

Scallop Enhancement for the U.S. Federal Fishery for *Placopecten magellanicus* White Paper

Sally A. Roman and David. B. Rudders

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Introduction

The Atlantic sea scallop, *Placopecten magellanicus*, fishery along the U.S. East Coast has had an extended period of high landings and revenue resulting from management measures and recruitment. While the fishery has enjoyed a protracted period of high landings and revenue, there are concerns regarding the long-term sustainability of the resource. These concerns stem from multiple factors that have the potential to reduce the productivity of the stock. These issues range from natural recruitment variability to emerging issues such as changing oceanic conditions (warming water and changes to circulation patterns) and marine spatial planning (offshore wind development). Stock enhancement offers a possible avenue to maintain or supplement the wild scallop production for the federal U.S. sea scallop fishery. While many elements of a stock enhancement program would be similar to the existing management of the fishery, numerous aspects of enhancement efforts would represent a change in how the resource, managers, and industry interact. These efforts would require not only a foundational understanding of the species and its environment, but a comprehensive treatment of the socioeconomic and policy issues involved with a shift in management approaches.

Implementation of an enhancement program is centered around the biology and ecology of the sea scallop in U.S. waters. These aspects have been extensively studied, and attributes of this species, characterized by fast growth, high fecundity, and frequent large recruiting classes, make this species an attractive candidate for enhancement (Morse et al., 2020). Despite these attributes, numerous data gaps (habitat, reproduction, disease, predators) and technical hurdles (culture methods/husbandry, ocean ranching techniques, marine spatial planning, ownership, economics) exist. These issues have limited the success of scallop enhancement efforts to date.

A Scallop Enhancement Workshop was held in Providence, RI in October of 2024 to discuss the current state of knowledge, share research and technical expertise, and to provide a basis for the potential that this collective knowledge could be used to supplement the wild-caught fishery, as well as potential refinement of sea scallop aquaculture approaches on the U.S. East Coast. The workshop was supported through NOAA's Sea Scallop Research Set-Aside Program (RSA) and guided by a steering committee and a professional facilitator. Details about the workshop can be found in the Workshop Proceedings document. The four focus areas discussed were:

- Seed production,
- Planting & Transplanting,
- Ecological Considerations, and
- Regulatory & Management Regimes.

The objective of this white paper is to highlight the strengths and weaknesses of pursuing scallop enhancement efforts in federal waters, as well as opportunities and challenges for scallop enhancement, with a focus on the four topic areas of the workshop. The discussion of these topics will focus on science, management, policy, and the application of enhancement efforts for the scallop fishery and stakeholders.

Strengths

Seed production – Scallop seed, or spat, is currently collected from the wild population in the US by deploying passive collection devices suspended in the water column. One advantage of gathering spat from the wild population is that seed can be collected from areas of marginal habitat, where the probability of survival is low once settlement occurs. This collection approach maximizes the survival of recruits in the wild population while minimizing the negative impact on recruitment in areas where commercial fishing occurs in federal waters. This method could also reduce potential user conflict issues between commercial scallop fishermen and individuals or companies collecting seed for aquaculture-based approaches. Commercial fishermen depend on scallop recruits to enhance the wild population available for commercial harvest. Currently, individuals or companies collecting seed for aquaculture-based approaches rely almost exclusively on wild spat collection for hatchery operations.

Another strength of collecting wild spat is the genetic diversity in the wild population. This genetic diversity may aid in reducing disease and allow scallops to adapt to varying environmental conditions relative to scallops reared in hatcheries, where genetic diversity may be limited until methods for selective breeding are developed for this species.

While efforts to develop hatchery-based production for sea scallops have been investigated for many years, technical challenges (e.g., long larval period, scalable nursery techniques) have proven to be difficult. Recent progress in this area has been encouraging, and replicable success has been experienced, which suggests that techniques to reliably produce *P. magellanicus* seed in the hatchery may be a realistic possibility. In support of this effort, hatchery capacity exists in regions (e.g., Gulf of Maine) that possess favorable environmental conditions to support hatchery-based production. These facilities appear open to exploring the viability from a technical and economic perspective to produce sea scallop seed in hatchery-based systems. Depending on scale, this approach could potentially support smaller-scale production and enhancement at finite spatial scales in certain systems.

Planting & Transplanting – Several countries, including Japan, Canada, and the US, have conducted research on this topic to support enhancement efforts, and this experience can inform future enhancement efforts for the US East Coast. While each effort has varied based on the specifics of their respective systems, as well as biological

and ecological characteristics, these experiences can provide valuable insight into a framework for potential sea scallop resource enhancement efforts based on transplantation of seed. Specifics of these research efforts have focused on seed collection methods, collection sites, settlement sites, predator issues, and transportation. Lessons learned and findings from this research can also help inform best management practices for future planting and transplanting efforts for the federal scallop resource.

Ecological Considerations – Extensive research and understanding of scallop biology and ecological factors impacting scallop survival and growth exist for the sea scallops on the US East Coast. Ecological factors studied include habitat preference and oceanography (e.g., temperature and ocean circulation) and predator assemblages and dynamics. Understanding of how the sea scallop fits into the ecology of the Northeast Continental shelf system is supported by many decades of resource assessment surveys, oceanographic data, and stakeholder knowledge.

Regulatory & Management Regimes – While modifying the management process to include scallop enhancement will take time, the New England Fishery Management Council (NEFMC) will be developing a 3–5 year strategic plan for scallops as early as 2026. Discussions at the workshop indicated that scallop enhancement would be included in the strategic plan. This would be the initial step toward incorporating scallop enhancement considerations into the Fishery Management Plan (FMP).

Weaknesses

Seed production – Variability in the quantity and quality of scallop seed collected from the wild population exists due to changing environmental conditions and manmade disturbances. The inherent variability of relying on seed from the wild population could limit the scale of production to meet commercial needs in quantity, quality, and financially. Scallops, especially at the juvenile stages, have thin shells, do not possess the ability to fully close their valves (desiccation risk), and are sensitive to high temperatures. These attributes make them susceptible to high levels of mortality throughout the transport process during hatchery-based operations or transplanting.

Hatchery production of sea scallops is challenging due to their long larval phase and sensitivity to environmental changes. Results from various experiments, including temperature and buffering trials, highlight the need for further research on selective breeding and husbandry through the larval and juvenile phases. Harnessing the productivity of the wild resource with respect to seed collection may be viable for a component of seed production; however, there is also a need to further understand how to optimize site selection for spat collection to be resilient to environmental and man-made (i.e., offshore wind development) changes in the environment. This is coupled with an understanding of the quantity of seed that would be needed to support the

enhancement of the federal commercial fishery. A final weakness is hatchery site selection. Due to the optimal water temperatures and environmental parameters required for sea scallops survival, many studies of hatchery production have taken place in the Gulf of Maine (GOM). There is a concern that the GOM could limit the scale of production needed to support the commercial fishery due to size constraints. There is also a concern about potential inequity resulting from the optimal area for rearing scallops being the GOM. Further research into expanding hatchery capacity in areas outside of the GOM should be investigated. For the seeding of sea scallops to have an impact at a larger scale, hatcheries would need to be tested along on the U.S. East Coast. The development of hatcheries along the East Coast could aid in minimizing transportation mortality and perceived inequity across stakeholder groups.

Planting & Transplanting – There has been limited success with planting and transplanting of wild sea scallops in U.S. federal waters. Issues include the best methods to capture and move scallops, relocating scallops after transportation, low survival, and high rates of predation. Transporting scallops from hatcheries to the wild population after the grow-out process also requires further understanding to determine best management practices to reduce mortality.

Ecological Considerations – There is limited research on other ecological factors, such as dissolved oxygen, food supply, and oceanographic conditions, that can affect scallop survival and growth. Other ecological concerns, such as predator abundance and distribution, also require additional understanding. The larger impacts of climate change on scallop distribution, survival, and growth should also continue to be assessed.

Regulatory & Management Regimes – Implementing a scallop enhancement program will require significant changes to the Atlantic Sea Scallop FMP, involving a multi-year process and collaboration among the NEFMC, NOAA Fisheries, the scallop industry, and stakeholders. This timeline will prohibit planting or transplanting of wild populations in the near future that could benefit the federal fishery. It is also unclear as to which other aspects of the regulatory and legal ecosystem would be relevant to this effort. Understanding this aspect of any enhancement effort is critical to moving forward.

Opportunities

Seed production – Several opportunities exist to fill data gaps in seed production. Understanding how to increase the survival of spat being reared in hatcheries can be viewed as the first hurdle in the process of taking steps toward scallop enhancement for the federal fishery. Identifying best practices to transport scallops from hatcheries to aquaculture farms and/or commercial federal scallop fishing areas is also an area where additional research is needed. The scalability of scallop hatchery and aquaculture to support the federal fishery and/or components of the federal fishery needs to be understood. This includes site selection for capture of wild spat, site selection for

aquaculture farms, site selection for potentially transplanting scallops for commercial harvest in federal waters, and an economic analysis to understand the financial support needed to supplement the federal fishery at any level. Having a reliable source of scallop seed for enhancement efforts is critical to supporting longer-term enhancement efforts and supplementing commercial wild harvest.

Planting & Transplanting – This topic area also has several areas where the knowledge base can be expanded through continued research and refinement of techniques. Research opportunities focusing on developing methods to capture and move scallops to preferred habitat while minimizing mortality and predation would be beneficial. This research should be focused on both the wild population and hatchery-reared scallops. Another research topic suggestion would be to understand the differences between the wild population and hatchery-reared scallops (i.e., genetic diversity, shell thickness, meat quality and yield). This would also lead to understanding if there is a need to be able to distinguish between the wild population and the hatchery-reared scallops in federal waters. This may be needed for assessment and management purposes. The application of habitat suitable models to aid in site selection that would identify areas where scallop growth and survival would be maximized should be investigated.

Ecological Considerations – Research to understand relationships between ecological factors such as climate change, dissolved oxygen, food supply, and oceanographic conditions and scallop distribution, survival and growth should continue. An opportunity also exists to have a better understanding of predator populations and distribution to help inform site selection in the future.

Regulatory & Management Regimes – Opportunities for cooperation between federal and state management agencies, as well as scallop fishery stakeholders and hatchery businesses, will boost scallop enhancement efforts. Both Japan and France demonstrated that cooperation among all parties involved in enhancement efforts was vital to successful enhancement efforts in both countries. A way to provide guidance for the regulatory and management process is to have investigators, states, and hatcheries pursue independent research outside of the management process and timeline. This will allow the generation of solutions, experience, and necessary knowledge for when the NEFMC is ready to begin implementing enhancement measures in the FMP. The NEFMC will need to identify research priorities and appropriate funding sources outside of the Sea Scallop RSA Program, as the RSA is subject to constraints of identified research priorities and the limitations of specific proposals submitted to address those identified priorities. Exploring collaboration with the surfclam fishery/research community may be possible and productive, as the surfclam community is also investigating enhancement techniques.

Challenges

Seed production – Challenges for seed production mirror several of the weaknesses and opportunities for this topic. There are several main challenges, including increasing survival at all stages of the process, having a reliable source of spat, and site selection for all grow-out phases. Another challenge could be the potential lack of equity for stakeholders with respect to hatchery and aquaculture farms locations and the opportunity to expand current business models to include seed production or collection. This challenge is a function of scallop biology and the environmental conditions needed to rear scallop seed. Funding to support seed production/collection may also be a challenge to acquire in the future.

Planting & Transplanting – The main challenges of relocating either hatchery-reared or wild scallops include the changing offshore environment, as well as the technical issues related to the capture and transport of scallops. This includes minimizing shell damage and mortality. Additional challenges include site selection, monitoring, predation, survival, and the source of seed. Funding to support research, data collection, and transplantation of scallops may also be a challenge to acquire in the future.

Ecological Considerations – Understanding current and future ecological factors and how those factors affect scallop survival, growth, yield, and the impact on the availability of productive scallop habitat is the greatest challenge. Also, being able to predict the impacts of climate change on scallops is a challenge. Funding to support research and data collection may also be a challenge to acquire in the future.

Regulatory & Management Regimes – Several key regulatory and management issues will need to be addressed to implement scallop enhancement. Fishery managers will need to consider how to manage hatchery-reared and wild scallops. Offshore aquaculture in federal waters will require permitting, which can have a lengthy timeline. The issue of equity across user groups and access to planted or transplanted scallops is another management concern that will need to be considered for the FMP and management measures. Also, the timeline for including enhancement efforts in the FMP may mean forgone harvest in the near future as transplanting of scallops is not currently included in the FMP.

Conclusions

There are cross-cutting themes across topic areas that will have an impact on future scallop resource enhancement efforts. While there are numerous technical challenges and gaps in our understanding of the underlying processes that are important for enhancement, much is already known about the Northeast shelf and sea scallops specifically. There is a need for additional research to fill data gaps in seed production, planting and transplanting, and ecological considerations. These data gaps should be used to develop a comprehensive roadmap forward to provide the knowledge

to underpin future resource enhancement efforts and generate recommendations for best practices across all three areas.

Establishing a cooperative framework that involves managers, scientists, stakeholders (i.e., commercial scallop and hatchery aquaculture businesses), and investigators will be necessary to establish any successful enhancement program, as this effort significantly bridges currently distinct efforts (aquaculture and wild capture fisheries). This effort would require creative thinking and cooperation between organizations and groups, and coordination to collect seed, plant or transplant scallops, remove predators, and harvest scallops. A major effort will be to essentially retrofit how the seafood production paradigm exists in the regulatory, legal, and policy realms, as well as provide a mechanism to support a new production strategy in federal waters. Bringing together a collective with the varied capacity to move forward an enhancement effort at scale will be a significant and potentially long-term endeavor.

Securing sources of long-term funding to support enhancement efforts will be necessary if small-scale enhancement efforts show promise and expansion to support the federal fishery is required. As stated in the Regulatory & Management Regimes Opportunities section, the RSA program may provide some support for enhancement efforts, but RSA priorities would need to reflect the need for enhancement research or enhancement efforts, like transplanting scallops. Also, understanding the economics of scallop enhancement is needed to assess if enhancement efforts are viable at larger scales for different components of the enhancement process. Transplanting wild scallops from marginal habitat to preferred habitat may be more cost-effective than planting hatchery-reared scallops in federal waters. Without an economic analysis, these questions remain unanswered.

References

Morse, D.L., Cowperthwaite, H.S., Perry, N. and Britsch, M. 2020. Methods and materials for aquaculture production of sea scallops (*Placopecten magellanicus*).