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ECOSYSTEMS

The Role of Eelgrass in Marine Community Interactions and Ecosystem Services: Results from Ecosystem-Scale Food Web Models

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ABSTRACT

Eelgrass beds provide valuable refuge, foraging, and spawning habitat for many marine species, including valued species such as Pacific salmon (*Oncorhynchus* spp.), Pacific herring (*Clupea pallasi*), and Dungeness crab (*Metacarcinus magister*). We used dynamic simulations in a food web model of central Puget Sound, Washington, USA developed in the Ecopath with Ecosim software, to examine how the marine community may respond to changes in coverage of native eelgrass (*Zostera marina*), and how these modeled responses can be assessed using an ecosystem services framework, expressing these services with economic currencies in some cases and biological proxies in others. Increased eelgrass coverage was most associated with increases in commercial and recreational fishing with some small decreases in one non-market activity, bird watching. When we considered ecosystem service categories that are aggregations of individual groups of species, we saw little evidence of strong tradeoffs among marine resources; that is, increasing eelgrass coverage was essentially either positive or neutral for all services we examined, although we did not examine terrestrial activities (for example, land use) that affect eelgrass coverage. Within particular service categories, however, we found cases where the responses to changes in eelgrass of individual groups of species that provide the same type of ecosystem service differed both in the magnitude and in the direction of change. This emphasizes the care that should be taken in combining multiple examples of a particular type of ecosystem service into an aggregate measure of that service.

Key words: ecosystem services; habitat restoration; eelgrass restoration; ecosystem models; food webs; economics.

INTRODUCTION

Humans benefit from marine and coastal ecosystems in numerous direct and indirect ways (Peterson and Lubchenco 1997; Guerry and others 2011). For example, people get nutrition from seafood, are protected from storms by coastal vegetation, and

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enjoy opportunities for recreation and renewal. Marine systems also provide indirect benefits by sequestering carbon and playing key roles in regulatory processes (for example, Das and Vincent 2009; Dore and others 2009). Benefits derived from natural systems are broadly characterized as ecosystem services and can be classified into four major categories: provisioning, regulating, cultural, and supporting services (Millennium Ecosystem Assessment (MEA) 2005). Provisioning services result in the delivery of goods to people (for example, seafood, biochemicals), regulating services keep natural processes in check (for example, erosion and flooding from storms), cultural services enrich lives (for example, recreation, sense of place), and supporting services serve as the foundation for all others (for example, nutrient cycling, primary productivity). With growing understanding of both the degradation of marine and coastal systems and the dependence of people upon them, governments and leaders around the world recognize that these systems need to be managed in ways that support sustained ocean productivity for the needs of present and future generations (Pew Oceans Commission 2003; MEA 2005; Lubchenco and Sutley 2010).

Increasingly, scientists and managers are pointing to links between diversity, productivity, and resilience attributes of marine systems and their response to human interventions in conserving, harvesting, and regulating marine ecosystem services (Elmqvist and others 2003; Levin and Lubchenco 2008; Murawski and others 2009; Brander 2010; Chan and Ruckelshaus 2010). An ecosystem services approach can highlight where tradeoffs occur among multiple objectives so that decisions to resolve those tradeoffs can be made transparently (Guerry and others 2012). Assessments of tradeoffs among objectives of multiple management sectors and ecosystem services are needed to inform more complex cases of ecosystem-based management that can accommodate a broader suite of actors (Foley and others 2010).

Here, we present an application of an ecosystem services framework to an ongoing effort to conserve and restore Puget Sound in Washington State, USA. The Puget Sound ecosystem is home to 3.8 million people encompassed in a 42,000-km^2 basin, including temperate-latitude lands and rivers from the crests of the Cascade and Olympic mountains through a deep, fjord-type estuary to the Pacific Ocean. The region's marine environment produces basic provisioning services such as commercial and tribal subsistence fisheries for salmon (*Oncorhynchus* spp.) and other finfish species, as well as clam, oyster, crab, and other shellfish harvests. It provides regulating services as global as the carbon cycle, and as local as waste treatment through the breakdown of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) by eelgrass (Huesemann and others 2009). It offers numerous cultural services through bird and whale watching, recreational fishing, educational opportunities, and simply the human value placed on the existence of the region's biodiversity. Puget Sound also provides a rich cultural heritage for Native American tribes. Underlying all these are basic supporting services such as primary production and the provision of habitat and forage for the Pacific Northwest icons salmon and orcas (*Orcinus orca*), in addition to a host of other species. A similarly rich set of services is provided by the terrestrial and freshwater ecosystems (Postel and Carpenter 1997; Shvidenko and others 2005; Vörösmarty and others 2005) that are linked to Puget Sound.

Using Puget Sound as a case study is motivated by the region's adoption of an ecosystem-based management approach. The marine waters, habitats, and species in Puget Sound are showing increasing signs of stress—key nearshore habitats are in decline, iconic taxa such as orca, and Pacific salmon and rockfish species are listed under the Endangered Species Act, and the Washington State Department of Health is issuing an increasing number of seafood consumption advisories and closures in shellfish growing areas due to contamination from toxics and pathogens (Essington and others 2012). In response to these signs of trouble, the Washington State Legislature in 2007 mandated formation of a new State agency guided by a public–private council—the Puget Sound Partnership (Partnership). The Partnership's Puget Sound recovery objectives explicitly include both the biophysical (that is, clean and ample freshwater, habitats, species) and the human (that is, human health and well-being) components of the ecosystem. An ecosystem services approach is, therefore, at the core of their recovery plan (Puget Sound Partnership (PSP) 2008).

As part of its mandate, the Partnership has developed ecosystem recovery targets based on a set of ecosystem indicators. One indicator is the areal coverage of native eelgrass (*Zostera marina*), which currently spans approximately 23,000 ha across 43% of Puget Sound's shoreline (Gaeckle 2009). The Partnership has set a target of 120% of the eelgrass coverage area measured in the period 2000–2008. Here, we integrate conceptual methods from community/ecosystem ecology and economics to explore how changes in ecosystem services may result from changes in ecosystem structure related to pursuing this aspect of Puget Sound recovery. In particular, we use a food web model to assess potential changes to ecosystem services that may result from the attainment of this target and two other possible future states of eelgrass in central Puget Sound (halving and doubling of current area).

The underlying operating framework is a multispecies food web model, which allows us to characterize the influence of eelgrass upon the rest of the system via direct and indirect pathways such as predator–prey interactions, fisheries, and habitat associations. Notably, eelgrass provides refuge habitat for juvenile salmon and young-of-year (YOY) Dungeness crabs (*Metacarcinus magister*) (for example, Simenstad and Fresh 1995; Semmens 2008), foraging habitat for juvenile salmon (Fresh 2006), and spawning substrate for Pacific herring (*Clupea pallasi*) (Penttila 2007). In turn, these species interact with many other species in the marine food web and are targets of both harvest and conservation. We first run a series of model simulations in which alternate future states of eelgrass areal coverage (degraded or restored) affect ecosystem structure by driving changes in the abundance of other organisms in the food web. We next quantify how these changes in abundances could change the flow of ecosystem services, which are expressed using economic currencies and, where economic data were not available, biological proxies. This framework can provide important insights into efforts such as the Partnership's in assessing potential changes in ecosystem service levels from restoration actions as well as revealing unexpected consequences to and likely tradeoffs among services.

METHODS

Basic Food Web Model Structure and Eelgrass Effects

We used a food web model of the central basin of Puget Sound to simulate future states of eelgrass and potential responses in all functional groups. The model was developed by Harvey and others (2010, 2012b) in the Ecopath with Ecosim (EwE) software, which has been thoroughly described (Christensen and Walters 2004) and reviewed (Fulton and others 2003; Plagányi and Butterworth 2004; Plagányi 2007). The software's dynamic module (Ecosim) tracks changes in the food web in response to perturbations in the system. Biomasses change as a function of production and losses, according to a master equation for each group *i*:

$$\frac{\mathrm{d}B_i}{\mathrm{d}t} = g_i \cdot \sum_j C_{ji} - \sum_j C_{ij} + I_i - (\mathrm{Mo}_i + F_i + e_i) \cdot B_i, \tag{1}$$

where B is the biomass, g is the growth efficiency, C is the consumption rates of all prey j by group i (C_{ji}) and of group i by all predators j (C_{ij}), I is the immigration rate, Mo is the mortality not attributable to other model groups, F is the fishing mortality rate, and e is the emigration rate.

The current central Puget Sound model considers 66 biological groups, representing primary producers, invertebrates, fishes, birds, marine mammals, and detrital pools. It also includes commercial and recreational fisheries. The parameters that underlie equation (1) are documented by Harvey and others (2010, 2012b). A change to the earlier models was the addition of resident orcas, specifically three pods of the endangered Southern Resident population that seasonally enter Puget Sound to feed on migrating salmon. Although their occupancy of these waters is brief and thus their food web impact is relatively small (Harvey and others 2010, 2012b), we added them because of their substantial cultural importance and value for ecotourism.

Ecosim dynamics are driven primarily by trophic interactions. Thus, special functions must be used to simulate indirect habitat effects derived from the presence of eelgrass, which is itself a relatively unimportant source of food (Mumford 2007; Harvey and others 2010). Ecosim handles these indirect effects using mediation functions, as described below.

In Ecosim, the consumption rate (Q) of prey i by predator j is defined as

$$Q = \left(\frac{a_{ij}}{A_{ij}}\right) \cdot \frac{v_{ij} \cdot B_i}{\left(2v_{ij} + a_{ij}/A_{ij} \cdot P_j\right)} \cdot P_j \tag{2}$$

where a_{ij} is the rate of effective search for i by j, A_{ij} is the search area in which j forages for i, v_{ij} is the flow rate of B_i between pools that are invulnerable and vulnerable to j, and P_j is the abundance of j in A_{ij} (Espinosa-Romero and others 2011). Increasing a_{ij} makes j a more efficient consumer of i, while v_{ij} controls the rate at which i moves between "unavailable" states, such as in refuges, and "available" states, such as j's foraging habitat (Christensen and Walters 2004). As v_{ij} increases, control over the predator–prey relationship shifts from the prey ("bottom-up") to the predator ("top-down"). In all cases, we used the v_{ij} values estimated by Harvey and others (2012b) in a study in which the model was tuned and calibrated to fit historic time series data.

Equation (2) can be modified by the abundance of a mediating group (Espinosa-Romero and others 2011), which in our case is eelgrass. Mediating a_{ij}

means that the intrinsic productivity of predator *j* is linked to the biomass dynamics of eelgrass, whereas mediating v_{ij} means that the nature of trophic control (bottom-up vs. top-down) between *i* and *j* is linked to eelgrass. Mediation multipliers were scaled so that they are =1 when eelgrass biomass was at its initial ''baseline'' density. We developed a series of hypothetical mediation effects; because we do not empirically know the true nature of eelgrass mediation effects on different predator–prey relationships, we assumed linear functions and examined several contrasting magnitudes (Figure 1; see next section).

Model Simulations

All simulations began at the same initial state, representing the food web circa the year 2000 (Harvey and others 2012b). In each simulation, we fixed eelgrass biomass at a constant proportion (0.5, 1.2, or 2.0) of the initial state. These levels represent the Partnership's stated goal of a 20% increase in eelgrass coverage (Puget Sound Partnership 2011) as well as plausible alternative futures (halving or doubling eelgrass coverage). We then assumed that eelgrass would positively mediate v_{ij} values for predator–prey interactions involving the juvenile salmon groups and their nearshore prey items (that is, more top-down control as eelgrass aggregates prey; Figure 1A); negatively mediate predator–prey interactions involving juvenile salmon and YOY crabs and their nearshore predators (that is, more bottom-up control as eelgrass increases and provides refuge; Figure 1B); and positively mediate the a_{ij} value for juvenile Pacific herring (that is, greater juvenile herring productivity as eelgrass increases and provides spawning substrate; Figure 1C). These assumptions are qualitatively consistent with literature reviews (for example, Mumford 2007; Ruckelshaus and McClure 2007) and management documents (for example, PSP 2008) on the ways in which eelgrass coverage benefits juvenile salmon, Dungeness crabs, and herring.

All simulations ran for 50 model years. For each eelgrass biomass level (0.5, 1.2, 2.0; the *x*-axis in Figure 1), we ran all combinations of mediation magnitudes (weak, moderate, strong; the *y*-axis in Figure 1) on the three sets of mediated species groups (salmon, crab, and herring). We imposed the condition that all the three juvenile salmon groups (wild, hatchery, and pink) used the same mediation strength in a given scenario (that is, salmon responses were all strong, all moderate, or all weak). In total, we ran 81 scenarios, along with an unperturbed baseline scenario in which all functional groups, including eelgrass, remained at initial values. We compiled results from the scenarios into radar plots, in which we averaged the final biomass for each group across all combinations of mediation strength within each eelgrass manipulation (50% decrease, 20% increase, and 100% increase). In all radar plots, a value of 1 implied no change in biomass, whereas deviations from 1 represented proportional increase or decrease by Year 50.

Ecosystem Services Derived from Food Web Groups

In the context of our food web model, ecosystem services such as provisioning and cultural services exist when a biological group is harvested or ben-

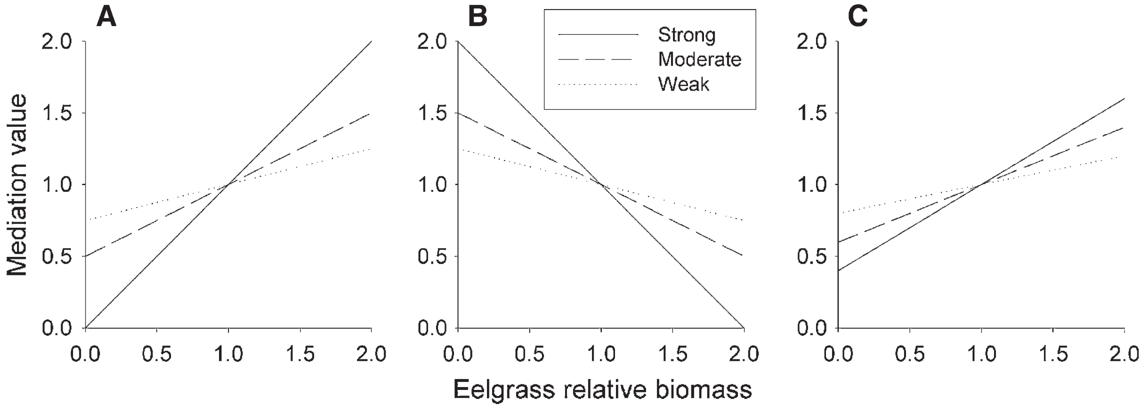

Figure 1. Mediation functions entered into Ecosim to affect specified relationships as a function of eelgrass relative biomass. Functions were applied to the vulnerability of prey to juvenile salmon (**A**), the vulnerability of juvenile salmon and YOY crab groups to their predators (**B**), and prey search efficiency for juvenile herring (**C**). Model simulations incorporated functions with strong (*solid lines*), moderate (*dashed lines*), or weak (*dotted lines*) mediation effects.

Table 1. Ecosystem Services Provided by Puget Sound Food Web Model Functional Groups

Provisioning services

Commercial fishing

- Adult lingcod
- Adult Pacific herring*
- Adult rockfish
- Age 1+ crabs*
- Forage fish*
- Geoducks*
- Infaunal bivalves*
- Juvenile Pacific herring*
- Large sea cucumbers*
- Octopus
- Pacific cod
- Shrimp*
- Skates*
- Spiny dogfish*
- Squid
- Subadult hatchery salmon*
- Subadult pink salmon*
- Subadult wild salmon*
- Urchins

Cultural services

Recreational fishing

- Adult lingcod*
- Adult Pacific herring*
- Adult rockfish*
- Age 1+ crabs*
- Demersal fish*
- Forage fish
- Infaunal bivalves*
- Mussels
- Pacific cod
- Piscivorous flatfish*
- Shrimp*
- Skates
- Small-mouthed flatfish*
- Spiny dogfish*
- Squid
- Subadult hatchery salmon*
- Subadult pink salmon*
- Subadult wild salmon*
- Surf perches*
- Walleye pollock

Bird watching

- Bald eagles
- Gulls
- Herbivorous birds
- Migratory diving birds
- Nearshore diving birds
- Resident diving birds

Marine mammal watching

- Harbor seals
- Resident orcas
- Sea lions

Existence value

- Adult rockfish
- Juvenile rockfish
- Subadult wild salmon
- Juvenile wild salmon
- Pacific cod
- Pacific hake

Supporting services

Benthic invertebrates: barnacles, deposit feeders, other grazers, predatory gastropods, sea stars, small crustaceans, soft infauna, suspension feeders, tunicates, YOY crabs

Fishes: juvenile hatchery salmon, juvenile lingcod, juvenile pacific herring, juvenile pink salmon, juvenile rockfish, juvenile wild salmon, ratfish

Microbial and detrital pools: algal/plant material, bacteria, detritus, salmon carcasses

Pelagic zooplankton: copepods, euphausiids, jellyfish, macrozooplankton, microzooplankton, small gelatinous zooplankton

Primary producers: benthic macroalgae, benthic microalgae, eelgrass, overstory kelp, phytoplankton

Criteria for assignment

(1) Commercial fishing: group has one or more species that are commercially harvested in central Puget Sound (PacFIN unpublished data, 2005–2009)

(2) Recreational fishing: group has one or more species that are recreationally harvested in central Puget Sound (RecFIN unpublished data, 2005–2009)

(3) Bird watching: group has one or more species that are included in Birds in Washington State: a county comparison (Washington Birder 2011) for central Puget Sound counties

(4) Marine mammal watching: all marine mammal groups are included

(5) Existence value: group has one or more species that are listed under the Endangered Species Act (Code of Federal Regulations (CFR) 2012) or protected by the Marine Mammal Protection Act (which covers all marine mammals)

(6) Supporting services: groups included based on their ecological function within the food web

** Group has significant harvest (>1 mt of total harvest for 2005–2009).*

efits humans in other ways. This benefit can also be an indirect, supporting service, as it is for groups that are not harvested but are prey for groups that are harvested. Using criteria based on this general approach, we assigned each of the model's 66 biological groups to one or more broad categories of ecosystem service: provisioning, cultural, and supporting (Table 1). Although groups that provide supporting services play important roles in their connections to other groups, the values of their services are reflected in the values of groups they support and that provide services directly (Boyd and Banzhaf 2007). Although these supporting service values can be estimated in our framework, reporting them alongside the values of the other services leads to double-counting, and so we do not consider them further.

Thirty-seven groups provide services of either provisioning or cultural value. We specifically considered one type of provisioning service (commercial fishing) and four types of cultural service (recreational fishing, bird watching, marine mammal watching, and existence value). A functional group can be placed in more than one type or category of ecosystem service. For example, hatchery salmon are harvested both commercially (a provisioning service) and recreationally (a cultural service). A change in the biomass of hatchery salmon thus can change the flow of both of these services. Wild salmon are harvested in both types of fisheries, and they also have significant iconic or existence value (a cultural service) (Wallmo and Lew 2011). These different services are often compatible but can, in some cases, conflict. Commercial and recreational harvests are compatible with existence values, for example, as long as harvest rates are not so high that they threaten the viability of the species.

The quantity and value of an ecosystem service type are related to the size of a functional group's biomass in different ways. For commercial fisheries, there is a market for the harvest of the biomass, and the quantity and value can be measured directly with market data. In other cases, the service takes the form of an activity that interacts with the species groups, either through non-market harvest (for example, recreational fishing) or observation (for example, bird and marine mammal watching). In these cases, the biomass is one component of the activity's ''quality'' (Bockstael and others 2000; Freeman 2003; McConnell and Bockstael 2005), but assessing the quantity and value of the service is more difficult because data are typically hard to obtain for these types of activities. Finally, existence value is a passive ecosystem service value, as it does not depend on any activity and so has a direct relation to the functional group's biomass (Freeman 2003).

We calculated the amount and value of each ecosystem service as described below.

Commercial and Recreational Fishing

We first assigned all harvested species to their appropriate functional groups, using data on commercial harvest (Pacific Fisheries Information Network (PacFIN), unpublished data; pacfin.psmfc.org/) and recreational harvest (Recreational Fisheries Information Network (RecFIN), unpublished data; www.recfin.org) for central Puget Sound. We then identified which groups had significant aggregate harvest (>1 mt of total harvest for 2005–2009; Table 1); we dropped groups that did not meet this threshold from further analysis. Ecosim applies specific commercial and recreational harvest rates to each functional group, with rates for non-harvested groups equal to zero. We used the modeled amount of harvest (mt/y) as the measure of the quantity of each of these ecosystem services.

To assess the economic value for commercial fishing, we used data on commercial harvest ex-vessel revenue (PacFIN, unpublished data) and net revenue margins (Lian 2012). We calculated a per unit gross economic value of harvest ($/mt) by dividing the ex-vessel revenue (the quantity of fish landed by commercial fishermen multiplied by the average price received at the first point of sale) by the harvest quantity (as recorded in the PacFIN data) for all species in each group. To estimate a net economic value (gross revenue minus harvest costs), we used 2005–2006 harvesting cost data from a survey of crabbing and salmon fishing on the Pacific West Coast (Lian 2012) to obtain net revenue margins (net revenue as a percentage of gross revenue) for salmon and crab harvests (44.5 and 60.2%, respectively). For other fisheries where no cost data exist, we were not able to estimate a net revenue margin, and so we chose a percentage, 50%, within the range for salmon and crab harvest. For each group, we then multiplied the gross economic value by the corresponding margin to get an estimate of the net economic value of commercial fishing harvest ($/mt; Table 2). In calculating the total commercial harvest ecosystem service value, we assume that changes in biomass do not affect harvest costs and that changes in harvest levels do not change ex-vessel prices.

To assess the value of recreational fishing, we used data on daily catch rates (RecFIN, unpublished data), annual days of recreational fishing (RecFIN, unpublished data), and estimates of the willingness to pay (WTP) for changes in recreational catch rates for some species using data from a recreational fishing survey conducted in Washington (NWFSC, unpublished data). We estimated the WTP for changes in catch rates using angler responses to survey questions that elicit saltwater fishing trip choices as a function of catch rates, bag limits, and fishing costs (NWFSC, unpublished data). This model covers recreational fishing in Puget Sound and coastal Washington marine waters. We translated % changes in the biomass of recreational fish species in central Puget Sound into equivalent % changes in their catch rates, which is further translated into changes in WTP by the model; WTP per trip as well as the total number of trips taken in central Puget Sound increase as catch rates increase. The economic value of recreational fishing is then the product of the WTP for a change in catch on an individual trip and the expected

Table 2. Gross and Net Economic Values for Functional Groups with Significant Commercial Harvest

Commercial harvest functional group	Ex-vessel gross revenue ($/mt)	Margin (%)	Net economic value ($/mt)
Adult Pacific herring	$843	50.0	$422
Age 1+ crab	$5,794	60.2	$3,488
Forage fish	$884	50.0	$442
Geoducks	$8,154	50.0	$4,077
Infaunal bivalves	$3,590	50.0	$1,795
Juvenile Pacific herring	$843	50.0	$422
Large sea cucumbers	$4,342	50.0	$2,171
Shrimp	$9,293	50.0	$4,647
Skates	$197	50.0	$99
Spiny dogfish	$482	50.0	$241
Subadult hatchery salmon	$1,686	44.5	$750
Subadult pink salmon	$449	44.5	$200
Subadult wild salmon	$2,837	44.5	$1,263

number of trips for each scenario. Because the model does not cover all groups with significant recreational harvest, we assigned a zero dollar value to changes in biomass of the recreational fishing groups that lacked WTP data. Omitting the values of these groups results in an underestimate of the total value of this ecosystem service when measured with an economic metric.

Bird Watching and Marine Mammal Watching

For wildlife-viewing activities, the quantity of the service is properly measured in terms of days of the activity. Although we posit a positive relation between this measure and a biological group's biomass, we cannot express the quantity of these services as a simple proportion of the biomass as we can for commercial harvest. Because we lack data on the economic value of bird and whale watching, no estimates of the ecosystem service values in monetary terms are possible. For that reason, we used aggregate biomasses (mt) of the bird groups and marine mammal groups as proxy metrics for ecosystem service quantities and values for bird watching and marine mammal watching, respectively. For each of these services, if all groups had identical economic values per unit of biomass, the aggregate biomass metric would be perfectly correlated with the aggregate economic value of the groups. Thus, using a biological metric as a proxy for economic value adopts this as an assumption.

Existence Value

In some ways, existence value is ubiquitous, in that it can be attached to any distinct entity, even an individual animal or plant. Here, we restricted our focus to species that have an official designation that is related to their ongoing or potential endangerment. We used the Federal Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) as the sources for these designations. If a functional group has one or more species listed under these acts or is designated as a species of concern (in the case of the ESA), we attributed existence value to that group.

Because we lack economic data on these values for Puget Sound, we again used the proxy metric of aggregate biomass (mt) of all such functional groups, again assuming that the groups (and the individual species within that group) have identical economic values on a per unit of biomass basis. We also assumed that the changes in biomass explored in this study are insufficient to trigger a change in the official status of the species in the group.

RESULTS

Ecological Responses to Eelgrass Changes

As a general overview of model behavior, we present three examples of output from the 81 scenarios examined (Figure 2). Initial results showed that salmon groups were most sensitive to changes in eelgrass, and that crabs and herring had comparable responses. Figure 2A–C thus shows outputs from scenarios with weak mediation on juvenile salmon groups and strong mediation on both YOY crabs and juvenile herring, to present examples with comparable response magnitudes among the mediated groups.

The sign and magnitude of the change in eelgrass had a marked influence on model food web response. A 50% decrease in eelgrass led to declines

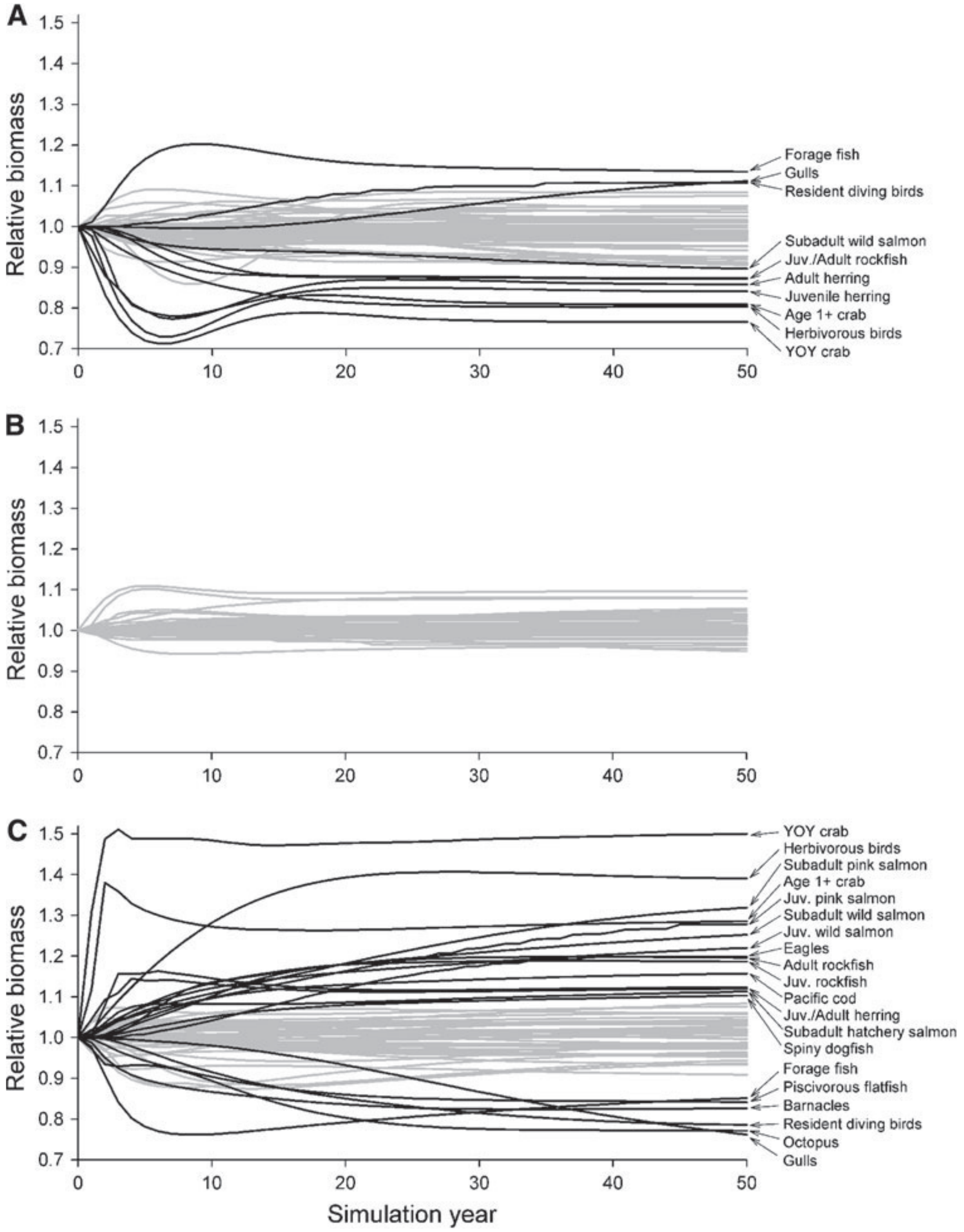

Figure 2. Output from scenarios of the central Puget Sound food web model, driven by changes in eelgrass biomass of −50% (**A**), +20% (**B**), or +100% (**C**). *Lines* represent biomass (relative to Year 0) of the 66 functional groups in the food web; groups that changed by at least 10% in year 50 are labeled and signified by *black lines*.

in the mediated groups as well as many other functional groups through direct pathways (for example, herbivorous birds, which consume eelgrass) or indirect trophic pathways (for example, rockfish, which prey on herring and crabs). In contrast, some groups increased due to relaxed predation or competitive pressures (Figure 2A). A 20% increase in eelgrass caused widespread changes, typically positive in sign, but with a lower overall magnitude (Figure 2B). Finally, a 100% increase in eelgrass caused changes in far more groups—increases in mediated groups as well as other consumers via direct and indirect pathways, and declines in many of their prey groups or competitors (Figure 2C). These patterns were consistent across other combinations of mediation strengths.

For the sake of brevity, we limited the radar plots of model outputs to 34 functional groups that represent mediated groups, marine mammals, seabirds, predatory fishes, and abundant functional groups at middle and lower trophic levels (Figure 3). As expected, mediated groups (salmon, crabs, and herring) responded positively to increases in eelgrass coverage (Figure 3A). The response was strongest in pink salmon (*Oncorhynchus gorbuscha*), and was also strong in wild salmon (that is, Chinook *O. tshawytscha*, chum *O. keta*, and coho salmon *O. kisutch* of natural origin). On average, pink salmon more than doubled when eelgrass biomass doubled, indicative of complex indirect food web effects that benefitted the pink salmon population at the highest levels of eelgrass.

In the upper trophic levels, the strongest responses were in the bird community (Figure 3B). Herbivorous birds responded strongly to changes in eelgrass, which they feed on directly. Bald eagle (*Haliaeetus leucocephalus*) biomass responded strongly to eelgrass through indirect means, most likely due to increases in salmon biomass, an important food supply (Harvey and others 2010, 2012b). Through heavy predation pressure, bald

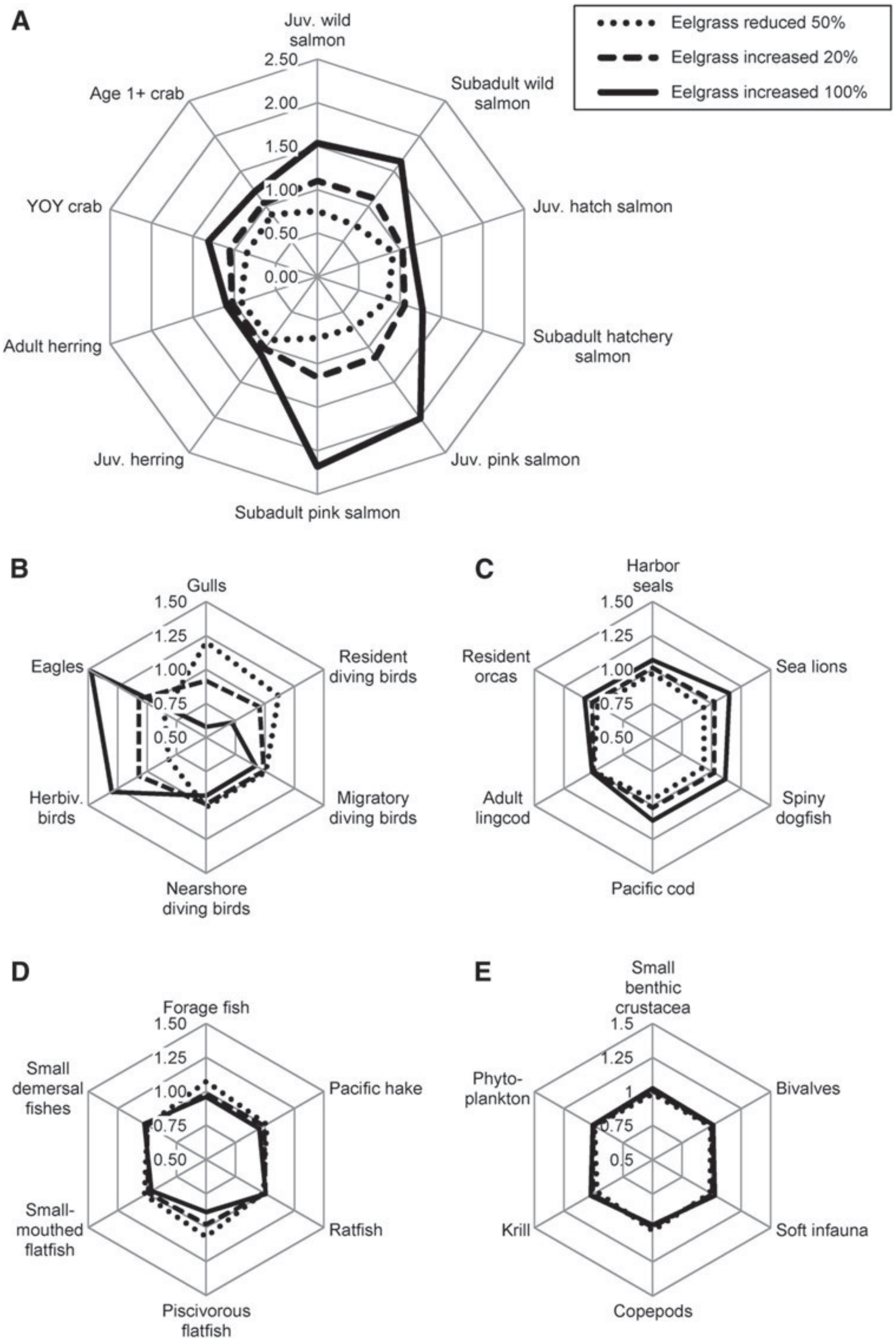

Figure 3. Radar plots showing the average change in relative biomass of 34 key functional groups in response to changes in eelgrass biomass in the central Puget Sound food web model. **A** Groups mediated by eelgrass, **B** seabird groups, **C** top predators, **D** other fish groups, **E** invertebrates and phytoplankton.

eagles depressed populations of seabirds, particularly gulls and resident diving birds (see Harvey and others 2012a). Among other top predators (trophic level >4), average responses were more muted (Figure 3C). Marine mammals, especially sea lions, responded positively to increased eelgrass biomass, due to increases in prey resources such as salmon, herring, and other fish populations that indirectly benefitted from increased eelgrass. Of the predatory fishes, spiny dogfish (*Squalus suckleyi*) and Pacific cod (*Gadus macrocephalus*) had a mild positive response to increasing eelgrass, whereas adult lingcod (*Ophiodon elongatus*) exhibited little change (<2%) on average.

Other fish groups and lower trophic levels were less responsive to food web changes brought about by eelgrass mediation. Of the other fish groups (Figure 3D), piscivorous flatfish were most responsive on average, and responded negatively to increased eelgrass because of build-ups of predators; the same was true of small-mouthed flatfish and Pacific hake (*Merluccius productus*), a species of note because its population in Puget Sound has declined dramatically over the past several decades (Gustafson and others 2000). Non-herring forage fish also declined as eelgrass increased, due to eelgrass-mediated increases in competitors (Pacific herring, juvenile salmon) and predators. Other abundant bottom-dwelling fishes, such as ratfish (*Hydrolagus colliei*) and an aggregated group of small demersal fishes, showed little response (<10% changes in final biomass). On average, invertebrates in benthic and pelagic habitats did not respond substantially (<5% changes in final biomass) to even large changes in eelgrass, nor did phytoplankton (Figure 3E).

Ecosystem Service Responses

Using an ecosystem service framework, we winnowed the food web model results down to ecosystem components that have direct human value and, where possible and appropriate, used a common monetary metric to compare changes in their values. For the five services we examined, all but one—bird watching—responded positively to changes in eelgrass when measured with a physical metric (mt/km^2) (Figure 4A). In physical terms, both commercial and recreational harvest and the biomass of the functional groups with existence value (mainly driven by changes in salmon) responded most strongly, marine mammals responded weakly (but still positively), whereas birds responded negatively (though weakly). For the harvest services, switching from a physical metric to a monetary metric did not change the direction of the response but did change its relative strength for recreational fishing (Figure 4B). The relative insensitivity of recreational harvest in monetary terms reflects the fact that its value is based on a willingness to pay (WTP) for an experience (a fishing trip) whose value is determined by many components, only one of which is the biomass of fish caught. As expected, commercial harvest value was more proportionately correlated with total biomass harvested.

Because existence value, marine mammal watching, and bird watching can only be measured in biological metrics given available data, we cannot draw conclusions with certainty about the overall change in the economic values of these ecosystem services. The slight negative change in the biomass of the species groups that constitute the bird watching service (Figure 4) reflects the bald eagle-driven decrease in most seabird groups, and suggests there may be some tradeoff among ecosystem services, however small, from increasing the amount of eelgrass in central Puget Sound.

DISCUSSION

Our ecological and economic modeling demonstrates the potential for habitat extent to influence broad community dynamics and thereby affect the flow of ecosystem services from the species in a marine ecosystem. The habitat mediation effects imposed on the juvenile salmon, juvenile herring and YOY crab groups clearly influenced those model groups. Salmon were particularly sensitive, possibly because they spend much of their life histories outside of Puget Sound, and thus are less constrained by internal food web dynamics compared to crabs and herring (Harvey and others 2010, 2012b). The especially strong pink salmon response may be due in part to their inherently high production rate compared to other mediated groups (Harvey and others 2012b). The effects of habitat mediation extended to other groups via trophic pathways, some of which were quite complex. For example, increasing juvenile salmon led to greater numbers of subadult salmon; the salmon and their carcasses supported a larger population of bald eagles, which in turn depressed the populations of several seabird groups and may have relaxed predation pressure on fish and other organisms preyed upon by those seabirds. Higher trophic level groups that have close trophic links to salmon, crabs and herring experienced strong responses to simulated changes in eelgrass; in contrast, species groups at lower trophic levels were

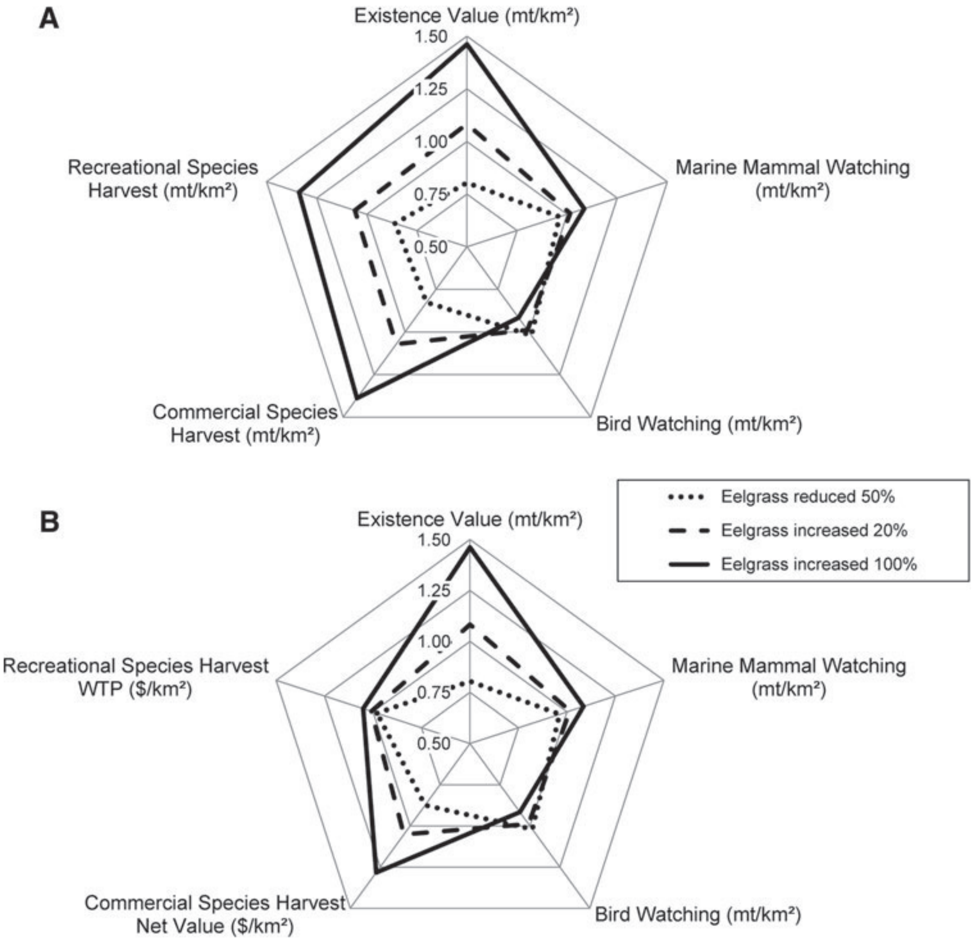

Figure 4. Radar plots showing the average change in **A** ecosystem service quantities and **B** values in response to changes in eelgrass biomass in the central Puget Sound food web model for five ecosystems services.

less sensitive. Such groups (for example, copepods, small benthic crustaceans, bivalves, small demersal fishes) are widely distributed species aggregates with high productivity rates (Harvey and others 2010, 2012b), characteristics that made them resilient to changes in the nearshore food web. Although changes in eelgrass coverage likely would have impacts on lower trophic levels at local scales, that did not appear to be the case at the scale modeled here.

It is important to stress that the mediation functions we used to relate change in eelgrass to change in species biomass were purely hypothetical, in terms of their signs, shapes, and strengths. We use these results to demonstrate the potential effects of habitat extent on both food web structure and ecosystem services. Our assumption is that increasing eelgrass habitat will support greater production of juvenile salmon, juvenile crab, and herring through provision of prey, refuge, and/or spawning substrate. This assumption is consistent with conclusions from multiple literature sources (for example, Simenstad and Fresh 1995; Fresh 2006; Mumford 2007; Ruckelshaus and McClure 2007; Semmens 2008). Because we know of no quantitative functional response estimates, however, we chose simple linear functions with highly contrasting slopes in hopes of producing plausible upper and lower bounds for system responses. Thus, the pronounced changes elicited by habitat mediation argue for empirical or experimental studies to quantify the nature of habitat mediation in nearshore marine ecosystems.

Using an ecosystem services framework, our results show that the values of most services are positively linked to changes in eelgrass area. In a decision context, the one discordant result of declines in bird watching can be explicitly weighed against the likely increases in the four other service categories. This kind of information gives management bodies such as the Partnership a method for clearly illustrating the potential tradeoffs inherent in ecosystem-based management and facilitates a transparent resolution of such conflicts.

The lack of an economic value metric for three of the services qualifies these conclusions in important ways. Using an aggregated biological metric as a proxy for aggregate economic value presumes, as noted above, that the individual groups being aggregated have identical economic values per unit of biomass. Commercial fishing illustrates how this assumption may be violated (Table 3). Among functional groups with significant levels of commercial harvest, the three salmon groups account for 68.6% of the initial biomass, whereas geoducks (*Panopea generosa*) account for 17.8%, herring 8.2%, and crab 2.3%. In terms of economic value, however, these rankings change, with geoducks accounting for 43.7% of the total value, salmon 39.0%, crab 4.9%, and herring 2.2%. Aggregate biomass, then, may not be a strong proxy for changes in economic value and may even produce misleading signals of the direction of change. For example, the biomasses of individual functional groups within the bird watching group responded differently to changes in eelgrass, both in direction and in magnitude (Figure 3B). Herbivorous birds (such as Canada geese *Branta canadensis*) and bald eagles responded positively and strongly to changes in eelgrass, whereas resident diving birds (such as cormorants *Phalacrocorax* spp.) and gulls exhibited a strong negative response. With sufficiently high values attached to the latter two groups, the biological measure of the bird watching service could increase while the economic measure could decrease.

Our results also illustrate the importance of distinguishing the total value of an ecosystem service from its incremental value, or the change in value that occurs when an ecosystem element (in this case, eelgrass) changes. Although the total value of one or more ecosystem services is often used to make the case for the importance of natural systems (Anielski and Wilson 2009; Beaumont and others 2008; Costanza and others 1997), estimating their incremental values is more relevant for ecosystem-based management because it provides policy makers with more meaningful comparisons across alternatives (National Research Council (NRC) 2004; Guerry and others 2012). Among our results, the following example illustrates these differences.

For functional groups with significant levels of commercial harvest, the salmon groups ($3,045/km^2) and geoducks ($2,840/km^2) have the highest total values under the baseline eelgrass conditions (Table 4). Changes in eelgrass, however, produce significant changes in the value of the salmon groups but relatively small changes in the value of geoducks. Similarly, whereas the total geoduck value under baseline conditions is almost ten times that of crabs, the incremental value of eelgrass changes for the latter ranges between 2.0 and 5.5 times that for the former across the three scenarios. Thus, if a manager used total economic values of geoducks, salmon, or crabs to target investments in eelgrass restoration or protection, the return on investment for eelgrass improvements would be lower than if they used the incremental values reported here. These results stem from the stronger connection between eelgrass and the mediated species, and so illustrate the importance of identifying the ecological links among the species groups, which allow estimation of how their values will change under different scenarios.

Finally, it is interesting to examine these results in light of the Partnership's consideration of eelgrass and ecosystem services. In choosing 120% of

Table 3. Proportion of Total Commercial Harvest Ecosystem Service Value Provided by Functional Groups with Significant Commercial Harvest, by Weight and Dollar Value

Commercial harvest functional group	Proportion of commercial fishing ecosystem service by	
	Weight % (mt)	Value % ($)
Adult Pacific herring	0.5	0.1
Age 1+ crab	2.3	4.9
Forage fish	0.2	0.1
Geoducks	17.8	43.7
Infaunal bivalves	0.9	0.9
Juvenile Pacific herring	7.7	2.0
Large sea cucumbers	0.5	0.7
Shrimp	0.2	0.7
Skates	0.0	0.0
Spiny dogfish	1.2	0.2
Subadult hatchery salmon	17.3	7.8
Subadult pink salmon	0.1	0.0
Subadult wild salmon	51.2	39.0

Table 4. Total and Incremental Values for Functional Groups with Significant Commercial Harvest across Eelgrass Scenarios

Commercial harvest functional group	Total commercial harvest net value ($/km^2) (eelgrass at baseline)	Incremental commercial net value ($/km^2)		
		Eelgrass reduced 50%	Eelgrass increased 20%	Eelgrass increased 100%
Adult and juvenile Pacific herring	$135	−$13	$3	$14
Age 1 + crab	$317	−$36	$15	$68
Geoducks	$2,840	−$18	$4	$12
Other groups	$166	−$2	$0	$2
Subadult hatchery, pink, and wild salmon	$3,045	−$746	$316	$1,747

Other groups include forage fish, infaunal bivalves, large sea cucumbers, shrimp, skates, and spiny dogfish.

current cover as their target for eelgrass area, the Partnership considered two other options: no change in the area of eelgrass and a target of a 100% increase (doubling) relative to the 2000–2008 area. For each option, the Partnership was presented with an informal assessment of how the levels of ecosystem services associated with eelgrass would respond to achieving the target (Puget Sound Partnership 2010). The informal assessment estimated that a stable area would maintain current levels; a 20% increase would provide a ''modest'' increase over current levels; and a 100% increase would provide an ''approximate doubling'' of current ecosystem service levels. For our scenarios, we found that the responses of the ecosystem services varied both in magnitude and in direction. Although uncertainty about eelgrass's mediation effects makes quantitative conclusions problematic, we note that our scenario in which eelgrass biomass doubles produced relatively strong increases in three ecosystem services, one relatively weak increase, and one decrease (Figure 4). This underscores the importance of focusing on individual services and, as illustrated by the varied response of individual bird groups within the bird watching ecosystem service, even individual components within a particular service. The approach used here also illustrates the importance of coupling ecological and economic models in highlighting likely responses that are not easy to discern using expert judgment.

Conclusions

Direct and indirect ecological consequences of increases in nearshore habitats such as eelgrass lead to greater biomass of many invertebrate, fish, and bird species that depend on those habitats for refuge or food. The food web modeling approach we used also illuminated a few unexpected species changes; most strikingly, decreases in some forage fish and bird species due to competition or changes in predator–prey dynamics. These results illustrate the value of food web models that can account for greater complexities in species–habitat interactions than the intuition of even the most experienced scientists. Combining habitat–food web models with economic models provides further evidence of the dangers of relying solely on expert judgment to predict changes in benefits flowing from ecosystems under different conditions. Quantitatively estimating how marginal changes in foundational nearshore species such as eelgrass give rise to changes in ecosystem service values offers important insights into likely responses of these ecosystems to protection or restoration interventions. Using basic ecological and economic models can provide critical logical checks for decision makers concerned about understanding trade-offs in investments, regulatory, or other management interventions aimed at recovering ecosystems.

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Attachment L

Patrick and Kathryn Townsend
7700 Earling Street NE
Olympia, WA 98506

February 20, 2015

Mr. Tony Kantas
Associate Planner
Thurston County Planning Department
2000 Lakeridge Drive SW
Olympia, WA 98502-6045

Subject: Presence of eelgrass in Zangle Cove

Re: Application by Pacific Northwest Aquaculture for geoduck farm in
Zangle Cove estuary; JARPA application number 2014108800; parcel number
12911440102

Dear Mr. Kantas,

The proposed geoduck applications by Pacific Northwest Aquaculture (ChangMook Sohn) contains critical errors and inaccuracies related to the presence of protected eelgrass (Zostera marina) in these sections (emphasis added):

> JARPA application, Page 4, Part 5L: "Briefly describe the vegetation and habitat conditions on the property":
>
> "The project occurs on private tidelands. The project site is a sandy, muddy beach with no structure. **There are no eelgrass beds** or other priority features. The uplands along the shoreline are native forest with mixed coniferous and deciduous trees. Areas adjacent to the single family residence are landscaped."

And,

> The Pacific Northwest Aquaculture Biological Evaluation, Page 7, Section 2.2, Construction Schedule:
>
> "**No eelgrass is present on our near the project area** … "

And,

> The Pacific Northwest Aquaculture Biological Evaluation, Page 8, Section 3.2, Action Area, Baseline conditions in the project area:
>
> "Sediments in the Action Area are largely similar to the Project Area, consisting of unvegetated, mud, course to fine soft sand, and gravel sediment. A site visit during negative tides in June of 2OL4 by ACERA biologists found **no instances of eelgrass** or attached macroalgae (kelp)."

And,

> The Pacific Northwest Aquaculture Biological Evaluation, Page 19, Section 5.4, Effects on Puget Sound Chinook Salmon Critical Habitat, Natural Cover:
>
> "The Project Area is a relatively simple low gradient mud/sandy beach and provides negligible natural cover. **Eelgrass and attached kelp are not present** within the Project Area."

These statements about eelgrass are false.

Eelgrass has been present in Zangle Cove for a number of years, adjacent to, if not actually on the Sohn tideland property. A marine biologist with the Washington State Department of Natural Resources identified eelgrass to local tideland owners on a site visit to Zangle Cove and explained the important role that eelgrass plays in Puget Sound ecology. Eelgrass is still present.

Additionally, the United States Department of Energy has sponsored, and the United States Environmental Protection Agency has provided funding for, eelgrass research and test planting of approximately 45 square meters in the vicinity of the proposed geoduck aquaculture farm. Please see the attached document "Eelgrass Restoration in Puget Sound: Development and Testing of Tools for Optimizing Site Selection", September 2014.

This report confirms the presence of eelgrass in Zangle Cove near the project property:

> Page 9, Section 2.4.2.1, South Sound:
>
> "The last plot was planted at Zangle Cove to the side of a small existing patch. Visibility at that site varied with tidal current."

The work of the US DOE in restoration of eelgrass in Zangle Cove next to the existing eelgrass has been successful to date:

> Page 24, Section 3.3.1, Quantitative Surveys of the Test Plots:

> "Zangle Cove and Westcott middle had some mortality, which is expected with the first year of this type of transplanting (e.g., Vavrinec et al. 2007), but did well enough to warrant further investigation for large-scale restoration."
>
> Page 30, Section 4.4, Test Plantings and Site Assessments:
>
> "Conversely, our expectation was that South Sound was largely inhospitable to eelgrass and restoration would be difficult. However, we found that portions of the South Sound may be very good for supporting eelgrass and recruitment limited. The decline on Anderson Island suggests that a strong southwest exposure may be undesirable in the region, so future work should focus on the north or east sides of landmasses (e.g., Zangle Cove) or where the fetch is minimized (e.g., Joemma State Park)."

The US DOE report identifies aquaculture activities as creating negative stressors on eelgrass (emphasis added):

> Page iii, Abstract:
>
> Surveys of stakeholders identified dredging/filling, shoreline development, water quality, and **commercial aquaculture as the most significant stressors on eelgrass**, and noted that new regulations and improved enforcement of existing regulations would be necessary to ensure continued recovery and protection of eelgrass.
>
> Page 29, Section 4.3, Stakeholder Input:
>
> The stakeholders we surveyed identified dredging and filling, water quality, shoreline development, and **commercial aquaculture as the greatest stresses to eelgrass.** As the human population in Puget Sound is projected to increase, attention to protecting critical habitats and limiting stressors will be critical to meeting eelgrass recovery goals.

The assertion that no eelgrass is present near the proposed property is inexplicable and it is false. We believe that based on this false assertion alone, the permit should be denied outright. It is inconceivable that Thurston County would give consideration to a permit application based on false information.

However, the more important and significant issue is that because of the ongoing United States Department of Energy eelgrass restoration project, of which Zangle Cove is a documented test site, we believe the permitting of any industrial activity on the tidelands of Zangle Cove should be prohibited now and in the future. Zangle Cove is significant in the effort to restore and preserve the important habitats of Puget Sound for endangered species – a goal that everyone claims is a priority.

The harmful effects of the proposed geoduck aquaculture operation on eelgrass are unmistakably stated in the United States Department of Energy report, which is attached to this letter. The installation of a commercial geoduck farm in the location of the eelgrass restoration project of the United States Department of Energy is contraindicated.

Furthermore, the ongoing study of Zangle Cove related to eelgrass recovery by United States Department of Energy should preclude the permitting of any geoduck aquaculture or any other type of aquaculture in or near Zangle Cove at present or in the future. Zangle Cove, as an eelgrass restoration site, should be off-limits to industrial aquaculture.

Sincerely,

Patrick and Kathryn Townsend

Included:
Photos of eelgrass in Zangle Cove

Attached:
Pacific Northwest National Laboratories, US Department of Energy, “Eelgrass Restoration in Puget Sound”, 2014

Photos of Eelgrass in Zangle Cove


5/13/06 First observed naturally growing eelgrass in Zangle Cove


5/13/06 Nautrally growing eelgrass in Zangle Cove

Photos of Eelgrass in Zangle Cove

5/13/06 Naturally growing eelgrass in Zangle Cove

2013 Eelgrass in Zangle Cove.

Photos of Eelgrass in Zangle Cove

2013 Eelgrass in Zangle Cove.

Star fish in its home on the eelgrass and kelp of Zangle Cove

SHORELINES HEARINGS BOARD
STATE OF WASHINGTON

COALITION TO PROTECT PUGET SOUND HABITAT, Petitioner, and PAUL H. GARRISON and BETTY N. GARRISON, Petitioner-Intervenors, v. PIERCE COUNTY; DARRELL de TIENNE and CHELSEA FARMS, LLC, Respondents.	SHB No. 13-016c FINDINGS OF FACT, CONCLUSIONS OF LAW, AND ORDER (SHB NO. 13-016)
DARRELL de TIENNE and CHELSEA FARMS, LLC, Petitioners, v. PIERCE COUNTY, Respondent.	(SHB NO. 13-018) (SHB NO. 13-019)

Petitioners Coalition to Protect Puget Sound Habitat (the Coalition) and Petitioner-Intervenors Paul and Betty Garrison (the Garrisons) (collectively, Petitioners) challenge Pierce County's approval of a Shoreline Substantial Development Permit (Permit) issued to Respondents Darrell de Tienne and Chelsea Farms, LLC (collectively, the Applicants) for a commercial geoduck farm in Henderson Bay, a portion of Carr Inlet located in Pierce County.

The Shorelines Hearings Board (Board) previously issued an Order on Motions to Dismiss and for Summary Judgment that, among other things, dismissed numerous legal issues and dismissed Paul and Betty Garrison's Petition for Review, but granted the Garrisons limited status as Petitioner-Intervenors.

A six-day hearing on remaining issues[1] was held in Tumwater, Washington from November 12 through November 19, 2013, at which time the Board received the sworn testimony of witnesses, admitted exhibits, and heard arguments from all parties to this appeal. The Board hearing this matter was comprised of Chair Tom McDonald, Kathleen D. Mix, Joan M. Marchioro, Pamela Krueger, Grant Beck, and Robert Gelder. Administrative Appeals Judge Kristie C. Elliott presided. Pennington Court Reporting provided court reporting services. Board members who missed any portion of the hearing listened to tapes for the portion(s) missed, reviewed the exhibits, and participated fully in the deliberations.

Having fully considered the record, the Board enters the following:

FINDINGS OF FACT

A. The Proposed Farm

[1]

In 2005, the Applicants submitted their Permit application for a five-acre geoduck farm

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[1] The Applicants filed their own Petition for Review to challenge certain conditions imposed by the Pierce County Hearing Examiner (Hearing Examiner), but settled all issues with the County prior to hearing. Though this settlement purported to encompass subsequent changes to the Permit, the Board's review in this matter is limited to the Hearing Examiner's Decision approving the Permit with conditions, and no changes to the Permit made subsequent are before the Board for review.

(the Farm) to be located on County Auditors Parcel No. R0122233064 (the Farm Site or Site), a 10.47-acre private intertidal and subtidal shoreline parcel owned by Darrell de Tienne in Pierce County. Meaders Testimony; Ex. R-167 at p. 3; De Tienne Testimony; Ex. R-2 at p. 2.

[2]

The Farm Site is located on the north shore of Henderson Bay, which is part of Carr Inlet. Burley Lagoon is located at the tip of Henderson Bay. The Site is designated Rural-Residential under Pierce County's Code, which permits aquaculture in this zone. It is also designated a shoreline of statewide significance. Booth Testimony; Ex. R-2 at p. 2; Ex. R-3 at p. 1; Ex. R-6; Ex. R-7; Newell Testimony; Ex. P-89.

[3]

Geoducks are large, edible burrowing clams indigenous to Puget Sound. Commercial harvest began in Washington State in 1970 after discovery of abundant subtidal populations. Ex. P-7. While commercial operations can be limited to harvest of native populations, they also include geoduck "farms," which artificially plant and then harvest the geoduck. Typically these geoduck farms are in the intertidal zone. Here, the Applicants' proposed Farm will include the subtidal zone.

[4]

The proposed Farm in this case would conduct a single planting and harvesting cycle in 10 years, with planting and harvesting staggered for different sections of the Farm. The Applicants will place 4-inch diameter neutral-colored PVC tubes about 15-18 inches apart into the substrate, which will extend about two to three inches above the substrate; three to four seed clams would be placed inside each tube. The tubes would remain for a maximum of two years, with a maximum of two acres of aquatic lands containing up to 56,000 tubes at any one time. After two years, the PVC tubes and predator netting would be removed (though predator netting may be replaced for up to six months), and after the geoducks reach market size in four to seven years, they would be harvested by hand at low tide or by divers in the subtidal area using hand-held water jets at a pressure of approximately 40 pounds per square inch and a volume of approximately 20 gallons per minute to loosen the substrate. The pumps would be run by small engines on a small boat offshore. De Tienne Testimony; Ex. R-1 at p. 4, ¶ 5; Ex. R-24 at pp. 2-4; Ex. R-165 at p. 7. It was also clarified that it is likely that only canopy netting, not the individual tube netting and bands as identified in the Hearing Examiner Decision, will be used for predator exclusion. De Tienne Testimony.

[5]

Planting and harvesting at the Farm Site would be primarily in the subtidal zone, which distinguishes this Farm from others reviewed by the Board located in the intertidal zone. The Farm would be the first subtidal commercial geoduck operation to be permitted in Pierce County. Booth Testimony; Ex. R-2 at p. 3. Operations would be set back 220 to 320 feet from the shoreline, with only 0.5 acres of the five-acre cultivable area at the Farm Site available for intertidal planting. In the SE quadrant of the property, approximately 3/4 acre of cultivable lands is intertidal while the rest is subtidal. Meaders Testimony; Ex. R-167 at p. 3; Ex. R-24 at p. 2; Ex. R-1 at p. 5, ¶ 6; Ex. R-2 at p. 2. While the Permit allows the Applicants to plant and harvest in this smaller area in the intertidal zone, they have not yet made the decision whether to do so. De Tienne Testimony.

[6]

Another difference of the proposed Farm from other geoduck farms reviewed by the Board is that it sits over a continuous swath of eelgrass that runs adjacent to the shoreline of Henderson Bay. Planting of geoducks in the subtidal area of the Farm would run along the seaward boundary of this eelgrass bed, separated by a buffer, discussed further below. Likewise, the intertidal planting area would run along the shoreward side of the eelgrass bed, again with a buffer area. Additionally, a portion of the planting area of the Farm will be over an area of eelgrass damaged by previous operations at the Farm Site. De Tienne Testimony.

[7]

This proposed Farm is also unique because it would be the first commercial geoduck farm permitted in the area. Booth Testimony. Though Burley Lagoon has been host to aquaculture previously, this has been focused on other types of aquaculture, in particular, oyster cultivation. *See, e.g.*, McDonnel Testimony.

[8]

This area of Puget Sound supports diverse aquatic life that includes eelgrass and kelp, forage fish (including herring, surf smelt, and sand lance), aquatic organisms (including sand dollars and sea stars), and various terrestrial species such as bald eagles. Purdy Creek is a nearby salmon spawning creek that flows into the north end of Henderson Bay. Orca and grey whales have also been spotted in the Bay. *See, e.g.*, Penttila Testimony; Daley Testimony; Newell Testimony.

[9]

This area also boasts a large fetch, the distance over which the wind can blow unobstructed by land, making it a popular windsurfing spot. The winds create high waves that translate into a higher energy shoreline environment. Newell Testimony; Paradise Testimony; Meaders Testimony.

[10]

Historically, environmental impacts from commercial geoduck operations have not been extensively studied. The state Legislature recognized the need for more scientific study of industry practices and passed legislation in 2007 that led to commencement of research by the University of Washington Sea Grant Program. Booth Testimony; *see also* Ex. R-3 at p.3; *Coalition to Protect Puget Sound Habitat v. Pierce County*, SHB No. 11-019 (2012) ("*Longbranch*") at COL 16, p. 25 (recognizing same); RCW 28B.20.475. At that time, the Applicants requested their application for this Farm be put on hold until the new research became available. At some later point, when research was taking too long and County processing deadlines loomed, the County proceeded to review the application. Booth Testimony.

[11]

The County assessed and mitigated for potential impacts from this project in part under the State Environmental Policy Act (SEPA), chapter 43.21C RCW. On November 21, 2012, the County issued a Mitigated Determination of Nonsignificance (MDNS), in which the County

Responsible Official, Ty Booth, initially determined that "the proposal will adversely impact fish and wildlife species and their habitat" and imposed 12 mitigation measures. The County concluded based on these mitigation measures that "the proposal does not have a probable significant impact on the environment." The MDNS was not appealed. Ex. R-3; Booth Testimony. The County also submitted a Staff Report to the Hearing Examiner that contained additional recommendations for conditions to place on the Farm. Booth Testimony; Ex. R-2. Following a series of public hearings, the Hearing Examiner then approved the Permit with 27 conditions. Ex. R-1. The County still needs to issue a Fish and Wildlife Habitat Area approval for the project under its Critical Areas Ordinance. Mr. Risvold testified that the conditions of the fish and wildlife approval are likely to be the same conditions as for the shoreline permit. Risvold Testimony.

[12]

The Coalition presented five witnesses at hearing (Bradford Newell, Robert Wenman, John McDonnel, Susan Macomson, and Robert Paradise) who were neighbors and/or recreationalists and who testified about impacts from the proposed Farm on the environment and/or recreational use of the area. The Coalition also presented the testimony of three scientific expert witnesses: Daniel Penttila, a fish biologist; Wayne Daley, also a fish biologist; and Dr. Gary Ritchie, a forestry expert with statistical expertise. In addition, Paul Garrison as Petitioner-Intervenor testified on environmental conditions at the Farm Site. Four witnesses including one expert witness testified for Respondents: Darrell De Tienne; Ty Booth, a planner with the

County; Dave Risvold, an environmental biologist with the County; and Marlene Meaders, a fish biologist with expertise in shellfish aquaculture.

[13]

Testimony about the potential impacts from the proposed Farm fell into identifiable subject areas including impacts from marine debris and how farm operations may affect the benthic environment, forage fish, and other species. There is some similarity between the issues alleged in this proceeding and prior challenges by the Coalition of other proposed farms. *See Longbranch,* SHB No. 11-019 (2012) at FF 5-8, 15-18, pp. 4-6, 11-12*; Coalition to Protect Puget Sound Habitat v. Thurston County*, SHB No. 13-006c (2013) ("*Lockhart*") at FF 17-23, 27-30, 33-35, 36-39, pp. 8-11, 12-15, 16-19. Each shoreline appeal must be based upon its own merits, however, and this case presents some unique aspects that include the presence of eelgrass at the Farm Site, the proximity of known herring spawning locations to the Farm Site, the specialized recreational use of the area for windsurfing, and the Farm Site's location on a shoreline of statewide significance. These areas of distinction serve as the main focus of the Board's analysis and, ultimately, its decision to deny the Permit in this case.

B. Impacts to Eelgrass

1. Role of Eelgrass in the Ecological System

[14]

Eelgrass and nearshore marine algal communities (*e.g.,* kelp) provide major ecological benefits. Penttila Testimony; Ex. P-4; Ex. P-49. Eelgrass, in particular, has been called "the bread and butter of the marine environment." *Holley v. San Juan County*, SHB No. 00-001 (2000) at FF 5. The Board has previously found:

> Eelgrass serves essential functions in the developmental life history of fish and shellfish. WAC 220-110-250. It provides refuge sites and shelter from predators for fish and invertebrates, and for other small organisms. Eelgrass is a source of food for many marine animals and birds, and is habitat for red algae and other marine plants. It also provides physical stabilization of the nearshore area. Seagrasses baffle wave and tidal energy, protecting subtidal sediments and shorelines from erosion and can alter local and regional hydrography. Seagrasses such as eelgrass are the only rooted organisms in the near-shore region and they serve as the foundation for thousands of vertebrate and invertebrate species that use it for shelter, foraging, spawning habitat, and nurseries. . . .

Friends of the San Juans v. San Juan County, SHB No. 08-005 (2008) at FF 15.

The Board has repeatedly acknowledged the vital role of eelgrass to the health of Puget Sound and noted its "significant decline" over time, finding:

> Damage to eelgrass can affect whole populations of fish, including threatened salmon, waterfowl, shellfish, and other animals. Eelgrass also serves to physically stabilize the state's shorelines by concentrating in nearshore areas where these animals live, feed, and spawn. There has been a marked decline in eelgrass and other sea grasses world-wide, which can be classified as a global crisis. This decline has accelerated in developed countries such as the United States. Due to the site-specific nature of the functions and values of eelgrass, protection of eelgrass beds is preferable to replacement of beds because the surrounding environment loses the functions and values that the destroyed eelgrass beds provide, and replacement efforts are not always successful, and can take a long time. When seagrasses are damaged, restoration is expensive and uncertain. Many of the lost ecological services cannot be adequately restored, and the cumulative effects from loss of seagrasses such as eelgrass can degrade seagrass biomes on both local and regional scales. Documented success of restoration by replanting is rare.

Id. at FF 18 (internal citations omitted).

The Board has thus recognized the need to protect eelgrass because doing so "safeguards species richness, biodiversity, ecosystem structure, and many ecological processes." *Id.* at FF 15.

[15]

Both eelgrass and macroalgae provide major ecological benefits as habitat for out-migrating juvenile salmon and for forage fish, including herring, to spawn. Herring are one of three major shore-spawning forage fish species in Puget Sound; they are a key species in the marine food web and therefore a good "indicator species" for gauging the relative health of the Sound. Herring spawn cling to vegetation, including eelgrass. Evidence of spawning can easily be seen by the naked eye, especially when spawning occurs at medium or high intensities. Penttila Testimony; Exs. P-4; P-23; P-40-41; P-44-48.

[16]

Eelgrass and macroalgae[2] serve vital ecological roles in addition to providing spawning habitat. This includes carbon-fixing/sequestration, the production of organic matter and detritus (the basis of the food chain), and the provision of physical habitat for use by adult marine species and as a refuge and nursery area for juvenile life stages. Eelgrass is particularly susceptible to disturbances. This can include both direct disturbances like trampling, plus effects from indirect

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[2] In addition to establishing an eelgrass buffer, the Permit mandates a physical separation be maintained between Farm activities and attached kelp species (order Laminariales). Ex. R-1 at p. 30 (Condition 26.C). No attached species of kelp were found at the Farm Site, however. Meaders Testimony. While Mr. Penttila testified that protection should have been afforded to unattached kelp species found at the Farm Site, he did not specify—and it remains unclear—how this could be accomplished (*e.g.,* how a buffer from activities can practically be maintained from unattached, free-floating aquatic vegetation). Penttila Testimony. The Board makes no finding in this regard because the burden of proof as to proper kelp protection was not met. The Board does note that, while the Permit requires a buffer from attached kelp species, it did not (and possibly should) require subsequent surveys to assess whether any attached kelp species are present. *See* Ex. R-1 at p. 31 (Condition 26.D) (requiring surveys for eelgrass, but not kelp).

disturbances (e.g., sedimentation and related turbidity) that decrease light availability. Penttila Testimony; Ex. P-4; Ex. P-49.

2. Presence of Eelgrass at the Farm Site

[17]

Eelgrass at the Farm Site was surveyed and mapped in 2004, 2009, and 2012. Ex. R-23; Ex. R-24; Ex. R-21. These surveys have been relied upon by the Applicants to establish baseline conditions for the Site. *See* Ex. R-9 at p. 1. The surveys confirm that a native eelgrass bed (*Z. marina*) spans the Farm Site. It covers approximately 20% of the 10.74-acre parcel. It is present in a tidal range of approximately -2.5 to -8.5 ft MLLW, and contains two zones of eelgrass growth: (1) continuous bed growth within a tidal range of -2 and -7 ft MLLW, and (2) patchy bed growth in a slightly more truncated area between -2 and -7 ft MLLW. There are also isolated patches (less than 4 ft^2) and smaller areas (up to 0.04 acres) extending out to approximately -13 ft MLLW below the continuous bed, and to approximately -8 ft MLLW below the patchy bed. The continuous bed growth ranges from moderate to dense (60-80%) in a 36-m-long band with short breaks (1-2 m) in vegetation. The patchy bed growth ranged from sparse to dense coverage (10-80%) in short (2-6 m) sections with long breaks (2-8 m) in vegetation or areas dominated by other vegetation. *See* Ex. R-24 at p. 44 (summarizing same). Maps showing the eelgrass bed in relation to proposed growing areas are provided in numerous exhibits. *See, e.g.,* Ex. P-142l at pp. 35-36; Ex. R-7; Ex. R-9 at Figure 1; Ex. R-24 at p. 45, Figure 8.

[18]

The eelgrass bed extends both directions along the Henderson Bay shoreline, and beyond the boundaries of the Farm Site. Meaders Testimony. The Farm Site also sits, at least in part, on an area of eelgrass that was degraded by prior operations at the Site, discussed further below. De Tienne Testimony.

3. Degraded Condition of Eelgrass at the Farm Site

[19]

The eelgrass underlying the Farm Site was heavily damaged—including removal of eelgrass—during past commercial geoduck operations conducted onsite. In 2001, Mr. De Tienne entered into a lease with Doug McCrae of Washington Shellfish, Inc. to plant and harvest geoduck on the Farm Site. Mr. McCrae also leased three additional nearby parcels, and he began farming all four parcels without shoreline permits. Shoddy and illegal practices led to an enforcement action by the County against Washington Shellfish, and Mr. De Tienne as the property owner. The County issued a cease and desist order that halted the operations in 2003. De Tienne Testimony; Wenman Testimony; Ex. R-2 at p. 4, ¶ 6; Ex. R-3 at p. 2, ¶ 5; Ex P-142h (cease & desist order).

[20]

To support the Permit application and extent of farming activities at the Site, the Applicants rely on eelgrass surveys performed after the eelgrass beds had been damaged by the previous operations. Ex. R-23 (2004 survey); Ex. R-24 (Biological Evaluation that includes a 2009 survey); Ex. R-21 (2012 survey). Notably, the first survey just two years after farming at the Site, in 2004—which also assessed the three other parcels leased by Mr. McCrae—found eelgrass to be in a highly degraded condition:

> Eelgrass (Zostera marina) was noted in most of the shallow areas of the survey between -2.5 MLLW and -7.5 MLLW. All areas were patchy and sparse, with an estimated range of one turion per 1/4 M^2 to 10 turions per 1/4 M^2 within the patches. All specimens of Eelgrass were in an unusual condition. Unlike most specimens where blades grow in a vertical direction, the blades on all Eelgrass noted throughout the entire survey were curved. The growing edge was located toward the substrate, not the water columns. In addition to the condition of the individual plants, if taken as a whole, the area looked like a "warzone." All plants were either partially or wholly dislodged from the substrate with the roots and rhizomes exposed.

Ex. R-23 at pg. 1-2 of Eelgrass Survey report.

[21]

The surveyor did not assign a specific cause to the degradation found, other than to note there could be "many potential causes for such altered Eelgrass," including "high levels of disturbance from algae harvesters." Ex. R-23 at pg. 2 of Eelgrass Survey report. Though the surveyor (Amy Leitman) later clarified that the "war zone" comment referred to the County area surveyed, and not De Tienne's area (Ex. R-22), the survey nonetheless concluded for the privately owned tidelands that "there were no dense beds observed and no healthy Eelgrass observed." Ex. R-23 at p. 2 of Eelgrass Survey report.

[22]

No actions were taken to restore eelgrass at the Farm Site. The eelgrass is still found, at least to some extent, to be in a degraded state at this Site. The latest survey in 2012 confirmed that the eelgrass continues to be found in a degraded state within the shoreward 20-25 meters along the vertical transects perpendicular to shore. Ex. R-24 at pp. 47; Wenman Testimony; Ex. P-128; Meaders Testimony.

4. Existing Eelgrass Bed and Adequacy of Eelgrass Buffers in the Permit

[23]

The Permit sets buffers that prohibit farm activities within certain distances from both the intertidal and subtidal edges of the eelgrass bed that crosses the Farm Site. Farm activities must maintain a minimum of ten horizontal feet away from the eelgrass bed on the shore side for intertidal activities, and a minimum of 25 horizontal feet on the seaward side for subtidal activities (however, the Eelgrass Monitoring Plan allows for ten horizontal feet buffers on fifty percent of the seaward side for each new planting cycle). Ex. R-1 at p. 30 (Condition 26.C(1)); *see also* Finding of Fact No. 33, *infra*. The Permit defines an eelgrass bed as more than three (3) shoots of eelgrass per 0.25 square meters and within one (1) meter of adjacent shoots. Ex. R-1 at p. 30 (Condition 26.C).

[24]

The primary purpose of implementing a buffer is to protect eelgrass from sedimentation caused by farm activities, and physical trampling by divers. Risvold Testimony. Sedimentation and turbidity can occur from commercial geoduck operations and, in particular, from harvest activities. Such disturbances can harm eelgrass, especially if farming activities were to be performed directly within eelgrass. Part of the question before the Board was the spatial extent of "spillover" effects to eelgrass from nearby farm activities, and what size buffer would be necessary to adequately protect the eelgrass from these activities.

[25]

In 2001, the Washington Department of Natural Resources (DNR) and Washington Department of Fish and Wildlife (WDFW) issued a Final Supplemental Environmental Impact Statement for the State of Washington Geoduck Fishery (SEIS). Ex. P-7. In the SEIS, DNR and WDFW relied on "30 years of fishing, observation, and research" to review the potential environmental impacts from commercial geoduck operations as a "non-project proposal" under the SEPA, WAC 197-11-442. The SEIS took ten years of agency effort and went through significant peer review. It is the only environmental impact statement performed for subtidal geoduck harvesting. Wenman Testimony; Exs. P-7-8.

[26]

Sedimentation from harvest was addressed as a known impact in the SEIS:

> Harvest of geoducks disrupts the sediment around each geoduck and the animals that live within the sediment. The area actually dug within a commercial tract depends on the density of geoducks. Average density on unfished tracts in Washington is 1.7 geoducks/m^2, and 1.9 geoducks/m^2 in central Puget Sound, southern Puget Sound, and Hood Canal (Goodwin and Pease 1991). Assuming an average density of 1.9 geoducks/m^2, digging will affect 21% of the area within a harvest tract if all geoducks are removed. A liberal estimate of the amount of area affected by digging would be 25% (State of Washington 1985).

Ex. P-7 at p. 69.

[27]

While the SEIS generally concluded that "[g]eoduck harvest does not have significant, long-term, adverse impacts on the benthic environment and (non-geoduck) flora and fauna," it also explicitly included (within its conclusions) a number of mitigation measures, which were already being implemented for State-Tribal management agreements and harvest plans. Among these mitigation measures was that "[a] 2 foot vertical buffer or a minimum of 180 foot buffer (for tracts with a very gradual sloping contour) is maintained between the harvest area and eelgrass beds and any substrate used for herring spawning." Ex. P-7 at pp. 5-6.

[28]

Following the SEIS, the Applicants originally proposed a two vertical foot buffer in the subtidal zone,[3] which would equate to a 40-50 foot horizontal buffer based on conditions at this Site. Ex. P-5 at p. 5. The County's MDNS and Staff Report that reviewed the application were based on this proposed larger seaward buffer. Booth Testimony; Ex. R-2; Ex. R-3. In addition, some federal agency consultation was based on the larger, two-foot vertical buffer. Booth Testimony; Meaders Testimony; *see, e.g.*, Ex. R-24 (Biological Evaluation for proposal) at p. 2; Ex. R-73.

[29]

However, as the Permit underwent further review, the Applicants began negotiations for a smaller buffer, with the express intent of gaining more farmable area. The Applicants viewed the larger buffer as "severely restricting the cultivable area of the farm and imposing a significant hardship. . . ." Ex. R-5 at p. 5; De Tienne Testimony; Booth Testimony; Risvold Testimony; Meaders Testimony. While the Applicants assert that agreement was reached as to

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[3] Booth Testimony; Ex. R-1 at p. 4, ¶ 5 (noting same). In fact, the estimate of five cultivable acres available to be farmed at the Farm Site was based on applying the larger two vertical foot buffer from the subtidal edge of the eelgrass bed. *See* Ex. R-24 at p. 2; Ex. P-1421 at p. 37. The Board was not provided a different estimate for the cultivable area now available for farming under the smaller buffer contained in the Permit, but it can be assumed to be larger than five acres.

the acceptability of a smaller buffer in conversations with individuals at the State Department of Ecology, WDFW, DNR, the USFW and/or the Corps (Meaders Testimony), the record lacks documentation to show agreement by all agencies involved.

[30]

The County and the Applicants agreed that the two-foot vertical buffer was too conservative and should not be directly applicable to a shallow subtidal project such as the Farm Site. Regarding sediment transport, they concluded that the larger buffer set out in the SEIS was based on worst case sediment transport that will not really occur. Risvold Testimony; Meaders Testimony. Ms. Meaders asserted that smaller buffers are within the range of buffers (between ten and 25 feet) that regulatory agencies have historically applied to protect eelgrass from other activities, including other types of aquaculture. Meaders Testimony; *see, e.g.*, Ex. R-135; Ex. R-166.

[31]

The County recognized the range of potential buffers for this project could span from ten horizontal feet as the smallest possible buffer, to two vertical feet (40-50 horizontal feet) as the larger buffer, based in part on the SEIS and eelgrass buffers that had been applied for this and other types of activity. Ex. P-1421 at p. 1.[4] However, the County ultimately agreed to require smaller buffers (ten feet for the intertidal portion of the Farm and 25 feet for the subtidal portion). In part, the County put substantial weight on the concurrence of the other agencies.

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[4] Mr. Risvold referenced the two-foot vertical buffer as being equal to 180 horizontal feet in this correspondence, but clarified at hearing that he meant a two-foot vertical buffer—which translates into 40-50 horizontal feet as applied at this Site; confusion came merely from the alternate reference of 180 feet provided in the SEIS for the two-foot vertical buffer. Risvold Testimony.

The County was also convinced by the Applicants that the smaller buffers represented the implementation of "best available science" at the Farm Site, based in large part on Ms. Meaders' presentations to them. Booth Testimony; Risvold Testimony; Ex. P-1421 at p. 27.

[32]

The ten-foot buffer established by the Permit on the intertidal portion of the Farm follows the jagged edge of the eelgrass bed as it runs adjacent to the shoreline. Ex. R-7. The Applicants concede that farming in this intertidal area will allow sediment to be distributed over the landward edge of the eelgrass bed during harvest activities. This is likely, as sediment will travel laterally along the shore and therefore over the eelgrass, where it will begin to settle out. Meaders Testimony. There has been no analysis of the effects of this sediment deposition on the eelgrass in this area, only a recognition of the potential problem. No Permit term addresses this issue.

[33]

Although the Permit set a 25-foot seaward buffer, it allowed further reductions in the size of this buffer "in a limited number of locations for purposes of monitoring." Ex. R-1 at p.31 (Condition 26.C(1)). The Applicants prepared a monitoring plan after the Hearing Examiner issued her decision. Ex. R-34. Under the monitoring plan, each of the five subtidal blocks of the Farm Site is divided in half, with a 25-foot buffer on one half and a ten-foot buffer on the other half of each block—resulting in a 50% reduction of the seaward buffer to ten feet. *Id.* at 3. The Permit also allows for reductions in the 25-foot seaward buffer "if monitoring over the course of at least one complete planting and harvest cycle demonstrates a small buffer provides effective protection of the eelgrass bed." Ex. R-1 at p. 31 (Condition 26.C(2)). No standards, criteria, or process were established for determining whether a buffer change is appropriate.

[34]

While the claim was made that the 25-foot buffer accounts for the potential expansion of eelgrass, Ms. Meaders clarified that no actual space was added to the buffer for purposes of expansion. *See* Ex. R-34 at p. 1; Meaders Testimony. In short, the buffers will not change under the Permit based on the eelgrass bed expanding or contracting at the Site. Meaders Testimony. The County and Applicant agreed that the extent of the eelgrass bed documented in survey(s) for the Site would constitute a fixed "line" (baseline) for the buffer. The Permit does not contain or reflect this agreement. Risvold Testimony; Ex. R-1; Ex. R-106.

[35]

The Coalition's expert, Mr. Penttila, testified that these buffers are not protective of eelgrass. He asserts the project should be denied based in part on the need to protect eelgrass, or else that a two-foot vertical seaward buffer should be imposed. He relies for support on the fact that a two-foot vertical buffer was recommended as mitigation in the SEIS, and is considered necessary to protect forage fish spawning, specifically herring. Ex. P-4; Ex. P-13; Penttila Testimony.

[36]

While Ms. Meaders is knowledgeable of the geoduck industry and science underlying aspects of industry practices, based on testimony and evidence, the Board did not find her to be a credible expert in all aspects of study related to the nearshore environment to which she claimed expertise. The Board finds that Ms. Meaders is not an expert, in particular, in geomorphology or sediment transport, or eelgrass biology and growth. Due to her lack of independent expertise in these areas, Ms. Meaders' testimony largely constituted her summarization of work done by other experts on the potential for spillover effects to eelgrass, thus making her unable to offer an independent opinion. In any event, as discussed further below, the Board found the studies upon which Ms. Meaders relied to be unpersuasive scientific support for the smaller eelgrass buffer at this Site.

[37]

Ms. Meaders relied upon one soon-to-be published study and three unpublished studies or analyses subsequent to the SEIS as showing that the small 10-25-foot buffer is protective of eelgrass at this Site. She first pointed to a study conducted by Glenn R. VanBlaricom, Jennifer R. Price, and others as part of the University of Washington Sea Grant research. The VanBlaricom/Price Study, now in press for publication, assessed the benthic effects of geoduck aquaculture at three existing intertidal farms. It considered impacts to infaunal benthic organisms like polychaetes, mollusks, and crustaceans, and found modest effects but no significant ("significant" being an undefined term in the study) "spillover" effect. The study concluded that turbidity and suspended sediments produced by geoduck harvesting are at levels similar to natural disturbances, with effects that are highly localized and limited in duration. Meaders Testimony; Ex. R-167 at p. 13; Ex. R-143; Ex. R-116. However, this study did not address impacts to eelgrass, in particular, and it was not one of the three pieces of evidence Ms.

Meaders primarily relied upon for her opinion on the reduced eelgrass buffer in this case. Meaders Testimony.

[38]

Published studies have proven that severe effects result when geoduck farming occurs *within* eelgrass beds, *see* Ex. R-20 at 3 and Ex. R-87, however, no published studies have examined the effects of geoduck harvest on *nearby* eelgrass. *See* Ex. P-116 at 6 (noting same). In the absence of any such published studies, Ms. Meaders relied primarily on the following three unpublished analyses or studies to support the smaller buffer being applied at this Site: (1) an internal agency Technical Memorandum on the Operational Definition of an Eelgrass (*Zostera marina*) Bed (Tech Memo: Ex. R-51); (2) an unpublished study by Michael Horwith at the University of Washington that assessed "spillover effects" from an existing Samish Bay geoduck farm (Horwith Study: Ex. R-121); and (3) an unpublished study by Dr. Pearce of the Department of Fisheries and Oceans in Canada that directly assessed the impacts of a subtidal geoduck harvest on nearby eelgrass (Pearce Study: Ex. R-68, Ex. P-116).

[39]

The agency Tech Memo was prepared for internal use in 2011 by DNR, in order to summarize then-current discussions among representatives of the Washington shellfish aquaculture industry, DNR management, and DNR aquatics staff. Risvold Testimony; Ex. R-51 at p. 1. It addressed how to define an eelgrass bed, and described the biological constraints of eelgrass beds (*e.g.*, how far seed dispersal would occur, and the extent to which a bed will recede or expand). The analysis did not address impacts to eelgrass from geoduck aquaculture, nor suggest an appropriate buffer area. However, Ms. Meaders relies on it for its assessment of the extent of natural expansion and contraction of eelgrass beds, which the Tech Memo concludes is four to five meters seasonally. Meaders Testimony; Ex. R-51 at p. 26. Ms. Meaders indicated that this Tech Memo supported her opinion that eelgrass is limited in its ability to expand at the Farm Site based on limitations in subtidal light. The Board does not find Ms. Meaders' opinion on this point persuasive due to her lack of expertise in this area, the fact that the Tech Memo did not provide direct support for this opinion, and the fact that her opinion was not supported by any site-specific analysis. Nor did Ms. Meaders evaluate the fact of prior eelgrass damage and degradation as it pertains to the manner in which eelgrass would be expected to recover and expand at the Site over time. Meaders Testimony; De Tienne Testimony; Wenman Testimony; Ex. R-167.

[40]

The Horwith Study assessed impacts from an operating intertidal geoduck farm in Samish Bay. The farm in this study was attributed to having created an artificial edge to eelgrass, which Ms. Meaders acknowledged distinguishes it from the proposed Farm in this case. Mr. Horwith examined potential spillover effects to eelgrass in subsequent areal zones that spread away from the farm, and found both positive and negative effects. Meaders Testimony. In particular, and to a statistically significant degree, he found higher shoot density and lower shoot size in summer within the first few zones. Meaders Testimony; Ex. R-167 at pp. 13, 25 (Reference #38); Ex. R-121; *see also* Ex. R-61.

[41]

Interpreting the possible spatial extent of impacts found in his study, however, Mr. Horwith was fairly circumspect in his conclusions, and stated only that:

> If we interpret any difference from the reference zone as evidence of a spillover effect, then there is essentially just as much evidence for spillover effects 3 to 9 meters from the farm as there is from 0 to 3 meters. There is much less evidence for spillover effects more than 9 m from the farm.

Ex. R-121. He also noted that recovery of eelgrass from observed impacts took at least two years post-harvest, and that the magnitude of the difference in impacts between the zones actually increased post-harvest—which led him to conclude that, while harvest may be a driver for spillover effects, other aspects of geoduck farming also likely contribute to spillover effects. Ex. R-121.

[42]

Although acknowledging the limited use of the study results to the proposed Farm, Ms. Meaders nonetheless relied on this study as identifying a maximum spatial extent for spillover effects from geoduck harvest that is limited to nine meters (the end of the second zone in the study). She further testified that, in her opinion, nine meters overestimates the potential for spillover effects at this Site. Meaders Testimony. This opinion is not adequately supported by the Horwith Study.

[43]

Ms. Meaders testified that she relied most heavily on the Pearce Study because it actually looked at effects from a subtidal geoduck harvest on nearby eelgrass. The test plot in the Pearce

Study was planted five meters from an existing eelgrass bed. Results post-harvest showed no change in parameters (biomass, shoot length, or shoot density) in the eelgrass bed or in samples downcurrent from the harvest plot. Suspended sediments were not generally perceived beyond five meters from the harvest plot, with levels measured comparable to those during a calm sea, and lower than those during a winter storm event. Meaders Testimony; Ex. R-167 at p. 14; Ex. R-68 (slide labeled "Summary"). However, Mr. Pearce apparently requested that the report on his study (Ex. P-116) not be relied upon as evidence at hearing, as it has not been peer reviewed or published—and Appellants cautioned the Board not to rely upon it. Meaders Testimony (relying on a personal communication with Mr. Pearce); Ex. R-167 at pp. 14, 25 n. 35 (same); Statement by Robert M. Smith (counsel for the Applicants); *see also* Ex. R-68.

[44]

To the extent the Board considers the Pearce Study, the Board finds it provides limited applicability to the current proposed Farm. The planting densities and duration of harvest activities in the Pearce Study are different from those of the proposed Farm in this case. In the Pearce Study, a 1.5-acre subtidal plot (60 x 100 m^2) was planted with geoducks at a density of 1.58 individuals per one-half square meter (approximately five square feet). Ex. P-116 at pp. 7-8. The edge of the study plot was five meters seaward of an eelgrass bed. *Id.* at 48. Geoducks were harvested over a two-day period, with a total of 1,554 harvested. *Id.* at 12. In contrast, the tubes at the proposed Farm will be placed approximately 15 inches apart on center and will be planted with three to four seeds each. Ex. R-24 at p. 6. Harvesting activity will be more intense as it will occur five to eight days at a time, for up to four hours on 0.1 to 0.8 acres depending on the number of harvesters. Ex. R-1 at p. 14. Although no precise figure was presented, it is anticipated that the harvested quantities of geoducks from the proposed Farm will substantially exceed those in the Pearce Study.

[45]

It is also not clear that the Pearce Study assessed subtidal conditions like those found at this Site, including the high wind and wave activity translating into a higher energy subtidal environment at the Site.

[46]

In support of the Pearce Study, Ms. Meaders also referenced a personal communication with Dr. Jennifer Ruesink at the University of Washington in which Dr. Ruesink reportedly conveys her "similar observation" that "the effects of geoduck farming are likely restricted to the farm footprint, and buffers would be important to consider primarily [for] access issues." Meaders Testimony; Ex. R-167 at p. 14. However, as Ms. Meaders herself characterizes, most of Dr. Ruesink's studies are "in relation to the direct effect of harvest operations and subsequent recovery, but not necessarily the distance that would protect eelgrass resources adjacent to geoduck operations." Ex. R-86. Dr. Ruesink's work is of limited or no applicability in this case because it analyzed the effects of geoduck planting and harvesting directly within an eelgrass bed. Ex. R-20 at p. 3; Ex. R-87.

[47]

The Board finds these studies do not provide sufficient scientific support for Ms. Meaders' opinion that the buffers imposed will adequately protect eelgrass at this Site, and thus finds Ms. Meaders' opinion on the protectiveness of the smaller buffer unpersuasive. The Board is left with no real analysis in the record that assesses spillover effects to nearby eelgrass for a similarly-scaled geoduck farm operating in a higher energy subtidal environment.

[48]

In the absence of better information on a protective buffer size, the County and the Applicants apparently shifted to monitoring and adaptive management to justify the reduced buffer size. Ms. Meaders and Mr. Risvold both stated that their comfort with the smaller buffer was in part based on the fact that monitoring would be done to assess its effectiveness at protecting the eelgrass bed. Meaders Testimony; Risvold Testimony.

[49]

Both qualitative and quantitative monitoring will be done two times a year, and six months before harvesting. The Permit requires some of this monitoring be done in various conditions. In addition, monitoring will be performed under an agreement in which Mr. De Tienne would permit DNR to assess the effects of the Farm on eelgrass compared to a control plot on state lands, to help assess more generally the potential impacts of geoduck aquaculture. De Tienne Testimony; Meaders Testimony; Ex. R-1 at pp. 30-31 (Conditions 25 and 26.D) (incorporating MDNS mitigation conditions and eelgrass surveys); Ex. R-3 at p. 9 (MDNS mitigation condition # 11); Ex. R-34.

[50]

An unspecified approach to adaptive management will ensue based on the monitoring results. The Applicants stated a commitment to changing the buffers to be more protective if monitoring shows any impacts. De Tienne Testimony; Meaders Testimony. The commitment to change the buffers is not reflected in the Permit's terms or conditions, however. Ex. R-1; Risvold Testimony. Mr. Risvold agreed it would have been "prudent" to include a permit condition specifying that the buffers would change if monitoring proves them not protective. Risvold Testimony.

[51]

Based on the preceding Findings of Fact, the Board finds that the Coalition has met its burden to show that the Permit conditions are inadequate to protect eelgrass. The ten-foot landward buffer, and 25-foot seaward buffer (50% of which has already been reduced to ten feet, with further reduction possible), represents the lowest sized buffer that could have been applied from the range of buffers typically applied to protect eelgrass. The Board finds a lack of complete and/or reliable scientific evidence in the record to support a buffer of this size at this Site, given the scale and density of the commercial geoduck farming proposed in both intertidal and subtidal zones, and the conditions found at this Site.

[52]

The Board also finds an overreliance on monitoring and adaptive management to mitigate impacts. This overreliance is particularly concerning given that the Permit does not incorporate any required implementation for change—*i.e.* to increase the buffer should monitoring prove the need for greater protection. There may be real consequences from selecting the small buffer here, given the particularly fragile state of eelgrass at this Site. Neither the Applicant nor the County considered the extent to which eelgrass might persist in a degraded state, that the past survey(s) may consequently have set what is an already-degraded baseline for assessing eelgrass, and that no area for potential expansion was included in the buffer. Instead, the degraded Site will be used for aquaculture in a manner that will ensure no further recovery.

[53]

Finally, the Board finds the Applicants cannot limit their assessment exclusively to on-site (on-property) impacts to eelgrass, but must look at impacts to eelgrass off-property as well. The eelgrass bed at this location runs continuously along the Henderson Bay shoreline, extending beyond Farm Site boundaries, but the Applicants did not consider impacts of farming activities to eelgrass on adjacent properties. They only considered whether sedimentation from subtidal operations would flow towards shore and into the eelgrass bed at the Farm Site. Yet Ms. Meaders admitted that sedimentation from intertidal harvest, in particular, would travel laterally along the shore, and that this would be more problematic. Meaders Testimony.

C. Impacts to Herring

[54]

Most testimony regarding herring was directed at the need to protect eelgrass as potential spawning habitat. Herring spawn in Burley Lagoon due to excellent habitat and good water flushing. The nearest documented herring spawning habitat from the Farm Site is 0.3 miles to the northwest, or roughly 1,500 feet away, on the other side of Henderson Bay. Meaders Testimony; Ex. R-67; Ex. R-167; Penttila Testimony. This local stock (the Purdy stock) is now recognized as the largest known herring stock in Pierce County, but was only recently discovered in 2008. This means that surveys to date have been limited. Penttila Testimony; Ex. P-4 at pp.

2-4; Exs. P-24-32; Exs. P-34-35. As a fisheries expert who has conducted approximately 800 herring spawn surveys over the past three decades, it was Mr. Penttila's unopposed view that the Purdy stock's habitat is not yet completely known, and that additional surveys would be necessary to accurately determine the full spatial extent of their spawning habitat. It was also his unopposed opinion that the distance from where the Purdy stock have been documented to spawn to the Farm Site would be a small spatial leap for them to make in subsequent seasons, making it highly likely that herring will spawn at the Farm Site in subsequent years. Penttila Testimony; Ex. P-4. The Board finds that eelgrass at the Farm Site is, therefore, a potential spawning habitat for Purdy stock herring and it is highly likely herring will spawn in the eelgrass beds on and around the Farm Site. The Board finds that, because the Permit fails to adequately protect eelgrass, it also fails to adequately protect herring, which depend on eelgrass for spawning habitat.

[55]

Only limited testimony was presented on any direct impact to actual spawning activity. Mr. Penttila testified that the herring spawning work windows should be changed from January 15 through March 31 to February 1 through April 15—in recognition of the unusually late spawning season documented for the Purdy herring stock. Penttila Testimony. There is no work window imposed in the Permit for herring spawning, however, just the "[m]inimization of activity within the beach" (between October 1 and April 30) for potential sand lance and surf smelt spawning. Ex. R-1 at p. 31 (Condition 26.H(1)). The Permit instead requires that aquatic vegetation (including eelgrass) be inspected for the presence of herring spawn and, if found, that all activities cease until the eggs have hatched. Ex. R-1 at p. 31-32 (Condition 26.I). As Mr. Penttila acknowledged, this incorporates the same recommendation for protecting the potential spawning habitat of forage fish that he made in a previous hearing. Penttila Testimony. Because we reverse the Permit on other grounds, we need not address these more direct conditions for protecting herring spawning activity at this Site.

D. Cumulative Impacts

[56]

The portion of the Farm Site waterward of -4.5 tidal elevation is designated a shoreline of statewide significance. Ex. R-2 at p. 2. The Farm will be the first permitted geoduck aquaculture in the Carr Inlet/Henderson Bay area, and the first geoduck operation since the demise of the unpermitted Washington Shellfish operation that was forced to close. Booth Testimony; Wenman Testimony.

[57]

There is a long history of oyster cultivation in Burley Lagoon at the tip of Henderson Bay, but only about 15-20 acres have been farmed historically. There are no other geoduck farms in Henderson Bay or Burley Lagoon. The closest geoduck farm is on the tip of Key Peninsula, which is the Longbranch facility. The state wildstock and geoduck fishery has tracts throughout Puget Sound, including Henderson Bay. Booth Testimony.

[58]

There are six pending applications for geoduck farms in Pierce County. New aquaculture projects in this area have been approved, proposed, or are contemplated for proposal. A manila and littleneck clam farm has been approved on the other side of Henderson Bay. In addition, Taylor Shellfish, which is now harvesting oysters and clams on 79 acres, just proposed a new project in Burley Lagoon. There is also an additional geoduck farm intended to be located northeast of the Farm Site that will be virtually on forage fish habitat. Bed preparation has been witnessed since 2012 near the Farm Site. Mr. Booth confirmed he understood there may be an attempt in the near future to submit another geoduck application. Mr. McCrae of Washington Shellfish submitted an application in 2002, but was recently told he needs to submit a new one if he wishes to proceed with aquaculture operations. De Tienne Testimony; McDonnel Testimony; Penttila Testimony; Newell Testimony; Booth Testimony; Ex. P-117; Ex. P-139; Ex. P-142c.

E. Recreational Impacts

[59]

Witnesses presented evidence that the gear used in aquaculture—including the nets and PVC pipes specifically used in geoduck aquaculture—can break and/or escape and can result in significant marine debris. Newell Testimony; Ex. P-127; Macomson Testimony; Ex. P-129; McDonnel Testimony; Wenman Testimony; Ex. P-128; Paradise Testimony. Additionally, the high winds and waves in this area would make it more likely that gear will come loose. The County has received increased complaints regarding aquaculture debris in Burley Lagoon, with loose netting being a particular complaint. Booth Testimony; Ex. P-111. The Permit requires beach patrols be done weekly at the proposed Farm Site, and within one day of storm events to retrieve any debris. Ex. R-1 at p. 30 (Condition 25) (incorporating MDNS mitigation conditions and eelgrass surveys); Ex. R-3 at p. 9 (MDNS mitigation condition # 8). This was a mitigation measure premised on the assumption that debris will occur. Booth Testimony.

[60]

Numerous witnesses testified that they use the area around the proposed Farm Site to swim, scuba dive, kayak, windsurf, and otherwise enjoy the natural environment. *See, e.g.*, Paradise Testimony; Newell Testimony; Macomson Testimony. In particular, the high waves in the area make it a popular windsurfing site. The Farm Site is located roughly 1,500 feet west of Purdy Sand Spit Park/Wauna Public Boat Launch. Windsurfers often begin there and ride towards the area nearer the Farm Site. It is possible some could end up closer to the Farm Site. Paradise Testimony; Newell Testimony; Ex. R-2 at p. 2 (proximity to boat launch). In addition, many of the witnesses recounted incidents in which they or others who were boating, swimming, or otherwise recreating, became ensnared in loose netting, or had their recreational or boating gear damaged or ensnared. This was presented as a safety concern, given the potential for individuals to drown or otherwise come to harm. Broken PVC tubes left in place intertidally have also injured people walking or otherwise recreating on the tidelands. Finally, concerns over potential harassment by farm owners were expressed, based on similar experiences elsewhere. Newell Testimony; Wenman Testimony; McDonnel Testimony; Paradise Testimony; Macomson Testimony; Ex. P-103; Ex. P-106; Ex. P-109.

[61]

There are no conditions in the Permit to protect recreational users in the area. The Permit requires that "[b]uoys on anchors shall be placed intervisibly along and at angle points on any ownership boundaries that extend below extreme low tide, for the harvest term," but this a measure for the harvest divers. Ex. R-1 at p. 29 (Condition 10). No conditions were added because, in the County's view, impacts to recreational users would be unlikely. Mr. Booth testified that this is especially true given the subtidal nature of the Farm, in which the PVC tubes planted (which protrude two to three inches above the substrate), will be fully submerged. Booth Testimony.

[62]

The Board finds that the recreational use in this area, and in particular its popularity for windsurfing, makes this proposed Farm unique from past geoduck farms reviewed by the Board. While the Board agrees that planted PVC tubes submerged at this subtidal location pose a minimal risk to recreational users, the extent to which other risks may exist nonetheless remains unclear based on the testimony. Of particular concern, is the likelihood that boaters or windsurfers might unknowingly cross into the Farm Site at a time when canopy nets or other gear that could pose a risk are exposed, or that more experienced windsurfers may come in contact with the subtidal structures. In case of a future application at this Site,[5] any permit issued should contain a condition to better address the unique recreational use of this area and mitigate

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[5] While we have reversed the Permit in this case, the decision does not completely rule out that a future operation, with appropriate analysis, buffers, and conditions that address site characteristics and limitations, could not be permitted under the SMA.

for any farm activities and use of aquaculture gear that could pose a risk of harm to windsurfers or others.

F. Impacts to the Benthic Environment, Forage Fish, Juvenile Salmon, Whales, Other Aquatic Organisms, and Bald Eagles

[63]

As noted above in the Findings of Fact, eelgrass serves as habitat and refuge for juvenile salmon. It also serves vital ecological roles that include carbon-fixing/sequestration, the production of organic matter and detritus (which forms the basis of the food chain), and the provision of physical habitat for use by adult marine species and as a refuge and nursery area for juvenile life stages. Because of these vital ecological roles served by eelgrass for benthic species, forage fish, and salmon, the Board finds that adverse impacts to eelgrass at this Site are also likely to adversely affect the ability of these other dependent species to utilize or benefit from eelgrass habitat. The Board thus finds on this basis that the Coalition has also met its burden to show inadequate protection for those species in addition to herring that are dependent on eelgrass—including juvenile salmon, forage fish, and other benthic organisms.

As further addressed below, however, the Board finds that Petitioners otherwise failed to show any direct adverse impacts would occur from Farm activities to the benthic environment, to juvenile salmon or forage fish, to whales, to other aquatic organisms, or to terrestrial species like bald eagles.

1. <u>Benthic Impacts</u>

[64]

While the effects of geoduck aquaculture on benthic communities (alteration of the substrate and other impacts to the benthic community) was an area of debate involving multiple experts in past cases, only limited testimony or other evidence was presented to the Board in this case. Mr. Daley opined that alteration of the substrate can occur based on cumulative impacts from the netting used in farm operations. He explained that netting in the area would interfere with normal activity of wave action that would provide normal transgression of sediment and silt at a site; that this would then impede the normal flow of water along the shoreline, which will make substantive changes and alter the character of substrate along the shore; and that the change in structure of the substrate will impact several aquatic organisms including shrimp and anthropods. Daley Testimony. Other evidence relied on by the Board in prior cases leads to a finding that impacts to the benthic environment from geoduck operations and/or gear are limited in nature, of short duration, and that sediment dynamics return to baseline conditions relatively quickly afterwards. Ex. R-167 at pp. 9, 13. This included a study by the University of Washington Sea Grant Program (VanBlaricom/Price Study). Ex. R-167 at pp. 13, 25 (Reference # 34); Ex. R-143. Mr. Daley, who is not an expert in sediment geomorphology, performed no studies or analysis in support of his opinion on benthic effects, and thus made no initial showing that adverse benthic effects could occur from this proposed Farm. The Board finds insufficient evidence the Farm will cause adverse benthic effects.

2. <u>Forage Fish</u>

[65]

Surf smelt (Hypomesus) and sand lance (Ammodytes) are intertidal forage fish that spawn on sand and gravel beaches in Puget Sound. Both species spawn in Carr Inlet, with a documented sand lance spawning site in Henderson Bay. Additional spawning sites may exist in the area, as the Farm Site shoreline is suitable and actually mapped as potential habitat for spawning and the spawning seasons for surf smelt and sand lance fall within a time period between fall and spring each year. Penttila Testimony; Ex. P-4 at pp. 5-8; Exs. P-36-39. The Permit contains conditions that protect surf smelt and sand lance spawning by minimizing activities within the beach between October 1 and April 30. Ex. R-1 at pp. 31-32 (Conditions 26.J and 26.H). Mr. Penttila did not address any deficiencies in these Permit conditions, or otherwise allege any direct impacts to surf smelt or sand lance spawning from the proposed Farm. Penttila Testimony. The Board finds insufficient evidence that the Farm will cause any more direct impacts to sand lance and surf smelt other than impacts to eelgrass utilized by these forage fish for habitat and refuge.

[66]

Mr. Penttila did opine that geoducks compete with forage fish larvae for food, and that forage fish larvae could be ingested by planted geoducks. Because sand lance and surf smelt do spawn in the area during certain times of the year, they could be contributing hatched larvae to the local water column. Northern anchovies are also year-round residents of southern Puget Sound, and have 1 mm planktonic eggs and very "immature" 3 mm larvae during summer months. Finally, as discussed above, herring are known to spawn nearby. Penttila Testimony; Ex. P-4 at pp. 5-8; Exs. P-36 through P-39.

[67]

Mr. Penttila provided no evidence on the diet of geoducks and admits that published data on the diet of geoducks is lacking. Despite insufficient data, his view is that theoretically, geoducks could ingest zooplankton, and he relied on studies that found a large variety of other bivalves ingest zooplankton and cumulatively create competition for food source. He cited published data that suggests an increase in filtration rates and prey sizes occurs with increasing bivalve body size, and asserts that (based on geoduck clams being among the largest clams in the region) it should be assumed they may be capable of ingesting significant amounts and larger-sized zooplankton, including forage fish larvae. Penttila Testimony; Ex. P-4 at pp. 5-8, 19-21; Exs. P-50-56. However, Mr., Penttila's testimony provides an insufficient scientific basis for the Board to find that geoduck feeding practices will affect forage fish. As the Board has found previously—and which has not been adequately controverted by the expert testimony provided in this case—"the weight of scientific evidence supports a finding that it is unlikely that the geoducks' feeding practices will affect forage fish." *Lockhart*, SHB No. 13-006c at FF 29, pp. 13-14. The Board finds insufficient evidence that geoducks will cause an adverse impact to forage fish by competing for food or ingesting forage fish larvae.

3. Juvenile Salmon

[68]

Chinook salmon, steelhead, chum salmon, coho salmon, and coastal cutthroat trout are all found in the proposed Farm area, with designated or proposed critical habitat existing in the proposed area for Puget Sound Chinook. The Puget Sound Chinook evolutionarily significant unit (ESU) is listed as threatened. Puget Sound Chinook migrate into Carr Inlet to spawn in local creeks, including Burley Creek and Purdy Creek. Burley Creek is a large salmon-bearing stream that empties into Burley Lagoon. Salmon migrate through Burley Lagoon to reach Burley Creek. In addition, a salmon hatchery is located just downstream of the entrance to the lagoon and released juveniles utilize Henderson Bay and Carr Inlet. Newell Testimony; McDonnell Testimony; Daley Testimony; Exs. P-64, P-68-69, P-71; Meaders Testimony; Ex. R-167 at p. 8; Ex. R-2 at pp. 20-25.

[69]

Mr. Daley cited the general decline in the health of Salish Sea and salmon stocks and noted that intensive culture of shellfish may or may not be a part of that process. He points to studies that show forage fish are the major source of food for Puget Sound Chinook and other salmonids, both in adult and juvenile form. He also discussed the fact that juvenile forage fish are dependent on water quality. Daley Testimony.

In Mr. Daley's view, there has been inadequate study on impacts from turbidity in particular on forage fish. He thinks there may be higher than allowable levels of turbidity created by geoduck operations, and that this could have an effect that, while not persistent, would nonetheless be cumulative. He surmised that the process of hydraulic injection in the water column during harvest could result in levels of turbidity ten times greater than background or allowable levels.[6] He suggested that work windows extending through April be imposed to protect juvenile salmonids. Daley Testimony; Exs. P-58-60, P-64-65, P-70.

[70]

In response, Ms. Meaders noted that studies show the disturbances from geoduck operations are of short duration, localized, and infrequent, and that juvenile salmonids tend to avoid the areas disturbed. Meaders Testimony; Ex. R-167 at p. 18.

[71]

The Board finds that Mr. Daley's testimony did not support a finding that adverse effects would occur from this proposed Farm. He provided no evidence or analysis to support his opinion on the proposed Farm operation's direct impacts on juvenile salmon. His estimate on turbidity levels was based on random visual observations. Further, his opinion was not that adverse effects would occur from the proposed Farm, but that the potential for impacts from geoduck aquaculture in general should be studied before any new projects are permitted. This level of analysis is not sufficient to meet Petitioners' burden of proof. The Board finds insufficient evidence that the Farm will cause direct impacts to salmon, other than impacts to the eelgrass used as habitat and refuge for juvenile salmon.

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[6] Mr. Garrison also testified on conditions related to turbidity at the Site. He provided photographs showing that surface water from an outfall enters the Bay at one location, and produces some level of turbidity at that location onshore. Garrison Testimony; Ex. PG-2. No measurement of turbidity or any analysis was provided by any witness for how this would translate to impacts from the proposed Farm, however.

4. <u>Whales</u>

[72]

The Coalition also alleged that marine debris from aquaculture poses a risk to whales. The general area near the proposed Farm is sometimes used by the southern resident killer whale, which has designated or proposed critical habitat in the proposed project area, and by gray whales. Newell Testimony; Ex. P-127 (photo of whale); Meaders Testimony; Ex. R-167 at p. 8; Ex. R-24 at pp. 73-74. Though the gray whales that have been spotted typically stayed in the center of the Bay, they sometimes have come closer to shore. Wenman Testimony. Gray whales are baleen whales (bottom feeders). Exs. P-74-75. Mr. Paradise has seen areas on the bottom of Puget Sound, including areas in Henderson Bay, littered with tubes and other debris. Paradise Testimony. The concern cited was that any whales found in the area could ingest plastics and this could harm or kill them. The only evidence provided in support was an article citing that plastics were found in the guts of some whales that had died, and the fact that gray whales are bottom feeders. Newell Testimony; Ex. P-77.

[73]

This level of analysis is not sufficient to meet Petitioners' burden of proof. The Board finds insufficient evidence that the proposed Farm will cause adverse impact to whales. However, in case of any future application at this Site, the Board would suggest that the mitigation measure for avoiding Southern Resident Orcas (if spotted), which was proposed by the Applicants as an adaptive management conservation measure in their Biological Evaluation, be made a permit condition. *See* Ex. R-24 at p. 76.

[74]

5. Other aquatic organisms

Sand dollars, crabs, and starfish (sea stars) can all be found at the Farm Site. Sand dollars, in particular, are found extensively in the eelgrass beds onsite. Newell Testimony.

[75]

Evidence was presented that aquaculture uses destructive methods to "manage" aquatic organisms like crab, sea stars, and sand dollars as "pests" all year round. Newell Testimony; Ex. P-87. Damage to aquatic organisms like sand dollars has been observed from other aquaculture operations. Macomson Testimony; Ex P-106. Further, a 2011 report prepared by the Applicants—which the County later questioned—stated that it could take up to five days to relocate sand dollars. Ex. P-142l at p. 50.

[76]

The Permit contains the following condition to protect such aquatic organisms:

> It is expected that relocation of beach features and wildlife will not be necessary. Tube placement and farming activities are to be done in a manner that accommodates existing habitat features (such as, but not limited to, logs and rocks) and wildlife (such as, but not limited to, sand dollars and sea stars). Where the relocation of such features is unavoidable, they are to be relocated as minimally as possible and no farther than to another section of the beach, within the same parcel and at the same tidal elevation.

Ex. R-1 at p. 30 (Condition C.26.A).

[77]

There was insufficient evidence to convince the Board that this condition will not adequately protect these species. The Board finds the Petitioners failed to meet their burden to prove any more direct adverse impacts to other aquatic organisms like sand dollars and sea stars, given the terms of the Permit, other than impacts to eelgrass as habitat for these organisms.

6. Bald Eagles

[78]

The Henderson Bay area is host to many different bird species, including bald eagles. Evidence was presented that aquaculture nets can ensnare birds; one incident documents a bald eagle that became ensnared in a canopy net. Newell Testimony; Wenman Testimony; P-128. This level of analysis is not sufficient to meet Petitioners' burden of proof. The Board finds that while this speculative risk may exist, there was insufficient evidence to support a finding that the Farm poses an actual risk of environmental harm to bald eagles.

[79]

The Board finds insufficient evidence of adverse impacts to bald eagles or other birds from the proposed Farm. However, in case of any future application at this Site, the Board would suggest that the 600-foot buffer from any existing bald eagle nests, which was proposed by the Applicants as an adaptive management conservation measure in their Biological Evaluation, be made a permit condition. *See* Ex. R-1 at p. 7, ¶ 11; Ex. R-24 at p. 76.

[80]

Any Conclusion of Law deemed to properly be considered a Finding of Fact is hereby adopted as such.

Based on the foregoing Findings of Fact, the Board enters the following:

CONCLUSIONS OF LAW

[1]

The Board dismissed many of the legal issues in this case prior to the hearing, on motions to dismiss and for summary judgment. The hearing focused only on Legal Issue No. 15 (with subparts), which states:[7]

> Legal Issue No. 15: Was the Pierce County Hearing Examiner's approval of the deTienne SSDP done in violation of RCW 90.58.020 (and other subsections included in part B) and PCC 20.24.020 (and other subsections included in part B) because:
>
> a. The authorized development in this high value site that includes a Shoreline of Statewide Significance does not protect against adverse impacts of harm, damage, and loss of ecological functions, loss of the natural environment and values of the shorelines?
>
> b. The authorized development does not promote and enhance the public interest including the quality of life, public's opportunity to enjoy the physical and aesthetic quality of the shoreline, preservation of the natural environment, safety, and intensive recreational uses afforded to the public?
>
> c. The authorized development is not consistent with the overarching goal of protecting, preserving, restoration of Washington's natural shoreline or consistent with related state agency goals and management actions?
>
> d. The authorized development does not preclude damage to specific fragile areas and existing aquatic resources and does not maintain the highest possible levels of environmental quality and compatibility with native flora and fauna?
>
> e. The authorized development with perpetual operations does not preclude damage to the natural ecosystem and ecology of the area including, but not limited to, the following issues: forage fish, salmon, native species, prey resources, forage fish eggs, forage fish larvae, crab larvae and other intertidal species eggs and larvae?
>
> f. The authorized development does not preclude damage by allowing plastic netting that decreases biodiversity, increases siltation/sedimentation, increases organic

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[7] Though the Garrisons were dismissed as parties after all their legal issues were dismissed, they were granted limited intervention to participate on Legal Issue No. 15(d).

matter, entangles aquatic life as well as poses a safety risk to the public?

g. The authorized development does not prevent the standard operating procedures that exceed the noise limits regardless of date or time?

h. The authorized development allows significant interference with the public's use of the water for safe swimming, water skiing, scuba diving, windsurfing, bottom fishing, dropping an anchor, or boating?

i. The authorized development allows significant interference in navigational and recreational use of the area which violates the public trust in these shorelines?

j. The authorized development does not protect against aquaculture operations that cannot be maintained in a safe and sound condition in this well-known wind/high energy area?

k. The authorized development and the arbitrary buffers do not protect the eelgrass and macroalgae conservation areas as required by Pierce County critical areas regulations?

l. The authorized development has not completed the mandatory Fish and Wildlife Habitat Area approval prior to this permit being issued for review and consistency?

m. The authorized development failed to provide adequate conditions to properly mitigate for impacts to the shoreline areas as to insure no harm, no loss of ecological function, minimize insofar as practical any resultant damage to the ecology, forage fish, juvenile salmon migratory corridor, or the interference with the public's use of the water?

n. The authorized development does not require the respondent (deTienne) to mitigate or restore eelgrass degraded during past geoduck aquaculture activities in this area?

o. The authorized development does not require a record of survey to be filed prior to any activity on this proposed high value site and surrounding area that was necessary to determine the true and full impacts upon the critical habitat and prevent future damage?

p. The authorized development does not recognize and protect private property rights consistent with the public interest?

q. The authorized development does not control pollution, which includes marine debris aquaculture pollution?

r. The authorized development does not protect the first subtidal critical habitat used for geoduck aquaculture without necessary science?

s. The authorized development failed to consider the cumulative impacts to the ecology and environment of the shorelines of this area and region due to the adverse effects arising from its operations?

[2]

Legal Issues No. 15(o) and (p) present similar private property concerns (e.g., boundary surveys required under other authority of law) as issues already dismissed on which the Board previously ruled it lacked subject matter jurisdiction. Legal Issues No. 15(o) and (p) are thus dismissed for the reasons expressed in the Board's Order on Motions for Dismissal and Summary Judgment. In addition, no testimony or evidence was presented at hearing to support Legal Issue No. 15(g); it will therefore be considered waived and the Board will not consider it. Legal Issues No. 15(a)-(f), (i)-(n), and (q-s) remain for resolution and are addressed by general subject area below.

[3]

The Board has jurisdiction pursuant to RCW 90.58.180. The scope and standard of review for this matter is *de novo*. WAC 461-08-500(1). The Petitioners have the burden of proof. WAC 461-08-500(3).

A. The Shoreline Management Act and Pierce County Code

[4]

Shoreline development in Washington must be consistent with the policies and procedures of the Shoreline Management Act (SMA), its associated regulations, and the applicable local shoreline master program. RCW 90.58.140(1); WAC 173-27-150.

[5]

Aquaculture is encouraged in Washington in numerous ways. The SMA identifies a preference for water-dependent uses of the shoreline, with aquaculture being a "desired and preferred water-dependent use of the shoreline." RCW 90.58.020. The Board has upheld various permits for aquaculture involving geoducks as consistent with this standard. *See Lockhart,* SHB No. 13-006c at p. 30, CL 6 (*citing Longbranch*, p. 23, CL 12).

[6]

The Pierce County Shoreline Master Program (SMP), implemented through the Pierce County Code (PCC), also encourages use of shoreline areas for aquaculture in areas well-suited for it, giving priority for aquaculture uses to shoreline areas that have the prerequisite qualities in order to protect the county's aquaculture potential. PCC 20.24.020(A)(1), 20.24.020(A)(10).

[7]

As noted in the Findings of Fact, the Farm Site is located in the Rural-Residential shoreline environment. Aquaculture is allowed in this shoreline environment, with geoduck aquaculture "permitted outright" subject to obtaining a shoreline substantial development permit. PCC 20.10.010; PCC 20.24.030. As also noted in the Findings, the portion of the Farm Site waterward of -4.5 tidal elevation is designated a shoreline of statewide significance. Ex. R-2 at p. 2; Ex. R-3 at p. 1.

[8]

There is a balance inherent in the SMA, its associated regulations, and the PCC that, while seeking to encourage aquaculture, also seeks to prevent damage to the shoreline environment, and avoid interference with recreational use. The SMA "contemplates protecting against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life, while protecting generally public rights of navigation and corollary rights incidental thereto." RCW 90.58.020.

Guidance provided by Ecology for developing local shoreline master programs also states that:

> Local government should consider local ecological conditions and provide limits and conditions to assure appropriate compatible types of aquaculture for the local conditions as necessary to assure no net loss of ecological functions.

WAC 173-26-241(3)(b).

[9]

Though the term "no net loss" does not appear in Pierce County's implementing code, County witness Mr. Booth testified the concept is embodied in the code's protection for environmental values. The PCC specifically requires protection for the shoreline environment from aquaculture as follows:

> Aquaculture operations shall be conducted in a manner which precludes damage to specific fragile areas and existing aquatic resources. These operations shall

> maintain the highest possible levels of environmental quality and compatibility with native flora and fauna.

PCC 20.24.020.A(3).

The PCC also recognizes that impacts on navigation and recreation can be minimized:

> Conflicts between the aquaculture use and the navigational access of current upland residents, and intense recreational boating, commercial fishing, and other commercial traffic can be minimized.

PCC 20.24.020.A(5).

[10]

Neither the SMA nor the PCC require the County to issue a Fish and Wildlife Habitat Area approval prior to issuing an SSDP. On this basis, the Board rejects the Coalition's contention in Legal Issue No. 15(l) that this was required.

[11]

In addition, the "no net loss" concept does not assume no impacts, but instead recognizes that future development will occur. *See* Ecology's SMP Handbook, ch. 4 at p. 2. Aquaculture is explicitly recognized as a statewide interest that, when properly managed, does not adversely impact recreation or protection for the shoreline environment, and results in long-term over short-term benefits for the State:

> [Aquaculture] is of statewide interest. Properly managed, it can result in long-term over short-term benefit and can protect the resources and ecology of the shoreline. Aquaculture is dependent on the use of the water area and, when consistent with control of pollution and prevention of damage to the environment, is a preferred use of the water area.

WAC 173-26-241(3)(b).

[12]

Shorelines of statewide significance receive special analysis under the SMA. The legislature declared that the interest of all of the people shall be paramount in the management of shorelines of state-wide significance. RCW 90.58.020. The SMA provides the following particular order of preference for uses on these shorelines:

> (1) Recognize and protect the state-wide interest over local interest;
> (2) Preserve the natural character of the shoreline;
> (3) Result in long term over short term benefit;
> (4) Protection of the resources and ecology of the shoreline;
> (5) Increasing public access to publicly owned areas of shorelines;
> (6) Increasing recreational opportunities for the public in the shoreline; and
> (7) Providing for other elements defined in RCW 90.58.100 as necessary and appropriate.

RCW 90.58.020.

[13]

The Coalition argues that Farm operations and/or related marine debris may or will impact eelgrass, kelp, forage fish, salmon, whales, other aquatic life (e.g., sand dollars and sea stars), and bald eagles, and that any loss of ecological function is a "net loss" that would be inconsistent with the SMA, its implementing regulations, and the PCC. They also allege impairment or risk to recreational use of the shoreline from farm operations and/or debris that is inconsistent with the SMA, its implementing regulations, and the PCC. Finally, they allege a cumulative impacts analysis should have been required before the project was approved. In short, they assert that special scrutiny should be afforded this project as the first subtidal geoduck farm proposed for Henderson Bay, which encompasses a shoreline of statewide significance with abundant aquatic life that includes eelgrass and nearby herring spawning, and which is popular with windsurfers and other recreationalists.

[14]

The Board concludes that the facts in this case require reversal of the County decision to issue this Permit. The Coalition met its burden to prove the Permit fails to offer adequate protection for eelgrass and is thereby inconsistent with the SMA, implementing regulations, and the local shoreline master program, and that a cumulative impacts analysis should have been performed prior to approval of this aquaculture operation.

[15]

As noted in the Findings of Fact, the Coalition failed to meet its burden on the legal issues related to marine debris, adverse impacts to the benthic environment, forage fish, salmon, other aquatic organisms (other than as affected by inadequate protection of eelgrass), whales, or birds. In addition, and although the Board recommended condition(s) to protect recreation, evidence was insufficient to deny the Permit exclusively based on risks to recreational users.

B. Lack of Adequate Protection for Eelgrass as a Fragile Aquatic Resource

[16]

As noted in the Findings of Fact, eelgrass is of particular importance to the health of Puget Sound. Eelgrass (zostera spp.) and macroalgae (kelp in the order laminariales) are explicitly recognized in state regulations as a saltwater habitat of special concern based on the essential functions they serve in the developmental life history of fish and shellfish. WAC 220-

110-250. They are also regulated under the County's Critical Areas Ordinance.[8] PCC Title 18E. While not directly applicable, these regulatory protections acknowledge the importance placed on eelgrass and kelp as a fragile aquatic resource. The SMA and PCC explicitly protect fragile but vital aquatic resources, with protection of the shoreline environment as a particular consideration for this shoreline of statewide significance. RCW 90.58.020(4); PCC 20.24.020. A(3).

[17]

The Board concludes that Pierce County approved a permit with the smallest buffer possible, in the absence of any scientific basis for such a small buffer. This small buffer, when combined with an overreliance on monitoring and adaptive management, a lack of accounting for off-site impacts, and the potential need for restoration and/or expansion of eelgrass made particularly fragile from past commercial geoduck harvest activity at the Site, contravenes the requirements in the SMA, its implementing regulations, and Pierce County's SMP. In particular, it contravenes the concept of "no net loss" and the local SMP requirement to "preclude[] damage to specific fragile areas and existing aquatic resources" and "maintain the highest possible levels of environmental quality and compatibility with native flora and fauna." PCC 20.24.020.A(3); WAC 173-26-241(3)(b).

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[8] Though witnesses for both sides placed reliance on what constitutes "best available science" for assessing impacts from this proposed Farm, the Board notes this is a term used under the Growth Management Act (*see, e.g.*, WAC 365-195-900) that is not employed by the SMA, its implementing regulations, or the local PCC.

[18]

Although it is clear impacts to eelgrass will occur without an adequate buffer in place, the lack of evidence on what size buffer would be adequate for a proposed project of this size, density, and location in a high-energy subtidal environment, prohibits the Board from making any definitive determination on a more appropriate buffer size within the ranges discussed in the evidence. Rather than change the Permit's conditions, the Board will deny the Permit on this basis.

C. Lack of Appropriate Balance of Statewide Interests

[19]

The Board further finds that the preferences and priorities normally provided to properly mitigated and designed aquaculture in state and local regulation do not apply here. Pierce County only prioritizes those projects that are situated in shoreline areas well-suited (i.e. having the "prerequisite qualities") for aquaculture. PCC 20.24.020(A)(10). The fact that the Farm Site here will be operated in a high-energy subtidal environment, bordering a continuous eelgrass bed that provides spawning habitat for nearby herring, and habitat and refuge for other forage fish, juvenile salmon, and various aquatic organisms—makes this Site one without the prerequisite qualities for prioritizing it as an appropriate aquaculture site under PCC 20.24.020(A)(10).

[20]

These site-specific factors also elevate the importance of other statewide interests over any preference given to aquaculture for this Site. The recognition of aquaculture as a preferred use that is of statewide interest is premised on its proper design and management preventing damage to the environment. Given the lack of protection for eelgrass and related ecosystem values at this Site, the Board concludes that the Farm proposed is not consistent the SMA's requirement that the interest of all people be paramount in the management of this shoreline of statewide significance. RCW 90.58.020. In particular, the potential for impacts to eelgrass and other dependent aquatic resources make this proposal one that does not "recognize and protect the state-wide interest over the local interest," does not "result in long term over short term benefit," and does not adequately "protect the resources and ecology of the shoreline." RCW 90.58.020(1), (3), (4). Further, because the Farm may negatively impact the public's use of the area for windsurfing and other recreational uses, it does not "increase recreational opportunities for the public in the shoreline." RCW 90.58.020(5).

Balancing these considerations as mandated by the SMA weighs in favor of denying the Permit for this shoreline of statewide significance.

D. The Need for a Cumulative Impacts Analysis

[21]

Neither the County nor the Applicants performed a cumulative impacts analysis prior to approval of the Permit. The Coalition, which did not challenge the MDNS issued for the project under SEPA, argues this impacts analysis should have been required under the SMA, local shoreline master program, and associated legal precedent.

While the SMA contains no mandate for a cumulative impacts analysis on review of an SSDP, the Board has held it is not precluded from considering cumulative effects where appropriate. *May v. Pierce County*, SHB No. 06-031 (2007); *see also Fladseth v. Mason County*, SHB No. 05-026 (2007) at COL 13, pp. 21-22.; *Lockhart*, SHB No. 13-006c at COL 21-27, pp. 37-42. This is particularly true for "cases where there is a clear risk of harmful impacts to high value habitat, loss of community uses, impacts to views or the loss of extraordinary aesthetic values. *See May*, SHB No. 06-031 at COL 18, p. 30. The Washington Supreme Court has confirmed that the Board's statutory duties encompass concern over the ultimate cumulative impact of piecemeal development on state shorelines. *Fladseth*, SHB No, 05-026 at COL 13, p. 21, *citing Hayes v. Yount*, 87 Wn.2d 280, 288, 552 P.2d 1038 (1976). The Supreme Court has, in fact, recognized that approval of one project can set a precedent for others to follow, and that it is proper for the Board to consider cumulative impacts that might occur from the granting a substantial development permit. *Id.*, citing *Skagit County v. Department of Ecology*, 93 Wn.2d 742, 750, 613 P.2d 121 (1980). As noted by the Board:

> The Court said that, "[l]ogic and common sense suggest that numerous projects, each having no significant effect individually, may well have very significant effects when taken together." *Skagit County*, 93 Wn.2d at 750 (quoting *Hayes* at page 287). The *Skagit County* court went on to conclude that "[t]he SMA recognizes the necessity for controlling the cumulative detrimental impact of piecemeal development through coordinated planning of all development. RCW 90.58.020." *Skagit County*, 93 Wn.2d at 750 (1980).

Id.

[22]

The factors the Board weighs in considering whether a cumulative impacts analysis is required for an SSDP are listed below:

1. Whether a shoreline of statewide significance is involved;
2. Whether there is potential harm to habitat, loss of community use, or a significant degradation of views and aesthetic values;

3. Whether a project would be a "first of its kind" in the area;
4. Whether there is some indication of additional applications for similar activities in the area;
5. Whether the local SMP requires a cumulative impacts analysis be completed prior to the approval of an SSDP;
6. The type of use being proposed, and whether it is a favored or disfavored use.

Lockhart, SHB No. 13-006c at COL 22, p. 38.

[23]

Factors 5 and 6 do not apply here. As noted above, the PCC allows aquaculture as a favored use, and also does not require a cumulative impacts analysis be performed for an SSDP. The rest of the factors do apply, and weigh in favor of a cumulative impacts analysis being required here.

[24]

This case is unique compared to the past geoduck farm proposals considered by the Board, for which the SSDPs issued by Thurston and Pierce Counties were upheld. The first geoduck proposal that the Board considered, in *Longbranch*, involved a 2.5-acre intertidal farm to be located on Key Peninsula in Pierce County. The shoreline at issue was not designated a shoreline of statewide significance. Eelgrass was not present, and herring did not spawn nearby. The Board found insufficient evidence of impacts in that case to warrant denial of the SSDP, and no evidence was presented of other similar projects proposed or approved to warrant a cumulative impacts analysis. *Longbranch*, SHB No. 11-019 (2012).

[25]

The second, most recent, geoduck case considered by the Board, *Lockhart*, involved four projects proposed for Henderson Inlet in Thurston County (not to be confused with Henderson Bay here, in Pierce County), each of which would impact less than 1.25 acres of intertidal tidelands. Again, none were to be situated on a shoreline of statewide significance, no eelgrass was present in the areas to be farmed, and no herring spawned nearby. The Board likewise found insufficient evidence of impacts to warrant denial of the farm permits in that case. Though the Board seriously considered whether to require a cumulative impacts analysis in that case, it ultimately declined to do so. *Lockhart*, SHB No. 13-006c (2013).

[26]

This Farm's proposed location on a shoreline of statewide significance means that particular consideration must be given to balancing the interests of aquaculture as one statewide interest, with other statewide interests like the shoreline's ecological values and the public's recreational use. This is the Board's first opportunity to consider the potential impacts of a larger five-plus (5+)-acre geoduck farm proposed on a shoreline of statewide significance, where extensive but fragile resources including eelgrass are present and where herring spawn nearby. The proposed farm would be a first-of-its kind operation in an area where minimal aquaculture already exists, where unauthorized practices have impacted fragile marine resources through prior harvesting activity, where farm operations pose a potential harm to habitat and loss of community recreational use, and where additional projects have either been approved, proposed, or are likely to be proposed—including at least one similar project.

[27]

The careful review required for this shoreline of statewide significance weighs in favor of requiring a cumulative impact analysis of the impacts that might result from granting the first subtidal geoduck farm permit in Henderson Bay—in particular, to assess the potential for longer term impacts to fragile resources like eelgrass, as well as unique use of the area by recreationalists like windsurfers.

[28]

Any Finding of Fact deemed to be a Conclusion of Law is hereby adopted as such.

Having so found and concluded, the Board enters the following

ORDER

For the reasons expressed above, Pierce County's issuance of SSDP No. 35-05 is REVERSED, and the Permit is therefore DENIED.

SO ORDERED this 22nd day of January, 2014.

SHORELINES HEARINGS BOARD

Tom McDonald

TOM MCDONALD, Chair

Kathleen D. Mix

KATHLEEN D. MIX, Member

J. Marchioro

JOAN M. MARCHIORO, Member

PAMELA KRUEGER, Member

Robert Gelder

ROBERT GELDER, Member

[See dissenting opinion]

GRANT BECK, Member

Kristie C Ell

Kristie C. Elliott, Presiding
Administrative Appeals Judge