CALIFORNIA COASTAL COMMISSION
45 FREMONT STREET, SUITE 2000
SAN FRANCISCO, CA 94105-2219
VOICE AND TDD (415) 904-5200

F7a

August 8, 2012

To: Coastal Commissioners and Interested Persons

From: Alison Dettmer, Deputy Director
Cassidy Teufel, Environmental Scientist, Energy, Ocean Resources & Federal Consistency Division

Subject: **STAFF REPORT ADDENDUM for Item F7a**
CDP Amendment Application E-02-005-A2 (Coast Seafoods Company)

Coastal Commission staff recommends the following minor modification to the staff report. Deletions are shown with ~~strikethrough~~ and additions are underlined.

[MODIFICATION 1: The following change to Special Condition 8 on page 5 of the staff report]

8. Marine Wildlife. If any marine mammals or more than ~~five~~ ~~seabirds~~ ten pelicans and/or cormorants ~~at one time~~ are observed on one of Coast's clam cultivation rafts for more than two weeks, Coast shall within 10 days notify the Executive Director ~~of the event~~ and within 30 days of such notification to the Executive Director submit, for review and approval, a plan to install passive deterrent devices (such as exclusionary fencing or netting) to prevent future use of the clam cultivation rafts by marine mammals or seabirds. Coast shall install the passive deterrent devices and maintain them as approved by the Executive Director.

[MODIFICATION 2: The following insertions and deletions to the first full paragraph on page 18 of the staff report]

…In addition to these direct effects, colonization of the proposed clam rafts by marine mammals or seabirds (both of which may prey on special status fish species such as longfin smelt and salmon that are known to be present in the project area) may have adverse indirect effects by augmenting the local abundance of predators and thereby increasing salmon and smelt predation. Longfin smelt, in particular, are known to be eaten by a variety of predatory fishes, birds and marine mammals and are considered to be a major prey of harbor seals (*Phoca vitulina*) in the Columbia River (Emmett et al. 1991). In addition, numerous studies throughout North America and Europe have demonstrated that avian predators such as cormorants and pelicans can consume large numbers of juvenile salmonids when appropriate conditions occur. Research in the

Columbia River estuary prompted by concern that avian predation might constitute a significant source of mortality to juvenile salmonids during out migration has shown that these fish accounted for a majority of the diet of double-crested cormorants in the estuarine portion of the river (Collis et al 2002). Research also shows that substantial foraging by double-crested cormorants occurs in close proximity to their nesting and roosting areas and that these roosting areas often include man-made overwater structures (Lyons et al 2007). This work by Lyons et al also suggests that disproportionately greater cormorant foraging activity at man-made overwater structures may indicate greater vulnerability of salmonids to predation at those features. In recent years, the Sand Islands in Arcata Bay, located only a few miles from the project site, have been found to support the largest nesting colonies of double-crested cormorants in California (Capitolo et al 2004). The presence of these colonies near the project area, the propensity of this species to roost on man-made overwater structures and the limited number of such structures currently present in Arcata Bay suggests that colonization or development of roosts on new structures could occur. With a surface footprint of approximately 4800 square feet, the proposed clam rafts could support a large cormorant roost that could substantially increase the current amount of avian predation on juvenile salmon and longfin smelt in the project area. To a lesser extent, another piscivorous seabird species known to establish roosts on man-made overwater structures, the brown pelican also may increase predation on longfin smelt and juvenile salmon in the project area if it is also able to colonize the proposed clam rafts. These birds have already established a consistent roost on other clam rafts near the project site and may expand to the proposed rafts once they are in place, potentially increasing avian predation on juvenile salmon and longfin smelt in this area as a result. To address these potential adverse impacts, the Commission is requiring Coast in **Special Condition 8** to report to the Executive Director if ~~any~~ marine mammals, cormorants, or pelicans begin establishing a haul-out or roost on its clam rafts. ~~or more than five seabirds at any one time use its clam cultivation rafts.~~ **Special Condition 8** also requires that Coast submit for Executive Director review and approval a plan for the installation of passive marine mammal and/or seabird exclusion devices on the clam rafts within 30 days of the submittal of such a report...

[MODIFICATION 3: The following insertions to Appendix A of the staff report]

Collis K, D. D. Roby, D. P. Craig, S. Adamany, J. Adkins, and D. E. Lyons. 2002. Colony size and diet composition of piscivorous waterbirds on the lower Columbia River: Implications for losses of juvenile salmonids to avian predation. Transactions of the American Fisheries Society 131:537-550.

Capitolo, P.J., H.R. Carter, R.J. Young, G.J. McChesney, W.R. McIver, R.T. Golightly, and F. Gress. 2004. Changes in breeding population size of Brandt's and Double-crested Cormorants in California, 1975-2003. Unpublished report, Department of Wildlife, Humboldt State University, Arcata, California.

Lyons DE, DD Roby, and K Collis. 2007. Foraging patterns of Caspian terns and double-crested cormorants in the Columbia River estuary. Northwest Science 81: 91-103.

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FAX (415) 904- 5400

F7a

Filed: March 9, 2012
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Staff: C. Teufel-SF
Staff Report: July 19, 2012
Hearing Date: August 10, 2012

STAFF REPORT: PERMIT AMENDMENT

Application No.:	**E-02-005-A2**
Applicant:	**Coast Seafoods Company**
Agent:	Plauché & Stock LLP
Location:	Humboldt Bay, Humboldt County.
Project Description:	Install and operate twenty additional clam cultivation rafts in an area currently supporting ten previously permitted clam cultivation rafts.
Staff Recommendation:	Approval with conditions.

SUMMARY OF STAFF RECOMMENDATION

Coast Seafoods Company (Coast) proposes to amend its Coastal Development Permit E-02-005 (formerly 1-96-069) to add 20 floating clam cultivation rafts within a 0.62 acre submerged area leased from the Humboldt Bay Harbor, Recreation, and Conservation District (Harbor District) for a total of 30 rafts. The 20 new rafts are proposed to be installed in the Mad River Slough Channel area of Arcata Bay (northern Humboldt Bay) in a row adjacent to 10 existing rafts.

Each raft would be 12-feet wide by 20-feet long and are proposed to be installed in two lines of ten; one to the north and one to the south of the existing rafts.

Coast proposes to cultivate approximately 270 million juvenile Manila clam (*Venerupis philippinarum*) per year on the new rafts. The clams would be grown to a size of approximately 3.6 millimeters and harvested for export offsite before reaching maturity. Maintenance of the clam rafts would be carried out on a daily basis by boat and would involve washing and sorting the cultivated clam seed.

Major Coastal Act issues associated with this project include potential adverse impacts to marine resources. The proposed clam cultivation rafts would approximately double the amount of new floating and in-water structural materials in an area of Arcata Bay – the Mad River Slough Channel - that currently supports limited amounts of such structures. The Mad River Slough Channel supports a variety of sensitive marine resources including harbor seals, seabirds, and special status fish species. The presence of the proposed floating structures and the associated cultivation operations have the potential to adversely affect these marine resources by altering benthic, water column, and surface water habitat characteristics and by providing a source for potential disturbance, injury, and predation.

Commission staff believes that Coast's proposed mitigation measures, in combination with the implementation of new **Special Conditions 4-9**, will reduce impacts to marine and visual resources such that the project can be found consistent with the terrestrial and marine resources policies of the Coastal Act. **Special Condition 4** would establish a permit term limit consistent with the current lease term for the project site. In addition, to address potential impacts to special status fish species associated with habitat alteration and increased predation, **Special Condition 5** would require the development, submittal, and conduct of a juvenile salmon and longfin smelt predation assessment in order to further evaluate potential impacts of the proposed rafts on state listed species due to possible attraction of predatory fish to the novel in-water structure provided by the rafts. **Special Condition 5** would also require Coast to submit a permit amendment application to reduce the risk of predation if the results of the predation assessment demonstrate that significant numbers of known predatory fish are consistently present below the rafts. Changes to water column habitat would also be addressed by **Special Condition 6** which would require the configuration of the proposed raft arrays to be moved northward in order to reduce their visual profile and provide a greater separation between the new and existing rafts to reduce the potential cumulative effects of the combination of the existing and proposed raft arrays. **Special Conditions 7-9** would further reduce potential marine resource impacts by reducing the potential release of invasive species into Humboldt Bay during maintenance cleaning, requiring the installation of passive wildlife exclusion devices if colonization of the rafts by marine mammals or seabirds begins to occur, and by requiring the design of the wash water intake system to reflect current standards established to minimize the entrainment and impingement effects.

Commission staff therefore recommends that the Commission **APPROVE** coastal development permit amendment application E05-005-A2, as conditioned.

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EXHIBITS

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Exhibit 4 - Pacific Northwest National Laboratory's *Field Protocol for Assessment of Predation Risk to Juvenile Salmonids*

I. MOTION AND RESOLUTION

Motion:

I move that the Commission approve Coastal Development Permit Amendment E-02-005-A2 subject to conditions set forth in the staff recommendation specified below.

Staff recommends a **YES** vote on the foregoing motion. Passage of this motion will result in approval of the permit amendment as conditioned and adoption of the following resolution and findings. The motion passes only by affirmative vote of a majority of Commissioners present.

Resolution:

The Commission hereby approves the Coastal Development Permit Amendment for the proposed project and adopts the findings set forth below on grounds that the development as amended and conditioned will be in conformity with the policies of Chapter 3 of the Coastal Act. Approval of the permit amendment complies with the California Environmental Quality Act because either 1) feasible mitigation measures and/or alternatives have been incorporated to substantially lessen any significant adverse effects of the development on the environment, or 2) there are no further feasible mitigation measures or alternatives that would substantially lessen any significant adverse impacts of the amended development on the environment.

II. SPECIAL CONDITIONS

All terms and conditions of Coastal Development Permit E-02-005, as amended, shall remain in full force and effect, and the following Special Conditions 4 through 9 shall be added:

4. Permit Term Limit. The term of the permit shall be limited to the current term of the Humboldt Bay Harbor, Recreation, and Conservation District Lease for Water Bottoms for Aquaculture which ends on September 7, 2015. If this lease is amended or a new lease is issued by the Humboldt Bay Harbor, Recreation, and Conservation District, an application for a permit amendment may be submitted to request an extension of the permit term.

5. Salmon and Smelt Predation Assessment.

a. PRIOR TO PERMIT ISSUANCE, Coast shall submit for Executive Director review and approval a Juvenile Salmon and Longfin Smelt Predation Assessment Plan that is based on the Pacific Northwest National Laboratory's *Field Protocol for Assessment of Predation Risk to Juvenile Salmonids* (Exhibit 4) and includes the use of DIDSON acoustic camera surveys, underwater video surveys, or diver surveys, as well as hook and line sampling of fish predators and stomach content analyses of captured fish. Once approved, the Juvenile Salmon and Longfin Smelt Predation Assessment Plan shall be implemented by Coast and both interim and final results shall be submitted to the Executive Director. Interim results shall include sampling date, a description of sampling method used, data collected, and a

summary of observations and shall be submitted within 10 days of the completion of each sampling event. Final results shall include all recorded data and observations from previous sampling events as well as a summary of all sampling events and methods used and shall be submitted within 30 days of completion of the final sampling event.
b. If the Executive Director determines that the results of the predation assessment demonstrate that fish species known to prey on juvenile salmon or longfin smelt are consistently present below the cultivation rafts, Coast shall within 90 day of that determination submit an application for a permit amendment to (1) temporarily remove the rafts during the season of peak juvenile salmon and longfin smelt abundance in the project area; (2) temporarily or permanently relocate the rafts to an area shown not to support juvenile salmon or longfin smelt; (3) install fish exclusion devices such as mesh netting on all of the clam cultivation rafts; or (4) otherwise modify the configuration, design, or location of the rafts to minimize attraction of fish species known to prey on juvenile salmon or longfin smelt. A permit amendment application for the installation of fish exclusion devices on the clam cultivation rafts shall also include a Fish Exclusion Effectiveness Monitoring Program.

6. **Installation Location.** No clam cultivation raft shall be installed south of the southernmost clam cultivation raft in the existing Coast raft array.

7. **Maintenance Cleaning.** All maintenance cleaning operations of the raft structures, raft floats, racks, and well infrastructure (not including clam cultivation trays) shall be carried out onshore. All biofouling organisms and biological materials removed during these cleaning operations shall be collected and disposed at an appropriate upland facility. No discharge of untreated wash water or biofouling materials into Humboldt Bay shall occur during maintenance cleaning operations.

8. **Marine Wildlife.** If any marine mammals or more than five seabirds at one time are observed on one of Coast's clam cultivation rafts, Coast shall within 10 days notify the Executive Director of the event and within 30 days of such notification to the Executive Director submit, for review and approval, a plan to install passive deterrent devices (such as exclusionary fencing or netting) to prevent future use of the clam cultivation rafts by marine mammals or seabirds. Coast shall install the passive deterrent devices and maintain them as approved by the Executive Director.

9. **Intake System Design.** All intake systems used to supply water from Arcata Bay for maintenance cleaning and clam tray washing shall be designed with a screened intake with mesh openings of no more than 3/32 inches and a maximum intake water velocity of 0.33 feet per second.

III. FINDINGS AND DECLARATIONS

A. BACKGROUND AND PROJECT DESCRIPTION

On June 13, 1997, the Coastal Commission issued to Coast Seafoods Company (Coast) Coastal Development Permit (CDP) E-02-005 (formerly CDP 1-96-069) for the development of a clam

seed nursery in the Mad River Slough Channel area of Arcata Bay (northern Humboldt Bay). The nursery consisted of ten 12-foot long by 20-foot wide wooden clam cultivation rafts and a 20-foot wide by 27-foot long floating work platform for washing, sorting, and counting seed. In 2002, the Commission approved an amendment to this permit (CDP E-02-005-A1) to allow Coast to change the configuration of the rafts and replace the original wooden clam cultivation rafts with aluminum rafts of the same size and design. Coast currently operates these ten clam rafts on 0.31 acres of submerged tidelands in Arcata Bay that it leases from the Humboldt Bay Harbor, Recreation, and Conservation District (Harbor District).

In this amendment application, Coast proposes to install and operate an additional 20 clam rafts on 0.62 acres of submerged tidelands adjacent to this area that it also leases from the Harbor District. The new total area of Coast's clam raft operations in Arcata Bay would then be approximately one acre.

The 10 existing clam rafts are located along the west side of the entrance to the Mad River Slough Channel opposite Bird Island, approximately ½ mile north of the Samoa/Highway 255 bridges. Ten new rafts are proposed to be installed in a line to the north of the existing rafts and 10 are proposed to be installed in a line to the south of the existing rafts (see Exhibit 1). Each new clam raft would be 12 feet wide by 20 feet long, would be constructed from aluminum and use polyethylene encapsulated Styrofoam for floatation (see Exhibit 2). The 20 rafts would require a total of 16 500-pound steel anchors to be placed in water depths of approximately 20 feet. Each raft would have 24 tray wells and each well would contain a stack of about 20 suspended plastic clam cultivation trays. The rafts would be stocked with Manila clam (*Venerupis philippinarum*) seed of approximately 0.05 inches in size imported from land based hatchery facilities in Washington and Hawaii. These seed would be allowed to grow to approximately 0.14 inches over a period of one to six months in the cultivation rafts. Once it reaches the appropriate size, the clam seed would be harvested by hand, sold, and shipped out of Humboldt Bay for further cultivation (mostly to Willapa Bay, Washington). Each year, Coast anticipates cultivating up to 270 million seed clams on the new proposed rafts.

Each of the new clam rafts would be constructed at upland facilities, placed into the water by crane, and towed by boat into place at the proposed project site. Each set of 10 rafts would then be linked together in a line, separated and held in place by two 60 foot long steel cables between each raft and eight anchors used to keep the array of ten in place (see Exhibit 3). Once in place, the clam rafts would be accessed by skiff and scow. Activities at the clam rafts are proposed to include regular washing, maintenance, harvest, and planting of clam seed. Washing and maintenance activities would be carried out on a daily basis and would include the use of a pressure washer, an onboard water intake pump and hose system on the maintenance vessels. Twice each year the raft anchors and ground tackle would be examined and repaired as necessary by divers using scuba, skiffs and an oyster barge.

B. OTHER AGENCY APPROVALS

Humboldt Bay Harbor, Recreation, and Conservation District
On February 9, 2012 the Harbor District adopted a Negative Declaration and approved an amendment to Coast's permit for the proposed addition of 20 clam rafts to its operation, the lease

of 0.62 additional acres for clam cultivation, and the reduction of other shellfish aquaculture operations in Humboldt Bay by 0.37 acres. In 2010, the Harbor District confirmed a five year renewal of the lease to Coast for aquaculture operations in Humboldt Bay. This lease terminates on September 7, 2015.

U.S. Army Corps of Engineers
Coast submitted an application to the U.S. Army Corps of Engineers (ACOE) on December 22, 2011, to amend its Section 10 permit to include the placement and operation of 20 additional clam cultivation rafts adjacent to its 10 existing rafts. Coast expects to receive ACOE approval pending Commission authorization of the proposed project.

California Department of Fish and Game
Coast's aquaculture operations are required to be registered annually with the California Department of Fish and Game (DFG). Coast has a valid registration for 2012. Commission staff worked closely with DFG during the review of this permit amendment application and are recommending several special permit conditions in response to concerns raised by DFG staff regarding (1) the potential impingement or entrainment of sensitive fish species (such as longfin smelt, juvenile salmon, and euchalon) during proposed raft maintenance operations; and (2) the attraction of predatory bird and fish species to the rafts which may increase mortality rates on juvenile salmon. These issues are discussed in detail below in the Marine Resources section of this report.

U.S. Coast Guard
Consultation between representatives of Coast and U.S. Coast Guard District Eleven staff occurred on January 31, 2012. Coast Guard staff stated that no permit would be required for installation of the proposed clam cultivation rafts and that the Coast Guard would have no concerns with the proposed project as long as no rafts were placed in or near the middle of the channel and no more than 300 feet from the mud flats at low tide. The proposed locations of the clam rafts are consistent with these parameters.

C. FILL OF OPEN COASTAL WATERS

Section 30233(a) of the Coastal Act states:

> *The diking, filling, or dredging of open coastal waters, wetlands, estuaries, and lakes shall be permitted in accordance with other applicable provisions of this division where there is no feasible less environmentally damaging alternative, and where feasible mitigation measures have been provided to minimize adverse environmental effects, and shall be limited to the following:*
>
> *(1) New or expanded port, energy, and coastal-dependent industrial facilities, including commercial fishing facilities.*
>
> *(2) Maintaining existing, or restoring previously dredged depths on existing navigational channels, turning basins, vessel berthing and mooring areas, and boat launching ramps.*

(3) In open coastal waters, other than wetlands, including streams, estuaries, and lakes, new or expanded boating facilities and the placement of structural pilings for public recreational piers that provide public access and recreational opportunities.

(4) Incidental public service purposes, including but not limited to, burying cables and pipes or inspection of piers and maintenance of existing intake and outfall lines.

(5) Mineral extraction, including sand for restoring beaches, except in environmentally sensitive areas.

(6) Restoration purposes.

(7) Nature study, aquaculture, or similar resource dependent activities.

The placement of the clam rafts' 16 anchoring devices on approximately 96 total square feet of bay sediment within the Mad River Slough Channel constitutes "fill" as defined by the Coastal Act. Section 30108.2 of the Coastal Act states:

> *"Fill" means earth or any other substance or material, including pilings placed for the purpose of erecting structures thereon, placed in a submerged area.*

Coastal Act Section 30233(a) permits fill in coastal waters if three tests are met: 1) the fill constitutes an allowable use under 30233(a); 2) there is no feasible less environmentally damaging alternative; and 3) feasible mitigation measures have been provided to minimize any adverse effects.

Allowable use

Coast proposes to place fill in coastal waters for the purpose of cultivating clam seed. As discussed above, Coast's proposed project is an aquaculture project, and as such qualifies as an "allowable use" under 30233(a)(7). The project is therefore consistent with the first test of Section 30233(a).

Alternatives

The Commission investigated project alternatives that would reduce or eliminate the need for fill. Due to the tidal and wind forces present within the project area, a mooring system is required to keep the proposed clam rafts in place. In addition, the proposed cultivation of clam seed requires structures to be placed in the water; therefore, eliminating fill is not a feasible alternative for clam seed culture operations. Coast evaluated several anchoring systems including pile-driven moorings, wedge anchors, and concrete-filled barrel anchors, and determined that the proposed 250 to 500 pound navy anchors would be the most effective at keeping the rafts in place with a limited disturbance footprint on the bay bottom. In addition, Coast evaluated several mooring array options including a more extensive system with 28 anchors before selecting a smaller system with only 16 steel anchors, each weighing between 250 and 500 pounds and with a footprint of six square feet. The proposed project uses off-bottom culture techniques and the installation of floating rafts with a minimally designed mooring system that does not include the permanent placement or pile driving of anchors. These project elements reduce the amount of fill compared to alternative mooring and cultivation techniques. The Commission therefore finds

that the proposed project minimizes the amount of fill to the maximum extent feasible and is therefore consistent with the second test of Section 30233(a).

Mitigation Measures
The final test of Coastal Act Section 30233(a) requires that feasible mitigation measures have been provided to minimize any adverse effects of the fill. As discussed in the Marine Resources section below under the heading *Smothering and Disturbance*, the placement of anchoring devices on 96 total square feet of bay sediment is expected to result in loss of benthic habitat and mortality and disturbance to associated organisms. However, as described in more detail in the following section, given the small size of the project anchoring footprint and associated disturbance areas relative to the abundance of similar benthic habitat in Humboldt Bay, adverse impacts associated with the installation and presence of the proposed anchoring system are expected to be minimal. The Commission therefore finds that mitigation measures to further minimize the adverse environmental impacts associated with the project's use of fill are not necessary and finds that the third and final test of Coastal Act Section 30233(a) has been met.

Conclusion
Because the three tests have been met, the Commission finds the proposed project consistent with Section 30233 of the Coastal Act.

D. MARINE RESOURCES

Section 30230 of the Coastal Act states:

> *Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*

Section 30231 of the Coastal Act states:

> *The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.*

The proposed installation and operation of 20 clam cultivation rafts has the potential to adversely affect marine resources and the biological productivity of coastal waters in Humboldt Bay by potentially causing adverse impacts to benthic and water column habitat, longfin smelt, listed salmonids, marine birds, and marine mammals.

Benthic Habitat

The raft array would be held in place by 16 steel anchors, each weighing between 250 and 500 pounds and with a footprint of six square feet. In total, this proposed 16 unit anchoring system would take up roughly 96 square feet of substrate.

Benthic habitat at the proposed project site is comprised of fine sands and silts that support a variety of invertebrate species including polychaete worms, mollusks, and crustaceans (Barnhart et al. 1992). No eelgrass or other submerged aquatic vegetation is present at the project site and all of the proposed anchoring locations are well below the depth range of eelgrass in Humboldt Bay (Confluence Environmental Company 2011).

Potential adverse impacts to benthic habitat from the proposed project include: (1) smothering of organisms and loss of habitat due to the presence of anchoring devices on the bay bottom; (2) disturbance to sediments from initial anchor installation activities and sediment scour due to anchor drag and movement of ground tackle; and (3) shading of benthic habitat from the presence of the proposed rafts on the water surface.

Smothering and Disturbance

Placement of the proposed anchoring system is expected to result in the long-term loss of 96 square feet of benthic habitat (spread across 16 sites of six square feet each) and the short-term disturbance of a similar amount of adjacent areas due to the installation and presence of the steel anchors. Mobile organisms such as crabs are expected to be able to relocate to adjacent habitat areas when the anchors are installed but other types of benthic invertebrates such as polychaete worms and molluscs may be smothered and killed by the anchors. Additionally, the loss of this habitat area would reduce the forage opportunities for fish, rays, seabirds, and marine mammals that prey on benthic invertebrates. However, in the context of the larger project area and Humboldt Bay as a whole, the loss of 96 square feet of benthic habitat and mortality of a small number of fast growing benthic organisms due to anchor placement and sediment disturbance is not anticipated to adversely affect the biological productivity of Humboldt Bay or substantially reduce populations of marine organisms. Ecological studies of Humboldt Bay have shown that benthic habitat comprised of fine sand and silt sediment similar to the habitat present at the project site is dominant in Humboldt Bay (covering hundreds of acres) and that many of these areas support similar communities of benthic invertebrates (Barnhart et al. 1992). Therefore, given the small size of the project anchoring footprint and associated disturbance areas relative to the abundance of similar benthic habitat in Humboldt Bay, adverse impacts associated with the installation and presence of the proposed anchoring system are expected to be minimal.

Shading

The presence of the new clam rafts, comprising a total surface footprint of 4800 square feet, may also adversely affect benthic habitat by restricting the amount of light that is able to penetrate the water column and reach the bay sediment below the rafts. Such shading may stunt the growth of submerged aquatic vegetation or benthic algae, alter benthic invertebrate community structure, and modify the presence and abundance of bottom fish in the affected area. However, water clarity in the project area is very limited and sunlight penetration through the water column is naturally restricted by the particulate matter and sediment typically in suspension. In fact, water clarity samples taken in the summer and fall near the proposed project site have measured the

maximum depth to which 1% of surface illumination penetrates at less than four feet on average (Barnhart et al. 1992). Because the clam rafts would be placed in water depths of approximately 20 feet where light penetration to the bay bottom is already not expected to occur, shading from the rafts is not anticipated to result in any adverse effects on benthic habitats. In addition, the design of the proposed cultivation rafts includes metal grating across much of the surface of the rafts (see Exhibit 2), allowing some light penetration to occur through the structures and reducing the size of each raft's shade footprint.

Water Column Habitat

As noted by the National Marine Fisheries Service's Habitat Conservation Division: "Overwater structures reduce light penetration through the water column harming eelgrasses and other photosynthetic organisms. Additionally, overwater structures provide substrate for invasive species, alter current flow and aggregate upper level predators, causing unnaturally high pressure on forage fishes." With a total footprint of 4800 square feet on the water surface and a variety of in water structures to depths of seven feet, the project has the potential to result in some of these adverse impacts to water column habitat and associated species by: (1) reducing light penetration into the water column and thereby altering the abundance of photosynthetic phytoplankton that forms the base of many marine food webs; (2) providing substrate for invasive species to colonize; and (3) aggregating upper level predators and increasing mortality rates on forage fishes, including special status species.

Shading

The presence of large floating structures on the surface typically results in lower light transmittance to the water below. For photosynthetic organisms, including phytoplankton, this shading effect can limit growth rates, abundance, and diversity. Reduced size, diversity, and abundance of low trophic level phytoplankton species can have corresponding effects on the abundance and diversity of species farther up the food chain, including fish and invertebrates.

However, the proposed location and design of the clam rafts would help to minimize the likelihood of such effects occurring. Specifically, the proposed location of the rafts in the deep water of the Mad River Slough channel, an area of frequent tidal currents, would enhance water flow beneath the rafts and increase the frequent movement of phytoplankton from partially shaded to un-shaded adjacent waters. This constant movement is expected to reduce the potential for the rafts to adversely affect primary productivity. In addition, the rafts would be built with metal grating as approximately one-half of the surface material. This grating would allow some sunlight to penetrate through the raft into the water column below. Areas between the grated metal walkways would support vertical wells holding plastic clam cultivation trays that would not provide as much light transmittance, however. While the shading effects of the rafts on the water column would be substantially reduced through the use of metal grating, some shading would still occur below roughly half of each raft – approximately 96 square feet. However, the vertical tray wells providing this shading are proposed to extend as solid structures to approximately seven feet below each raft (see Exhibit 2), thereby occupying much of the water column below each raft to a depth at which light transmittance is substantially reduced due to the natural turbidity of Humboldt Bay. In other words, most of the shaded space below each raft would be taken up by the cultivation wells. Given the relatively small footprint of the shaded portion of each raft as well as the water depth, current flow, and natural turbidity of the

bay water, installation of the proposed array of new rafts is not expected to adversely affect the productivity of Humboldt Bay by significantly reducing the amount of water column habitat available for photosynthetic plankton.

Non-native Species
Based on a February 28, 2002, report to the California Department of Fish and Game titled, *Non-Indigenous Marine Species of Humboldt Bay, California*, over 95 invasive marine species are present in the bay, including numerous species known to present significant economic and ecological risk to both Humboldt Bay and other marine areas along the west coast. Many of these species are know to be "fouling organisms," species of invertebrates and algae that are known to seek out and colonize artificial hard substrate in the marine environment. Maintenance activities for in-water structures and vessels that involve periodic removal of fouling organisms without proper collection and disposal protocols may result in increased dispersal and propagation opportunities for these species. Such opportunities for dispersion and spread pose a particular risk with some algal species and colonial species such as didemnum that may break apart into many pieces when disturbed, each of which may be capable of surviving, growing, and reproducing on its own.

Each of the proposed clam rafts includes 24 approximately two foot square by seven foot long metal cultivation wells that would extend below the rafts into the water column. These structures attract fouling organisms over time and are proposed to be periodically removed and cleaned by Coast. These cleaning activities involve the use of a pressure washer and are proposed to be carried out on the rafts themselves, with wash water and removed fouling organisms discharged into the bay. To address the potential risk that this activity would have with regard to the spread and dispersion of invasive marine species, the Commission is requiring Coast in **Special Condition 7** to carry out the cleaning and pressure washing of the rafts and cultivation well infrastructure at an onshore facility and to collect and dispose of all removed biological material and organisms at an upland facility.

The purpose of the new rafts is to cultivate a non-native species, the Manila clam. In its approval of CDP E-02-005, the Commission found: (1) a population of Manila clams has already been established in Humboldt Bay as a result of introductions in previous decades; and that (2) the bottom area in the vicinity of Coast's clam seed nursery does not contain the kind of shell and hard material that would promote Manila clam growth. In addition, Coast is implementing three management measures to further minimize the potential for the clam nursery to contribute to a self-sustaining population of Manila clam in Humboldt Bay:

- Coast Seafoods Company will make every effort to minimize further introduction of live clams into the bay through diligent management practices during grading and handling to prevent spillage.
- During washdown of seed and equipment, screens will be used to contain all clams regardless of size and any culls will be discarded in onshore trash containers.
- All clam seed will be removed from the clam raft system and shipped back to Washington for planting by Coast, or sold to other shellfish customers prior to reaching 12mm shell size, at which size they are not sexually mature.

These management measures would remain in place and apply to these additional rafts, minimizing the potential for expanded operations to further augment existing naturalized populations of Manila clam in Humboldt Bay by limiting the potential for accidental releases to occur and ensuring that all cultivated clams are removed prior to reaching the size and age necessary to begin reproducing.

Although these measures would address the issue of augmenting the self-sustaining or naturalized population of Manila clam in Humboldt Bay, the proposed placement of the clam rafts would still increase the total population of non-native Manila clam in Humboldt Bay by as much as 270 million[1]. The filter feeding behavior of this population of non-native clams has the potential to adversely affect native clam species, communities of native organisms that rely on the same food resources, and the overall biodiversity and productivity of Arcata Bay if they affect a large enough volume of water and if they significantly decrease the amount of food resources in that water available for native species. For example, the invasion of the San Francisco Bay-Delta Estuary by the non-native clam *Corbula amurensis* has had an apparent effect on longfin smelt population abundance, presumably through competition and its negative effects on the upper Estuary's planktonic food web (Bay Institute et al 2007, Kimmerer et al 1994).

Based on an analysis carried out by Confluence Environmental Company in the Draft Biological Evaluation it produced for Coast on this project, each day, the population of clams proposed to be cultivated on the clam rafts would filter 3.5% of the total tidal prism – the volume of water that leaves Arcata Bay at ebb tide each day – and 1.5% of the total volume of water in Arcata Bay at high tide. Although notable, the filtration of this volume of water does not appear overly large when considered in the context of the average tidal exchange of water in this portion of the bay. In Arcata Bay, 44% of the total volume of water is replaced each day and 99% of the total volume of water is replaced every seven days. Accordingly, a portion of the water filtered by the cultivated clams is expected to exit the bay each day and the remainder would mix thoroughly with new water entering the bay. The population of Manila clam proposed to be cultivated on the clam rafts is therefore not expected to substantially reduce the amount of available phytoplankton in Arcata Bay and is not anticipated to adversely affect native clam species, communities of native filter feeding organisms, and the overall biodiversity and productivity of Arcata Bay.

Special Status Species

Three species of salmonids that inhabit Humboldt Bay and its tributaries are listed as threatened under the federal Endangered Species Act of 1973. Two of these species are also listed as threatened under the California Endangered Species Act. Coho salmon (*Oncorhynchus kisutch*) is federally and state listed for the Southern Oregon/Northern California Coasts Evolutionarily Significant Unit (ESU), Chinook salmon (*O. tshawytscha*) is federally and state listed for the California Coastal ESU, and steelhead (*O. mykiss*) is federally listed for the Northern California ESU. These salmon species are present in Humboldt Bay both as adults during their migration from the sea into spawning rivers in the fall and winter and as juveniles as they move downstream into the ocean in the spring and early summer. In addition, longfin smelt

[1] Confluence Environmental Company, *Clam Raft Expansion – Draft Biological Evaluation,* April 5, 2012.

(*Spirinchus thaleichthys*) is listed as a threatened species under the California Endangered Species Act. Longfin smelt generally spawn in freshwater and move downstream to estuarine conditions to grow. Although once among the most abundant fish species in Humboldt Bay, present in larval, juvenile, and adult life stages, longfin smelt were considered to be possibly extinct there by 1996 (Eldridge and Bryan 1972, U.S. Fish and Wildlife Service 1996). In recent years, however, longfin smelt have again been observed in Humboldt Bay and are thought to be present year-round (Pinnix et al 2005).

Research suggests that artificial overwater and in-water structures such as docks and rafts can alter surface and mid-water habitat and result in adverse effects on juvenile salmon and possibly other fish such as larval, juvenile, and adult longfin smelt. Simestad and Nightengale (1999) note in their study of overwater structures in Puget Sound that overwater structures:

> *…may affect juvenile salmon (especially ocean-type Chinook and chum) directly and indirectly: (1) directly by disrupting their migratory behavior along shallow-water shoreline habitats and (2) indirectly by reducing carrying capacity because of reduced production of under-structure habitats and increased predation by other fish, birds, and, marine mammals. Although individual shoreline structures may not impose significant impacts on salmon stocks, the cumulative effect of dense, contiguous shoreline modifications may contribute to the present decline of several Puget Sound salmon stocks and may inhibit the success of future salmon recovery actions.*

Although different than typical overwater structures, such as piers and docks, the additional rafts result in approximately 4800 square feet of new floating raft structures and 7200 square feet of total raft structures along an approximately half-mile alongshore stretch of the Mad River Slough Channel. The additional rafts would approximately double the current surface area of in-water floating structures in the Mad River Slough Channel area of Arcata Bay. Each of the 30 total rafts would be placed roughly 60 feet apart, and the line of rafts would run parallel to shore on the west edge of the Mad River Slough Channel approximately 150 feet from the shoreline at low-tide. Each raft also includes 24 clam cultivation wells extending to a depth of almost seven feet (see Exhibit 2), thus providing both horizontal and vertical structure in the water. As such, the clam rafts would alter the open water environment of the Mad River Slough Channel by adding substantial habitat complexity to both the surface and the first seven feet of the water column (slightly less than half the water column depth at the proposed project site).

Some of the effects related to over-water structures evaluated by Simestad and Nightengale (1999) appear to be directly associated with lighting changes caused by shade cast on the water column by structure. Studies carried out on these effects found that juvenile salmon are more likely to slow their migration and fall prey to predators by becoming disoriented after encountering lighting changes, dispersing from their schools under low light conditions, and moving from their preferred migratory pathway into deeper waters with fewer refuges in order to avoid light changes. Although, as discussed above, the proposed rafts would be designed to include metal grating as a surface material in order to increase the amount of light that is able to pass into the water column, approximately half of each raft would be occupied by clam cultivation wells and trays that are expected to limit light transmittance and create shaded areas below each raft. As such, the proposed rafts have the potential to result in adverse impacts to

juvenile salmon due to shading. In fact, recent research by Pinnix et al. (2012) on the migratory behavior and habitat use patterns of Coho salmon smolts in Arcata Bay suggests that displacement of smolts away from the existing array of cultivation rafts and towards the deeper water center of the Mad River Slough Channel may already be occurring. However, because these studies were carried out recently and similarly detailed information is not available regarding the historic use patterns of salmon smolts in the same channel prior to installation of the exiting rafts, definitive conclusions cannot be drawn regarding the effects of the raft array on salmon migration.

Longfin smelt may potentially be susceptible to similar shading effects as well but no direct research efforts have been carried out on this species and little is known about its preferred depth range and use of water column habitat in Humboldt Bay. Research from San Francisco Bay suggests that larval longfin smelt (less than 0.5 inches in size) typically occupy the upper one-third of the water column while larger juveniles and adults typically inhabit the bottom two-thirds of the water column (U.S. Fish and Wildlife Service 2008). Considering the turbidity of the project area (little light penetration past four feet in depth), if similar behavioral patterns were typical of longfin smelt in the Mad River Slough Channel, it is unlikely that larger juveniles and adults of the species would encounter areas shaded by overwater or floating structures, although larval smelt might be affected.

In addition to the direct effects of shading, research by Castro et al. (2002) and Clynick et al. (2011) also suggests that objects floating on the water surface or in the water column attract fish by providing forage opportunities and refuge that would otherwise not be present in open water habitat. The novel structure that the proposed rafts would provide in the water column, the possible protection from tidal currents they may provide, as well as any invertebrate species or biofouling organisms that subsequently colonize their submerged surfaces have the potential to attract aggregations of predatory fish species to the rafts. In turn, these aggregations could prey on species such as longfin smelt and juvenile salmon that may pass by or become attracted to the proposed raft array during outward migrations or foraging. While frequent concerns about the effect of overwater structures on juvenile salmon predation have been raised in Puget Sound, several of the studies directed at evaluating this issue (Simestad and Nightengale 1999, Nightengale and Simestad 2001, Williams et al. 2003) suggest that attraction to overwater structures of fish species known to prey on juvenile salmon is limited and confirmed predation events are few.

However, the structures and environmental setting evaluated in these studies differ from the project area and proposed clam cultivation rafts in several key characteristics including size, orientation to the shoreline, water clarity, depth range, and development of surrounding areas. These differences make it difficult to use the results of the Puget Sound studies to draw definitive conclusions on this issue for Humboldt Bay and other areas, a point recognized in all three papers and discussed by Williams et al. (2003) as support for the need for increased research attention:

> *Though our findings may not enable us to extrapolate impacts to all ferry terminals or overwater structures, or about cumulative impacts of predators to juvenile salmon in the nearshore, the study does provide good insight into general trends at the sites we studied. It*

> *also provides the basis for recommending standardized survey protocols at other sites that may guide and strengthen more general conclusions about predation risk of juvenile salmonids near overwater structures. Drawing on the lessons learned in this study, we recommend use of a field protocol that is intended to provide a standardized procedure for evaluating predation risk to juvenile salmonids at ferry terminals and other overwater structures… Application of this protocol to more locations and situations will allow the scientific community to develop a much stronger case for evaluating predation pressure associated with nearshore anthropogenic structures.*

Therefore, although the potential for this impact to occur is well established, its likelihood and magnitude in relation to the proposed project cannot be known with any high degree of certainty. To date, no studies have been carried out on the existing clam cultivation rafts in Humboldt Bay to determine which species of fish, if any, are being attracted to them and aggregating below them. Additionally, although this area of Humboldt Bay has historically been shown to support abundant populations of larval longfin smelt (Eldridge and Bryan 1972) and it has been well established through the use of telemetry tracking of Coho salmon smolts (Pinnix et al. 2012) that the Mad River Slough Channel, including the project site, is a key migratory route, it is less well known what proportion of each population is likely to interact with the proposed rafts. Pinnix et al. (2012) demonstrated that the largest salmon smolts prefer the center of the Mad River Slough Channel (outside of the project footprint), but little is known about whether this preference is in response to the existing raft array or if the movement and foraging behavior of other age and size classes of salmon smolts also reflect this behavior. Similarly, while observations and capture locations of longfin smelt in San Francisco Bay suggests that juvenile and adult fish typically prefer deeper waters (at least during the day) while larvae remain near the surface (U.S. Fish and Wildlife Service 1996, 2008), these observations have yet to be corroborated in Humboldt Bay where water clarity, salinity gradients, and depths may be different.

While more research on this topic is needed in order to facilitate a more comprehensive analysis, given the available information regarding the use of the Mad River Slough Channel by special status forage fish and the potential attraction of predatory fish to overwater structures such as rafts, the Commission is requiring **Special Condition 6** to minimize the cumulative effect of the proposed clam raft array on special status fish species and water column habitat. **Special Condition 6** requires that Coast install all proposed new clam rafts to the north of its 10 existing rafts. This modification to the project would provide a greater separation between the array of clam cultivation rafts that Taylor Mariculture maintains in the Mad River Slough Channel and those proposed by Coast. **Special Condition 6** would increase the separation distance between both sets of rafts by 1000 feet, potentially interfering with the ability of both arrays to function as a larger alongshore line of overwater structures and thus reducing any adverse effect that the cumulative array may have in terms of impeding migratory salmon smolts or aggregating predators.

In addition, the Commission also requires in **Special Condition 5** that Coast develop and submit a Juvenile Salmon and Longfin Smelt Predation Assessment Plan to the Executive Director for review and approval. This plan is required to include the use of both passive and active sampling techniques aimed at determining the number and species of fish that may be aggregating below the existing and proposed arrays of clam cultivation rafts. These techniques would include a

combination of hook and line sampling and either acoustic imaging, video, or diver surveys (given the limited water clarity, diver or video surveys would only be used if they are first shown to be capable of effectively observing fish under typical conditions). In addition, the plan would include the use of stomach content analyses for fish captured during hook and line sampling in order to further establish the list of fish species known to prey on juvenile salmon or longfin smelt. Overall, the plan would be adapted from the protocol and techniques developed and discussed in the Pacific Northwest National Laboratory's *Field Protocol for Assessment of Predation Risk to Juvenile Salmonids* (Exhibit 4). If, upon review of the results of the assessment plan, the Executive Director determines that significant numbers of fish species known to prey on juvenile salmon or longfin smelt are consistently present below the clam rafts, the Commission also requires in **Special Condition 5** that Coast submit an application for permit amendment to modify the clam rafts such that attraction of juvenile salmon and longfin smelt predators is avoided. Possible modifications would include the use of passive exclusionary devices to keep predatory fish from aggregating below the rafts or temporary removal or relocation of the rafts during the seasons of highest juvenile salmon and smelt abundance.

Marine Mammal and Seabird Use

Floating structures located close to the water surface, such as docks and rafts, may be colonized by seabirds and marine mammals for use as resting areas. Such use may result in potential conflicts between human and wildlife use of the structures and increased incidences and opportunities for disturbance, harassment, or injury to marine wildlife. Disturbance to wildlife may occur if wildlife use causes damage or property loss and steps are taken to actively deter or displace the wildlife such as through the use of noise-makers, lights, or physical herding devices. Disturbance may also occur as humans and vessels approach within close proximity of an occupied floating structure. In addition, wildlife may be accidentally injured when using man-made structures due to entanglement or interactions with sharp materials.

Coast has indicated that pelicans, cormorants, herons, loons, and seagulls have been periodically observed roosting on its existing rafts but that no consistent roosting behavior has been observed, and marine mammals have not been known to haul out on the structures. In addition to the 10 rafts operated by Coast, Taylor Mariculture also operates several similar clam cultivation rafts in the Mad River Slough Channel. California Department of Fish and Game staff and Coast employees have observed large numbers of roosting California brown pelicans on these rafts. The presence of these birds on the Taylor Mariculture rafts was also confirmed by the Commission staff on a June 15, 2012, site visit. While the design and materials used for the Taylor Mariculture rafts differs somewhat from the existing and proposed Coast rafts, the observed presence of seabirds on both sets of rafts and the high numbers of pelicans that make use of the Taylor rafts – located approximately 1500 feet from the proposed site of the southernmost array of Coast rafts – suggests that colonization of the proposed rafts by seabirds may occur.

In addition, although marine mammals have also not been known to haul-out on the Taylor Mariculture rafts, both the existing Taylor Mariculture and Coast rafts are located near a low tide harbor seal haul-out site (see Exhibit 1) observed by the Commission staff on June 15, 2012. The proposed location of the southern array of 10 rafts would bring the clam rafts to within approximately 1100 feet of this haul-out site and provide a potential alternate haul-out site during times when the tide may preclude their use of the sandbar haul-out site. The proximity of the

proposed clam rafts to a harbor seal haul-out site suggests that future colonization of the proposed clam rafts by marine mammals may also occur.

In the case of marine mammal or seabird use of the proposed clam rafts, Coast has specified that it is its policy to not harm, harass, or injure marine wildlife. However, such affects on marine wildlife may be unintentional consequences of these animals using the rafts (entanglement or injury on the metal structure), attempting to prey on cultured shellfish on the rafts, or necessary deterrence activities that may be carried out in order to prevent property loss or damage. In addition to these direct effects, colonization of the proposed clam rafts by marine mammals or seabirds (both of which may prey on special status fish species such as longfin smelt and salmon that are known to be present in the project area) may have adverse indirect effects by augmenting the local abundance of predators and thereby increasing salmon and smelt predation. Longfin smelt, in particular, are known to be eaten by a variety of predatory fishes, birds and marine mammals and are considered to be a major prey of harbor seals (*Phoca vitulina*) in the Columbia River (Emmett et al. 1991). To address these potential adverse impacts, the Commission is requiring Coast in **Special Condition 8** to report to the Executive Director if any marine mammals or more than five seabirds at any one time use its clam cultivation rafts. **Special Condition 8** also requires that Coast submit for Executive Director review and approval a plan for the installation of passive marine mammal and/or seabird exclusion devices on the clam rafts within 30 days of the submittal of such a report. To further reduce the potential colonization of the proposed rafts by marine mammals, the Commission also includes **Special Condition 6** which requires Coast to install all 20 rafts to the north of the existing array of 10 rafts. This would ensure that none of the proposed rafts would be installed closer to the harbor seal haul-out area than the existing rafts and additionally reduce potential sources of disturbance to these seals that may result from noise and boat activity generated during harvest and maintenance operations on the proposed clam raft array.

Maintenance and Cleaning Water Intakes

The removal of seawater through intake structures is known to result in the impingement and entrainment of marine life. The type and quantity of marine life that may be adversely affected in this way is related to the size and velocity of the intake structures. Larger, high-velocity structures can cause the impingement and entrainment of larger organisms that can include adult fish while smaller low-velocity structures can typically only impinge and entrain smaller larval and juvenile organisms. While impingement (capture of fish and marine organisms against an intake screen due to suction) can often result in the injury or mortality of the affected organism, adverse effects of entrainment (capture of fish and marine organisms in the intake stream) vary based on the type of intake system (configuration of pipes, pressure changes, temperatures) and ultimate use of the entrained water.

As part of its maintenance operations, Coast carries out a variety of washing and cleaning activities including the rinsing of the clam seed and cultivation trays as well as the well structures in which the trays are housed. Rinsing of the clams and cultivation trays would occur on a daily basis in order to remove any accumulated sediment or non-target organisms that may also be growing on the cultivation trays. Such non-target organisms may include native and non-native algae, bryozoans, hydroids, tunicates, sponges, amphipods, and mysid shrimp that are present in Arcata Bay as adults and larvae. Coast proposes to use both a hose and pressure washer for these daily cleaning activities. Coast proposes to use Arcata Bay as a water source

for these activities and initially proposed to use a coarsely screened intake system on its maintenance vessel with an intake capacity of 160 gallons per minute and a velocity of 12 to 16 feet per second. Coast proposes to use this system to collect approximately 10 million gallons of bay water per year for maintenance washing activities.

However, in response to concerns raised by California Department of Fish and Game (DFG) staff regarding impingement of listed species such as longfin smelt and juvenile salmon as well as inconsistencies between the design of this intake system and DFG intake standards, Coast has committed to use intakes designed according to National Marine Fisheries Service and DFG requirements as protective of fish – in other words, with intake velocities not to exceed 0.33 feet per second and 3/32 inch mesh screening. The Commission has previously found these standards to reduce the potential impingement and entrainment of juvenile and adult fish because an intake velocity of 0.33 feet per second is not be likely to exceed a fish's swimming ability and most juvenile and adult fish exceed 3/32 inch in size. **Special Condition 9** requires that the seawater intake velocity for Coast's maintenance and cleaning wash system not exceed 0.33 feet per second and that the screen openings for the intake point screen remain no larger than 3/32 inch.

Conclusion

Although the Commission finds that the proposed project has the potential to adversely impact marine resources and the biological productivity of coastal waters, with implementation of **Special Condition Nos. 5** through **9**, the project is expected to be carried out in a manner in which marine resources are maintained, species of special biological significance are given special protection, the biological productivity of coastal waters is sustained, and healthy populations of all species of marine organisms will be maintained. In addition, the proposed project, as conditioned, is expected to maintain the biological productivity of coastal waters appropriate to maintain optimum populations of marine organisms. The Commission therefore finds that the proposed project, as conditioned, is consistent with the marine resource sections (Sections 30230 and 30231) of the Coastal Act.

E. ACCESS AND RECREATION

Section 30210 of the Coastal Act states:

> *In carrying out the requirement of Section 4 of Article X of the California Constitution, maximum access, which shall be conspicuously posted, and recreational opportunities shall be provided for all the people consistent with public safety needs and the need to protect public rights, rights of private property owners, and natural resource areas from overuse.*

Section 30211 of the Coastal Act states:

> *Development shall not interfere with the public's right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation.*

Section 30220 of the Coast Act states:

> *Coastal areas suited for water-oriented recreational activities that cannot readily be provided at inland water areas shall be protected for such uses.*

The proposed project has the potential to affect public access and recreation by precluding recreational activities in areas where the proposed clam cultivation rafts would be located.

Recreation activities in and around Arcata Bay include boating, paddling (e.g., kayaks and canoes), fishing, clamming, birdwatching and nature enjoyment, walking and hiking, beach play, and enjoyment of scenic views. Hunting is allowed at several locations, including the State-managed area at Fay Slough Wildlife Area. Portions of the US Fish and Wildlife Service Jacoby Creek and Eureka Slough units are open during the State waterfowl hunting season; these locations are designated for boat access only. Boating in Arcata Bay is somewhat limited because of the shallow water and tidal conditions; popular areas include the Mad River Slough area, with ("unofficial") access from the Highway 255 bridge and other locations.

The proposed clam raft array would be installed in line with the existing array and would be within a portion of the Mad River Slough Channel that is approximately 600 feet wide. The clam raft array would be parallel to shore and would be limited to between 12 and 20 feet wide along the western edge of the channel. Although the raft array would extend for approximately 3200 feet along shore, the size of the channel in this area provides adequate access opportunities for recreational boating. Coast's proposed operations would not affect public access to the water.

For these reasons, the Commission finds that the proposed project is consistent with the public access and recreation policies (Sections 30210, 30211, and 30220) of the Coastal Act.

F. VISUAL RESOURCES

Section 30251 of the Coast Act states:

> *The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas. New development in highly scenic areas such as those designated in the California Coastline Preservation and Recreation Plan prepared by the Department of Parks and Recreation and by local government shall be subordinate to the character of its setting.*

Because of the low profile of the rafts in the water, and their proposed location offshore, the proposed raft arrays would not be visible from most public vantage points around the shores of Humboldt Bay. However, the clam rafts would be visible from Highway 255 along a portion of the Samoa Bridge, the bridge that spans Humboldt Bay between Eureka and the Samoa Peninsula. The existing rafts are located approximately 3000 feet from the bridge and, as shown in Exhibit 4, appear quite small. While the 20 proposed rafts would increase the visual footprint of the total clam seed nursery, **Special Condition 6** would require the 20 proposed rafts to be installed to the north of the existing rafts, making them appear even smaller due to their greater distance from the bridge.

Therefore, the Commission finds that the proposed development is consistent with Section 30251 of the Coastal Act, as the clam cultivation rafts will avoid significant adverse impacts on visual resources.

G. CALIFORNIA ENVIRONMENTAL QUALITY ACT

On February 9, 2012, the Humboldt Bay Harbor, Recreation, and Conservation District certified a Mitigated Negative Declaration for Coast's installation and operation of 20 new clam cultivation rafts in the Mad River Slough Channel portion of Arcata Bay. In addition, Section 13096 of the Commission's administrative regulations requires Commission approval of coastal development permit applications to be supported by a finding showing the application, as modified by any conditions of approval, to be consistent with any applicable requirements of the California Environmental Quality Act ("CEQA"). Section 21080.5(d)(2)(A) of CEQA prohibits approval of a proposed development if there are feasible alternatives or feasible mitigation measures available that would substantially lessen any significant impacts that the activity may have on the environment. The project as conditioned herein incorporates measures necessary to avoid any significant environmental effects under the Coastal Act, and there are no less environmentally damaging feasible alternatives or mitigation measures. Therefore, the proposed project is consistent with CEQA.

Appendix A: Substantive File Documents

Coastal Development Permits and Application Materials:

Revised Staff Report for Coastal Development Permit number 1-96-69
Notice of Immaterial Permit Amendment for Coastal Development Permit number E-02-005-A1
Project file for Coastal Development Permit Amendment Application number E-02-005-A1
Application for Coastal Development Permit Amendment number E-02-005-A2
Plauché & Stock , LLP, Letter to Commission staff, February 7, 2012
Plauché & Stock, LLP, Email to Commission staff, March 6, 2012 - 3:31PM
Plauché & Stock, LLP, Email to Commission staff, March 6, 2012 – 4:07PM
Plauché & Stock, LLP, Email to Commission staff, March 27, 2012
Plauché & Stock, LLP, Email to Commission staff with attachment, June 21, 2012
Plauché & Stock, LLP, Email to Commission staff with attachment, July 18, 2012
Plauché & Stock, LLP, Email to Commission staff with attachment, July 19, 2012

Environmental Documents:
Confluence Environmental Company and Plauché & Stock, LLP, *Draft Mitigated Negative Declaration and Initial Study for Coast Seafoods Company Clam Raft Expansion Project,* December, 2011.

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U.S. Fish and Wildlife Service. 1996. Sacramento-San Joaquin Delta native fishes recovery plan. Portland (OR): U.S. Fish and Wildlife Service.

Exhibit 1 – Project Location

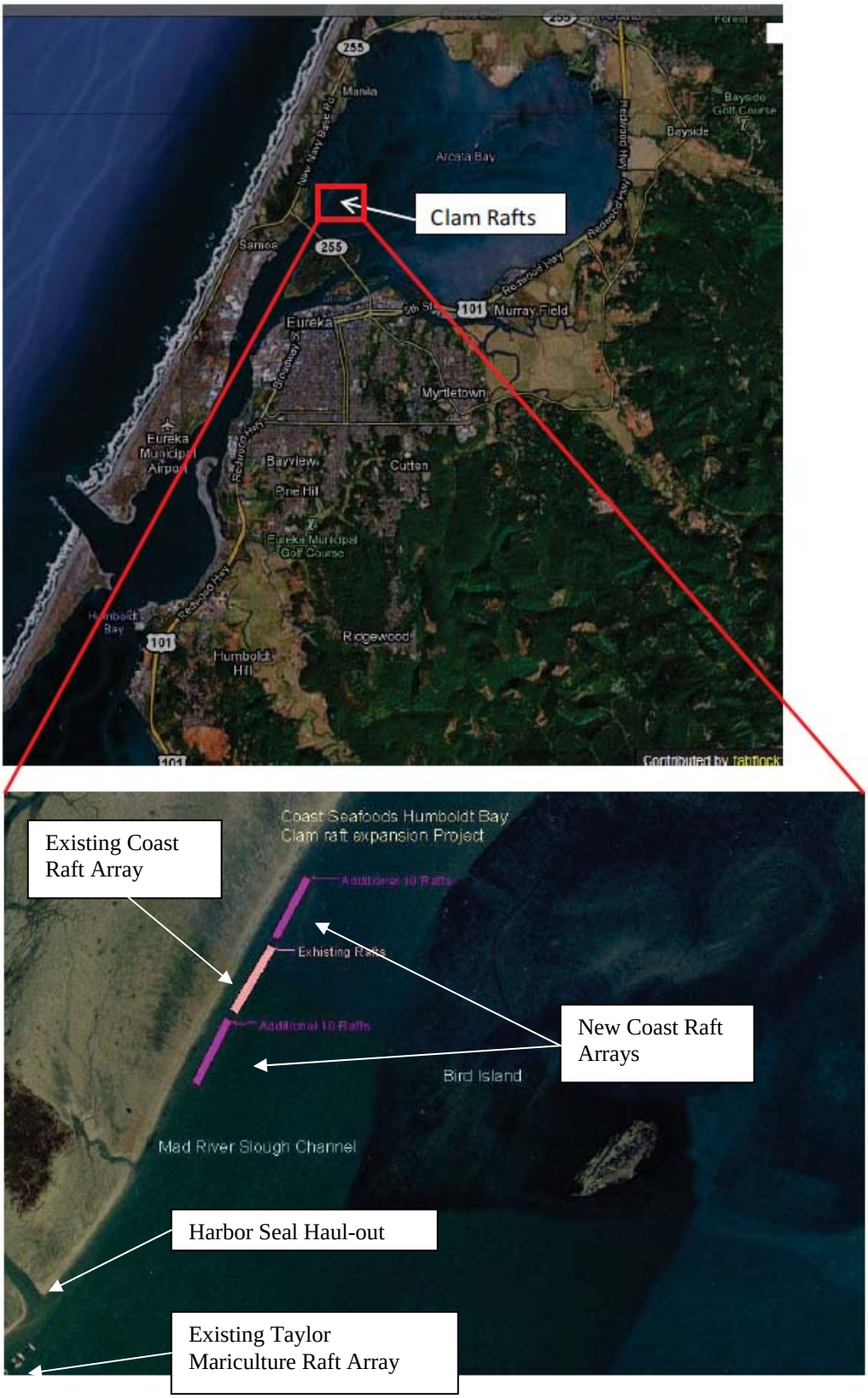

EXHIBIT 1

Project Location

Exhibit 2 – Clam Cultivation Raft Design

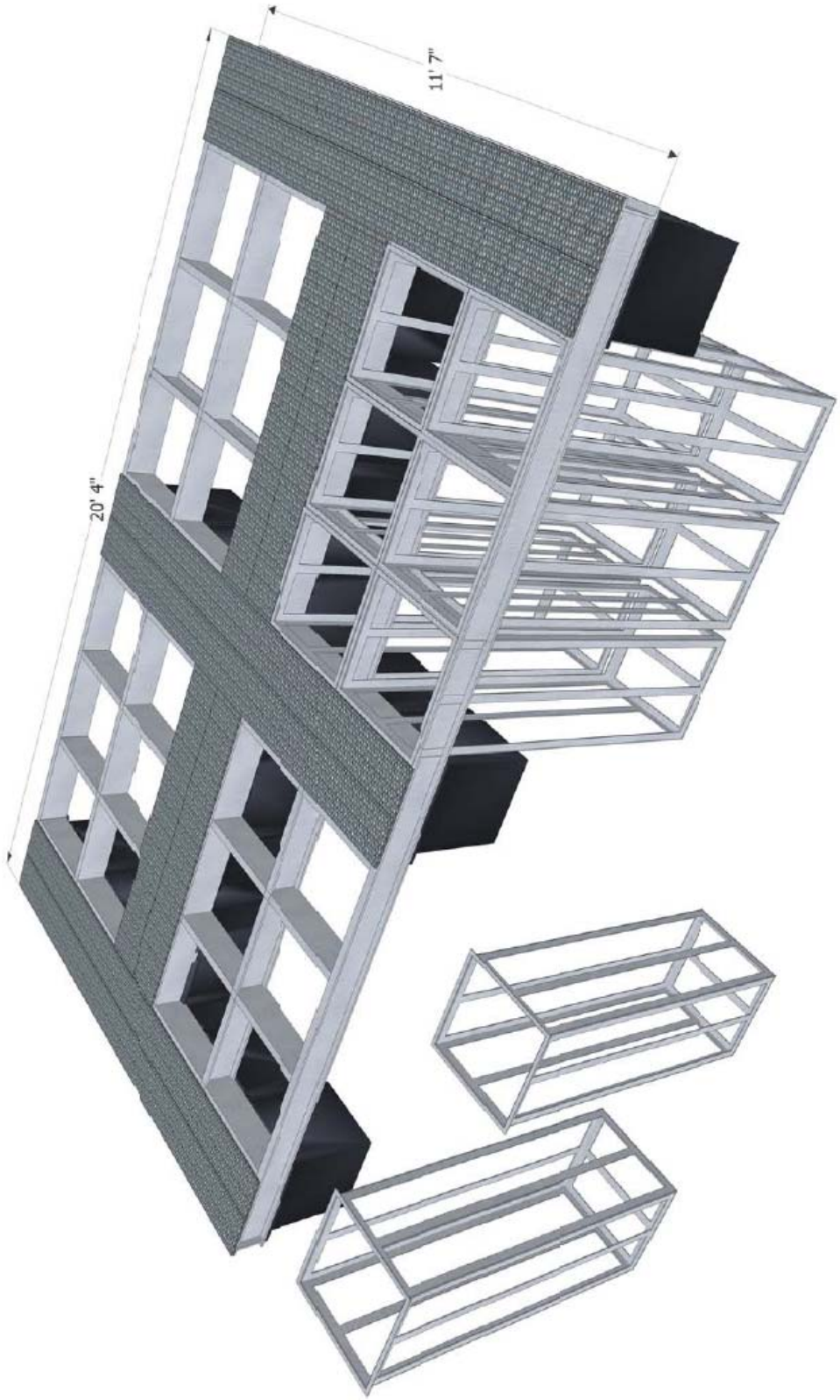

EXHIBIT 2
Clam
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Exhibit 3 - Mooring System Diagram

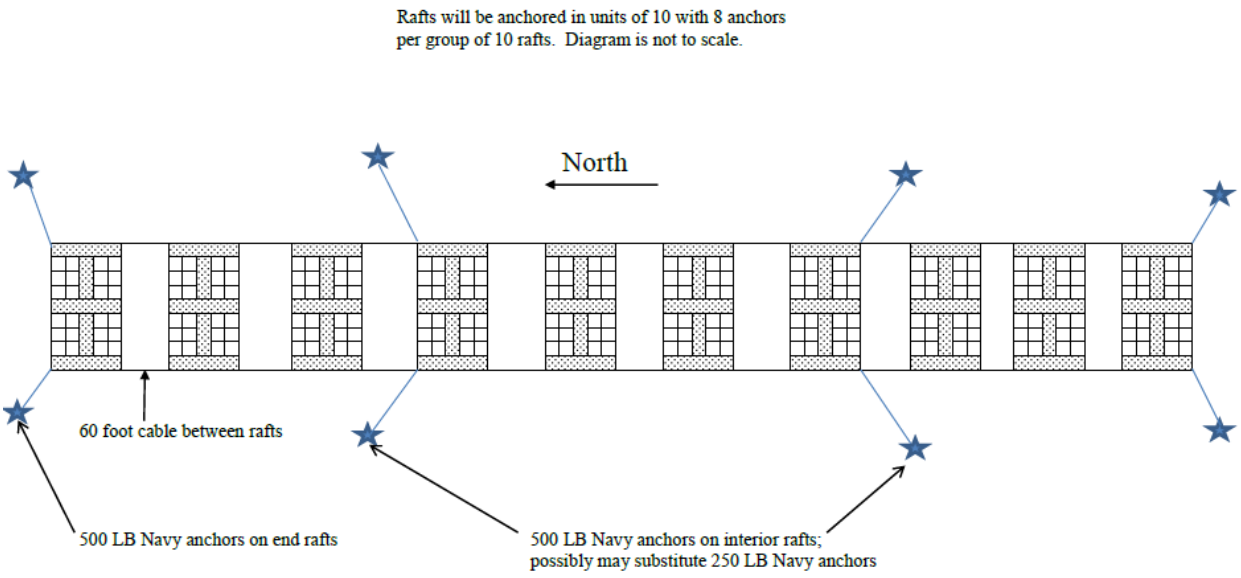

EXHIBIT 3
Mooring System Diagram

Exhibit 4 - Pacific Northwest National Laboratory's *Field Protocol for Assessment of Predation Risk to Juvenile Salmonids*

Appendix A - Field Protocol for Assessment of Predation Risk to Juvenile Salmonids

Purpose

The Field Protocol is intended to provide a standard procedure for evaluating predation risk to juvenile salmonids at ferry terminals and overwater structures, and is based on the lessons learned during the Pacific Northwest National Laboratory (PNNL) study of ferry terminal-associated predation on juvenile salmon at the Mukilteo ferry terminal. Application of this protocol to additional locations and situations will allow the scientific community to develop a database, based on consistent methods, to evaluate predation pressure associated with nearshore anthropogenic structures.

Guidance Documents

In addition to the study above, we recommend consulting the following key document before implementing this Field Protocol:

Estuarine Habitat Assessment Protocol (EHAP; Simenstad et al. 1991) provides procedures that quantitatively assess the function of estuarine wetlands and associated nearshore habitats for fish and wildlife. The goal of EHAP is "*to initiate systematic, on-site measurement of estuarine wetland and nearshore habitat function for fish and wildlife utilization by assessing the attributes of the habitats identified as being functionally important to fish and wildlife.*" Though some aspects of the EHAP are due for revision, it continues to serve as an essential tool that provides consistency among the many biological sampling programs in the region.

Tiered Approach to the Field Protocol:

There are many constraints (e.g., cost, spatial and temporal variability in predator and juvenile salmon abundances, availability of field staff, permitting issues, existing overwater structures, frequency of ferry arrivals/departures, etc.) in attempting to assess predation risk to juvenile salmonids in the vicinity of ferry terminals or other overwater structures. Recognizing these constraints, we have organized potential assessment activities within the Protocol in hierarchical order:

1. **Minimum**: those assessment activities that should be conducted under all circumstances.
2. **Recommended**: those assessment activities that provide an adequate or appropriate measure of predation risk.
3. **Preferred**: those assessment activities that provide an optimum measure of predation risk. This may include some experimental technologies that offer promise in the future.

Matrix of Assessment Activities

Assessment activities that we have identified as being useful for evaluating predation risk to juvenile salmonids are summarized in Table 1. For each assessment activity, we have made a determination of whether that activity should be performed as part of a minimum, recommended, or preferred level of assessment. We made these determinations based on the likelihood of obtaining data for any given activity, and by weighing the various advantages and disadvantages of implementing that activity.

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The following assessment activities are the **minimum** that should be performed:

- Bird Surveys
- Marine Mammal Surveys
- Salmon Fry/Potential Predator Abundances: Beach Seine
- WDFW Salmon Fry Index Area Surveys
- Gut Content Analysis (Fish): Beach Seine Collection/Gastric Lavage
- Gut Content Analysis (Fish): Hook and Line plus Gastric Lavage (Note: this can include opportunistic sampling of fishes collected by recreational fishers in locations where there is a fishing pier next to the ferry terminal)
- Gut Content Analysis (Fish): Hook and Line plus Excise Stomach (Note: this can include opportunistic sampling of fishes collected by recreational fishers where there is a fishing pier next to the ferry terminal).

In addition to the above minimum activities, the following additional activities are **recommended:**

- Fish Surveys: SCUBA Transects
- Salmon Fry/Potential Predator Abundances: Enclosure Sampling
- Salmon Fry/Potential Predator Behavioral Observations: SCUBA/Snorkel and Underwater Video
- Light Levels.

The **preferred** level of assessment includes minimum and recommend levels activities, as well as the following:

- DIDSON ("acoustic flashlight")
- Tagging of Validated or Potential Predators
- Gut Content Analysis (Fish): Spear and Excise Stomach
- Salmon Prey Availability-Epibenthic Plankters
- Salmon Prey Availability-Pelagic Zooplankton
- Salmon Prey Availability-Neuston
- Feeding by Juvenile Salmon: Gut Contents Analysis.

We believe that the **minimum** level of assessment could be conducted by one funding entity with a few trained field staff and access to the requisite field equipment. The **recommended** level of assessment would require more resources in terms of dollars, field staff and effort, and equipment. The **preferred** level of assessment would likely require a collaborative effort on the part of several (or multiple) funding partners and access to equipment (e.g., DIDSON camera; PIT tags, scanners) that is either not readily available or expensive to rent or buy.

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Table 1. Assessment Activities for Evaluating Predation Risk to Juvenile Salmonids Near Overwater Structures.

Assessment Activity	Specific Methods	Data Collected	Advantages	Disadvantages	Data Likelihood	Tiered Approach
Predation on Juvenile Salmonids						
Standardized Surveys of Potential predators						
Bird Surveys	Fixed-point Count Shore-based observer	Bird species & abundance; behavior, predation observations	Bird ID straightforward; low time	Predation events seldom observed; difficulty identifying prey (esp. salmon fry)	Good	**Minimum**
Marine Mammal Surveys	Fixed-point Count Shore-based observer	Marine mammal species & abundance, behavior, predation observations	Mammal ID straightforward; low time	Predation events seldom observed; difficulty identifying prey (esp. salmon fry)	Good	**Minimum**
Fish Surveys	SCUBA transects	Fish species & abundance; behavior, georeferenced locations	Accepted methods; conclusive results	Time & gear intensive; requires expertise in fish ID underwater; predator avoidance of divers?	Good	Recommended
Potential Fish Predator / Salmon Fry Abundance						
Potential Predator / Salmon Fry	Beach seine	Species, abundance, lengths	Accepted method for determining salmon abundance; can be used near structures	Ineffective under most structures; labor intensive (boat & field crew of 3 minimum); large predators may avoid net; permit issues	Good - fry Fair - predators	**Minimum**
Potential Predator / Salmon Fry	Enclosure net	Species, abundance, lengths	Accepted method for determining salmon abundance; can be used near structures	Ineffective under structures' labor intensive (boat & field crew of 3 minimum); permit issues	Good	Recommended
Salmon Fry	WDFW Salmon Fry Index Area Surveys; shore-based observer	Visual estimate of pink & chum fry abundances (by species)	Salmon run timing; little additional field effort besides coordination with WDFW for data; verifies presence/absence of salmon as prey	WDFW does not survey all shorelines; qualitative method with high variability; surface-oriented pink & chum are surveyed most effectively; coho or chinook underrepresented	Good	**Minimum**

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Assessment Activity	Specific Methods	Data Collected	Advantages	Disadvantages	Data Likelihood	Tiered Approach
Behavioral Observations						
Potential Predator / Salmon Fry	SCUBA / snorkel + video	Underwater video footage	Conclusive results; no fish mortality	Hit or miss method; visibility dependent; predator avoidance of divers?	Fair to Good	Recommended
Potential Predator / Salmon Fry	DIDSON (dual-frequency identification sonar)	Underwater images of potential fish predators in water column	Visibility not an issue, even at night; predator avoidance not an issue	Species ID problematic - requires divers to "groundtruth"; expensive to purchase or rent & requires specialized expertise to operate; labor intensive (requires boat, field crew of 3)	Fair to Good	Preferred
Potential Predator / Salmon Fry	PIT tag or radio tracking of validated predators	Site fidelity, growth, survival, locations & movements of predators	Conclusive results; low fish mortality	Initial capture difficulties; cost of PIT tags & scanners or radio tags & tracking equipment	Fair to Good	Preferred
Stomach Content Analysis						
Fish Predators	Seine collection + gastric lavage	Species ID of prey in stomachs	Conclusive results; low fish mortality	Capture difficulties	Fair	**Minimum**
Fish Predators	Hook & line + gastric lavage	Species ID of prey in stomachs	Conclusive results; low fish mortality	Capture difficulties; public perception issues	Fair to Good	**Minimum**
Fish Predators	Hook & line + excise stomach	Species ID of prey in stomachs	Conclusive results; opportunistic use of recreational catches	Fish mortality; some capture difficulties; public perception issues?	Fair to Good	**Minimum**
Fish Predators	Spear + excise stomach	Species ID of prey in stomachs	Conclusive results	Fish mortality; some capture difficulties; public perception issues?	Fair to Good	Preferred
Juvenile Salmon	Seine collection + gastric lavage	Species ID of prey in stomachs	Conclusive results; low fish mortality	Permit issues; sample processing & analysis time + costs	Good	Preferred
Associated Environmental Variables						
Light Levels	Light sensor	Photosynthetically	Rapid, straightforward, conclusive information on light	Requires purchase/rental of light	Good	Recommended

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Assessment Activity	Specific Methods	Data Collected	Advantages	Disadvantages	Data Likelihood	Tiered Approach
		active radiation	levels	sensor		
Salmon Prey Availability	Epibenthic cores	Species,abundances, densities	Conclusive results	Sample processing & analysis time + costs	Good	Preferred
Salmon Prey Availability	Plankton nets	Species, abundances, densities	Conclusive results	Sample processing & analysis time + costs	Good	Preferred
Salmon Prey Availability	Neuston net	Species, abundances, densities	Conclusive results	Sample processing & analysis time + costs	Good	Preferred

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Descriptions of Assessment Activities and Specific Methods

Assessment activities and specific methods are listed and described below in the order in which they appear in Table 1. Additional details of some sampling methods may be obtained in the body of the report.

Standardized Surveys of Potential Predators

Birds and Marine Mammals

Although there are variants in the general methods, quantitative fixed-point count surveys of birds and marine mammals can be conducted to document both the presence and feeding behavior of potential predators at overwater structures relative to paired reference sites without overwater structures. Each fixed-point count survey consists of four 20-min observation periods: two at each "treatment" site and two at each paired reference site. For each study site, observation stations encompass a stretch of shoreline (50 m in this study) located to either side of the overwater structure, as well as similar lengths of unaltered shoreline at the reference site.

During each 20-min observation period, all taxa and numbers of birds and marine mammals observed within the station boundaries (from shore to maximum viewing distance seaward) are counted with the aid of binoculars, and recorded over five successive scans at 5-min intervals (0 min, 5 min, 10 min,15 min, and 20 min). To account for possible redundant counts of the same subjects, the mean number of individuals recorded per count is calculated for each 20-min observation period. General behavior (e.g., diving, foraging, perching) should be recorded, as well as qualitative observations of unusual or noteworthy marine mammal and/or bird activity. All successful predation events on fishes are to be noted, with attempts made to verify fish prey species.

Observation times should be stratified over time of day to maximize the likelihood of differences in diel activity (day and crepuscular periods) by particular species. Based on the findings of our study, additional effort should be directed at examining bird and mammal predation near overwater structures at night, especially relative to artificial lighting. Tide status (ebb/flood) and height, general weather and water characteristics, and human activity should also be noted during each observation event. Chi-square analysis can be used to test hypotheses of distribution between location and over time.

Fishes

Quantitative and repeatable estimates of fish density and behavior can be obtained using standardized SCUBA and snorkel transects. SCUBA transects involve divers recording observations along measured, underwater "strip" transects on the species, size, activity, and other characteristics of demersal (bottom-associated) fishes. This technique is generally nondisruptive and is adaptable to a variety of environmental conditions, diel phases (e.g., day and night), and human activity windows (e.g., ferry departures and arrivals). In our experience, fish densities were higher during night SCUBA surveys at the Mukilteo ferry terminal (see report results).

Semipermanent strip transects are established along the length of the overwater structure by anchoring marked lead lines to the bottom. Transects are located perpendicular to shore at both the overwater structure and "unaltered" reference areas with similar depth contours. Each "strip" or line transect should be standardized in length based on the length of the terminal structure, and assigned a letter/number designator for subsequent survey identification. The location and spacing of transects should be designed to estimate fish utilization directly under the overwater structure, at its edges, and on its periphery (e.g., 10 m from either edge).

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Once the transects are established, observational data are then systematically recorded at selected intervals (e.g., 5-m intervals: 0-5 m, 5-10 m, etc.). Divers record all fishes observed at a fixed distance (based on visibility; 1-m in this study) to either side of the transect, enabling quantitative estimates of fish density. Strip transect observations can either be made by two divers independently covering the entire transect width, or two divers each making simultaneous observations along each side of the transect line. True replicate sampling should involve repeated surveys of the transect. Video and still photography should also used if possible to verify fish observations and the structural attributes of the overwater structure. Rapid visual assessments using SCUBA should also be conducted to collect supplemental observational data in areas that are not systematically surveyed with the transect method.

Snorkel surveys may also be conducted in a manner similar to those described for SCUBA methods to document the presence of potential water-column fish predators. Relative abundance and behavioral observations of salmon fry, which are often associated with near-surface waters, may also be conducted with this method, although water clarity may impact effectiveness.

Potential Fish Predator / Salmon Fry Abundance

In addition to SCUBA and snorkel transects, a variety of capture methods may be used to estimate the abundance and species composition of fish assemblages.

Beach Seine

Beach seining can be used to gather data on the species composition and relative abundance of fish associated with the edges of overwater structures, although the structural complexity of these habitats may inhibit sampling underneath these structures. A standard 37-m by 2-m Puget Sound floating beach seine (Simenstad et al. 1991), designed for capturing both sedentary and motile fish, is composed of 3-cm mesh with two 18-m-long wings that taper from 0.9 meters high at the ends to 2 m high where the wings attach to the central bag; the bag is 2 m high by 2.4 m wide by 2.3 m deep and made of 6-mm mesh. In this design, the top 2 m of the water column is sampled, which may affect perceptions about fish species (including salmon) assemblage composition.

A boat is generally used to facilitate setting the seine, which is deployed 30-m from and parallel to the shore, then pulled shoreward onto the beach (see Simenstad et al. 1991 for more details). In this configuration, it samples 520 m^2, although site-specific variables (i.e., slope, tidal stage, structures) may affect the area sampled. After each seine haul, species identity and number of fish species are quantified. All individuals are measured (standard or fork length) and weighed, although subsamples (generally at least 25 randomly selected individuals) may be taken of abundant species.

Enclosure Net Sampling

Enclosure net sampling can be used to assess the presence and abundance of fish in shallow water habitats; we refer to the methods used by Toft et al. (2003) along City of Seattle marine shorelines. Enclosure nets consist of a 60-m long, 4-m deep, 0.64-cm mesh net placed around temporarily fixed poles to corral a rectangular section of the shoreline. The poles are installed at low tide the day before net deployment so as to minimize disturbance at the time of sampling. The net is installed at high tide, with fish removed by small pole seine or dip nets as the tide recedes.

Sampling data provides per-unit-area and volume densities of juvenile salmon and other fish on each unit of shoreline that is sampled. Nets typically sample a 20-m square section of shoreline; volume is determined by measuring water depth at the poles when the net is set, assuming a steady slope from shore to the poles. Sampling typically takes place during spring tides to take advantage of higher tides.

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WDFW Salmon Fry Index Area Surveys

Marine salmon fry abundance indices are collected by above-water observations at various locations within Puget Sound by WDFW. These spring surveys have been conducted since 1966 in some locations by WDFW biologists, who walk sections of the marine shoreline at favorable tides and estimate the numbers of salmon fry observed migrating along shallow nearshore waters. Biologists use polarized glasses to better observe these surface-oriented fry, and species identity is confirmed by periodic dipnet samples.

In the absence of existing WDFW data, similar qualitative visual surveys of salmon fry abundance can be conducted from shore to provide an indicator of presence/absence of juvenile salmon at each site and assist in verification of potential predation events. Fry behavior should also be noted relative to ferry terminal structures, operations, and measured light levels. Relative abundance of salmon fry (number/km) can be compared over time and across locations.

Behavioral Observation

Though standardized surveys provide a good deal of information on the behavior and movements of potential salmon predators, other technologies may need to be enlisted to observe behavior during low light and high turbidity conditions, or to document individual fish movement and residency patterns.

DIDSON (acoustic camera)

In low-light (e.g., night) or low-visibility situations, novel technologies like the DIDSON (Dual-frequency IDentification SONar) can capture near-video-quality images to ascertain the identity, abundance, and behavior of potential fish predators associated with overwater structures. The DIDSON, developed by engineers at the University of Washington Applied Physics Laboratory (see http://www.apl.washington.edu/ programs/DIDSON/DIDSON.html), uses multi-channel acoustic reflections to create images of juvenile salmon and their potential predators. In high frequency mode, all but the smallest targets (<63 mm at 12-m range, <16 mm at 3-m range) intercept multiple beams. The software can record and display images in real time, and at a 12-m range will do so at 7 frames per second (Belcher et al. 2001). Both structural details and fish can be observed at the same time on the same transmitted pulse (Moursund et al. 2002).

The DIDSON is deployed from a mount that can be swiveled and tilted by an operator aboard a vessel. Surveys involve the slow circumnavigation of overwater structures at a distance of 2 to 10 m, panning and tilting the camera to encompass most of the submerged structural dock elements. Survey locations are collected simultaneously using a Trimble differential global positioning system (DGPS), and stored with the DIDSON records during the survey. Data are displayed in real time on a monitor aboard the vessel, with data files saved to a notebook computer.

Tagging of Validated or Potential Predators

Tagging and recapturing individual fish has been one of the fundamental challenges of fisheries research. One of the best available methods for long-term tagging of individual fish is to use Passive Integrated Transponder (PIT) tags. In contrast to radio tags, which have a battery that eventually will cease to function, PIT tags contain a small computer chip that transmits its code only when induced by an external energy source. PIT tags are tiny identification chips, about the size of a grain of rice, which are injected into fish specimens for permanent identification. Tags are inserted into the body cavity with nearly 100% tag retention and high fish survival. The tag ("chip") is detected by means of a hand-held scanner. The scanner reads the tag's electromagnetic code and displays the tag's number. The tag does not require any

AC current. The scanners can be either portable, working on batteries, or require AC current. Some have the capability to store codes from many fish before they are downloaded to a computer; others simply display the code of the current reading without storage. With the use of PIT tags, researchers are better able to study the individual growth, reproduction, and survival of fish. The main disadvantage of using PIT tags is the lack of submersible detection equipment. Using current technology, the PIT tag can only be detected at a distance of up to 18 cm in water. Thus, PIT-tagged fish have to be recaptured. This method would allow researchers to evaluate growth, survival, and the site fidelity of individual predators to a particular ferry terminal. It would not, however, enable researchers to evaluate real-time predator movement patterns.

An alternative, but shorter-term and more expensive, method would be to affix radio transmitters to predators. The radio transmitter emits a unique signal that is picked up by a hand-held antenna aboard a vessel. The signal becomes stronger as the researcher gets closer to the tagged fish. The advantages of this methodology are that it would allow for real-time tracking of predator movements, and it doesn't require the researchers to recapture the fish.

Fish Predator Capture

Besides the beach seine and enclosure net methods outlined above, other means may be used to capture large fish predators for stomach content analyses or for tagging and tracking. Hook-and-line fishing from a boat or from shore can be particularly effective for nonlethal capture of fishes, especially if one can enlist the efforts of local recreational fishermen. Hook-and-line sampling is generally conducted in the vicinity of the overwater structure of interest using live bait or artificial lures that imitate small forage fish. In addition, a speargun can be used by divers to lethally collect some individuals.

Stomach Content Analysis

Two approaches may be used for obtaining the stomach contents (prey) of selected fish species: gastric lavage and stomach dissection. Gastric lavage offers a nonlethal approach to stomach content collection, and is preferred in most cases. Live-captured fish are anesthetized in a solution of tricaine methanesulfonate (MS-222), and a tube, syringe, or nozzle is inserted into their stomach. Pumped seawater is then used to flush stomach contents into a collecting sieve or container (Giles 1980). After pumping, fish are placed in an oxygenated bath of fresh seawater and then released upon recovery. Stomach dissection is generally conducted on fish that are speared or collected (kept) by recreational fishermen. Contents from the foreguts are retained. In all cases, stomach contents are preserved in 70% ethanol and later examined in the laboratory.

The recommended method for fish diet composition is an Index of Relative Importance (IRI), which is calculated for each food item "i":

$$IRI_i = \%FO\ (\%NC_i + \%GC_i)$$

where %FO is the percentage of frequency of occurrence, %NC is the percentage of numerical composition, and %GC is the percentage of gravimetric/volumetric composition (Simenstad et al. 1991, pp. 91-92). Because the resulting numerical values for the IRI depend greatly upon sample size, the relative importance is often converted to the percentage of the total IRI (%IRI).

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Associated Environmental Variables

Light Levels

Light measurements are recorded using LI-COR LI-193SA spherical quantum sensors and a LI-250 light meter. The sensors measure photosynthetically active radiation, or PAR, which is the spectrum of light between 400 and 700 nm that supports photosynthetic production and growth. Units are µmol m^{-2} s^{-1}. The spherical quantum sensor is waterproof for use in aquatic environments, and collects light from all directions. Individual PAR readings are averages of instantaneous readings over a 15-sec interval.

Ambient light should be measured just above the water's surface and at a depth of approximately 0.1 m, where most juvenile salmon are observed. Transects under the structure may be used to measure light levels at selected intervals (1 m to 10 m), and light attenuation may be measured by taking vertical readings at selected intervals in the water column. The presence or absence of juvenile salmonids should also be noted when light measurements are recorded.

Salmon Prey Availability-Epibenthic Plankters

The following section has been extracted and modified from the Estuarine Habitat Assessment Protocol (Simenstad et al. 1991, pp. 69-74) and Cordell et al. (1994). Epibenthic plankters are very small macrofaunal or meiofaunal organisms, which live in the interface between the bottom substrate and the water column, either in the very surface layer or in the benthic boundary layer. Epibenthic plankters include predominantly harpacticoid copepods, gammarid amphipods, cumaceans, and isopods.

The historically recommended sampling method is to use a portable, hand-held epibenthic suction pump, in which a sampling cylinder with fine mesh (typically 0.130 mm) screened ports is very slowly lowered to enclose an area of the bottom (179 cm^2) and a segment of the adjoining benthic boundary layer (Simenstad et al. 1991). The pumped water and epibenthic plankters are captured and screened on a 0.130-mm mesh sieve. More recent comparisons (Cordell et al. 1994) have suggested cores that sample an area of 0.0024 m^2 to a depth of 10 cm are equally effective. Each sample is rinsed from the sieve into a labeled jar or plastic vial and preserved in 5% buffered formalin. The label contains the date, time, sample location, transect number and elevation, and replicate number. After 7 to 10 days in buffered formalin, the sample should be transferred to an alcohol solution, usually 45% isopropanol or 70% ethanol.

In the laboratory, epibenthic plankters should be sorted and identified under a stereo microscope to the lowest possible taxa, preferably to species. Density and standing stock of each taxa should be expressed, respectively, as the number and biomass per unit area (e.g., no. m^{-2}, g wet m^{-2}) or volume (e.g., no m^{-3}, g wet m^{-3}) of the habitat.

Epibenthic plankters should be sampled biweekly from March through June. In lieu of statistical predetermination using pilot studies or historical data, the sample size should be (n) = 15 in intertidal habitats distributed randomly within uniform microhabitats along tidal elevation strata (transects). Optimum tidal elevation is 0.0 ft (MLLW) with additional transects recommended at +2.0 ft, -2.0 ft, +4.0 ft, and -4.0 ft in that relative order of priority.

Salmon Prey Availability-Pelagic Zooplankton

The following section has been extracted and modified from the Estuarine Habitat Assessment Protocol (Simenstad et al. 1991, pp. 75-79). Pelagic zooplankton are those organisms that occupy the water column and are passive or only weakly swimming. Except for larvaceans and fish larvae, these are

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exclusively crustaceans, including predominantly calanoid and cyclopoid copepods, as well as several decapods (larvae), euphausiids, hyperiid amphipods, and cladocerans.

The recommended sampling method is to use paired nets in a "bongo" configuration towed from an outboard boat. The most common bongo net configuration uses a 60-cm diameter mouth opening equipped with 0.333-mm or 0.500-mm mesh nets funneling into two separate cod-ends. Often, one net of each mesh size is used to maximize the efficiency of each mesh type for zooplankton (0.333-mm) versus ichthyoplankton (fish larvae) (0.500-mm). Two flow meters should be installed inside the net openings to provide precise sampling volumes. Sampling should be conducted in the surface layer, as many juvenile salmon prey taxa are found concentrated in this microhabitat.

In the field, each sample is rinsed from the cod-end into a labeled jar or plastic vial and preserved in 5% buffered formalin. The label contains the date, time, sample location, net mesh size, and replicate number. After 7 to 10 days in buffered formalin, the sample should be transferred to an alcohol solution, usually 45% isopropanol or 70% ethanol. In the laboratory, pelagic zooplankton should be sorted and identified under a stereo microscope to the lowest possible taxa, preferably to species. Density and standing stock of each taxa should be expressed, respectively, as the number and biomass per unit area (e.g., no. m^{-2}, g wet m^{-2}) or volume (e.g., no m^{-3}, g wet m^{-3}) of the habitat.

Pelagic zooplankton should be sampled monthly from March to August. In lieu of statistical predetermination using pilot study or historical data, the sample size (n) = 5 standardized tows at, or just below, the surface. Optimum sampling times are associated with dawn and dusk periods, when vertical migrators are nearest the surface layer.

Salmon Prey Availability-Neuston

The following section has been extracted and modified from the Estuarine Habitat Assessment Protocol (Simenstad et al. 1991, pp. 80-82). Neustonic and drift invertebrates are a distinct assemblage of organisms comprised of adult and larval insects that are deposited onto or emerge into the surface layer, and certain other aquatic insects and crustaceans that spend most of their time in the surface layer of the water column. The recommended sampling method is to use a neuston net equipped with 0.253-mm mesh net and a cod-end for collecting the sample. A neuston net is essentially a modified plankton net that is designed to float on the surface of the water with its mouth opening (0.025 m^2) sampling just the water surface layer. Usually the neuston net is hand towed, held in an active current, or towed outboard of a small boat. Maintenance of a constant depth (position at which the net sits in the water) or simultaneous measurements of current velocity are required to determine the sampling volume.

In the field, each sample is rinsed from the cod-end into a labeled jar or plastic vial and preserved in 5% buffered formalin. The label contains the date, time, sample location, and replicate number. After 7 to 10 days in buffered formalin, the sample should be transferred to an alcohol solution, usually 45% isopropanol or 70% ethanol. In the laboratory, neustonic and drift invertebrates are sorted and identified under a stereo microscope to the lowest possible taxa, preferably to species. Density and standing stock of each taxa should be expressed, respectively, as the number and biomass per unit area (e.g., no. m^{-2}, g wet m^{-2}) or volume (e.g., no m^{-3}, g wet m^{-3}) of the habitat.

Neustonic and drift invertebrates should be sampled monthly, during discrete freshwater and tidal flow phases. In lieu of statistical predetermination using pilot study or historical data, the sample size should be (n) = 5.

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Sampling Design

In all cases, we stress the importance of simultaneously sampling at a paired reference site (without overwater structures) to provide a local basis of comparison. Reference sites should be in fairly close proximity to the study site, with similar physical characteristics (e.g., substrate, beach slope, water properties).

The following discussion is modified from the Estuarine Habitat Assessment Protocol (Simenstad et al. 1991). The distribution of physical, chemical, and biological attributes of the nearshore habitats where overwater structures are located are complex over space and time. Thus, sampling the habitats (and predators) around ferry terminals will be necessary, as most habitats are too complex to monitor in their entirety. Sampling design will necessarily vary from structure to structure, because habitats and the corresponding biological community at each area will vary.

An adequate sampling design always incorporates three principal components of scientific quality: 1) *repeatability* in terms of the potential to be exactly repeated, 2) *reliability* as the quality to sustain scientific confidence, and 3) *validity,* because it is based on precedence and evidence.

Proper sampling requires considerable time and effort. Thus the dilemma: how do you balance sampling rigor with the resources at hand? How do you distribute the sampling effort and intensity to minimize the damage that destructive methods (e.g., spear fishing to collect predators) will cause at the site?

The Estuarine Habitat Assessment Protocol (Simenstad et al. 1991) recommends considering five "rules" in developing a sampling design:

- Rule 1: Know the habitat you are proposing to sample
- Rule 2: Know the sampling response (attribute) you are monitoring
- Rule 3: Select samples using a consistent standardized technique
- Rule 4: Clearly specify your sampling strata
- Rule 5: Determine the optimum sampling size statistically, given the purposes and resources of the study and considering the potential damage to the site with excessive destructive sampling.

One cautionary note: Prior to initiating sampling at any ferry terminal, we cannot overemphasize the importance of coordinating with WSF Operations and the terminal agent on duty. Depending on the nature of the sampling and the proximity to where ferries are departing or arriving, WSF will issue the researchers a hand-held VHF radio. This allows frequent and direct communication between the terminal agent and the researchers to ensure the safety of everyone involved.

EXHIBIT 4
Predation
Assessment
Field
Protocol