say that the flows associated at that river reach be given additional scrutiny. That may only be looking to see if they only fall below the flow range once in the POR, or many, or is it 1% below or 50% below. It really only focuses on the flows. How that is incorporated may affect what you are talking about in terms of implementation. I like option 4 since it would incorporate use of information that DENR would have readily available, and then applying eco-deficit approach on an appropriate scale because it seems that if you apply it, where you apply it would make a big difference. I don't know that it is reasonable to expect them to run it at every point in the basin and be able to adequately interpret the results. Or should they apply it at a strategic point where you accumulate impacts upstream. I think that is ideal, but I don't know that we have the information to adequately evaluate whether or not that is the correct approach though so my fall back would be #2.
- I did not mean to say regarding #2 that if no flags went up you would not use the eco-deficit tool.
- I like 2 and 4 a lot better than 1 and 3. Perhaps they should both be used: DENR should check the results on a project by project basis, starting with the flow-by test, then use the eco-deficit test, which may in fact give some relief to their conclusion. Then I think DENR should experiment at different scales for doing roll-up analysis and find the scale that works best for #4. We have no reason to believe that #4 won't work at most scales. It was developed at NHD+ catchment level and tested at watershed level. It probably will work at intermediate scales; the question is at what scale is it best used. I think we need to leave that up to DENR to decide because we don't have time to do it.
- Facilitator: Would it be useful if Tom elaborated on how it is one strategy instead of 2?
- To do eco-deficit you have to have a hydrograph. The flow-by gives you one; projecting into the future gives you another. Until you have done that, you cannot apply the eco-deficit. They are linked.
- Facilitator; Does that linkage need to be described in the report?
- You can use the first one without the second, but to use the second one, you have to have two different hydrographs (current and future) to compare to come up with an eco-deficit number.
- The first one does not have a direct link to biologic effects. We are saying that because we preserve the hydrograph we preserve the biology, which is a good place to start. The second one has a direct link to biological data in NC.
- In terms of scale, when creating the 80-90% flow-by you do it at all the nodes in the model. Thinking about the effort involved, if you also then did that at the 10 digit HUC or whatever that is a whole different level of hydrographs that need to be created. That would potentially be a lot more work.

- If you're evaluating a future scenario, you're likely doing it at an existing node or one you create. For a significant proposed withdrawal, you create a node there, and then you test what happens at that node. That node has a management action associated with it. The second question then becomes how does that node add up; what does it do to nodes downstream in parallel or adjacent watersheds that merge with this one further downstream and so on. Is there some reason to not only check at the management node you insert in the model, but to also accumulate that somewhere down the watershed?
- The nodes will be done no matter what. The question then is what is the relationship of those nodes to some other layer of hydrologic accumulation (HUC 8 or 10 whatever). If it's in the middle of one of those HUC units, it's still accumulating to that point. The next node down you accumulate to that point. If you do away with the different HUC levels, you still are answering what is happening accumulating to that point.
- The question is what is happening below that point.
- Depending on how those nodes are laid out within the watershed, there is another node downstream somewhere. How are they dispersed is one question. We won't answer that today; that's up to DWR's expertise to figure out whether it's beneficial to add another layer to accumulate down. Another point, the hydrographs generated are the current and projected hydrographs. There is not an 80-90% hydrograph. There is just what we have now and what the future projection. Those go into creating your eco-deficit or into the analysis to determine whether the flags get raised in the flow-by approach.
- That's correct. The future hydrograph is the future hydrograph with the proposed management. The 80-90% is a way that that is tested, not a target hydrograph.
- Exactly. I'm just saying that you are not creating an 80-90% hydrograph.
- We've made the assumption that 80% flow-by is fine. We haven't tested that. Does eco-deficit provide the ability to test that assumption? We have PHABSIM and eco-deficit to test that assumption?
- That's basically what I am suggesting, to test using eco-deficit every time.
- Facilitator: We have a recommendation on the table: Run both every time, using the eco-deficit as an additional tool, but also to develop a better understanding of the first.
- To clarify, I propose a recommendation: DENR should use the 80-90% flow-by test, and then test the results with the eco-deficit approach. I also have a suggestion that DENR develop an eco-deficit based strategy for accumulating biological impact at some appropriate scale.
- So you are talking about going down the stream and assessing the cumulative impact.
- Yes. If I were DENR I would want to know.
- I thought that was part of the charge of this committee--a methodology to do that on a basin wide scale, rather than project by project.
- It is on a basin-wide scale.
- If you want to, my suggestion can turn into a recommendation.
- In my mind, the first one is what DENR is doing with its basinwide planning approach every time they run the basinwide planning models. Then when a flag goes and a site-specific evaluation is needed or somebody proposes something, then you are doing that. I think any time you use those tools it is cumulative impact because you are looking at everybody's action at that point. I don't think you are ever not looking at it from a cumulative perspective.
- Every site-specific analysis accumulates everything upstream of it.
- Every time you run it.
- It is always cumulative for everything upstream, but what I am also concerned that DENR develop a strategy for seeing how things accumulate downstream.
- They would look at the next lower node.
- Is that the appropriate strategy, or should they develop a strategy to do it on some consistent basis, for example at some appropriate scale. The next node may be far downstream. Is that the appropriate scale?

- Everybody downstream is going to care what is going on upstream. I don't think it is the next node or in between. I think it is...
- OASIS is set up watershed by watershed. So every OASIS model actually produces an outflow at the bottom of the model. Is that the appropriate scale for looking at cumulative impacts? For the Roanoke that includes a large chunk of Virginia. The Savannah (if they model it) would be a teeny tiny model. That's why I suggest we leave it to DENR.
- I think we are talking about a distinction without difference.
- I'm trying to understand how DENR would use these in their basinwide management plans. We're recommending an action that is not particularly related to a specific point, but rather just looking at the future use, etc. and we recommend in general that they take a look, model it based on the 80-90% threshold, then they evaluate that with the eco-deficit model. Is that what's on the table?
- I think what we are suggesting is that they are testing every flow regime against the flow-by standard. Then they are also testing it against the eco-deficit standard or model?
- Yes.
- With that, I don't see any distinctions between 2 and 3. You are testing the future scenario with both tests.
- I think originally, #2 was to use the flow-by and then if it triggered...
- But then Sam said that was not it. So I don't understand the distinction between 2 and 3.
- The distinction is that #3 says use the one that is more sensitive. Number 2 says use them both.
- And then what?
- I tried to explain that by saying that if you go with #2, sometimes the eco-deficit is actually going to give you comfort, and you may end up not going with the more sensitive, but rather you go with the one based on biology, and you may actually find that the 80-90% test is too sensitive in some cases.
- To clarify the language: DENR should test the future flow scenario against both the flow-by standard and the eco-deficit model.
- I think it makes sense to not go beyond that with more specificity because they have actually done it for a while, to know how many flags or what kind of flags go up in the flow-by test against how many and what kind of impact from the eco-deficit test, until they get experience with that it is hard for us to give more detail on whether to use the more sensitive or any other permutation.
- I agree.
- Regarding having a larger scale accumulation strategy, I got enough pushback on that that I am withdrawing it. I would note in doing so that the next node downstream is not placed in any geographically consistent way. The next node downstream is where someone has a management action. Even if we don't suggest it, I think at some point DENR is going to want to have some spatially consistent strategy for telling what is going on as these things add up over time.
- I came into this process in the middle. What defines a node?
- It's typically where some management action is taken--a withdrawal, a dam or something OR it's a place DENR has selected as a place for analysis.
- My suggestion was that a node would be a place just downstream or somewhere logically downstream of a major tributary joining the system.
- No, not necessarily. They are not just dropped in everywhere though because they have to be calibrated to gage data.
- Facilitator: For clarification, where would this go? Would this be an additional statement to go with the recommendations you already developed, the recommendation 1 and recommendation 2, then this would be a third statement to go into the statewide recommendations? [nods] Then

the next question is do you want to leave the first 2 statements in the recommendations the same or do you want to add something affirmatively about their running both?

- I like it the way it is there [it says both], and then add a third statement.
- Facilitator: I want to test for consensus on this.
- Just to clarify, to test the application of that, this is geared towards DENR's basinwide planning for the future as opposed to the implementation for the other recommendations, which appear to be more geared toward DENR's evaluating a specific request. Am I evaluating that correctly? We have recommendations that we have been working on, which send up flags under certain conditions. If somebody proposed a withdrawal, you would use the 80-90% flow-by and that raised a flag you would take additional actions. My understanding has been that the additional steps would be either additional modeling, or you would run it in conjunction with the eco-deficit tool or some other action. What this is proposing, across the board, DENR needs to apply these tools everywhere.
- I think the way it is implemented is that they do the entire basin; this tool is for the entire basin not a particular project. It could be, but the way it is set up in the statute is that it is for planning the entire basin. So if in the next iteration that they do it there has only been one new proposal you're analyzing that one proposal. But those long-term horizons are going to be multiple changes of multiple projects plus overall population growth and everything else. It is a cumulative analysis.
- How does this fit into the recommendations we already had in place?
- In terms of the flags?
- And how does it fit into the report? If this is what we are recommending as recommendation #3, I don't really see how this is different from recommendation #1?
- They go together--1, 2, and 3.
- Right now it is set as the following two tools will be used simultaneously.
- We actually haven't changed anything. I had neglected to read the header that says to use the two simultaneously.
- I think this is a better sentence than what we had.
- The current draft of the report line 137 just says, "In the basinwide hydrologic models use 80-90% flow-by as the ecological flow." It doesn't say anything about eco-deficit at that point. And then #2 says that the eco-deficit tool should be used to determine current and future biological condition...
- Facilitator: So what is in the report currently does not include the preface statement?
- It is written in two separate locations. What I am trying to figure out is are we going to delete these and substitute the other sentence?
- No, no.
- There are two tools.
- I understand.
- Facilitator: Look at line 135-136. That's what they are talking about.
- You could add this sentence or figure out a way for that 135-136 to add this into that as that preface. You are saying these are the tools, and this is how they should be implemented. It is not a separate recommendation.
- Facilitator: Is there any value in replacing what is currently there with what you have just discussed?
- I think we are saying to use the word "both" instead of the word "simultaneously". I don't like the word simultaneously.
- What you want to say is to use both at every site. "Simultaneously" doesn't get to that.
- How about in the existing recommendation, replace "simultaneously" with "together".
- I would just say "are to be used", and take out "simultaneously".
- But to be used doesn't mean they have to be used together.

- I like replacing the word "simultaneously" with the word "together".
- "Together" could imply the same location.
- Facilitator: I think that this report needs to be as explicit as possible because if it is not, some of these nuances that you all understand may not be clear. If your intention is "at every site" you should say that. It's not just the process (simultaneously, together...), but it is also the where.
- Is it appropriate for us to say that DENR needs to do this exact prescriptive approach everywhere or something specific but less prescriptive?
- I think that we have to keep in mind the adaptive management sort of recommendation that is in here. They do need to run it everywhere for a little while to figure out what the data looks like. Then they can refine it. As a Board we have not had time to do that. Tom has.
- I don't agree that an 80-90% flow-by is an ecological flow. They can test a management action against the 80-90% standard.
- What we are doing is assessing whether ecological flows are being maintained or something along those lines.
- I suggest that we use the word degradation rather than change in the happy event that eco-deficit is diminished and biologic condition change is positive.
- That's not the part we are on right now.
- This is a statewide recommendation. This is what we have determined what we think ecological flows are. That's where we started; now we are getting into the implementation. We need to be very clear that the testing concept...
- What we are really doing is testing our recommendations and whether they are sufficient. That's what the tools are doing.
- What is #1 right is the ecological flow recommendation. That's one thing. The testing of it is another concept that you are saying is tested with this flag stuff and also eco-deficit.
- So 135 and 136 should be after those recommendations because now we are looking at an evaluation tool.
- Number 2 is not the statewide flow recommendation.
- The last part is.
- I don't agree that 80-90% of ambient mean flow-by is a statewide ecological flow. I think that what we talked about yesterday afternoon is that we could test management actions and see if they violate an 80-90% ecological flow as a test for whether those management actions are ecologically sustainable or not. There is a big difference. In the former, there is an assumption that all streams get down to 80-90% ambient inflow. In the latter, we are testing specific management actions to make sure that they don't violate a standard.
- I think we agreed on what you said but it's not clearly stated in what we have.
- We're not setting an ecological flow for all streams, we are not making an across the board flow recommendation. We're recommending a process for setting ecological flows.
- The group then played around with some wordsmithing.
- We are not making an across the board ecological flow recommendation. What we are saying is that it is going to be different in every stream and these are the tools to evaluate that.
- More wordsmithing.
- The group arrived (temporarily) at: Ecological needs are unique in every stream. To evaluate flow scenarios in most North Carolina streams, the following two tools are recommended to assess whether ecological flows are maintained.
- More wordsmithing.
- We are not saying that 80-90% is the ecological flow. We have to make that clear.
- More wordsmithing.

**The Board tested consensus on lines 134 through 136 in the current master draft, which say:
"Statewide Ecological Flow Evaluation"**

“To evaluate flow scenarios in most North Carolina streams, the following two tools are recommended to assess whether ecological flows are maintained:” [9 ones; one 2]; they also reached consensus on changing the word in line 145 from “change” to reduction [also 9 ones; one 2].

IV. Discussion: Nine New Written Sections of the EFSAB DRAFT Report

Facilitator: Mary Lou Addor

In order to discuss the nine new written sections of the EFSAB DRAFT Report 4.0, the following review process was proposed.

- Clarification
- Proposed Changes
- Propose Location in report
- Agree on revised language and location in report

The EFSAB spent several hours discussing the nine new written sections and the appropriate location in the EFSAB Report 4.0. The nine topics of discussion were identified in the Sept 25 section, II. The following narratives include edits provided by the EFSAB.

1. ADD A DESCRIPTOR IN THE REPORT WHERE THE MOUNTAIN PHABSIM INFORMATION IS EARMARKED

The following changes were recommended for this section.

- Fred would:
 - submit a section titled “Physical Habitat Simulation (PHABSIM) & Time-Series Analysis” and determine where to insert into EFSAB Report 4.0
 - replace PHABSIM figure with map of analyzed sites for piedmont and mountains (figure 1 in version 4.0 of EFSAB) with descriptive example
 - replace site, stacked bar charts with descriptive example (figure 2, EFSAB Report 4.0)
 - include figure for the mountains with descriptive example (figure 3, EFSAB Report 4.0)
 - provide definition of Index B in glossary
 - place species info in appendices section or turn that information into sentences.
 - provide an intro paragraph following line 625 –just after Flow-habitat Relationships
- Lou will integrate Fred’s section into EFSAB Report 4.0

Fred’s written section to include into the EFSAB Report 4.0: Physical Habitat Simulation (PHABSIM) & Time-Series Analysis

DWR has conducted or been involved in numerous site-specific studies to evaluate the effect of water resource projects on stream flows and aquatic habitat. The types of project proposals have included federal hydropower relicensing, water supply reservoirs, new or expanded water supply withdrawals, and water resource planning studies. Most, if not all, of the studies have employed the Instream Flow Incremental Methodology (IFIM). IFIM is meant to be implemented in five sequential phases: problem identification, study planning, study implementation, alternatives analysis, and problem resolution (citation: www.fort.usgs.gov/Products/Software/ifim/5phases.asp).

Each study involved the collection of site specific data for the stream channel: cross-section profiles, depths, velocities, and bottom substrate and cover objects. Individual cross-sections

(transects) were selected to represent the range of habitat types available at each site. Data was collected under at least three different stream flow conditions, and a series of models (known as PHABSIM) were calibrated using this data to allow simulation of the physical conditions over a wide range of flows.

Each guild or species being modeled has a set of habitat suitability indices that represents how that organism responds to different stream velocities, depths, bottom substrates, and cover objects. These suitability indices are sometimes referred to as preference curves. When the preference curves are applied to the physical conditions the PHABSIM model simulates at different flows, the habitat model produces a relationship between the amount of habitat and stream flow (cubic feet per second, cfs) – with each guild or species having its own habitat versus flow relationship for each study site.

Time-series analysis relates the habitat versus flow relationships to the availability of water in the stream. The output from the aquatic habitat model is used to convert a record of stream flows into a record of habitat values. This can be done for daily flows or monthly flow values.

Two items of data are needed to perform time-series analysis:

a. a set of habitat versus flow relationships for each guild, species or life stage for the site in question. These curves or tables are produced by physical habitat simulation modeling of depths, velocities, substrate, and cover at cross-sections selected to represent aquatic habitat in the reach being evaluated. Physical conditions at a particular flow are merged with habitat preference indices for each guild, species, and life stage being considered to determine the “weighted usable area (WUA) at that flow. Repeating this for a range of flows produces the table or curve for each guild or species.

b. a record of flow data – typically a record of daily stream flows from either a U.S. Geological Survey gaging station or simulated by a hydrologic model – OASIS or WaterFALL, for example. Index B is calculated as the average of all habitat values in a month (for all years) that are between the 10% exceedance level of habitat and the 90% exceedance value for that month. The highest and lowest 10% of the habitat values for the month are not included in the calculation.

Piedmont PHABSIM Sites

Very early in the ecological flow process, to assist the EFSAB, DWR decided to re-run the time-series analysis on PHABSIM models located in the Piedmont physiographic region to determine the amount of habitat for selected species and associated life stages and the variability of habitat under various minimum flow or flow-by requires.

The 19 guilds/species used for the Piedmont analysis were:

- shallow slow, young of year guild (SSYOY)(based on bluehead chub YOY);
- shallow slow, aquatic vegetation cover guild (SSVEG)(based on notch lip (formerly silver) redhorse YOY, veg cover);
- shallow slow, woody debris cover guild (SSWOOD)(based on notch lip (formerly silver) redhorse YOY, woody cover);
- shallow slow, coarse substrate (SSCOARSE)(based on generic requirements);
- shallow slow, fine substrate, no cover guild (SSFINENC)(based on redbreast sunfish);
- shallow fast lower velocity guild (SFLOWVEL)(based on margined madtom adult);
- shallow fast moderate velocity guild (SFMODVEL) (based on generic requirements);
- shallow fast higher velocity guild (SFHIVEL)(based on fantail darter adult);
- deep slow, cover guild (DSCOV)(based on generic requirements);
- deep slow, cover guild version 2 (DSCOV2)(based on redbreast sunfish adult);
- deep slow, no cover guild (DSNC)(based on generic requirements);
- deep fast, fine substrate guild(DFFINE)(based on notch lip (formerly silver) redhorse adult);

- deep fast, gravel/cobble substrate guild(DFGRCOB)(based on white bass spawning);
- deep fast, coarse substrate guild (DFCOARSE)(based on shorthead redhorse adult);
- golden redhorse adult (GORHA)(surrogate for Carolina redhorse);
- golden redhorse juvenile(GORHJ)(surrogate for Carolina redhorse);
- mayfly nymph(EPHEM)(based on Jim Gore research);
- stonefly nymph(PLECO)(based on Jim Gore research);
- caddis fly larvae(TRIC1)(based on Jim Gore research);

The Piedmont sites are:

- Tar River;
- First Broad River (3 sites: upper, middle, lower);
- Rocky River;
- Buckhorn Creek;
- Eno River;
- West Fork Eno River;
- Buffalo Creek;

Mountain PHABSIM Sites

It was later determined to re-run PHABSIM sites located in the mountain physiographic region as additional foundation for decision-making. Nineteen species and/or life stages were selected because of their use in the original model runs and the appropriateness for mountain streams.

These 19 species/life stages selected were:

- caddisfly (general Trichopteras) (TRIC);
- mottled sculpin (adult/juvenile) (MTSX);
- northern hogsucker (adult) (NHSA);
- rainbow trout (adult) (RBTA);
- rainbow trout (spawning) (RBTS);
- brown trout (adult) (BRTA);
- Brown trout (spawning) (BRTS);
- mayfly (general Ephemeropteras)(EPHEM);
- stonefly (general Plecopteras) (PLECO);
- northern hogsucker (juvenile) (NHSJ);
- rainbow trout (fry) (RBTF);
- brown trout (juvenile) (BRTJ);
- brown trout (fry) (BRTF);
- blacknose dace (juvenile) (BNDJ);
- blacknose dace (fry) (BNDF);
- blacknose dace (spawning) (BNDS);
- longnose dace (adult/juvenile/spawning) (LNDX);
- creek chub (adult) (CRCA);
- creek chub (young-of-year) (CRCY);

The ten PHABSIM sites are:

- West Fork Tuckasegee River (53 square miles, mi²);
- West Fork Tuckasegee River (56.3 mi²);
- “East Fork” Tuckasegee River (81.6 mi²);
- Tuckasegee River (287 mi²);
- Nantahala River (101 mi²);
- Whiteoak Creek (13.8 mi²);
- Nantahala River (143 mi²);
- Davidson River (13.8 mi²);
- Jonathan Creek (13.7 mi²);

North Fork Mills River (10.5 mi²).

Due to the lack of an OASIS model for the Little Tennessee and French Broad basins in which the sites are located, the flow record used in analysis was generated by WaterFALL.

2. INCLUDE THE RE-WRITTEN RECOMMENDATION FOR HEADWATER STREAMS

The following changes were recommended for this section.

- David added new sentence to the headwater recommendation:

*There are 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, for streams with drainage basins ≤ 10 km², DENR should conduct additional analyses to determine the potential for impact.***

- Lou will integrate David's section on page 11 of the EFSAB Report 4.0 following the labeled Headwater Streams section

3. POTENTIAL RECOMMENDATION- DWR SHOULD HAVE NODES GEOREFERENCED TO ENABLE ANALYSIS

The following changes were recommended for this section.

- David picked a location in the report for the following addition:

DWR should georeference nodes to facilitate analysis.

- Lou will integrate sentence on page 14 of the EFSAB Report 4.0 following the Ongoing Validation Using an Adaptive Management section.

4. ADD DESCRIPTION IN REPORT ABOUT WHY EFSAB RECOMMENDATION DEVIATES FROM RTI'S RECOMMENDATION FOR BIOLOGICAL THRESHOLDS (JUSTIFICATION FOR USING 5-10%), IMPLICATIONS FOR USING THE RANGE WITHOUT THE STREAM CATEGORIES.

The following changes were recommended for this section.

- Tom drafted two new paragraphs for insertion into the EFSAB Report 4.0:

The RTI/USGS report recommended varying the criteria for acceptable change on the basis of the condition class of the stream or river. A 5 % change would be tolerated for sites rated as excellent, 10 % for sites rated as good or good-fair, 15 % for sites rated as fair, and a minimum flow criterion for sites rated as poor. The rationale for this approach was to provide higher protection for sites with high EPT taxa richness and lower protection for sites with lower EPT taxa richness. The EFSAB decided not to adopt the RTI/USGS variable criteria because (1) it requires that the site condition be known before the criterion can be applied and (2) there was concern that the 15 % acceptable change criterion was too large.

- The **adoption** of a **range** (5-10 %) **applied statewide** carries important implications. **For example,**

*EPT taxa richness at **the** least disturbed sites is known to vary by region (i.e., decreases from **mountains to piedmont to coastal plain**) and to decrease with **diminishing** water-quality conditions. Consequently, the amount of change (number of EPT taxa) that will be acceptable using the 5-10 % criterion will vary by region (i.e., larger change allowed in the mountains and **smaller** change allowed in the Coastal Plain) and by level of disturbance (larger change allowed at sites with excellent conditions, smaller change allowed at sites with poorer conditions). While the EFSAB supports the 5-10 % change criterion, it acknowledges that the application of this criterion may result in the reduction of conditions at sites with exceptional quality **conditions**. The EFSAB encourages DENR to consider additional protection for sites with outstanding biological characteristics.*

- Lou will integrate both paragraphs after line 221 in EFSAB Report 4.0.

A bit of discussion occurred about this proposed rewrite. Concern was expressed that fish diversity was not mentioned because the EFSAB had discussed the range classes. Tom clarified that the 10% came from the invertebrates and not from the fish (there's no basis in the fish). This section is coming out of the RTI USGS report, and using their approach. This basically talks about what RTI USGS report does. Given the EFSAB adopted the 5 to 10% gives a couple of reasons for it.

Changes included:

On line that begins with 'Criteria because' it requires that the site condition be known before the criterion can be applied and there was concern that the 15% acceptable change was too large. Both of those are true. But I also heard a third reason, which was that following the variable criteria strategy was a policy recommendation and that we had decided that while it might be good policy, we were not going to recommend a policy to DENR, And whether we want to say so or not, we at least need to deliberately not say it. My second change is much easier. It's in the next line, after the period at the end of the line – put 'for example,' thereby. This makes it clear that fish species respond, or fish diversity responds in a similar way. Or that we're using the EPT richness to make a point. On the third line where it says 'e.g., number of EPT – remove the e.g. What you're clarifying is the example, not creating another example.

Group decided not to include information on the working rivers or any policy suggestion to DENR to maintain report that focused on planning. EPT tax or richness, for example, gets at changes by region and by condition without introducing a working rivers concept.

5. In the flow-by recommendation statement, describe why the range was chosen (based on range seen in the literature, PHABSIM results, range chosen versus a number based on ability to reach consensus, other?), and implications of choosing the various percentages. Note that implications are not clear cut, there is a continuum.

The following changes were recommended for this section.

- Chris and Hugh developed the following section to respond to items 5,6, and 7. This information was based on an early narrative Chris had developed. This section replaces line 147 -198 in EFSAB Report 4.0. Sections bolded are recommendations.
- At some point, instead of using the phrase 80 to 90% flow-by, we need to define it as: the flow-by recommendation, or the flow-by criterion, or flow-by strategy or flow-by threshold. And then use that phrase throughout rest of document. The report will read a lot better.
- Lou will replace the current section in 4.0 with the Chris and Hugh version.

Narrative is:

Natural flow regimes are important in maintaining instream, riparian, and floodplain ecosystem diversity and resilience (Poff et al. 1997). The “natural flow paradigm” postulates that natural ecosystems are best protected by maintaining flow regimes close to their unaltered state in terms of the five flow components (magnitude, duration, frequency, timing, and rates of change), including intra- and inter-annual variability. The most effective mechanism for resembling a natural flow regime in altered river systems is to use a percentage of flow approach (Richter et al. 2011), also known as a “flow-by” approach. It is conceptually simple and relatively easy to implement.

As an ecological flow standard, the flow-by approach works by requiring a percentage of the “instantaneous” natural flow to remain in the river (Figure 1). The flow-by approach is being used in the US, Canada, and Europe (Richter et al. 2011, Locke and Paul 2011). The percentages typically range from 80-90%. **In the North Carolina basinwide hydrologic models, the EFSAB recommends that the ecological flow should be 80-90% of the instantaneous modeled baseline flow.**

The EFSAB recommends a flow-by range of 80-90% for several reasons. Based on results of PHABSIM analyses for North Carolina, there was no apparent threshold indicating a decline in predicted habitat and flow-by percentages greater than 80% were most protective of all guilds and species modeled. Furthermore, there was no consensus on a single flow-by percentage by the group. A range of 80-90% is common in the literature and other jurisdictions. Therefore, the EFSAB recommends a range of 80-90% as protective for North Carolina streams. The group is not recommending using different values for different kinds of stream, but suggesting that DENR use its discretion to select the most appropriate value for planning purposes.

The definition of “instantaneous” depends on how the flow-by approach is implemented. In a hydrologic planning model, “instantaneous” would be set at the normal time step of the model. For example, in a model that uses daily average flow, the flow-by value would be 80% of the daily flow for each day in the model’s period of record. On the other hand, if a model uses a time-step of 15 minutes, such as for a peaking hydropower project, the flow-by value would still be 80%, adjusted every 15 minutes. In any model, the flow-by calculation is simply the baseline flow multiplied by the flow-by percentage. In a “real world” implementation, the time step might be daily or every three days. Another difference in a practical application is that the flow-by might be based on the flow from the previous day, because, unlike a model, the flow for the current day is unknown. **Because the North Carolina basinwide hydrologic models use daily average flow, the flow-by value should be calculated on a daily time step.**

To the extent possible, flow regimes representing natural conditions (flow regimes without withdrawals or returns), baseline conditions (flow regimes incorporating current withdrawals and returns), and projected conditions (flow regimes incorporating current and future withdrawals and returns) should be estimated by basinwide hydrologic models. Baseline conditions will be compared with natural and future conditions to assess how much hydrology has been altered and to determine the effects of future withdrawals and returns. DENR should use this information to identify areas that have undergone substantial hydrologic change and that warrant additional attention when considering further water withdrawals. **As the hydrologic models are updated with new withdrawals and returns, baseline conditions should continue to be used as a benchmark to avoid comparisons to a continually shifting “current” condition. The recommended**

baseline should be the management regime extant when the legislation was passed in 2010.

Another consideration of the flow-by approach is that it must consider cumulative effects; otherwise, multiple withdrawals could result in an overall reduction in flow below the flow-by standard (Figure 2). Therefore, **the cumulative net upstream withdrawals at any point in the basin must not allow the flow-by criterion to be violated.**

Percentage flow-by will be combined with a critical low-flow component that is intended to protect the aquatic ecosystem during periods of drought (Figure 3). The critical low-flow represents a point at which further human-induced reductions in flow are likely to result in unacceptable levels of risk to the health of aquatic resources. Low flow events are most critical for contributing to biological impacts. The critical low-flow criteria are derived from historical flow records and represent expected low-flows. These criteria are intended to prevent increasing the frequency or duration of extreme low flows (drought conditions) that are damaging to ecosystem health.

DENR should consider identifying a critical low flow component. Alberta, Canada uses the monthly 20th percentile flow as a critical low flow. DENR could consider Alberta's approach and other examples in the literature for setting a critical low flow for planning.

Ecological flows are set as the larger of the flow-by or critical low-flow values on a daily time step. If actual flows fall below the criterion for ecological flows, DENR should evaluate current water uses to determine the best path forward/strategy to minimize ecological effects while meeting the basic needs of current water users.

The establishment of ecological flows based on a combination of percentage flow-by and critical low-flow thresholds represents the best available methodology for the protection of aquatic resources. However, these methods are based on hydrologic models that may not be applicable to all streams across the State since the stream gages needed for model verification may not be available for smaller streams. These models also do not directly address the relation between flow alteration in the State and biological effects. Fortunately, North Carolina has a well-developed biological assessment program that can be used to model the effects of flow alteration on biology.

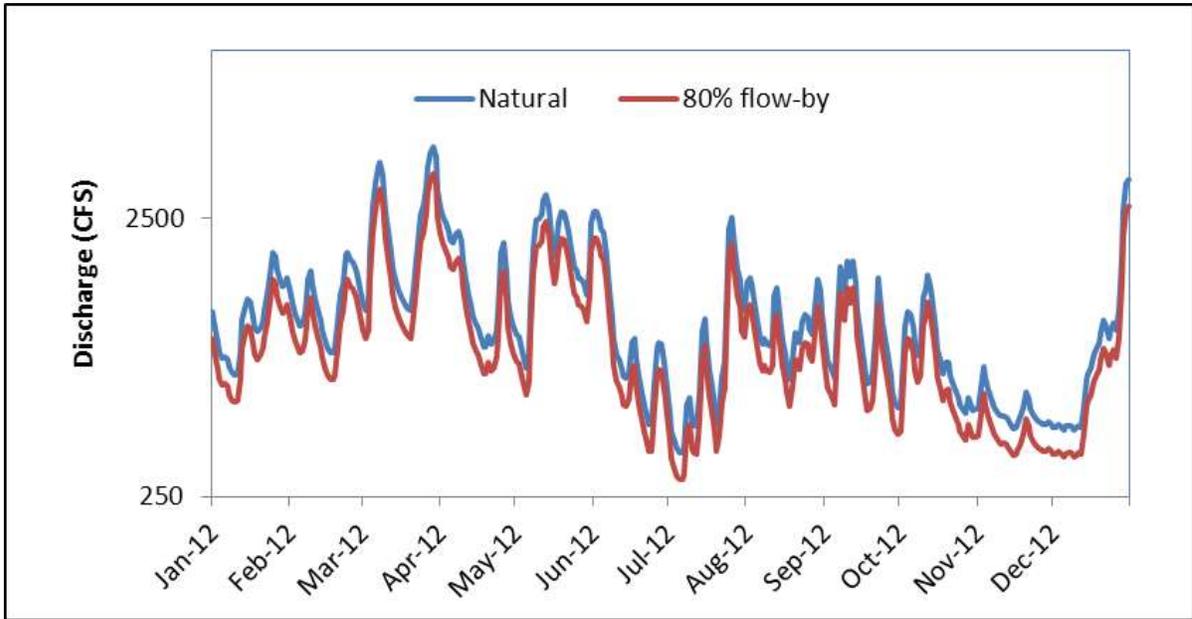


Figure X. Percentage flow-by preserves the variability inherent in the natural flow regime that is important in maintaining diverse and resilient aquatic ecosystems.

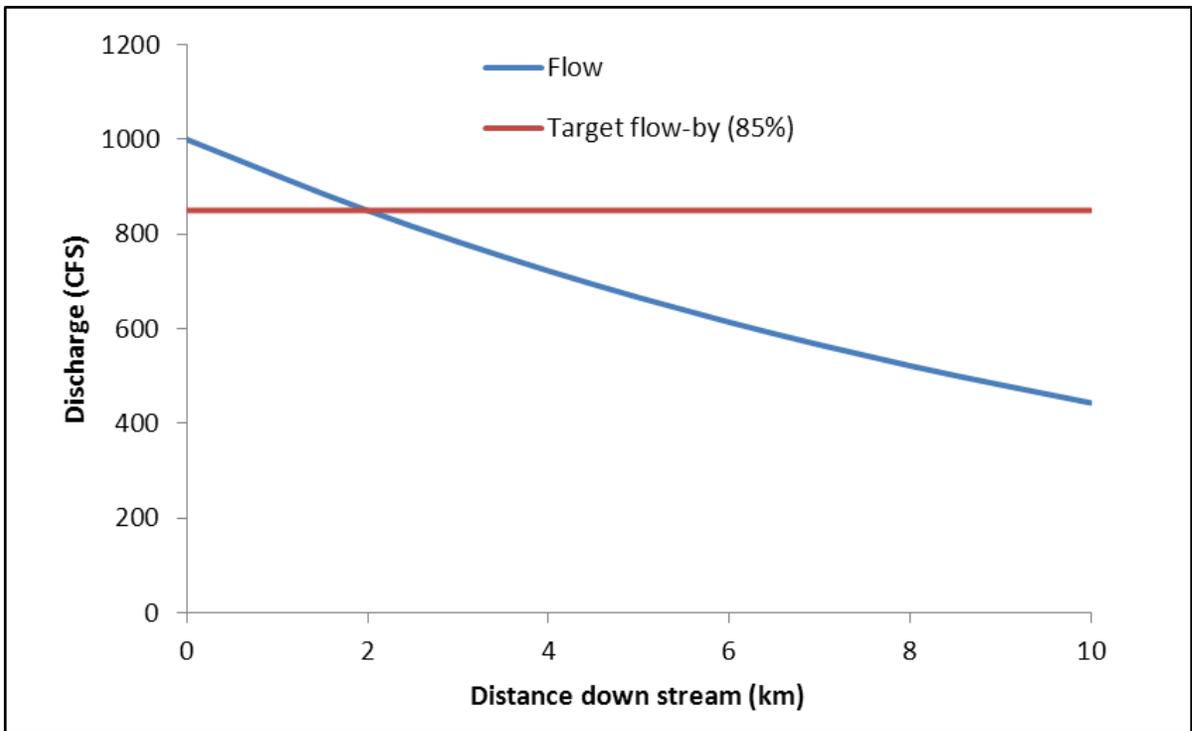


Figure X. A percentage flow-by criterion must take into account the cumulative effects of water use along each stream. This example shows how quickly 5 withdrawals each adhering to an 85% flow-by criterion for incoming flows can result in a large cumulative loss in flow (56% reduction between 0 and 10 km) for a section of stream with no inflows (e.g., tributaries or return flows).

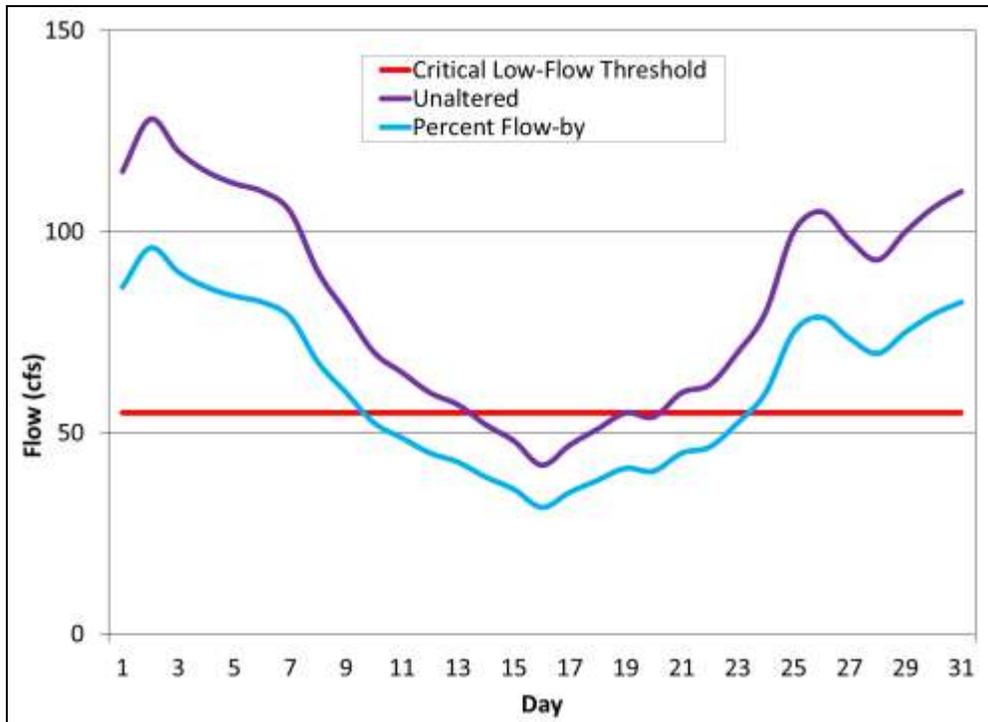


Figure X. Percentage flow-by is coupled with a critical low-flow threshold to protect against increasing the severity and duration of drought periods. The criterion for ecological flow is the larger flow value defined by the daily percentage flow-by or the critical low-flow.

6. CRITICAL LOW-FLOWS- FLESH OUT THE STATEMENT THAT IS CURRENTLY IN THE REPORT. LANGUAGE IN THE FLIPCHART NOTES TO DRAW UPON- THE INCREASED FREQUENCY AND DURATION OF DROUGHT IS A CONCERN. LOW FLOW EVENTS ARE MOST CRITICAL FOR CONTRIBUTING TO BIOLOGICAL IMPACTS. DENR SHOULD CONSIDER IDENTIFYING A CRITICAL LOW FLOW COMPONENT. ALBERTA, CA USES 20TH PERCENTILE FLOW ADJUSTED MONTHLY IS USED AS A CRITICAL LOW FLOW. DENR COULD CONSIDER ALBERTA'S AND OTHER EXAMPLES IN THE LITERATURE FOR SETTING A CRITICAL LOW FLOW FOR PLANNING.

7. PREVAILING FLOWS- USE AS BASELINE THE MANAGEMENT REGIME EXTENT USED WHEN LEGISLATION PASSED ON 7/22/2010

8. FOR RAISING FLAGS, USE TOM FRANSEN'S SUGGESTED APPROACH (JAIME AND FRED AND JEFF)

Jamie, Fred, and Jeff discussed a proposal during the meeting but determined that they needed to meet with Tom Fransen in order to work through their ideas. They will present a new narrative prior to the Oct 22 and 23 meeting. Chris will join their group (anyone else is invited). Some of the ideas that they discussed included:

- Inserting their section after line 141 of EFSAB Report 4.0
- Weave this section into the narrative Hugh and Chris developed to replace lines 174-198.

- Ensure critical low flow is defined in glossary and main body
- For Index B, determine another term to use
- Provide an explicit description of what it means when the flag is green, yellow, and red
- Fred, Jeff, Jamie, Chris meet with Tom Fransen
- Proposed language developed and team will revisit includes:

For evaluating potential impact of reduced flow when critical low flows [not just when below critical low flow but when below 80%] are encountered, the EFSAB recommends DENR undertake additional analyses of potential for impact to ecological integrity. We recommend these additional analyses be conducted whenever flows are predicted to be below the (threshold) and also below the Index B value [determine less confusing term than Index B] for one or more days as calculated daily for the period of record.

When the modeled flow falls below the threshold level for any day but has no days that fall below the threshold for the Index B record, flows at the associated river reach should be given additional scrutiny.

Discussion about #8:

Distinguish #8 critical flow concept: the concept here is not just about whether it's below the critical low flow but whether or not any portion of the 80% or the critical low flow is violated.

Meaning if either the 80% or the critical low flow are violated, then the flag would trip. Most likely add to the bottom of the whole section narrative on the flow by recommendation.

Probably want to address in more detail - what's a critical low flow, what's the threshold, and what's B.

The index is not an Index B value. What Fransen does is he runs the full hydrology data set (calling it the Index B hydrology data set). But it's not really- It's the hydrology data set that has the 10% and 90% ends chopped off. Index B is a whole other concept that may not belong in this section. Discuss and clarify with Fransen.

Green, yellow, red; we'd like to reverse the presentation order so that the first thing we're presenting is the critical level. This is the reason we listed 'whenever these conditions are that triggers the additional scrutiny or additional analyses'. The yellow can be approached next, when it says 'when model flow falls below the threshold level for any day but has no days that fall below the threshold for the Index B record' – so that'll be redefined to reflect what occurred.

Flows at the associated river reach should be given additional scrutiny. We were having some real difficulty figuring out how to put in that additional scrutiny part in the correct way. So we're open to suggestions. If people think additional scrutiny is a reasonable term. We were trying to put it in there such that it called for an action, but we weren't positive what action everyone felt like needed to happen at that point. That's the one that was going to trigger something fairly frequently, and our understanding was what it would trigger, initially at least, was a flow- a further look at flows primarily to start with. To see if it exceeded that threshold for one day a year, 20 days a year, 200 days a year, and how far below it exceeded. And then that would determine if further work needed to be done. But this was just the yellow caution flag. So, we're open to input there.

How about assessment?

That's why we just said further scrutiny. We're really talking about scrutiny of flows at this point, not necessarily the other analyses. Because the point that I understood from what he was presenting,

is he was looking at these flows to use just the flow data and his measures of flow data as a way to tell whether or not you needed to look a lot more at the flows first before making a decision on what to do next.

I think another thing that might help clear it up is in the first sentence in blue 'for evaluating' where you're talking about undertake additional analysis at the end of that sentence. If we could incorporate the language that we talked **about yesterday (Sept 24) that Amy had added. [This information was not available for the Sept 25 group to use]**

9. Add paragraph about how EFSAB addressed ecological resiliency (Using ecodeficit approach)

The following changes were recommended for this section by Bob and Sam.

- Fred would:
 - Add narrative
 - Locate around line 636 – section of Flow-Ecology Relationships
- Lou will integrate Bob and Sam's narrative around line 636 (now line and add reference to Reference section.

Measuring and assessing ecological integrity in its entirety across the waterways of the State is a challenge beyond the scope of the available resources of DENR. The Board recognizes that indicators of ecological integrity were needed. These indicators should be (1) part of an extant and ongoing monitoring program, (2) sensitive to flow and (3) important components of the ecosystem. Integrity involves the interplay of both ecosystem structure and function and their ability to respond to environmental perturbations. Functional indicators of ecosystems are particularly difficult to measure directly, and structural indicators have had a long history of defining function in environmental management (Brinson and Rheinhardt 1996). Without statewide data on ecosystem structure and function, the Board had to rely on fish and invertebrate community composition to infer ecological integrity.

Two assemblages of animals were evaluated to as the basis for indicators: fish and benthic macroinvertebrates. Two components of the ecology of these assemblages were assessed: (1) habitat availability and (2) species distribution. Habitat availability of both assemblages was used in the PHABSIM approach. Species distribution was assessed in the RTI/USGS approach. Sensitive indicators for the latter approach were designated as the Shannon – Wiener Diversity index of the riffle-run fish guild and the species richness of the EPT (mayfly, stonefly, and caddisfly) benthos. These indicators are correlated with eco-deficits, a measure of flow deficiency over the period of evaluation (typically the period of record), so the species' responses reflect recovery (or lack of it) from environmental perturbations.

Discussion occurred around the terms of composition, structure and function. Among ecologists, communities have composition, structure and function. Among biologists, community structure is that list of species and the number of their abundance. So usually you put this as structure elements of the communities (composition and structure are treated as synonyms). Changes were made to the first paragraph to respond to this concern.

V: Discussion/Review of Requested Edits to the EFSAB DRAFT Report

Facilitator: Mary Lou Addor

Members present were divided into 3 teams in order to review the most recent EFSAB report (4.0) (dated 9.10.2013), and the edits that were requested to be made to the latest version (using document labeled "Complied and Reviewed – Aug 22 – Sept 16").

The first review team comprised of Sarah, Vann, Hugh, and Chris, reviewed #1-234 of the report and any requested changes.

The second review team comprised of Linda, David, and Tom, reviewed lines #235-392; and 615 to the end of the report and any requested changes.

The third review team, comprised of Jamie, Jeff, Sam, and Fred, reviewed lines #393-614 and any requested changes.

The responses of the three teams are being distributed with the new EFSAB DRAFT Report, 4.1.

Decisions and Recommendations for version 4.1 of the EFSAB DRAFT Report:

1. The following tables and figures in version 4.0 are to be updated by RTI:
 - Pg. 9-10. Figs. 5A - Quantile Regression showing relation between summer ecodeficit and Shannon-Wiener Diversity Index and 5B - Quantile Regression showing relation between summer ecodeficit and Macroinvertebrate EPT richness
 - Pg. 10 Table 1 – Statewide quantile regression models
 - Pg. 22 Fig. 3 – Example of flow – ecology relationships for fish and aquatic insects.
2. Decisions and action items from Sept. 25 EFSAB meeting
 - Locate Glossary and Acronyms to front of report
 - Glossary: provide definitions in body of report as well as include in glossary
 - Acronyms: ensure when incorporating into report that acronyms are placed correctly depending on when they first appear
 - Consider hyperlinking sections of the report to the EFSAB website where appropriate
 - Capitalization rule: mountains, coastal plain, and piedmont are lower caps; if it's a physiographic provinces - Appalachian mountains, the Piedmont, and Mid-Atlantic coastal plain – these provinces should be capitalized. If discussing geographic features in the mountains, the piedmont, and the coastal plain – none of which should be capitalized. The piedmont is the one of those that has the same name either way you go.
3. Ensure the PHABsim and IFIM sections are complete with all figures and tables (Fred) is complete (Fred)
4. Ensure when the flag is raised scenarios are described completely (Jamie, Fred, Chris, and Jeff with Fransen)
5. Ensure all sections of the report are completed such as:
 - a. Additional narratives and sections to complete:
 - (1) Other Recommendations – review for missing narrative
 - (2) Tools to Support Ecological Flow Recommendations –requires narrative or remove this Section
 - (3) #8 new written section on critical flow/flag raised scenarios by Jamie, Jeff, Fred, & Chris.
 - (4) Glossary –all terms identified and defined
 - (5) Acronym – all abbreviations are listed and identified
 - (6) Reference -all references in the report are listed in Reference section
 - b. Thoroughly review
 - (1) all recommendations to ensure support
 - (2) entire report for remaining edits
 - (3) for ease of reading

VI. October Agenda

Proposed Agenda for the October 22 and 23 Meeting

1. Continued review and development of EFSAB Recommendations
2. Continued review and development of the EFSAB DRAFT Report
3. Approval of the EFSAB Report

The next meeting of the EFSAB is scheduled for **October 22 & 23, 2013** at the Stan Adams Educational Center from 9:00am until 4:30pm on the 22nd, 8:30- 4:00 on the 23rd. 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>

