Oyster BMP Expert Panel Update

Update to the WQGIT and CBP Partnership
Monday, April 25, 2016

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Update Includes

- Target Recommendation Schedule
- Response to comments on the Oyster BMP Nutrient and Suspended Sediment Reduction Effectiveness Decision Framework
- Status of data review to determine reduction effectiveness for Water Column and Bottom Oyster Planting Aquaculture
- Next Steps

While the Oyster BMP Expert Panel is not looking for any decisions at this time, they do invite any feedback on what is presented in this update.

Written feedback can be sent to jreichert@oysterrecovery.org by May 13, 2016

Schedule Change

- The Panel will submit 1st set of draft recommendations late June/early July 2016 on the Oyster BMP reduction effectiveness decision framework and at a minimum, reduction effectiveness recommendations concerning nitrogen and phosphorus assimilation in oyster tissue for Water Column Aquaculture and Bottom Oyster Planting Aquaculture for 30-day public comment period.

- Target date for WQGIT approval of 1st set of recommendations is September 2016.

- The Panel will continue to deliberate on any outstanding reduction effectiveness crediting protocol/oyster practice category combinations after September 2016 and aiming to submit the 2nd set of draft recommendations for 30-day public comment by November 2016.

Target Recommendation Schedule

Orange = Likely to be in 1st set of recommendations (target approval date of September 2016)*

Blue = May be ready in time for 1st set of recommendations

Grey = Likely to be in 2nd set of recommendations (target approval date of December 2016)

Oyster Practice Category/ Crediting Protocol Combinations	A. Water Column Aquaculture	B. Bottom Oyster Planting Aquaculture	C. Bottom Oyster Substrate Planting Aquaculture	D. Oyster Reef Restoration
1. Nitrogen Assimilation in Oyster Tissue	**1st**	**1st**	2nd	2nd
2. Nitrogen Assimilation in Oyster Shell	1st	1st	2nd	2nd
3. Enhanced Denitrification Associated with Oysters	1st	1st	2nd	1st
4. Phosphorus Assimilation in Oyster Tissue	**1st**	**1st**	2nd	2nd
5. Phosphorus Assimilation in Oyster Shell	1st	1st	2nd	2nd
6. Suspended Sediment Reduction Associated with Oysters	2nd	2nd	2nd	2nd
7. Enhanced Nitrogen Burial Associated with Oysters	2nd	2nd	2nd	2nd
8. Enhanced Phosphorus Burial Associated with Oysters	2nd	2nd	2nd	2nd

*When recommendations are approved they will become available for BMP implementation

Response to Comments on Decision Framework

- The Panel received written comments from 5 groups: Citizen Advisory Committee (CAC), Chesapeake Bay Commission (CBC), Chesapeake Bay Foundation (CBF), Lynnhaven River Now (LRNow), and the Southern Environmental Law Center (SELC).

- The Panel reviewed comments during Panel's data review workshop on February 24, 2016.

- Detailed responses can be found in separate document (Framework comments_summary_with Responses_Final_4-25-16.pdf)

Policy-Related Comments

Comment Focus	Comment Summarized
Omit Shell Assimilation Protocols	CAC, CBC, CBF - Omit oyster shell crediting because of unintended consequence of reducing critically needed sources of oyster shell; SELC et al. - Crediting should not disincentivize shell recycling programs.
In-water BMP	CAC - Concerned with using shellfish as in-water BMP—disease potential from high-density culturing operations could threaten restoration; reduce efforts toward on-land stormwater controls; basing WQ on organisms that could die.
Permit Compliance	CBC - Should estimates match level of certainty for both permit compliance and Chesapeake Bay modeling framework?
Nutrient Trading	CBC - How should standard trading ratios apply; baseline in absence of trade. CBF- Only receive credit for new or expanding projects;

Panel Response: The Panel has suggested that the Chesapeake Bay Program Office organizes a separate policy group to evaluate policy-related concerns involving in-water biological BMPs as this is outside the purview of the Panel's charge.

Comments on Decision Framework

Comment Focus	Comment Summarized	Panel Response Summarized
Oyster Practices	CBC - Raft culture and cage culture may not have similar implementation considerations (don't group together). SELC et al. - Recommend eliminating or clarifying language for Oyster Restoration category-should only consider active oyster growth.	Implementation is viewed in a broader sense related to the crediting protocols. The Panel feels that raft and cage culture would have similar reduction effectiveness considerations based on these protocols. Active oyster growth will be addressed in the crediting guidelines.
Protocols	CBC - Expand on what is meant by additive. SELC et al. - Take into account seasonal variables on growth.	See slide 18 for additive example. The Panel is currently evaluating seasonality.
Baseline	CBF - Current wild and aquacultured populations should be determined; recommend temporal baseline of January 1, 2011 or after (reflects period after the completion of the Bay TMDL).	The Panel will evaluate baseline considerations and seek guidance from the CBP modeling workgroup.
Crediting Guidelines	CBF - Suggest credits only be given to harvested oysters. SELC et al. - Consider separate estimates for triploid versus diploid oysters (many aquaculture growers rely on faster growth rates of triploid stock).	Currently being evaluated by the Panel (see slide 25 for Panel's preliminary conclusions)

Comments on Decision Framework Cont.

Comment Focus	Comment Summarized	Response
Define "suitable from a scientific perspective" and "sufficient data"	CAC, CBF, CBC, SELC et al. - What would constitute as "suitable" and "sufficient"	See slide 11
Using Recommended Methodology to Determine Estimates	CBF - Not supportive of jurisdictions determining estimate using recommended methodology from Panel; any new proposed number should go through Expert Panel review. SELC et al. - Panel should consider recommending a specific protocol with metrics to guide these decisions.	The Panel modified this step (see slide 13).
Unintended Consequences	SELC et al. - How is the Panel addressing accumulation of nutrient biodeposits in systems with heavy aquaculture operations?	The Panel will be identifying unintended consequences and included additional step in framework for consideration (see slide 15).
Protocols	Lynnhaven River Now - Important that the panel continue to consider and determine crediting protocols regarding sanctuary oyster reef nutrient and sediment removal.	The Panel will continue to evaluate using recommended decision framework.

Data and Verification-Related Comments

Comment Focus	Comment Summarized	Panel Response Summarized
Data Concerns	CBF - There isn't enough data to support crediting enhanced burial (not opposed to as an option, but not at this time) CAC, SELC et al. - Not many studies available; STAC identified high variability in the data and spatial and temporal limitations; small amount of available science on sediment sequestration; no identified burial studies with rates.	The framework is being developed to allow for incremental approval for the different reduction effectiveness crediting protocols / oyster practice category combinations. Where there isn't sufficient science the protocol for the category would not be recommended to be used at this time (see slides 17 and 18 for decision flow).
Verification	CAC - Would like specific details on guidelines. SELC et al. - Panel should identify if they are taking a general or specific approach to guidelines. CBF - Any denitrification crediting should be accompanied with verification guidelines given that much variability exists among sites.	Per BMP Expert Panel Review Protocol, the Panel will be taking a general approach (guidelines will focus on variables that should be measured). The Panel included a step covering verification considerations in the framework (see slide 14)

Main Steps of Decision Framework

Step 1: Determine oyster practice categories and individual oyster-associated nutrient and suspended sediment reduction effectiveness crediting protocols for evaluation.

↓

Step 2: For each suitable oyster practice category and reduction effectiveness crediting protocol combination, determine the reduction effectiveness estimate (e.g., number/rate, equation/method to calculate estimate) based on current scientific understanding.

↓

Step 3: Decide if the estimate would be verifiable (i.e., a practical method and the information needed to apply the method exists)

↓

Step 4: Identify unintended consequences for the combination and decide if negative effects could be addressed so they don't outweigh environmental benefits.

↓

Step 5: Recommend BMP crediting and verification guidelines for recommended estimates, addressing key elements described in the CBP BMP Review Protocol and Verification Framework.

*Text in red are modifications to the decision framework

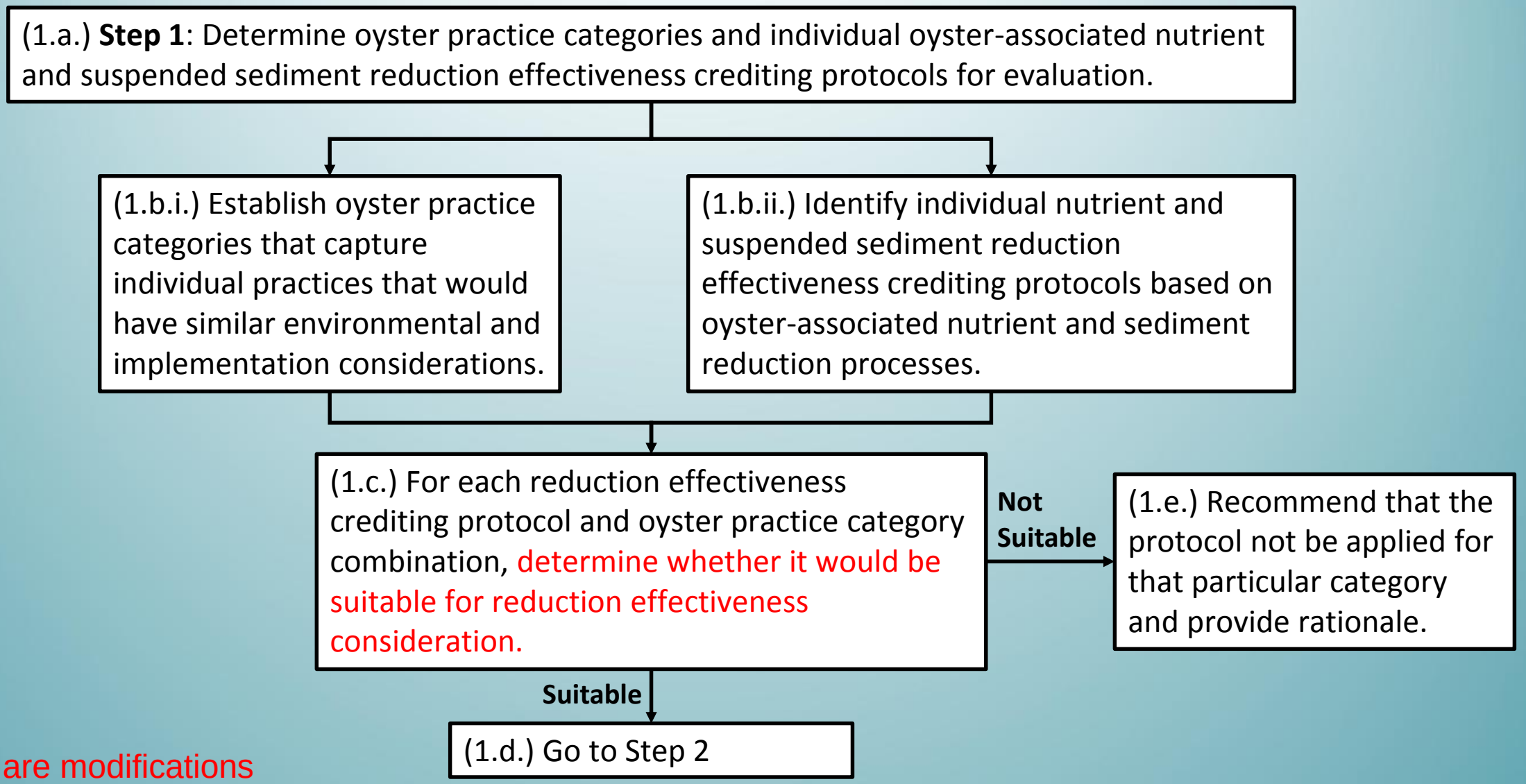
Definitions

Suitable for Consideration: In the Panel's best professional judgement, the reduction process could occur in association with a particular oyster practice category.

Sufficient Science: In the Panel's best professional judgement, data of sufficient quality and scope exist and can be used to generate a reasonably constrained estimate of the reduction associated with a particular oyster practice category.

Verifiable: In the Panel's best professional judgement, a practical method exists, or could be created, to track reduction effectiveness if the BMP is implemented.

Step 1 of Decision Framework



*Text in red are modifications to the decision framework

Step 2 of Decision Framework—Reduction Effectiveness Determination

(2.a.) Step 2: For each suitable oyster practice category and reduction effectiveness crediting protocol combination, determine the reduction effectiveness estimate (e.g., number/rate, equation/method to calculate estimate) based on current scientific understanding.

(2.b.) Is there sufficient scientific data to recommend an estimate?

no

(2.e.) Provide recommendations on how jurisdictions can fill knowledge gaps.

(2.f.) Can knowledge gaps be addressed with a scientifically established methodology so that an estimate could be determined in the near future (within 5 years)?

yes

no

(2.h.) Recommend that the protocol not be used for that practice category at this time until further review by an Expert Panel.

yes

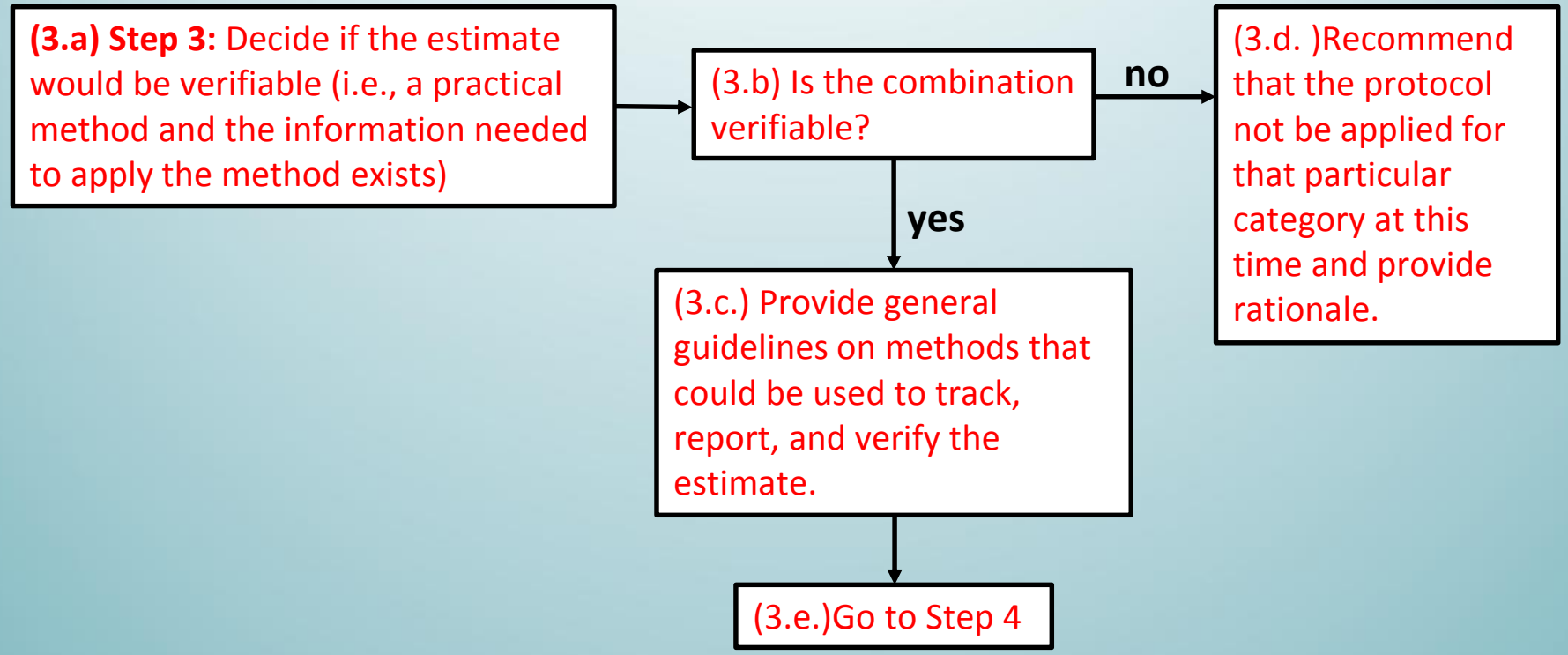
(2.c.) Determine the estimate based on existing science, including the identification and consideration of applicable environmental, baseline, and/or implementation factors that would influence the estimate.

(2.g.) Panel recommends methodology that could be used to determine the estimate. In order for the estimate to be submitted to CBP for approval and potential application, the jurisdiction has to first have an expert validate that the method was applied correctly.

(2.d.) After determining the estimate/calculation/knowledge gaps, go to Step 3.

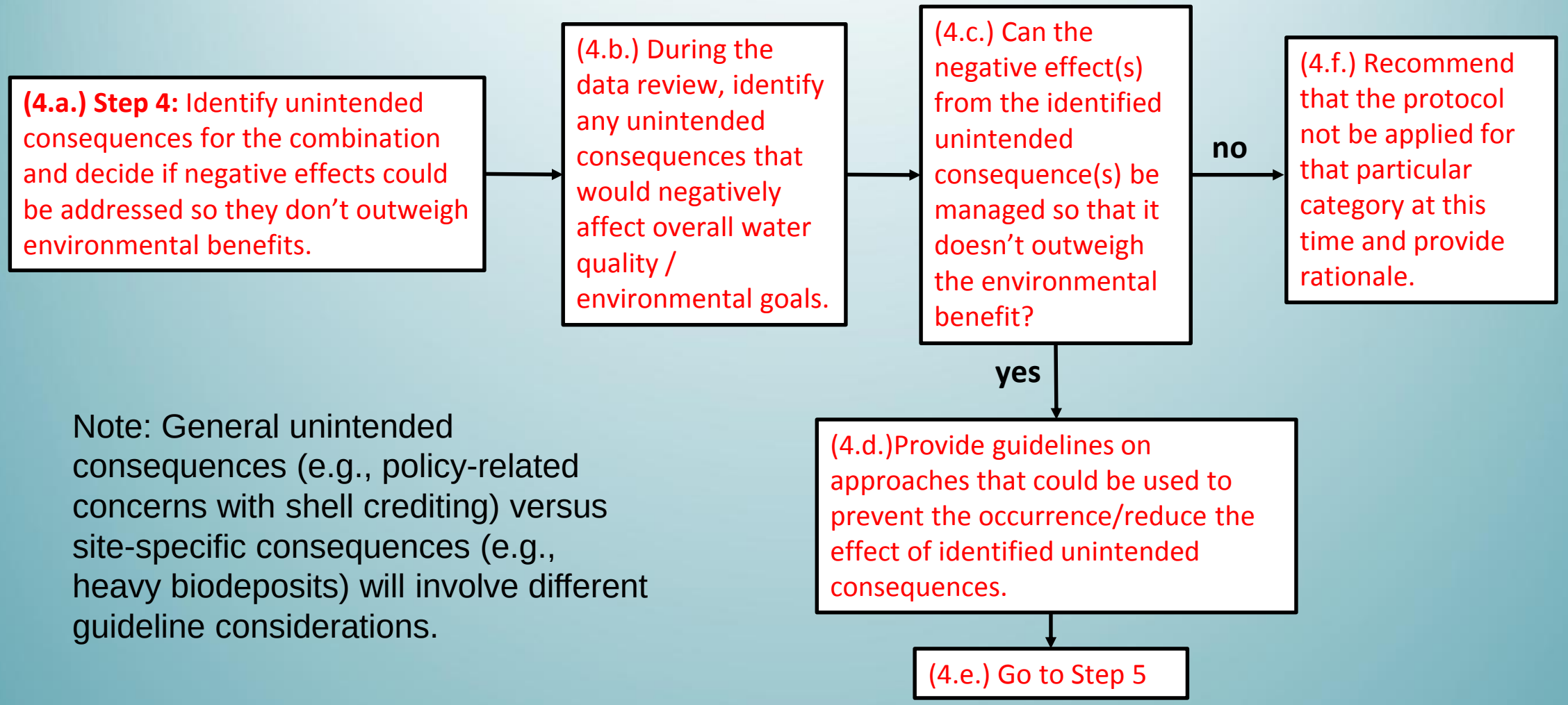
*Text in red are modifications to the decision framework

Step 3 of Decision Framework—Verification



*Text in red are modifications to the decision framework

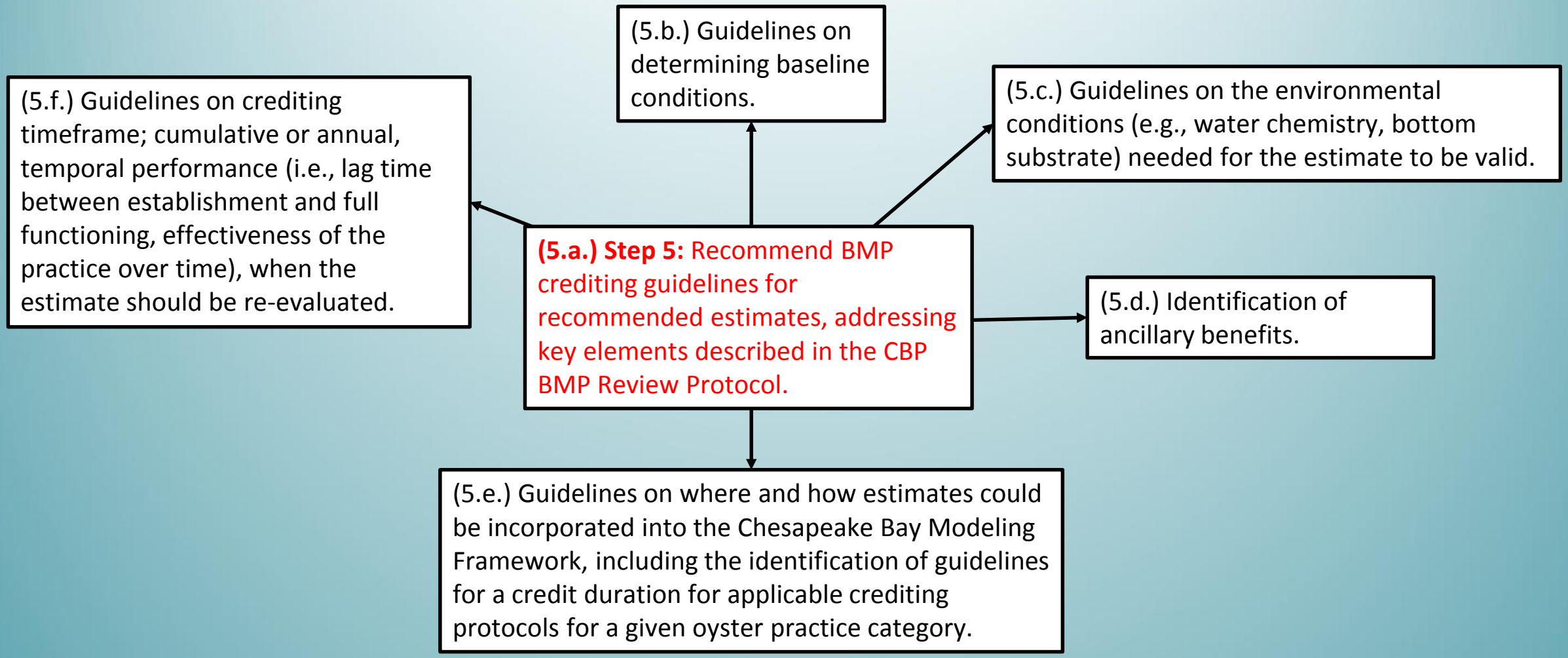
Step 4 of Decision Framework—Unintended Consequences



Note: General unintended consequences (e.g., policy-related concerns with shell crediting) versus site-specific consequences (e.g., heavy biodeposits) will involve different guideline considerations.

*Text in red are modifications to the decision framework

Step 5 of Decision Framework—Crediting Guidelines



*Text in red are modifications to the decision framework

Main Decision Points

Decision Framework Steps

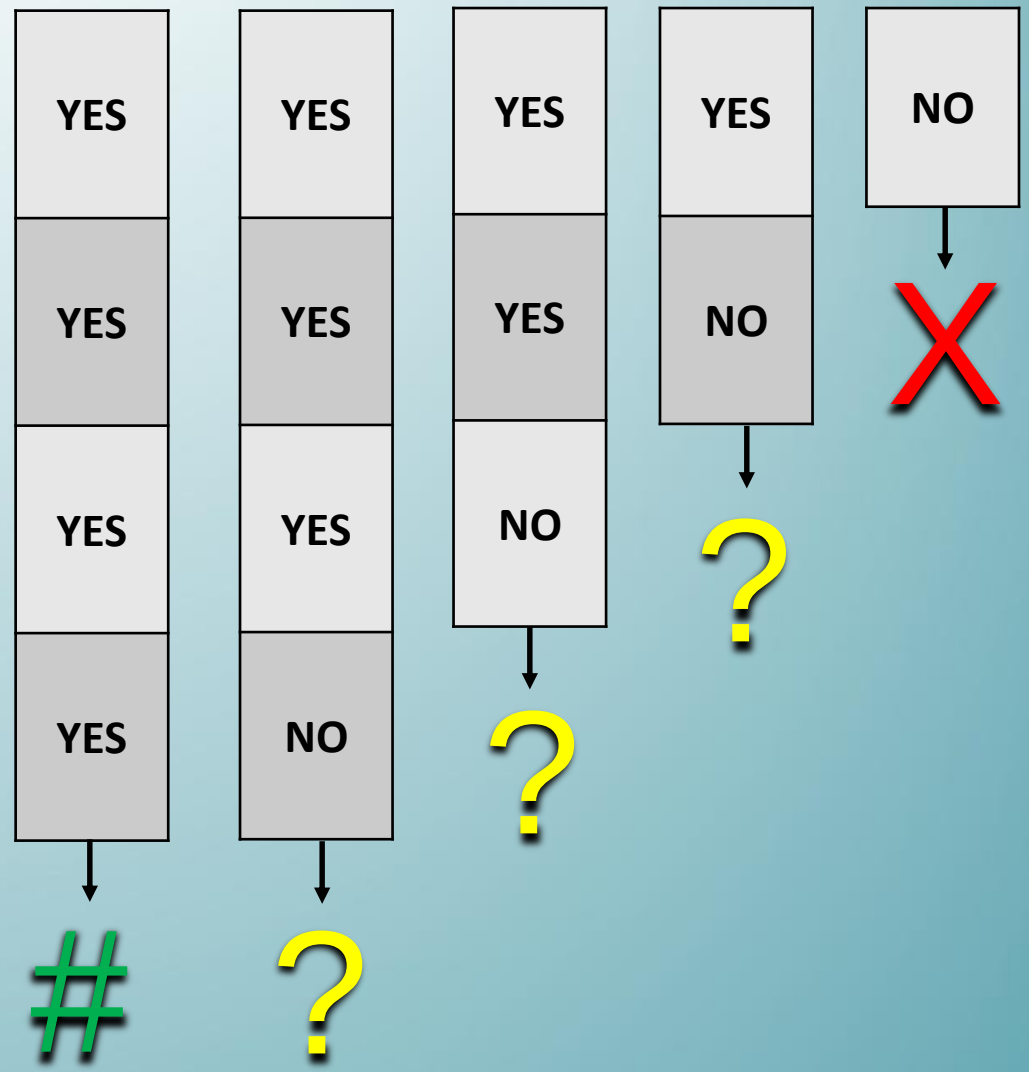
Step 1: Is the crediting protocol/oyster practice category combination **suitable for reduction effectiveness consideration** (i.e., can the biological process occur with that practice)?

Step 2: Is there sufficient science to determine the reduction effectiveness estimate? If not, how could the knowledge gaps be filled?

Step 3: Can the estimate be verified when implemented?

Step 4: Can negative effect from unintended consequence be managed so it doesn't outweigh the environmental benefit?

Decision Outcomes



= The combination meets all of the Panel's criteria for reduction effectiveness crediting; Panel will develop crediting guidelines (Step 5); reduction estimate would be ready to be implemented once approved.

? = Combination does not meet all the Panel's criteria, but could be applied for reduction effectiveness crediting if identified gaps/issues are resolved.

X = Biological process wouldn't occur under practice conditions; should not be implemented for reduction effectiveness crediting.

Decision Outcome Example (Hypothetical)

Oyster Practice Category/ Crediting Protocol Combinations	Oyster Practice Category A	Oyster Practice Category B	Oyster Practice Category C	Oyster Practice Category D
Protocol 1	#	#	?	#
Protocol 2	#	#	?	#
Protocol 3	?	?	?	?
Protocol 4	#	#	?	#
Protocol 5	#	#	?	#
Protocol 6	x	x	x	x
Protocol 7	?	?	x	?
Protocol 8	?	?	x	?

Reduction Effectiveness: E.g., for oyster practice category A, protocols with "#" can all be implemented once approved. Protocols with "?" are pending until data gaps/policy issues are resolved. Once resolved, evaluated by experts, and approved by CBP, the protocol's reduction effectiveness can be added to the total reduction effectiveness for the pollutant the protocol addresses. An "x" indicates that protocol shouldn't be considered for BMP reduction effectiveness application.

Data Review—Nitrogen Assimilation in Oyster Tissue and Shell for Water Column and Bottom Oyster Planting Aquaculture

Methods Reviewed by the Panel to Date:

1. Empirical Approach—Crediting N contained in oyster soft tissue and shells from reported farm-level aquaculture oyster harvest data
   a. Uses established shell size to oyster dry weight conversion equations and analyzed N and P percent content in dried tissue and shell to calculate the total nitrogen assimilated in tissue and shell.
   b. Similar approach as recommendations presented by STAC during July 9 and August 7, 2014 Watershed Technical Workgroup meetings.
2. FARM Model Approach (Ferreira et al. 2007)—Crediting N removal based on model estimates of potential farm-level oyster production via filtration / mass balance
   a. The FARM Model framework combines physical and biogeochemical models, shellfish growth models, and screening models at the farm scale to determine shellfish production and assess water quality changes on account of shellfish cultivation.
   b. Applicable to suspended culture from rafts or longlines and bottom culture.

Preliminary Conclusions: Panelists agreed that the empirical approach could be applied now for both N and P if sufficient data exists. Due to current limitations of the FARM model, the Panel did not feel this method could be implemented for BMP reduction effectiveness determination at this time.

STAC 2014 Recommendations (Water Column Oyster Aquaculture)

Q1. Did STAC recommend nutrient reductions for harvested oysters?

A1. Yes. After a thorough review of the existing science, STAC recommended that oysters harvested from **aquaculture cages (intensive oyster aquaculture)** could receive nutrient reduction benefits based upon the nutrient content of oyster tissue and shells. STAC found that on average:

Parameter	Tissue (% dry weight)	Shell (% dry weight)
Total Nitrogen	8.2	0.21

From STAC Technical Appendix for Caged Oyster Aquaculture presented to Watershed Technical Workgroup: http://www.chesapeakebay.net/channel_files/21399/intensive_oyster_aquaculture_bmp_technical_appendix_07092014.pdf

The Panel is currently evaluating additional data/studies; therefore, their recommended % N contents may be different than the above % N contents recommended by STAC.

STAC 2014 Recommendations

Q2. How will the STAC findings be used to estimate nutrient reductions based on number oysters harvested?

A2. STAC's recommendations assume that the modeling tools will have an estimate of dry weight for each harvested oyster's soft tissue and shell. Shell size can be used to determine dry weight using the equations below from Higgins et al. 2011 in Newell and Mann 2012.

Equation 1. Oyster Tissue Dry Weight

Oyster Tissue Dry Weight (g) = 0.0381(Shell Size (mm)) – 1.5742

Equation 2. Oyster Shell Dry Weight

Oyster Shell Dry Weight (g) = 0.89(Shell Size (mm)) – 34.704

The Panel is currently evaluating other equations for converting shell size to dry weight to % N content and considering variables that could influence the relationships—environmental condition (salinity), ploidy (diploid versus triploid), growout method (water column versus directly on bottom). The Panel's recommended equations may be different than the equations recommended by STAC.

Studies—Nitrogen in Harvested Oyster Tissue

Source	Growing Conditions	% Nitrogen (mean)
Higgins et al. 2011 Maryland / Virginia	Floating cages 2 sites	8.1 7.37
Carmichael et al . 2012 Massachusetts	Off bottom cages (6 cm) 5 Sites	8.47 8.95 8.04 9.19 8.37
Kellogg et al. 2013 Maryland	Restored reef	9.27
Grizzle and Ward 2011 / **2016** New Hampshire	Off bottom cages (20 cm) 6 sites	7.20 / 7.8 6.63 / 7.6 7.55 / 8.3 5.64 / -- 7.39 / 7.4 9.27 / 8.7 -- / 6.9
Dalrymple and Carmichael 2015 Alabama	Cages off bottom (10-20cm)	11.8
Sebastino et al. 2015 New York	Cages 1 m depth 2 sites	8.93 8.94

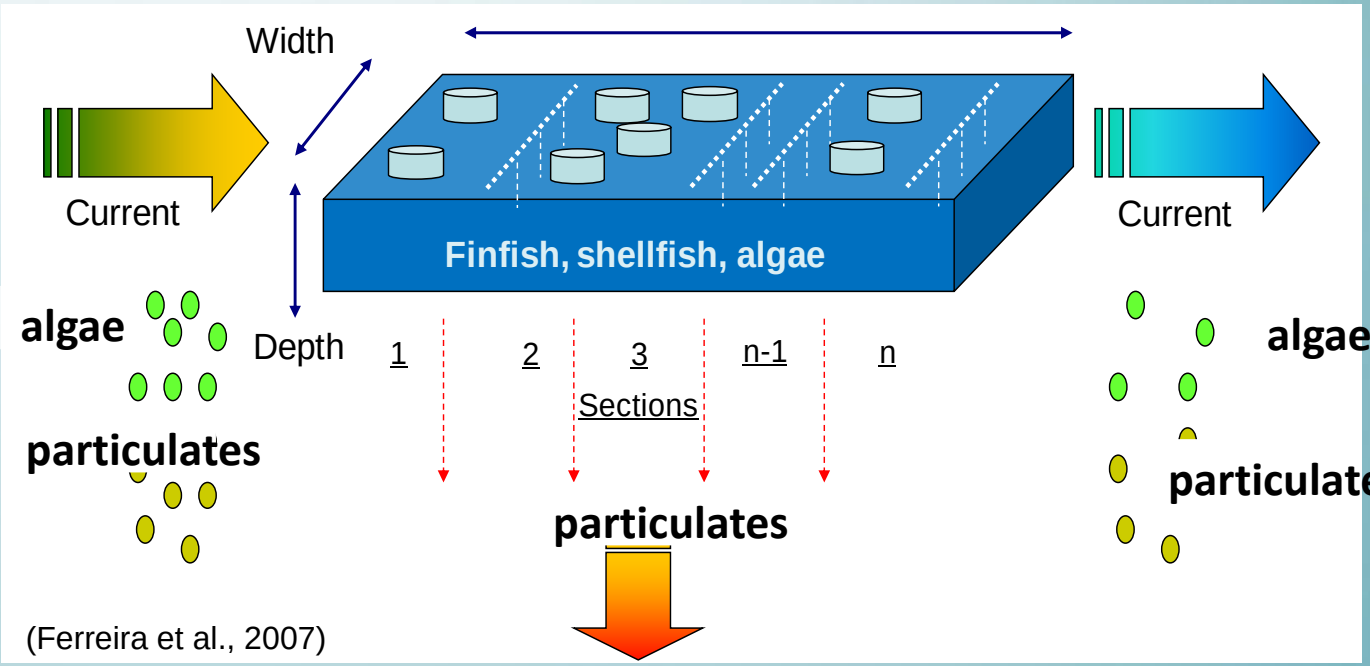
The majority of existing science is on caged aquaculture and % N. The Panel is evaluating whether there are conservative N and P estimates that could be recommended that could be applied to both water column oyster aquaculture and on-bottom oyster planting aquaculture.

Bold studies weren't available during STAC's evaluation

Farm Aquaculture Resource Management Model (FARM) (www.farmscale.org)

Advantages:

- Can apply the model to a single farm to estimate total harvestable biomass over set period of time.
- Estimates the amount of nitrogen assimilated by the whole population (also includes what is added back from excretion, faeces, and mortality).



Limitations:

- The model output doesn't separate N content in oyster tissue and shell (output is biomass of entire oyster population).
- The model does not include how many oysters are associated with the biomass output.
- Site-specific calibration needed for more reliable output.
- The model was designed to determine harvestable biomass; N removal hasn't been thoroughly validated.

Data Review—Nitrogen Assimilation in Oyster Tissue and Shell for Water Column Aquaculture and Bottom Oyster Planting Aquaculture

Preliminary Conclusions by Panel (evaluation still ongoing; full consensus not met yet)

1. Empirical Approach—Crediting N contained in oyster soft tissue and shells from reported farm-level aquaculture oyster harvest data (similar to STAC recommended method)
    a. Straightforward for tissue if harvest is reported (well established methods exist)
    b. Data appears to be available that could be used to determine a conservative nitrogen content estimate for oyster tissue, but the Panel is re-evaluating the % N and the shell size to dry weight relationships (will likely recommend new numbers).
    c. More data is likely needed to determine the phosphorus content estimate for oyster tissue, but this would be easy to do (could use same methods as N).
    d. N and P content in shell could be determined, but verification would be difficult due to not knowing where the shell ends up and what the degradation rate would be (i.e., release of N and P back in the water)
        i. Panelists have expressed concern about shell not being returned to the Bay, which is critical to meet the oyster-related sustainable fisheries goals in the 2014 Chesapeake Bay Watershed Agreement.

Data Review—Nitrogen Assimilation in Oyster Tissue and Shell for Water Column Aquaculture and Bottom Oyster Planting Aquaculture Cont.

Preliminary Conclusions by Panel

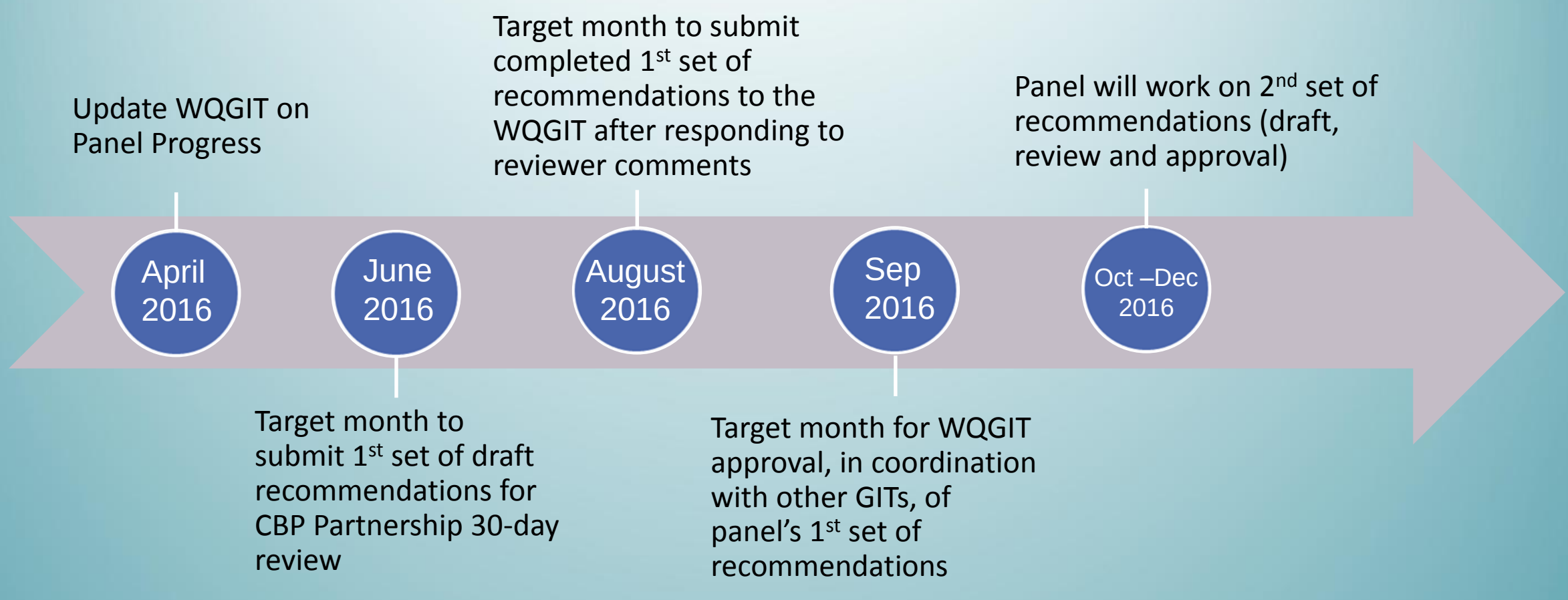
1. FARM Model Approach—Crediting N and P removal based on model estimates of potential farm-level oyster production via filtration / mass balance
    a. Not knowing the # of oysters per size class associated with the biomass and N removal numbers from the FARM model made it not possible to directly compare the amount of N assimilated between the STAC empirical (0.177 as the estimate of N content per market size, 76 mm, oyster) and FARM model approaches.
    b. N content of particulate matter is considered as Redfield ratio with FARM model calculations done via carbon and then converted to nitrogen. Is this representative of the location being simulated? N validation is needed.
    c. Site-specific model calibration would be needed.
    d. The Panel views this as a potential management tool; however, in the context of a method for BMP reduction effectiveness crediting, verification would likely be challenging; model limitations would need to be addressed and new model re-evaluated by an expert panel.

Water Column Oyster Aquaculture—Preliminary Decision Outcomes

Decision Points	Nitrogen Assimilation Oyster Tissue	Nitrogen Assimilation Oyster Shell	Phosphorus Assimilation Oyster Tissue	Phosphorus Assimilation Oyster Shell
Step 1 - Suitable for Consideration	YES	YES	YES	YES
Step 2 - Sufficient Science	YES	YES	Likely NO, but gaps could be easily filled	Evaluation in Progress
Step 3 – Verifiable when implemented	YES	Content-YES; Fate-NO	YES	Content-YES; Fate-NO
Step 4 – Identified Unintended Consequences Manageable	Evaluation in Progress	Evaluation in Progress	Evaluation in Progress	Evaluation in Progress
Preliminary Decision (Subject to Change)	#	?	?	?

On Bottom Oyster Planting Aquaculture would have similar decision outcomes if a conservative % N content in tissue can be determined. IF NOT, then the "#" decision outcome would be a "?" instead.

Oyster BMP Expert Panel Timeline



Where to Send Feedback

Please send any feedback on this presentation by **May 13, 2016** to jreichert@oysterrecovery.org

QUESTIONS?