Context Document: Oyster Reef Restoration Ecosystem Service Conceptual Model for North Carolina

http://bit.ly/NI-ESCM

Ecosystem Service Conceptual Models (ESCMs) are conceptual models that summarize the effects of an intervention, such as a habitat restoration project, on ecological and social systems. Each model links changes in biophysical systems caused by an intervention to measurable socioeconomic, human well-being, and ecological outcomes. ESCMs assume that the restoration is successful and include all potentially significant outcomes for the intervention; not all outcomes will be relevant to each individual project, depending on location and environmental conditions.

The direction of an outcome (whether the restoration will have a positive or negative influence) often depends on the specific situation—or remains unclear due to multiple links (arrows) that may have opposite effects leading into the same outcome. Thus, language like "increased" or "decreased" is not included in the models. These models are often used to consider management with or without an intervention or to compare different interventions.

This context document includes additional information about the restoration approach and details about some of the relationships in the oyster reef restoration ESCM created for North Carolina. The model was built at a workshop held at the North Carolina National Estuarine Research Reserve in February of 2019 and adapted from an oyster reef restoration conceptual model built for the Gulf of Mexico. This document also includes a list of the references used to develop the ESCM and names of experts with whom we spoke to refine the model.

Oyster Reef Restoration Description and Use in North Carolina

Specific techniques for oyster reef restoration vary in the process and materials used; we identified multiple techniques that are used in North Carolina. You can find further description of these types of techniques here.

- Structurally simple, subtidal, intensively harvested
- Structurally simple, intertidal, intensively harvested
- Structurally complex, subtidal, not intensively harvested
- Structurally complex, intertidal, not intensively harvested
- Aquaculture

External Factors That Influence Restoration Success

A number of factors, including environmental factors (salinity, sedimentation) and social factors (institutional constraints, overharvesting), can affect the success of an oyster reef restoration project but are outside of the project's control. During a workshop held to improve and expand this oyster reef restoration ESCM the following external factors affecting project success were identified by participants: illegal oyster harvest, hurricane impacts, fluctuations in dissolved oxygen levels, physical factors (e.g., wind direction, nutrient levels, pH levels), oyster predators

(e.g., drills, boring sponge), changes in seafood markets, limited access to other oyster harvest sites (resulting in exhaustive harvest at restored sites), supply of larval oysters, obtaining appropriate permits for restoration.

Model Notes and Clarifications

Water quality outcomes: While workshop attendees acknowledged that water quality concerns resulting from point and nonpoint source pollutants upstream could not be ameliorated with oyster reef restoration alone, they also acknowledged that water quality as an ecosystem services outcome was incredibly important for all stakeholders. Water quality outcomes such as nutrient concentration, algae blooms, and dissolved oxygen are retained in this model, but participants agreed that oyster reef restoration projects alone were unlikely to result in significant changes to these metrics, except perhaps at an extremely localized level. Those adapting this model to another site should consider whether effects of a particular oyster restoration project would impact these types of outcomes, and if not should remove those outcomes from their version of the model.

Carbon sequestration: Oysters may act as a carbon sink under certain circumstances, but research shows high variation in individual reefs' carbon balances, and the amount of carbon that could be sequestered or emitted by oyster reefs is relatively low. Therefore, these effects are not included in the ESCM.

Shellfish poisoning and microbial infections: Human exposure to contaminated shellfish and microbial pathogens can potentially be influenced by oyster reef restoration. Increased human consumption of oysters can cause adverse health effects like shellfish poisoning. Exposure to harmful ocean water microbes can also potentially be mediated by oysters' ability to filter these pathogens. Both of these links were retained in the model as workshop participants felt they were important to consider, but these linkages are relatively understudied.

Adjacent habitats: Oyster reef restoration can have effects on other types of habitat close to the project site. Changes to these habitats will have their own suite of ecological and socioeconomic effects. In the ESCM, these are referred to under the heading, "Outcomes related to adjacent habitat." If a project is expected to have substantial effects on other habitat types, we recommend referring to the separate ESCM for that habitat type.

Education and science opportunities feedback loops: Education and science opportunities provided by restoration sites will link back to increased restoration elsewhere. With increased awareness about the need for and benefit of habitat restoration, there will (hopefully) be increased demand for healthy habitats by the public and policy makers. This important linkage is not shown in the current model because it is such a long-term outcome.

Experts Consulted

Seth Blitch, The Nature Conservancy

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References

The literature used to develop and refine the oyster reef restoration ESCM is summarized in an evidence library, available for download here.