Executive Summary

Draft Programmatic Environmental Impact Statement for Oyster Restoration in Chesapeake Bay

Responsible Agency: U.S. Army Corps of Engineers, Norfolk District

ABSTRACT: The Norfolk District of the U.S. Army Corps of Engineers, the Maryland Department of Natural Resources, and the Virginia Marine Resources Commission have prepared a Draft Programmatic Environmental Impact Statement (PEIS) to present information regarding a variety of strategies for attempting to restore the population of oysters throughout Chesapeake Bay. The proposed action is to introduce a nonnative species, the Suminoe oyster, and continue efforts to restore the native Eastern oyster. The Suminoe oyster is a native of the China Sea that has environmental requirements and tolerances similar to those of the Eastern oyster but is resistant to diseases that have adversely affected the Eastern oyster. Eight reasonable alternatives that would involve both oyster species individually or together were evaluated during the study. This Draft PEIS addresses the direct and indirect effects of the proposed action and alternatives on ecological, environmental, and human issues identified during the public interest review. All factors that may be relevant to the proposed action and alternatives were considered. Those factors include the oyster population in the Bay, selected other components of the ecosystem of Chesapeake Bay, water quality, threatened and endangered species, essential fish habitat, social factors, economics, aesthetics and recreation, historic and archaeological resources, wetlands, sanctuaries and refuges, environmental justice, air quality, public safety and fouling, commercial navigation, and potentially affected resources outside Chesapeake Bay. As part of the NEPA process, a public participation and commenting period will be held from October 17, 2008, to December 15, 2008. Six public meetings will be held, three in Maryland and three in Virginia. Oral comments during the public meetings will be considered, and any reader may submit written comments on this Draft PEIS (preferably in electronic format). All comments must be received no later than December 15, 2008. The public response to the findings of the Draft PEIS will provide direction for the preparation of the Final PEIS.

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E.1 PROJECT OVERVIEW

This Draft Programmatic Environmental Impact Statement (PEIS) was developed by the U.S. Army Corps of Engineers (USACE), Norfolk District, and its non-Federal sponsors, the Maryland Department of Natural Resources (DNR), and the Virginia Marine Resources Commission (VMRC), in accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA; 42 USC 4321-4347), 40 CFR Parts 1500-1508, and 33 CFR Parts 230 and 325. This document assesses a range of options for restoring oysters to the Chesapeake Bay and evaluates the potential environmental consequences of those options. The need for an environmental impact statement was triggered by the proposed action, which is to introduce the nonnative Suminoe oyster to the Chesapeake Bay while continuing efforts to restore the native oyster. The process of evaluating a proposed action and alternatives for achieving the same goal generally results in the identification of a preferred alternative that establishes the course of future action. A programmatic evaluation (i.e., a PEIS) is used when subsequent NEPA analyses and documents may need to be prepared in tiers as narrower, more site-specific plans for implementing the preferred alternative are defined. A PEIS is especially valuable when considering actions that encompass a large geographic scale or that constitute complex programs, both of which are characteristics of the joint State and Federal effort to restore the size and functions of the oyster population throughout Chesapeake Bay. The information and assessments presented in this Draft PEIS are intended to help ensure that Federal and State agencies and private organizations work coherently and consistently toward a common restoration goal. The scope of this Draft PEIS is to evaluate the potential effects of the proposed action and each alternative on all elements of the environment that may be affected in as much detail as is possible, given the uncertainties about implementation. To facilitate the evaluation, representative implementation plans were created for the proposed action and each alternative to provide a basis for analyzing the potential adverse effects and benefits that might result from implementing those actions. The plans were designed to be reasonably realistic; however, they are not recommendations or specific proposals, but only representations of the kinds of actions that might be taken to implement each of the broad programmatic alternatives.

The analyses for this Draft PEIS were based on the best information available. The uncertainties associated with the use of limited or questionable data are described, and the consequences for conclusions are discussed. This PEIS has served the important purpose of facilitating collaboration among Federal, State, and local agencies that will be involved in future oyster restoration efforts.

E.2 PURPOSE AND NEED

The Eastern oyster *(Crassostrea virginica*) was once so abundant in Chesapeake Bay that it inspired the Algonquin to name the bay *Chesepiook*, meaning "great shellfish bay." The abundant oyster was a keystone species that provided a variety of ecological services within the Chesapeake Bay ecosystem. It was a primary component of the Bay's filtration system and provided rich habitat for many other species (Newell 1988). Oysters filter water to feed on small plankton, removing sediment and other particles from the water column, clearing the water, and increasing light penetration in the process. Improved water clarity promotes the growth of underwater grasses, which benefit blue crabs and many other aquatic organisms. Oyster reefs

also provide a unique kind of habitat for fish and other species in the Bay. In addition to its ecological functions, the Eastern oyster was as an important food resource for Native Americans and early European settlers, and the Bay's oyster fishery developed into a large export industry during the 1800s. The Chesapeake oyster fishery became the largest in the world during the 1880s (NRC 2004). Towns such as Crisfield on Maryland's Eastern Shore were established and prospered solely on the basis of the abundance of oysters in local waters. The oyster became widely recognized as an important cultural symbol of the Chesapeake Bay region.

Commercial landings of oysters in Chesapeake Bay declined steadily during the late 19th and early 20th centuries, and harvest yields were reduced by half in the 50 years between the late 1880s and about 1930. Major factors believed to have contributed to that decline include intense fishing pressure, mechanical destruction of habitat, siltation of optimal substrate, and overfishing. One hundred years of increasingly intensive and mechanized fishing contributed to leveling the profile of the oyster bars in Chesapeake Bay (Rothschild et al. 1994). Declining water quality also contributed to reducing the oyster population. Clearing of forests and development of land within the Bay's watershed caused increased agricultural runoff, sedimentation, nutrient input, and environmental pollution that killed oysters or created conditions that were less favorable for them (Kemp et al. 2005; Boynton et al. 1995)

During the mid-20th century, oyster harvests remained comparatively stable for several decades (through the late 1970s) before beginning another steep decline that continues to the present. The Bay's oyster population is now estimated to be less than 1% of its size during the 1800s (Newell 1988). The more recent decline in the population has been attributed primarily to the introduction of two foreign diseases to which the Eastern oyster had no resistance. The diseases Dermo and MSX are harmless to humans but usually are fatal to Eastern oysters. These diseases have been particularly detrimental to the oyster fishery because they kill many oysters before they reach market size. The high rate of mortality caused by these diseases not only decreases the number of oysters available for harvest, but also reduces the number of large, highly reproductive oysters that are left to propagate the species. Overall, oyster populations in the Bay are now strongly controlled by disease pressure (Ford and Tripp 1996) as well as the continuing loss of hard bottom and oyster shell essential for their successful reproduction. Harvest, various kinds of degradation of oyster habitat, poor water quality, and complex interactions among these factors are also negatively affecting oysters (Hargis 1994; NRC 2004).

Although some localized successes in restoring oysters have been documented as a result of more recent restoration activities, current management, repletion, and restoration programs do not appear to be reversing the overall, Bay-wide decline in the oyster population. Given that oyster diseases appear to be a major factor inhibiting recovery, the States began investigating the possibility of introducing a nonnative oyster that is resistant to disease. The Suminoe oyster (*Crassotera ariakensis*), a native of the China Sea, was found to have environmental requirements similar to those of the Eastern oyster and to be resistant to MSX and Dermo. In various studies conducted in the Bay, the Suminoe oyster exhibited greater survival rates and grew faster than the native Eastern oyster. Those studies suggested that the Suminoe oyster has the potential to improve the oyster fishery and water quality in Chesapeake Bay, which encouraged greater interest in the possibility of introducing the species.

Planned and unplanned introductions of nonnative species often have had negative effects on the ecosystems that receive them; furthermore, the introduction of a naturally reproducing nonnative species into an open aquatic environment is almost certainly irreversible. To assess the risks involved with introducing the Suminoe oyster into the Bay, the Chesapeake Bay Commission, the Chesapeake Bay Foundation, the U.S. Environmental Protection Agency, and the U.S. Senate Committee on Appropriations asked the National Research Council (NRC) of the National Academy of Sciences to describe the state of knowledge about the Suminoe oyster and begin assessing the risks involved with introducing the species in Chesapeake Bay. This study (NRC 2004) identified gaps in the state of knowledge about the Suminoe oyster and recommended research needed to support an adequate risk assessment. Beginning in 2004, Maryland, Virginia, the Potomac River Fisheries Commission, and the National Oceanic and Atmospheric Administration funded extensive research on the Suminoe oyster, much of it focused on risk questions identified in the NRC's report. This Draft PEIS incorporates the findings of those studies that are available to date.

USACE, VMRC, and DNR all have been conducting extensive programs to restore the native oyster in Chesapeake Bay for many years. The concept of introducing a nonnative species to achieve the oyster restoration objective for the Bay is very controversial and deviates significantly from all prior restoration efforts. For these reasons, the agencies concluded that it would be appropriate to prepare a PEIS evaluating the proposed introduction and alternatives that might also be feasible means of reaching the restoration objective. The restoration objective encompasses both ecological and economic goals; therefore, alternatives involving aquaculture are included among the range of actions considered in this Draft PEIS.

The following statements of need and purpose for action to restore oysters in Chesapeake Bay were developed through public-scoping meetings held in 2004:

> ***A need exists to restore the ecological role of oysters in the Bay and the economic benefits of a commercial fishery through native oyster restoration and/or an ecologically compatible nonnative oyster species that would restore these lost functions.***
>
> ***The purpose of this proposal is to establish an oyster population that reaches a level of abundance in Chesapeake Bay that would support sustainable harvests comparable to harvest levels during the period 1920–1970.***

E.3 ASSESSMENT OF ENVIRONMENTAL CONSEQUENCES

Management programs and scientific studies devoted to the Eastern oyster have been diverse, but most were conducted for purposes very different than addressing the kinds of issues evaluated in this PEIS. Basic characteristics, such as the size of the Bay-wide oyster population, the percentage of oysters that are harvested each year, and the rate of growth of oyster populations at different locations in the Bay and in different years, have been only poorly defined. Despite their limitations, the data and results from those programs and studies were the only resources available for use in conducting an assessment and served as the primary basis for the assessments of the Eastern oyster presented here. The uncertainties that result from data limitations are acknowledged in those assessments. In response to interest in introducing the

Suminoe oyster into Chesapeake Bay, State and Federal agencies funded an extensive research program to investigate the species (Section 1.4). Much of that research has been completed, but some studies are still in progress. All available information from those studies, whether completed and peer-reviewed or continuing and documented only in progress reports, has been used to assess the potential effects of the proposed action and alternatives that involve the Suminoe oyster. The assessments take into account the uncertainties associated with the use of preliminary or incomplete study findings. Analyses and conclusions based on all these data were subjected to a rigorous peer review process throughout the development of this Draft PEIS. Sequential peer reviews contributed to identifying limitations of the analytical tools and findings. The peer reviews established scientifically acceptable bounds concerning how the results should be employed in the PEIS, and the assessment of environmental consequences presented in this section recognizes those bounds.

A major objective for the analysis of the proposed action and the alternatives was to assess the extent to which each might contribute to attaining the goal established in the statement of purpose. The numeric benchmark value of that goal was estimated to be 12 billion market-size oysters, which could support an annual harvest of 1.4 billion market-size oysters (5 million bushels), if all the harvest was from wild stock. No data are available that could be used to estimate the number of oysters smaller than market size that would be required to maintain a population of 12 billion market-size oysters; therefore, a restoration goal for the entire oyster population could not be quantified. As a point of reference, the baseline 2004 Bay-wide population of market-size Eastern oysters was estimated to be 809 million. Substantial aquaculture production would reduce the size of the wild stock required to attain the total harvest goal of 5 million bushels; consequently, the development of a large aquaculture industry capable of producing 5 million bushels a year would obviate the need for any wild stock. A fully restored wild stock would be essential, however, to restore the ecological services that oysters provide to the Bay and satisfy the statement of need for action. The analyses presented in Section 4.1 illustrate a potential contradiction inherent in the statement of purpose between the goals of restoring the ecological services of an abundant wild stock of oysters and restoring the economic contributions of the oyster fishery when the proposed action and alternatives are considered individually as potential means of reaching those goals. The combinations of alternatives developed by the lead agencies when the Draft PEIS was nearing completion, all of which include aquaculture of one or both species of oysters (E.4.9), provide a possible approach for resolving that contradiction.

The stated purpose of the actions evaluated in this PEIS is to increase the abundance of oysters in the Bay to match a historical reference population; therefore, the assessment of each alternative begins with an evaluation of the alternative's potential for attaining the numeric benchmark estimate of that historical reference population. Next, effects on other components of the ecosystem and water quality of Chesapeake Bay are addressed. Additional sections address the potential consequences of each alternative for rare, threatened, and endangered species, essential fish habitat, and all other elements of the affected environment, including topics such as recreation, aesthetics, economics, and socioeconomics. Data and information used in the PEIS analyses had a wide range of quality and reliability; therefore, the level of uncertainty associated with all projections and assessments is substantial. Uncertainty can result from unpredictable, large natural variability in some factor of known importance to a predicted outcome as well as from lack of knowledge about other factors that might also influence an outcome. The sources

of uncertainty are identified, to the extent possible, in this Draft PEIS, and the consequences of the uncertainty are described.

A Draft PEIS typically identifies a preferred alternative selected from among the proposed action and alternatives based on the results of the analyses and associated conclusions about environmental effects. This Draft PEIS evaluates a very broad range of potential actions, including several that are quite controversial; moreover, the group of stakeholders who are interested in the final outcome of this evaluation is exceptionally large and diverse. For these reasons, the USACE, DNR, and VMRC, in consultation with the cooperating Federal agencies, concluded that the best way to move the evaluation forward is to release a Draft PEIS without identifying a preferred alternative. In this way, the input of all interested stakeholders who review the Draft PEIS can be considered in identifying any further analyses and assessments that may be required to support a selection and ultimately in selecting the appropriate action.

E.4 PROPOSED ACTION AND ALTERNATIVES

E.4.1 Proposed Action

The State of Maryland and Commonwealth of Virginia propose to introduce the Suminoe oyster (*C. ariakensis*) into the tidal waters of Maryland and Virginia, beginning as soon as a rigorous, scientifically based PEIS is completed and a Record of Decision prepared, for the purpose of establishing a naturalized, reproducing, and self-sustaining population of this oyster species. Diploid Suminoe oysters would be propagated from existing third or later generations of the Oregon stock of the species, in accordance with the International Council for the Exploration of the Sea's (ICES) *Code of Practices on the Introductions and Transfers of Marine Organisms 1994 (ICES 1995*). Deployment of diploid Suminoe oysters from hatcheries is proposed to occur first on State-designated sanctuaries separate from native oyster restoration projects, where harvesting would be prohibited permanently, and then on harvest reserves and special management areas, where selective harvesting would be allowed. Suminoe spat would be placed on existing bars that do not require habitat rehabilitation. The States further propose to continue efforts with the USACE to restore the native Eastern oyster throughout the Chesapeake Bay by using the best available restoration strategies and stock assessment techniques, including maintaining and expanding the existing network of sanctuaries and harvest reserves, enhancing the brood stock, and supplementing natural recruitment with hatchery-produced spat.

A representative plan for introducing the Suminoe oyster was developed to serve as input to a model of the demographics of the Eastern oyster in Chesapeake Bay. That plan is described in detail in Section 4.1.1. Current restoration programs for the Eastern oyster that would continue as part of this action are described in detail in Section 4.1.2.

E.4.2 Alternative 1: No Action

This alternative consists of continuing Maryland's present oyster restoration and repletion programs, and Virginia's oyster restoration program under current program and resource management policies and available funding using the best available restoration strategies and stock assessment techniques.

The details of the activities assumed under this alternative are presented in Section 4.1.2.

E.4.3 Alternative 2: Enhance Efforts to Restore the Native Oyster

This alternative consists of expanding, improving, and accelerating Maryland's oyster restoration and repletion programs, and Virginia's oyster restoration program in collaboration with Federal and private partners. This work would include but would not be limited to an assessment of cultch limitations and long-term solutions for this problem, and the development, production, and deployment of large quantities of disease-resistant strain(s) of the Eastern oyster to enhance the brood stock.

Details of the enhanced restoration activities assumed under this alternative are presented in Section 4.1.3. This alternative includes roughly doubling the number of acres of habitat to be rehabilitated over a 10-year period and increasing the number of seed oysters to be planted by a factor of 4.5 over 10 years. Initial evaluations lead to the conclusion that using disease-resistant oyster strains to restore wild oyster populations is inadvisable, and that element of the alternative was not considered in further analysis. Under Alternative 2, most spat would be planted on sanctuary bars.

E.4.4 Alternative 3: Harvest Moratorium

This alternative consists of implementing a temporary moratorium on harvesting native oysters and a compensation (buy-out) program for the oyster industries in Maryland and Virginia or a program that offers displaced oystermen on-water work in a restoration program.

For the purposes of analysis, the moratorium was assumed to be in place throughout a 10-year period used to establish milestones for comparing the actions evaluated in this PEIS. Current restoration programs, as described for Alternative 1, were assumed to continue under this alternative. It was also assumed that the cost of a compensation program would not exceed the estimated benefits that participants in the fishery would have realized over the 10-year assessment period (about $10.5 M).

E.4.5 Alternative 4: Cultivate Eastern Oysters

This alternative consists of establishing or expanding State-assisted, managed, or regulated aquaculture operations in Maryland and Virginia using the native oyster species.

An economic demand model was used to define the largest oyster aquaculture industry that would be economically viable in the Bay (about 2.6 million bushels). For the purposes of comparing the economics of the alternatives, the maximum industry was assumed to develop over time and to be achieved at the end of 10 years. The maximum industry was assumed to exist throughout that period for evaluating all other elements of the affected environment to illustrate the greatest possible contrast in potential effects among the alternatives.

E.4.6 Alternative 5: Cultivate Nonnative Oysters

This alternative consists of establishing State-assisted, managed, or regulated aquaculture operations in Maryland and Virginia using suitable triploid, nonnative oyster species.

Based on a review of studies of nonnative species considered for use in the Chesapeake Bay, the Suminoe oyster was determined to be the only species that has environmental tolerances suited to the Bay, is economically viable, and for which substantial data were available for use in analysis. Analyses for this alternative, therefore, considered only the use of triploid Suminoe oysters. The same maximum, economically viable industry estimated for Alternative 4 (2.6 million bushels) was assumed for this alternative. Biosecure hatchery facilities would be required. This assumption provided the greatest possible contrast in potential effects among the alternatives.

One important aspect of the assessment of this alternative that differs from the assessment of Alternative 4 is the estimate of the probability that a large-scale aquaculture operation using triploid Suminoe oysters could result in an unintended introduction of a reproducing population of the species.

E.4.7 Alternative 6: Introduce Another Nonnative Oyster Species

This alternative consists of introducing and propagating in the State-sponsored, managed, or regulated oyster restoration programs in Maryland and Virginia, a disease-resistant oyster species other than the Suminoe oyster, or an alternative strain of the Suminoe oyster from waters outside the U.S. in accordance with the *ICES Code of Practices on the Introductions and Transfers of Marine Organisms 1994* (ICES 1995).

Based on a review of studies of nonnative species considered for use in Chesapeake Bay, the Suminoe oyster and the Pacific oyster were determined to be the only species that have environmental tolerances suited to the Bay and that might be economically viable. Very little information about how the Pacific oyster might respond to conditions in Chesapeake Bay was available, which precluded a detailed analysis of the consequences of using that species for this alternative. At least two strains of the Suminoe oyster in addition to the Oregon stock specified in the proposed action are maintained in hatcheries in the Bay region. No comparative studies or field trials using these other strains have been conducted to date; consequently, no basis exists for assessing whether another strain would be more or less suitable than the Oregon stock for meeting the goals of the PEIS. Insufficient information is available for assessing the outcome of this alternative and comparing it to the outcomes of the other alternatives, and it was eliminated from detailed analysis in the PEIS

E.4.8 Alternative 7: Introduce the Suminoe Oyster and Discontinue Efforts to Restore the Eastern Oyster

This alternative would involve attempting to establish a naturalized, reproducing, and self-sustaining population of the Suminoe oyster in the tidal waters of Maryland and Virginia through introductions beginning when the PEIS is completed, but discontinuing efforts to restore the Eastern oyster.

Biologically, this alternative is similar to the proposed action, except that any benefits (or costs) of current restoration activities for the Eastern oyster would not be realized. Effects on other components of the affected environment were considered to be similar to those for the proposed action, except for the economic consequences. Initial analysis also suggested little economic difference between this alternative and the proposed action; therefore, this alternative also was eliminated from detailed analysis in the PEIS.

E.4.9 Alternative 8: Combination of Alternatives

The lead agencies defined three combinations of oyster restoration activities after analyses of the proposed action and other alternatives were near completion. The combinations are presented to provide stakeholders with the opportunity to consider and comment on efforts that would include the most promising elements of the proposed action and other alternatives. In considering the potential benefits and risks of each of these combinations, the lead agencies recognized that financial and physical constraints (e.g., oyster hatchery capacity, shell resources) might require some activities included as part of a combination to be implemented on smaller scales than were considered in evaluating the individual alternatives and the proposed action. The lead agencies will identify management actions that would best meet restoration objectives of the States of Maryland and Virginia after stakeholders have had an opportunity to review and comment on the proposed action and individual alternatives and the following combinations of alternatives:

- **Combination 8a** – Eastern oyster only
  - Alternative 2: Enhance efforts to restore Eastern oysters
  - Alternative 3: Impose a temporary harvest moratorium and a compensation program for the oyster industries
  - Alternative 4: Cultivate Eastern oysters

- **Combination 8b** – Eastern oyster and triploid Suminoe oysters
  - Alternative 2: Enhance efforts to restore Eastern oysters
  - Alternative 3: Impose a temporary harvest moratorium and a compensation program for the oyster industries
  - Alternative 4: Cultivate Eastern oysters
  - Alternative 5: Cultivate triploid Suminoe oysters

- **Combination 8c** – Eastern oyster and diploid and triploid Suminoe oysters
  - Proposed Action: Introduce diploid Suminoe oyster and continue Eastern oyster restoration
  - Alternative 2: Enhance efforts to restore Eastern oysters
  - Alternative 3: Impose a temporary harvest moratorium and a compensation program for the oyster industries
  - Alternative 4: Cultivate Eastern oysters
  - Alternative 5: Cultivate triploid Suminoe oysters

E.5 ENVIRONMENTAL CONSEQUENCES

Section 4 presents a detailed discussion of the consequences of the proposed action and all alternatives for all elements of the affected environment. Table ES-1 summarizes assessment findings for the proposed action and Alternatives 1, 2, 3, 4, and 5. Table ES-2 summarizes the consequences of the combinations of alternatives.

E.6 REQUIRED REGULATORY COMPLIANCE

If DNR and VMRC choose to implement a Bay-wide oyster restoration program based on the outcome of this PEIS, the projects designed to implement the preferred alternative could be required to comply with several Federal regulations. The implementation details of a specific restoration program designed following completion of the PEIS process will determine which Federal regulations apply to the program. NEPA requires the preparers of a PEIS to identify the potentially applicable regulations at the beginning of the process because those regulations help to define which elements of the natural and human environments must be evaluated and indentify the required consultations with other Federal agencies that have regulatory authority for components of the potentially affected environment. The following suite of potentially applicable regulations served as the basis for identifying topics addressed in Section 3, Affected Environment, and analyzed in Section 4, Environmental Consequences, of this Draft PEIS:

- **Endangered Species Act of 1973**, as amended (Pub. L. 93-205; 16 U.S.C. 1532 et seq.) – requires an evaluation of the potential consequences of the program for Federally listed species within the project area, and completion of Section 7 consultations with the FWS and NOAA's National Marine Fisheries Service (NMFS) as needed.

- **Magnuson-Stevens Fishery Conservation and Management Act**, as amended (Pub. L. 94-265; 16 U.S.C. 1801, et seq.) – requires evaluation of the potential consequences of the program for designated essential fish habitat for Federally managed species in the project area; NMFS reviews such evaluations.

- **National Historic Preservation Act of 1966**, as amended (Pub. L. 89-655; 16 U.S.C. 470. et seq.) – requires evaluation of the potential consequences of the program for historical and archeological resources in the project area; requires consultation with the appropriate State Historical Preservation Office(s) to ensure that cultural resources are identified and to obtain a formal opinion regarding potential loss or damage of important resources or to develop a Memorandum of Agreement about appropriate management or mitigation for any affected resources.

- **Fish and Wildlife Coordination Act of 1958**, as amended (Pub. L. 85-624; 16 U.S.C., et seq.) – requires equal consideration for fish and wildlife resources in conjunction with water resources development programs and projects. It provides authority for the involvement of FWS and NMFS in evaluating potential effects on fish and wildlife and requires Federal agencies that construct, license, or permit water resource development projects to first consult with the FWS or NMFS, as appropriate,

Table ES-1. Summary of potential effects of the proposed action and Alternatives 1 through 5

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Total Bay-wide Oyster Population (attainment of PEIS goal)	Disease resistance and rapid growth of the Suminoe oyster could contribute to a substantial increase in the Bay-wide oyster population and the potential to attain the restoration goal; continuing habitat loss, vulnerability to predation, and competition with the Eastern oyster are some of the factors that could constrain or preclude such an increase; the time frame of any increase can not be predicted.	A small increase in oyster abundance in lower salinity waters in Maryland associated primarily with planting hatchery seed is likely; continuing loss of hard-bottom habitat is likely to preclude increases elsewhere in the Bay; development of disease resistance that could enhance population growth is possible but the time required is unknown and cannot be predicted; no chance of meeting PEIS goal within 10 years.	A substantial increase abundance is possible, primarily in lower salinity waters in Maryland and associated with planting hatchery seed; continuing loss of hard-bottom habitat would limit increases elsewhere in the Bay; development of disease resistance that could enhance population growth is possible but time required is unknown; reaching the PEIS goal is unlikely within 10 years or after a longer period	Greater increase than Alt. 1 and less than Alt. 2, primarily in lower salinity waters and closely associated with planting hatchery seed; factors that could not be accounted for in population projections (e.g., continuing loss of hard-bottom habitat) could preclude the increase; no chance of meeting PEIS goal within 10 years; development of disease resistance that could enhance population growth is possible but time required is unknown	Maximum annual production could be several times the current Bay-wide population of market-size oysters but only about half the PEIS harvest goal; the wild population is distributed through-out the Bay, whereas aquaculture would be concentrated in certain areas; the estimated maximum industry is unlikely to be attained.	Maximum annual production could be several times the current Bay-wide population of market-size oysters but only about half the PEIS harvest goal; the current population of native oysters is distributed throughout Bay, whereas aquaculture would be concentrated in certain areas; the maximum industry is unlikely to be attained; fewer oysters would be in the Bay than under Alt. 4 because of faster growth rate of triploid Suminoe oysters.
Native Oyster	High potential for competition with Suminoe oyster; occurrence of Suminoe oyster in mixed-species reefs in its native range suggests that coexistence is likely, but could range from local extinction to mixed-species reefs; possible benefit to the native oyster from increased shell provided by Suminoe oyster.	Effects as described for Total Bay-wide Oyster Population.	Effects as described for Total Bay-wide Oyster Population.	Effects as described for Total Bay-wide Oyster Population.	Effects as described for Total Bay-wide Oyster Population.	Potential effect if diploid Suminoe oysters released due to triploid aquaculture establish a reproductive population; the probability of such an introduction cannot be calculated but is considered to be likely over a long period; rate of growth of a population via this mechanism would be slow

Table ES-1. (Continued)

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Other Ecosystem Components	Suminoe oyster is likely to provide ecosystem services similar to those provided by the Eastern oyster. If an introduction were successful, a large positive influence would be expected for reef-dependent fish; small potential negative influences for phytoplankton in local areas of high oyster abundance (via increased consumption by oysters), the benthic soft-bottom community (via reduction in the amount of organic matter from phytoplankton that reaches the sediment), zooplankton (via competition with oysters for phytoplankton food in local areas of high oyster abundance), planktivorous fish (via reduction in phytoplankton food), and avian soft-bottom feeders (via indirect effects of potential reduction in soft-bottom community); positive influences for all other receptor groups that benefit from increases in oyster biomass either directly as a source of food or habitat, or indirectly through changes in water quality (e.g., SAV benefits from increased water clarity) If an introduction is not successful, none of these effects would occur.	Small potential negative influences for phytoplankton (via increased consumption by oysters), the benthic soft-bottom community (via reductions in the amount of organic matter from phytoplankton that reaches the sediment), zooplankton (via competition with oysters for phytoplankton food), planktivorous fish (via reduction in phytoplankton food), and avian soft-bottom feeders (via indirect effects of potential reduction in the soft-bottom community) as a result of increased oyster abundance in low-salinity zone in MD; small positive influences for all other receptor groups in zones with increased oyster biomass; most negative influences would occur in high salinity zones in VA; magnitude of effects would be small based on small changes in oyster abundance.	Small influences, but larger than under Alt.1, given likely patterns of increase in oyster biomass over the state/salinity zones; small negative influences on phytoplankton and animals that depend on it, primarily in low-salinity areas in MD; small negative influence in higher salinity zones on species that depend on oysters for food or habitat or that are affected indirectly through changes in water quality.	Small positive influence in low-salinity areas in both states on species affected indirectly through changes in water quality (e.g., SAV); small negative influences on phytoplankton and animals that depend on it in those areas; small negative influence likely on species that depend on oysters for food or habitat in higher salinity zones in VA.	Minimal effect; some temporary beneficial influence if on-bottom techniques are used; positive influence through effects on water quality and habitat or food could be magnified if aquaculture is concentrated in restricted areas.	Minimal effects because confined culture is likely to be required; positive influence, particularly through effects on water quality, could be magnified if aquaculture is concentrated in restricted areas. Unquantifiable potential for unintended introduction of a diploid, reproducing stock of Suminoe oysters but expected to occur slowly over a long period; effects on other ecosystem components would be as described for the proposed action but would take longer to be realized.
Water Quality	If an introduction were successful, slight increases in dissolved oxygen (a few tenths of a milligram per liter) at the large scale of state/salinity zones; reductions in TSS of less than 6% on the large geographical scale; greater effects likely on smaller scales, which could result in local,(tributary) increases in SAV. No effects if an introduction were not successful.	No measurable effect.	Slight improvement in low-salinity areas in MD.	No measurable effect.	No change at the large scale of state/salinity zones; greater effects likely if aquaculture operations are concentrated in restricted areas.	No change at the large scale of state/salinity zones; greater effects likely if aquaculture operations are concentrated in restricted areas; effects might be greater than for Alt. 4 due to greater magnitude of filtering on a local basis; but potentially lower overall effects than Alt. 4 if few oysters were in the water.

Table ES-1. (Continued)

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Rare, Threatened, and Endangered Species	If an introduction were successful, potential slight negative effect on sturgeon due to reduction in soft-bottom habitat; potential positive effect for bald eagles and peregrine falcons due to increase in forage; potential minor negative effect for black skimmer, brown pelican, terns, and plovers if additional hatcheries are constructed; potential mixed effects on turtles through food chain interactions.	No effect on most species; potential small positive effect via food web for species that use low-salinity areas.	No effect on most species; potential small positive effect via food web for species that use low-salinity areas.	No effect on most species; potential small positive effect via food web for species that use low-salinity areas.	Construction of support facilities and operation and maintenance of aquaculture equipment could affect bald eagles and other birds and insects that nest along the shoreline; potential interference in foraging of black skimmer and terns; potential for entangling turtles if off-bottom techniques are used; effects would be limited to restricted areas.	Construction of support facilities and operation and maintenance of aquaculture equipment could affect bald eagles and other birds and insects that nest along the shoreline; potential interference in foraging of black skimmer and terns; potential for entangling turtles if off-bottom techniques are used, slightly greater than Alt. 4 because confined aquaculture probably would be required; effects limited to restricted areas.
Essential Fish Habitat	Portions of Chesapeake Bay provide essential habitat for 21 species; if an introduction were successful, possible negative effects on early life stages of 2 species through indirect competition with oysters for food; possible positive effects on 9 piscivorous species due to increase in forage fish; possible positive effects on 10 species considered to be reef-oriented. No effects with unsuccessful introduction	Small positive effects for species that use low-salinity areas; small negative effects for species that use higher salinity areas.	Small positive effects for species that use low-salinity areas; small negative effects for species that use higher salinity areas.	Small positive effects for species that use low-salinity areas; small negative effects for species that use higher salinity areas.	Some temporary positive benefit for reef-oriented species if on-bottom techniques are used.	Minimal effects on any species.
Culture	If an introduction were successful, potential to accomplish stakeholders' shared goal to restore oysters for multiple purposes; lack of success would preclude achieving multiple purposes. Stakeholders are uncertain about using a nonnative oyster for restoration.	Highly unlikely to achieve oyster restoration for multiple purposes; continued, slow decline in accomplishing ecological, economic and cultural/ community goals expected.	Highly unlikely to achieve oyster restoration for multiple purposes for most oyster stakeholders; localized successes in low-salinity areas may result in achieving goals for a few stakeholders in a few areas.	Multiple benefits of oyster restoration would not be realized; significant numbers of watermen would leave the fishery, and business for most growers and processors would not increase.	Does not accomplish goals of cultural model of oyster restoration; localized ecological benefits dependent on private-enterprise decision-making; watermen not able to participate without consideration of economic constraints; any economic benefits realized only for private-sector growers and processors; results inconsistent with the stakeholders' goal of a sustainable population of oysters in the Bay.	Does not accomplish goals of cultural model of oyster restoration; localized ecological benefits dependent on private-enterprise decision-making; watermen not able to participate without consideration of economic constraints; any economic benefits realized only for private-sector growers and processors; results inconsistent with the stake-holders' goal of a sustainable population of oysters in the Bay.

Table ES-1. (Continued)

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Economics	Estimated present value cost to implement hypothetical introduction program over 10 years is $264M; estimation of fishery, processor and indirect benefits (e.g., enhanced recreational fishing) not possible due to uncertainty concerning possibility and rate of Suminoe oyster population growth; fishery and processor benefits of a successful introduction not likely to be realized for an extended period of time because a substantial proportion of introduced Suminoe oyster spat would be on unharvestable bars; unsuccessful introduction would produce no fishery, processor or indirect benefits.	Estimated present value cost to implement current restoration programs over 10 years is $106.4M; assuming future harvests are similar to those in recent years, present value revenues from fisheries over 10 years would be $10.5M; estimated net present value of revenues for processors at the wholesale level for oysters harvested in Maryland would be $42.5M; no positive indirect effects are likely.	Estimated present value cost to implement expanded restoration programs over 10 years is $404.1M; fishery and processor benefits likely to be greater than for Alt. 1; if the population of legal oysters on harvestable bars increased by a factor of five, fishery benefits would be on the order of $52.5 M; some positive indirect benefits (e.g., improved recreational fishing), greater than under Alt. 1.	Restoration costs the same as for Alt. 1 ($106.4M); compensation program assumed to equal the foregone net income to watermen of $10.5M, for total cost of $116.9M; no direct fisheries benefits over an assumed 10-year moratorium, but potential benefits if fishery is reopened in the future; some positive indirect benefits (e.g., improved recreational fishing), greater than under Alt. 1. Although eliminating harvest would result in some decrease in benefits for processors and consumers, the effect would be limited because imported oysters dominate the current market.	Analysis assumed no direct government investment in implementing expanded aquaculture (indirect costs for technical support were not estimated); assuming growth to maximum size within 10 years, expanded industry would contribute about $8M, net present value (ranging from $6M to $15M); net present value could be higher with triploids, but available data were insufficient to estimate the difference; minimal indirect benefits.	Analysis assumed no direct government investment in implementing expanded aquaculture (indirect costs for technical support were not estimated); assuming growth to maximum size within 10 years, expanded industry would contribute about $16M, net present value (ranging from $9M to $23M), a substantial economic advantage over Alt. 4; unsuitability for half-shell market could reduce or eliminate the advantage, as could higher cost for biosecurity and production of triploid spat; would support more firms and create more employment opportunities for watermen and others; minimal positive indirect benefits and potential for negative indirect benefits due to interference with activities like recreational boating.
Visual & Aesthetic Resources	If an introduction were successful, some visual benefits might increase (e.g., increased activity by skipjacks and watermen; support to retain aesthetic shoreline facilities such as shucking houses). No benefits with unsuccessful introduction.	Possible decline in visual benefits (e.g., decline in working oystermen).	Limited benefit to visual resources such as working oystermen and skipjacks because most increased oyster stock would be on sanctuaries and reserves.	Decrease in visual benefits from loss of working oystermen and aesthetic shoreline facilities.	Limited visual and aesthetic effects of shoreline facilities if on-bottom techniques are used; potential visual effects of buoys and floats used with off-bottom techniques.	Limited visual and aesthetic effects of shoreline facilities; greater potential visual effects of buoys and floats than for Alt. 4 because confined methods probably required.
Recreation	If an introduction were successful, Bay-wide benefit to recreational fishing for reef-oriented fish and waterfowl hunting for diving ducks; little to no effect on recreational swimming and boating; minor, temporary disruption of wildlife viewing, boating, and fishing during seed and shell planting. No benefits with unsuccessful introduction	No effect on recreational boating, swimming, hunting or wildlife viewing except for minor, temporary disruption of wildlife viewing, boating, and fishing during seed and shell planting.	Modest benefits to recreational fishing for reef-oriented fish and waterfowl hunting where oysters increase; minor, temporary disruption of wildlife viewing, boating, and fishing during seed and shell planting.	Modest benefits to recreational fishing for reef-oriented fish and waterfowl hunting where oysters increase; minor, temporary disruption of wild-life viewing, boating, and fishing during seed and shell planting; elimination of minimal conflicts between recreational boaters and watermen activities.	Minor temporary benefits to recreational fishing if on-bottom techniques are used; potential interference with boating, fishing, wildlife viewing, hunting, and swimming due to buoys, floats, and other operations if off-bottom techniques are used.	Greater potential for interference with boating, fishing, wildlife viewing, hunting, and swimming from buoys and floats because confined methods probably would be required; also potential negative effects on similar activities due to cultivation operations and activities.

Table ES-1. (Continued)

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Historic & Archaeological Resources	If an introduction were successful and if exploitation increased, potential effects on underwater resources present on or adjacent to existing oyster beds, depending on the harvest method (e.g., greatest potential with dredging, least with diver harvest); increased boat activity could affect shoreline resources. No effects with unsuccessful introduction.	Minimal change in current status of archeological resources; assumes no new dredging of buried shell deposits.	Minimal change in current status of archeological resources; assumes no new dredging of shell deposits and no new methods of shell cleaning	Reduced potential to affect archeological resources in or adjacent to existing oyster beds; assumes no new dredging of shell deposits and no new methods of shell cleaning	High potential for wide range of cultural resources in many potential aquaculture locations; submerged resources exposed to potential effects of bar preparation and harvest, assuming on-bottom methods; submerged resources exposed to effects of anchors or other mooring structures and disturbances of bottom when equipment is retrieved, assuming off-bottom methods; potential effects on terrestrial resources from any required construction of shoreline facilities; more extensive boat traffic in confined waters could increase wave action and cumulative disturbance of submerged or shoreline resources; overall, potential for effects is greater than for the proposed action and other non-aquaculture alternatives	High potential for wide range of cultural resources in many potential aquaculture locations; submerged resources exposed to potential effects of bar preparation and harvest, assuming on-bottom methods; submerged resources exposed to effects of anchors or other mooring structures and disturbances of bottom when equipment is retrieved, assuming off-bottom methods; potential effects on terrestrial resources from any required construction of shoreline facilities; more extensive boat traffic in confined waters could increase wave action and cumulative disturbance of submerged or shoreline resources; slightly less potential for effects than Alt. 4.
Wetlands	If an introduction were successful, possible indirect benefits to wetlands due to local improvements in water clarity or dampening of wave action, only in localized areas of high oyster abundance. No benefits with unsuccessful introduction	No measurable effect.	Minimal indirect benefits to wetlands as a result of improvements in water clarity or dampening of wave action in low-salinity waters in MD, but only in localized areas of high oyster abundance.	Minimal indirect benefits to wetlands as a result of improvements in water clarity or dampening of wave action in low-salinity waters in MD, but only in localized areas of high oyster abundance.	Potential for adverse effects if construction of shoreline facilities is required; use of floats could dampen wave action in restricted waters, reducing shoreline erosion and increasing accretion to the benefit of wetlands.	Potential for adverse effects if construction of any shoreline facilities is required; use of floats could dampen wave action in restricted waters, reducing shoreline erosion and increasing accretion to the benefit of wetlands.
Sanctuaries & Refuges	If an introduction were successful, no effects on freshwater sites, where oysters would not occur; increases in oysters in the vicinity of sites in higher salinity waters could benefit some species that use the sites. No benefits with unsuccessful introduction	No measurable effect.	Increase in oysters in low-salinity zones in MD might benefit the Eastern Neck refuge by reducing wave action and erosion and promoting small, localized improvements in water clarity; however, effects likely to be dispersed and minimal at any single location.	Increase in oysters in low-salinity zones in MD might benefit the Eastern Neck refuge by reducing wave action and erosion and promoting small, localized improvements in water clarity; however, effects likely to be dispersed and minimal at any single location.	Aquaculture unlikely to be sited adjacent to a sanctuary or refuge.	Aquaculture unlikely to be sited adjacent to a sanctuary or refuge.

Table ES-1. (Continued)

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Environmental Justice	If an introduction were successful, possible benefit to minorities or low-income individuals to the extent that they become involved in an expanded fishery. No benefits with unsuccessful introduction	No effect.	No effect.	No effect.	Possible benefit to minorities or low-income individuals to the extent that they become involved in an expanded industry.	Possible benefit to minorities or low-income individuals to the extent that they become involved in an expanded industry.
Air Quality	Slight localized decreases in air quality with increased boat operation for introduction programs and increased harvesting activity.	No effect.	Slight localized decrease in air quality due to increased operation of boats used in restoration programs.	Slight benefit to local air quality due to absence of operation of oystering vessels.	Slight localized decrease in air quality in the vicinity of concentrated aquaculture operations resulting from boat and truck traffic for deployment, maintenance, harvest, and transport of oysters.	Slight localized decrease in air quality in the vicinity of concentrated aquaculture operations resulting from boat and truck traffic for deployment, maintenance, harvest, and transport of oysters.
Public Safety and Fouling	If an introduction were successful, increased oyster populations could contribute to increase in stinging sea nettles, adversely affecting swimmers; Suminoe oysters may bioconcentrate contaminants to greater levels than Eastern oysters; potential for greater fouling of artificial surfaces by the Suminoe oyster. No such effects with an unsuccessful introduction.	No effect.	Slight potential for boating accidents associated with restoration activities.	Slight decrease in potential for boating accidents associated with oystermen activities.	Possible local effects on public safety factors such as emergency services, law enforcement, and fire protection, to the extent that a large-scale aquaculture industry with a significant staff and infrastructure develops; increased risk of accidents due to boat and truck traffic involved in deployment, maintenance, harvest, and transport of oysters.	Possible local effects on public safety factors such as emergency services, law enforcement, and fire protection, to the extent that a large-scale aquaculture industry with a significant staff and infrastructure develops; increased risk of accidents due to boat and truck traffic involved in deployment, maintenance, harvest, and transport of oysters. Possibility of a diploid Suminoe oyster population becoming established; consequences would be the same as for the proposed action, but would take much longer to be realized.
Commercial Navigation	If an introduction were successful, creation of three-dimensional reefs in shallow waters could create new navigational hazards for shallow-draft commercial vessels that transit small inlets and tributaries in the Bay; no such effect if an introduction were unsuccessful	No effect.	Minor interference with commercial traffic during increased restoration activities.	Minor decrease in interference with commercial traffic with decrease in oystermen boating.	No effect.	No effect on commercial navigation; possibility for introduction of a diploid population of Suminoe oyster; consequences would be the same as for the proposed action, but would take much longer to be realized.

Table ES-1. (Continued)

Components of the Affected Environment	Proposed Action Introduce Suminoe Oyster	Alt. 1 No Action	Alt. 2 Expand Native Restoration	Alt. 3 Harvest Moratorium	Alt. 4 Aquaculture (native)	Alt. 5 Aquaculture (nonnative)
Resources Outside Chesapeake Bay	A successful introduction in the Chesapeake Bay carries a high probability of dispersal of Suminoe oyster into adjacent coastal waters; expansion of species is more probable to the north than to the south; colonization of subtidal habitat is more likely than of intertidal habitat; influences on other components of adjacent ecosystems expected to be similar to those predicted for representative species of Chesapeake Bay; coexistence with Eastern oyster is likely, but ranging potentially from local dominance of one species or the other to mixed species reefs of different proportions.	No effect.	No effect.	No effect.	No effect.	Possibility of unintended introduction of a diploid, reproducing stock of Suminoe oysters; probability high that free diploids would be dispersed to coastal waters; effects on coastal ecosystems would be the same for the proposed action, but would take much longer to be realized

Table ES-2. Summary of environmental consequences of the combinations of alternatives

Components of the Affected Environment	Alt. 8a Eastern Oyster Only (Alternatives 2,3,&4)	Alt. 8b Eastern Oyster and Triploid Suminoe Oysters (Alternatives 2,3,4,&5)	Alt. 8c Eastern Oyster and Diploid and Triploid Suminoe Oysters (Proposed Action + Alternatives 2,3,4,&5)
Total Bay-wide Oyster Population (attainment of PEIS goal)	Abundance likely to increase in low-salinity waters and remain constant or continue to decline in higher salinity waters; greater population growth in higher salinities possible if disease resistance develops in the population; local increases in areas where aquaculture operations are developed, but not likely to reach maximum economically viable size.	Abundance likely to increase in low-salinity waters and remain constant or continue to decline in high-salinity waters; some population growth possible in higher salinities if disease resistance develops in the population; local increases in abundance possible where aquaculture operations develop, but many constraints could limit ability to achieve maximum economically viable size; size of operations less than under 8a because use of triploid Suminoe oysters would require fewer oysters and less area; likely to result in an eventual introduction of reproductively viable Suminoe oysters	Greatest potential to significantly increase oyster abundance throughout the Chesapeake Bay but high uncertainty of realization due to many potentially constraining factors; localized increases in oyster abundance likely where aquaculture operations were established and expanded, but many constraints could limit ability to achieve maximum economically viable size; size of operations may be less than under 8a because use of triploid Suminoe oysters would require fewer oysters and less area.
Native Oyster	Same as described for Bay-wide oyster population.	Increases in native oyster likely in low-salinity waters; potential effects if diploid Suminoe oysters released due to triploid aquaculture were able to establish a reproductive population; accidental introduction considered to be likely but slow.	If the Suminoe oyster introduction were successful, high probability of competition with the native oyster; occurrence of Suminoe oyster in mixed-species reefs in its native range suggest coexistence is likely, but could range from local extinction to mixed-species reefs; possible benefit to the native oyster from increased shell provided by Suminoe oyster; failure of an introduction would result in no effect on the native oyster.
Other Ecosystem Components	Small negative influence on phytoplankton and receptors that depend on it in restricted areas with high oyster density; small positive influence expected for other receptors in low-salinity areas	Small negative influence on phytoplankton and receptors that depend on it in restricted areas with high oyster density; small positive influence expected for other receptors in low-salinity areas; possible minimal direct effects of aquaculture using off-bottom floats or cages through provision of habitat and food; small influence of aquaculture on other ecological receptors in areas where aquaculture is pursued; potential for some adverse effects on water quality, sediment, and benthos from concentrated shellfish aquaculture; risk of inadvertently releasing diploid Suminoe oysters into the Bay, which might establish a reproducing population of the species, but more slowly than under 8c.	Suminoe oysters and native oysters would provide similar ecological services; greatest potential for positive influences on other ecological receptors that depend on oysters if introduction were successful; slight negative influences in localized areas due to reductions in the biomass of algae for species that rely on planktonic algae for food; an unsuccessful introduction would result in ecological services similar to those of Combination 8b
Water Quality	Local improvements in water quality in lower salinity waters in Maryland and higher salinity locations where concentrated aquaculture operations would be established.	Similar to 8a but addition of triploid Suminoe aquaculture increases potential for local water quality improvements in high-salinity waters in Virginia	Successful introduction of the Suminoe oyster could result in local improvements in water quality in high-salinity areas in Maryland and Virginia; some improvements at local and possibly tributary levels in low-salinity areas as a result of expanded native oyster restoration and in specific tributaries where aquaculture develops
Rare, Threatened, and Endangered Species	Refer to Table ES-1 for summary of effects for Alts. 2, 3 and 4; cumulative effects of all three alternatives likely to be greater than impacts of any individual alternative.	Refer to Table ES-1 for summary of effects for Alts. 2, 3, 4 and 5; cumulative effects of all four alternatives likely to be greater than effects of any individual alternative.	Refer to Table ES-1 for summary of effects of the proposed action and Alts. 2, 3, 4 and 5; cumulative effects of all five actions likely to be greater than effects of any individual action
Essential Fish Habitat	Potential effects likely to be negative for planktivorous fish, skates and flounders and positive for piscivorous fish and most reef-oriented fish; declines in oyster abundance could positively influence planktivorous fish, skates and flounders, and negatively influence the remaining species; local effects of aquaculture expected to be positive for reef-oriented fish, negative for skates and flounders, and to have no large-scale effect for the remaining species	Negative influence likely on planktivorous fish, skates, and flounders; positive influence on piscivorous fish and most reef-oriented fish in low-salinity areas; in high-salinity areas where oyster abundance would continue to decline, positive effects expected for planktivorous fish, skates, and flounders and negative effects other Federally managed species with EFH in the Bay; effects of aquaculture locally positive for reef-oriented fish and negative for skates and flounders	Greatest potential for both positive and negative effects on EFH if an introduction were successful; widespread increases in oyster abundance could adversely affect planktivorous fish and skates and flounder and positively affect piscivorous fish and most reef-oriented species; failure of introduction would result in no change in EFH.
Culture	Least likely to meet the goals shared by all stakeholders but least risk of incurring any adverse effects of a non-native oyster.	Unlikely to meet the goals shared by all stakeholders but includes some risk of incurring potential adverse effects of a non-native oyster.	Greatest potential for accomplishing the stakeholders' shared objectives of restoring the ecological, cultural, and economic benefits of oysters in Chesapeake Bay; but stakeholders expressed concerns about a nonnative oyster.

Table ES-2. (Continued)

Components of the Affected Environment	Alt. 8a Eastern Oyster Only	Alt. 8b Eastern Oyster and Triploid Suminoe Oysters	Alt. 8c Eastern Oyster and Diploid and Triploid Suminoe Oysters
Economics	Assuming restoration under Alt. 2 is in addition to that under Alt. 1 and buy-out cost of watermen is included, the present value 10-year cost of this combination would be $521 M; benefits cannot be quantified but would likely exceed $68M (sum of benefits of the three alternatives); indirect benefits likely to be minimal but not quantifiable.	Assuming restoration under Alt. 2 is in addition to that under Alt. 1, buy-out cost of watermen is included, and no state funding for aquaculture, present value,10-year cost of this combination would be the same as 8a ($521 M) but fishery benefits would be greater due to inclusion of triploid Suminoe aquaculture.	Implementation cost for the proposed action includes the cost of Alt. 1; thus present value 10-year cost of this alternative, assuming no State funding for aquaculture, would be $668M; fishery, processor and indirect benefits probably would be much higher than for 8a and 8b but cannot be quantified.
Visual & Aesthetic Resources and Recreation	Temporary negative effects on visual and aesthetic resources during periods when oyster spat are planted, and shell or other substrate is replenished; no direct effect on visual or aesthetic resources from native oyster aquaculture; decrease in visual benefits of activity of skipjacks and watermen under a moratorium.	Temporary negative effects on visual and aesthetic resources during periods when oyster spat are planted, and shell or other substrate is replenished; some direct effect on visual or aesthetic resources as well as on fishing, boating and hunting from Suminoe oyster aquaculture due to buoys and floats; decrease in visual benefits of activity of skipjacks and watermen under a moratorium.	Temporary negative effects on visual and aesthetic resources greater than under 8a and 8b during periods when greater quantities of oyster spat are planted, and shell or other substrate is replenished; some direct effect on visual or aesthetic resources as well as on fishing, boating, and hunting from Suminoe oyster aquaculture due to buoys and floats; decrease in visual benefits of activity of skipjacks and watermen under a moratorium.
Historic & Archaeological Resources	Expanded culture of the native oyster creates greatest potential to adversely affect historic and archeological resources; increased boat traffic from restoration activities as well as aquaculture maintenance, which could increase wave action, shore erosion and impact to shoreline historic and archeological resources..	Expanded cultivation of the native oyster offers greatest potential to adversely affect historic and archeological resources; cultivation of triploid Suminoe oysters may reduce the spatial extent of aquaculture areas to less than under 8a but could require constructing new shoreline hatcheries; increased boat traffic from restoration activities and aquaculture maintenance could increase wave action, shore erosion, and effects on shoreline historic and archeological resources	Expanded cultivation of the native oyster would offer the greatest potential to adversely affect historic and archeological resources; cultivation of triploid Suminoe oysters may reduce the spatial extent of aquaculture areas to less than under 8a but could require constructing new shoreline hatcheries; increased boat traffic from restoration activities and aquaculture maintenance could increase wave action, shore erosion, and effects on shoreline historic and archeological resources
Wetlands	Least potential for formation of new oyster reefs that could have beneficial effects on wetlands by reducing the erosive force of wave action.	Minimal potential for formation of new oyster reefs that could have beneficial effects on wetlands by reducing the erosive force of wave action; floats or buoys associated with Suminoe oyster aquaculture could reduce wave action and enhance wetland growth.	Greatest potential for formation of new oyster reefs that could have beneficial effects on wetlands by reducing the erosive force of wave action; floats or buoys associated with Suminoe oyster aquaculture could reduce wave action and enhance wetland growth.
Sanctuaries & Refuges	Potential but minimal benefits to local NERRS sites in low-salinity waters.	Potential minimal benefits to local NERRS sites in low-salinity waters.	Greatest potential for benefit to several NERRS sites by enhancing ecological services associated with oysters, if an introduction were successful.
Environmental Justice	No effects.	Minimal effects with potential benefits from increased aquaculture.	Minimal effects with potential benefits from increased aquaculture.
Air Quality	Truck and boat emissions are unlikely to result in an increase that would exceed the threshold that requires a Clean Air Act conformity statement	Truck and boat emissions are unlikely to result in an increase that would exceed the threshold that requires a Clean Air Act conformity statement	Truck and boat emissions are unlikely to result in an increase that would exceed the threshold that requires a Clean Air Act conformity statement
Public Safety and Fouling	Minimal change in public safety risk and no fouling risk.	Increased safety risks due to increased aquaculture operations.	Potential risk from diploid Suminoe oysters that may cause fouling or bioconcentrate contaminants; increased safety risks from increased aquaculture operations.
Commercial Navigation	No effect.	No effect.	Minimal effect if significant reefs were to develop.

Table ES-2. (Continued)

Components of the Affected Environment	Alt. 8a Eastern Oyster Only	Alt. 8b Eastern Oyster and Triploid Suminoe Oysters	Alt. 8c Eastern Oyster and Diploid and Triploid Suminoe Oysters
Resources Outside Chesapeake Bay	No effect.	Any potential effects would arise from an accidental diploid introduction from triploid Suminoe aquaculture; effects would be realized slowly over a very long time period; if they occurred they would be the same as the proposed action.	Same as the proposed action, as described in Table ES-1
Cumulative Effects	Increases in oyster populations in lower salinity sections of the Bay could result in local ecosystem changes that would counteract some of the cumulative effects of watershed development and pollutant loading to the Bay, although the effects are likely to be small	Same as 8a, except that because triploid Suminoe oysters are resistant to MSX and Dermo, they could be cultivated over a larger portion of the Bay than the native oyster; as a result, benefits could be realized over a greater geographical area throughout the Bay	Highest potential to increase oyster abundance because it includes the proposed action; however, many factors could preclude that potential from being realized; could contribute significantly to local improvements in water quality; counteract the effects of such factors as watershed development and nutrient and sediment runoff; help to counteract the loss of hard-bottom habitat; contribute to enhancing populations of species that depend on oyster-reef habitat; reverse the decline in the Bay's oyster fishery and create a means of sustaining the watermen's culture in the Bay, exacerbate changes in the Bay's biodiversity, and contribute to further decline of the native oyster. A failed introduction would not contribute to any cumulative impacts on the Bay.

regarding the potential effects on fish and wildlife resources and measures to mitigate these effects.

- **Coastal Zone Management Act of 1972**, as amended (Pub. L. 92-583; 16 U.S.C. 1451, et seq.) – requires a Federal activity or program that may affect coastal areas to be consistent with applicable Coastal Zone Management (CZM) Plans and to receive a consistency determination from the applicable State CZM program(s) prior to taking action.

- **Clean Water Act of 1977**, as amended (Pub. L. 92-500; 33 U.S.C. 1251, et seq.) – Under Section 402, National Pollutant Discharge Elimination System permits could be required for stormwater discharges from, and sediment and erosion control at, construction sites (e.g., new hatcheries) or for other actions that might affect water quality (e.g., large-scale aquaculture operations) EPA has not determined if Section 402 applies to "discharges" of nonnative species into the waters of the United States. Further consultation with EPA Region 3 will be necessary if the proposed action is selected as the preferred alternative. Depending on the nature of the preferred alternative and the specific implementation plans for that alternative, Maryland, Virginia, or both may have to apply to USACE for permits under Section 404, which regulates the discharge of dredged or fill material into waters of the United States.

- **Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990**, as amended (16 U.S.C. 4701 et seq.); Lacey Act, as amended (18 U.S.C. 42); 1993 Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species and applicable and appropriate Executive Orders – include a range of requirements and assessments prior to the introduction of nonnative species.

- **Rivers and Harbors Act, Section 10** – requires permits from USACE for any work in, over, or under navigable waters of the United States.

- **Marine Protection, Research, and Sanctuaries Act Of 1972** – requires a permit from EPA to transport material from anywhere for the purpose of ocean dumping by United States agencies or United States-flagged vessels or for dumping of material transported from outside the United States into the United States territorial sea; USACE is the permitting authority for dredged material, subject to EPA concurrence and use of EPA dumping criteria and EPA-designated dumping sites.

Several other laws, executive orders, and agreements might be applicable to alternatives that involve the Suminoe oyster. The National Research Council (NRC) provided a comprehensive discussion of laws, regulations, and policies governing intentional introductions of nonnative species in the United States (NRC 2004). Section 1.1.3 provides details about the potentially applicable regulations.

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