White Paper on Revising Brook Trout Outcome for the Chesapeake Bay Watershed

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Outcome included in strategy published under Executive Order 13508: "*Restore naturally reproducing brook trout populations in headwater streams by*

- *improving 58 sub-watersheds from 'reduced" classification (10-50% habitat loss) to healthy (less than 10% of habitat loss)*
- *by 2025*."

My thinking on revising the goal statement:

- The original goal statement is stated based on a measure of habitat loss.
- The EBTJV document refers to reduced and intact with definitions of occupancy.

Let's look at how we can merge these two lines of thinking:

- "Reduced classification" means 50-90% inhabited in EBTJV text while the goal refers to reduced as 10-50% stated habitat loss.
- The implication may have been to have them mean the same meaning but to me these are rather different statements.
    - You can have good habitat that is unoccupied because of accessibility reasons. "Habitat loss" suggests less than suitable conditions for growth and survival to me. It could refer to accessibility.
    - Similarly intact means >90% inhabited (EBTJV) but the goal states <10% of habitat loss).
    - In either case, I interpret the statements as being meant to reflect a need to, at a minimum, increase the area of occupancy by Brook Trout.

Let's go back to the goal statement text: "…improving brook trout status in 58 subwatersheds by 2025." And now, let's bound the target for improvement as we move toward a translation here:

- 58 sub-watersheds is 10.7% (i.e. =((58/542)*100))) of all reduced condition watersheds identified in the Hudy analysis (N=542).
    - Note – this is not including the NY portion of the Chesapeake Bay watershed. We will address that missing piece of information as we go along.
    - Note - A back of the envelope, reasonable estimate of the amount of Chesapeake Bay watershed missing with no data for NY is about 10% of the basin.
- 58 subwatersheds is 7.5% of all reduced + intact watersheds identified in the Hudy analysis (N=542+266=768).
- Note, the sum of intact (226) + reduced (542) + extirpated (290) = 1058.
    - If there are 1443 sub watersheds across the Chesapeake Bay basin as stated in the Hudy white paper, this leaves 385 unclassified.
    - Using the ratio of intact:reduced:extirpated (1:2.4:1.3) as a means of estimating the condition distribution for the unclassified watersheds, we translate the 385 unclassified subwatersheds to be 82 intact, 197 reduced and 117 extirpated. Unless someone says the unclassified sites were not sampled because they were the least likely to have brook trout or the most likely to have brook trout, the truth is somewhere in the middle. This is a

middle of the road estimate based on what has been observed for the other 73% of the watershed that was censused.
    - Now we update the counts on watershed conditions with the 73% known and 27% estimated to give us an total estimated 308 intact populations, 739 reduced, and 407 extirpated watersheds as the baseline for Chesapeake Bay basin.
    - Going back to the goal statement to establish a basis for how much change improving 58 subwatersheds represents for brook trout, we use our updated numbers:
        - 58 subwatersheds is now 7.8% of "reduced" (known by census + estimated by ratio for the unclassified catchments in the study area) watersheds.
        - 58 subwatersheds is now 5.5% of "reduced" + "intact" subwatersheds.

- So, if you just want to base a translation on the census information available, or you want to try to account for some of the unclassified catchments, we are talking about a window of change to target for enhancement as between 5.5 and 10.7% improvement in brook trout habitat for the region.
    - Assumption – no loss of intact population acreage.
    - Assumption – the 58 subwatersheds represent a random sample of the universe of reduced + intact condition watersheds and therefore have a similar average size as the total population (in a statistical sense) of subwatersheds. That allows us to use count as a rough translation to area or acreage.

    - Therefore – I propose for your consideration that the goal uses the mid-point of all those targets above, to round off to whole numbers let's make it 8%. Restating the goal then:
        - Increase brook trout habitat acreage (as indicated first by occupancy but subject to more refined definitions to be have multiple levels of this goal e.g. occupancy as Level 1 and Effective population status as Level 2) by 8% as the expectation for improvement.
            - Brook trout distribution shifts are allowable here given the flexibility of the goal statement language.

    - We can translate further using the patch metric as the goal basis now
        - Change goal language to
        - "…increase the patch area by 8% over the existing patch area by 2025 ."

How realistic of a target is increasing patch area by 8% over existing patch area by 2025? In my analysis below, considering distributing the efforts across the region, it looks very achievable with a modest commitment of time and effort spread out over a decade. It should be even more achievable if you spread it out over 12 years – some of the work as I understand is already underway adding acres.

So, some additional conversions using the basic information available in the Hudy et al overview provided:

- A translation of subwatershed language to the language of patches and catchments might look something like this:
    - Sustain/Maintain intact population patches area

- "Patches" are defined as collection of occupied brook trout catchments per Hudy et al.

- Increase total patch acres 8% per the goal statement conversion -
  - According to the latest assessment, by some basic math manipulation of the available information, there should be about 2.43 million acres of occupied brook trout catchments per the following statement: "In the Chesapeake Bay there are 868 patches of brook trout habitat with an average patch size of 2,800 ha" (Hudy et al.).
    1. (Acreage math: 868 patches X an avg patch of 2800 acres gives us 2.43M acres as the baseline).
       1. To bound the uncertainties here, if we want to jump ahead and estimate the unknown NY contribution, NY is about 10% (6250 mi2 of 64,000=9.7%) of the Chesapeake Bay watershed.
       2. If you want to add 10% to the baseline then a back of the envelope estimate of the Chesapeake Bay total acres of brook trout habitat (assuming NY has a similar habitat distribution to the rest of the basin on a % basis) is perhaps closer to 2.67M acres.
          1. 4/9/2013 – I questioned my own thinking here and tried another calculation:
          2. The Chesapeake Bay basin is 64,000 square miles.
          3. NY has about 10% (9.7%, 6250 mi2) of the area.
          4. This means NY has about 4M acres of watershed
          5. The total Chesapeake Bay watershed without NY is about 37M acres.
          6. Hudy's assessment without NY has 868 patches = 2.43M acres.
          7. This is about 6.6% of the non-New York acres of the Chesapeake Bay watershed.
          8. If we assume that NY has the same ratio of brook trout occupied patch habitat, then we can estimate the NY contribution as 0.066*4M acres or about 263,000 acres of brook trout patch habitat.
          9. So my first back of the envelope estimate of total bay brook trout patch habitat was 2.67M acres, my check on that with a little more detailed logic is 2.69M acres.
             1. Having grown up in NY, and looking at Smith, C.L. 1985. The Inland Fishes of NY, the approximation of 6.6% of available habitat as brook trout patch habitat is, if nothing else, reasonable to conservative.
  - SO, An 8% increase would be 213,600 additional acres of occupancy (using the 2.67M acres estimate). For comparison, it bumps up to 215,200 acres with the 2.69M acres estimate, an 1800 acre difference. Reminder, the average patch size is 2800 acres so the difference in the two estimates is less than the size of 1 average patch over all juridications over a 10 yr period.
    1. With an average patch size of 2800 acres, you need the equivalent of 76 more patches of the same size by 2025 OR, since there are an <u>average of 5.4 catchments per patch</u> (4719 catchments allopatric + sympatric populations/868 patches), you need 410 new catchments as part of patches to be occupied (= 76 x 5.4).
       1. There are many metrics that can be tracked about the health of a catchment population
       2. The Management Board agreed to the Patch Metric.
       3. Patch is a collection of contiguous occupied catchments

4. Therefore, ***total occupied patch acres*** could be a tracking indicator.
    1. This metric, 'total occupied acres in patch areas' then lends itself to what I would call more "Level 2" or more detailed characterizations according to valued parameters to inform managers using genetic status assessments of population size, population persistence, age distribution, etc. within catchments and patches for as much detail as people want to put into refining the characteristics of patches. Level 1 – you need fish there, Level 2 – to manage them more effectively for the long term you need more detailed information.

- Planning restoration efforts: Over 10 years, the 213,600 acre goal amounts to a restoration rate of about
    1. 21,360 acres of habitat occupied per year
    2. On average, this is 7.6 patches with a total of 41 average catchments per year in effort (remember, average of 5.4 catchments per patch)
    3. distributed over 5 states (WV, VA,MD, PA, NY), that's on average about 9 catchments and just over 1 average sized patch restored per year per partner for 10 years to get to about 213,600 acres ahead of 2025.
        1. Just on the surface from having done stream stocking as one example that it seems like a manageable bite to efforts and budgets across the watershed. (In Maryland alone over 150 sites a year are stocked with trout for put-and-take purposes. We are talking about less than 10% of that sort of effort by comparison with one state in this system).
        2. With a mix of dam removals, transplanting, etc – again thinking this is a manageable bite site bit of targeting with these back of the envelope translation calculations.
        3. Something this needs is an assessment of potential habitat available for restoration – e.g. does the assessment of climate-change resistant catchments add up to at least 214,000 acres beyond the existing distribution? That would be a first cut feasibility check I think given there is a layer in the data out there somewhere about climate change sensitive versus climate change resistant catchment locations.

Suggestion of Restatement of the goals – this is my thinking of a long form goal statement but think it is supportable, attainable and feasible to meet if not exceed by 2025 ☺

Restore naturally reproducing brook trout populations with an 8% increase in total cumulative brook trout patch area by 2025 in Chesapeake headwater streams by "appropriate management options and actions".

My thinking about spelling out "appropriate management options and actions" to support the goal statement:

1) *populating unoccupied suitable habitats*
    a. *removing barriers to natural population movements*
    b. *transplanting wild stock brook trout from catchments with large wild populations to populate nearby suitable habitat*

   c. *stocking first generation brook trout derived from working with wild stock brook trout in modern hatchery setting within the patch region containing suitable but otherwise unaccessible habitat*
   d. *removing invasive species competitors in suitable reaches that have excluded brook trout, and reintroducing brook trout or from sympatric catchments being reconnected with allopatric catchments.*
2) *improve instream habitat in regions with occupied but 'less than intact' populations by*
   a. *treating pH issues,*
   b. *increasing riparian buffer shading to lower instream temperatures,*
   c. *improving reuse of waters in suburban watersheds to limit impacts to groundwater resources and reduce risk of low flow period issues.*
   d. *Improve additional BMPs for increasing infiltration and maintaining groundwater resources that feed headwater streams.*
   e. *Reduce invasive plant species populations that risk high evapotranspiration stress on improving habitats.*
3) *Sustain/preserve integrity of headwater habitats where intact populations persist*
   a. *Manage landscape conditions*
   b. *Ensure harvest regulations are suitable for population maintenance*
   c. *Enforce harvest regulations, land management policies, air quality conditions.*
   d. *Designate allopatric streams as off limits to stocking of exotic species (brown trout, rainbow trout, cutthroat trout)*

Final thoughts.

The expansion of brook trout populations in my view is complementary to states' work to sustain put-and-take fishery waters for trout fishing. Some accounting accommodation might need to be mentioned in the details of carrying out the goal.

Work on redistribution of improved catchment occupancy to lower-risk areas while accepting sites at to high-risk of climate change (i.e. temperature) are likely to continue to be lost. Stem the tide of loss. If gain occurs you can say you are ahead of the goal ☺.

Existing BT occupancy should be overlaid with projected vulnerability to climate risk on the landscape to assess projected suitability of catchments to lethal BT temperature thresholds.

Areas with high quality habitat and low risk near occupied patches should be the first targeted for restoration. Unoccupied areas with high risk of climate change impacts will be removed from the potential restoration catchment universe.

Patches with the fewest number of barriers to establish free flowing connections between occupied and unoccupied habitat would be given high priority.