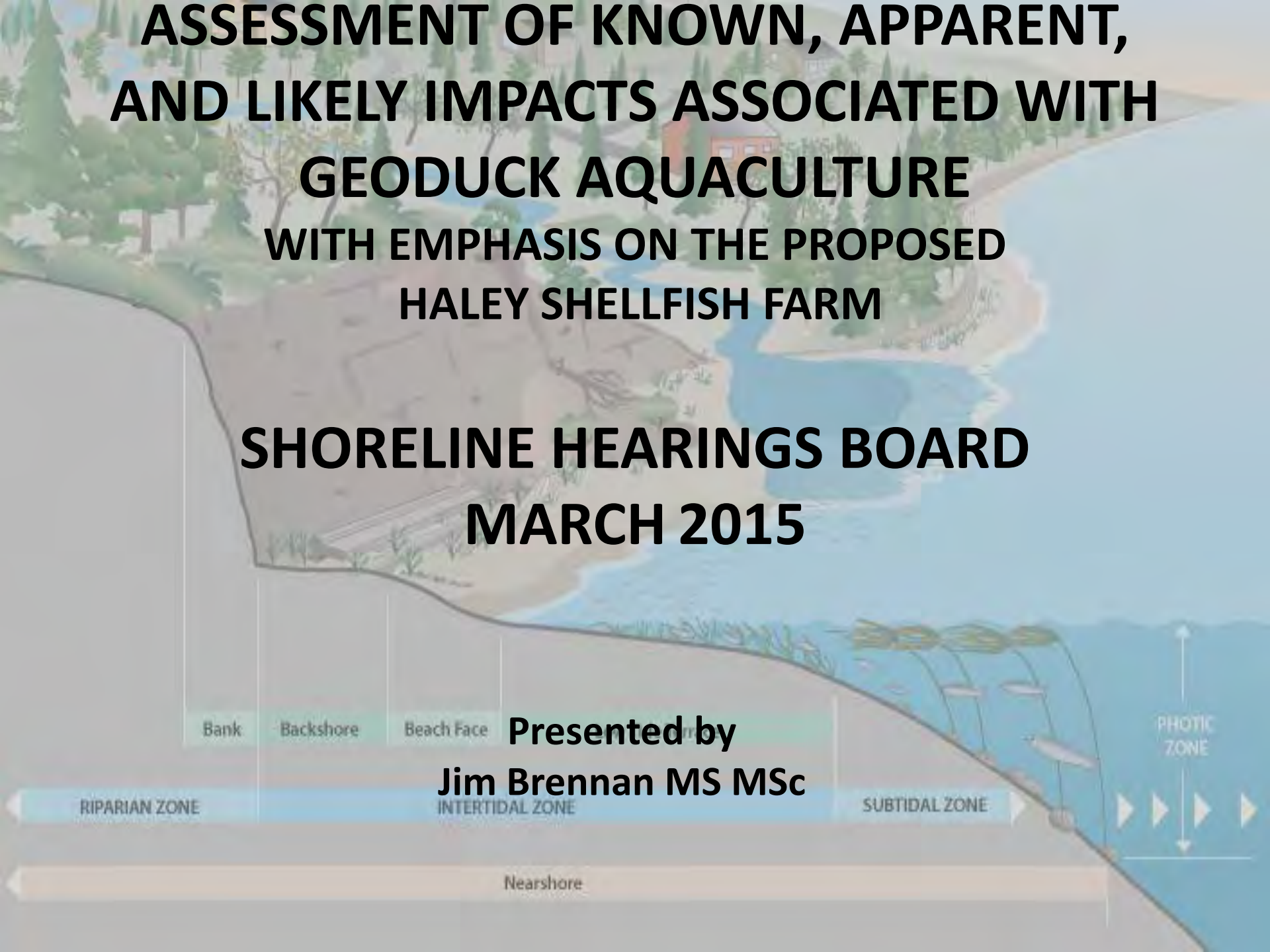
ASSESSMENT OF KNOWN, APPARENT, AND LIKELY IMPACTS ASSOCIATED WITH GEODUCK AQUACULTURE

WITH EMPHASIS ON THE PROPOSED HALEY SHELLFISH FARM

SHORELINE HEARINGS BOARD MARCH 2015

Presented by
Jim Brennan MS MSc



OUTLINE PART I
BACKGROUND

- PERSONAL/PROFESSIONAL BACKGROUND
- BASICS OF NEARSHORE ECOLOGY
- REVIEW THREATS/CHALLENGES
- REVIEW PROTECTION AND RESTORATION MEASURES

OUTLINE PART II
IMPACT ASSESSMENT

- Methods used for review
- Review of proposed project procedures
- Review of associated impacts

OUTLINE PART III
ADDITIONAL REVIEW & COMMENTS

- Review of geoduck research
- Review of Hearing Examiner's determination
- Summary and Conclusions

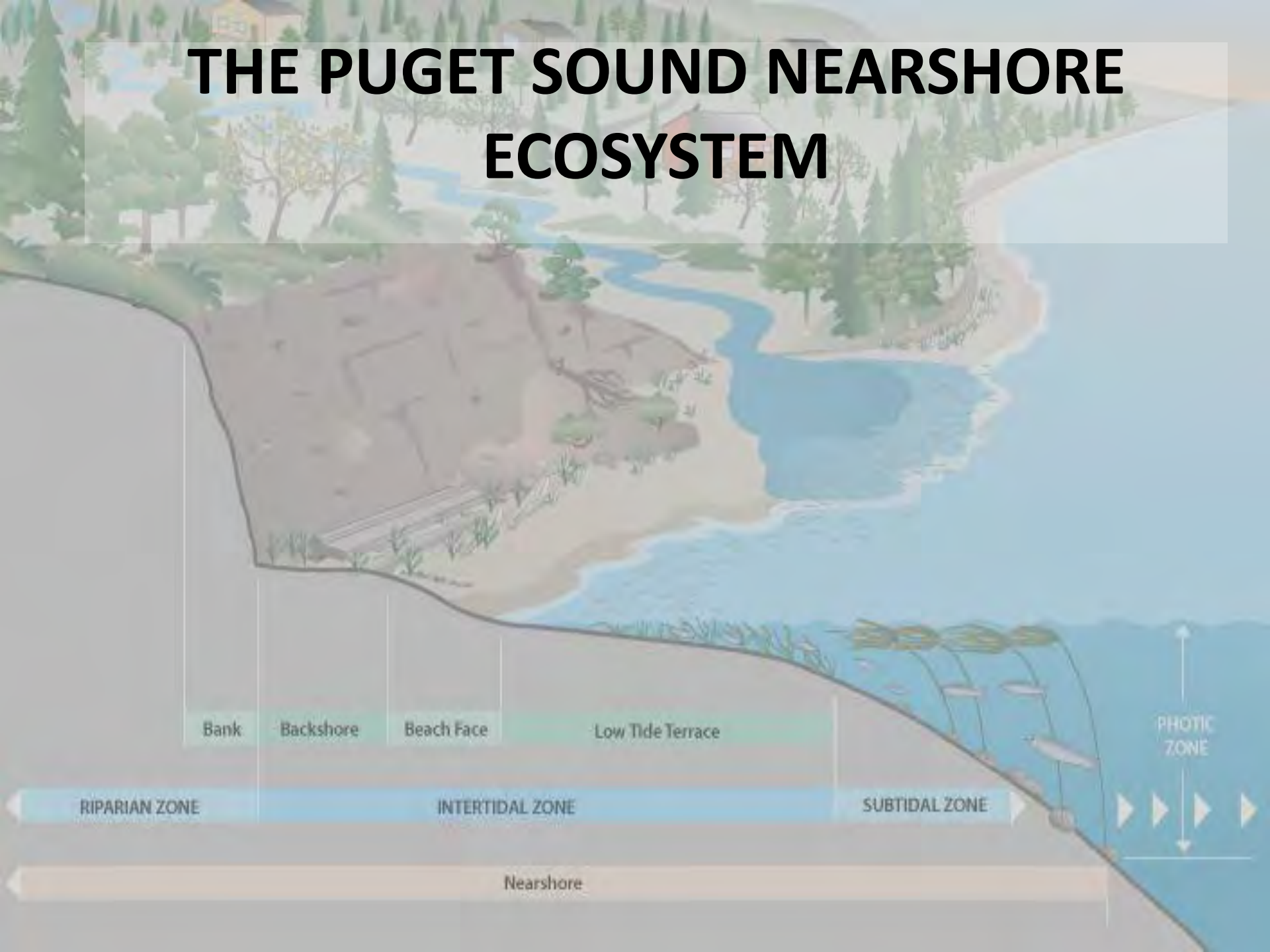
BACKGROUND
Professional Qualifications

- Education: MS MSc Moss Landing Marine Labs
- 33 years work experience/24 yrs in Puget Sound
- Puget Sound Nearshore
  - Research
  - Education
  - Environmental Assessment
  - Regulatory
  - Policy and Management
  - Restoration

BACKGROUND
Professional Qualifications

- Nearshore Technical Committees
  - KC sponsored NTC (Chair)(Local, State, Federal)
  - PSNERP NST (State, Federal)
  - SRFB TRP (State/Federal)
  - Regulatory Effectiveness TAG (State/Federal)
  - WDFW & WADNR HCP TAC (State)
  - ETAC/TAGs (Local)
  - Development, Regulatory, Restoration, Monitoring TACs
- Publications (empirical research and technical reports, guidance documents, education materials.)
- Editorial/Research Review (journals, funding) (State/Federal)
- Training/workshops (local, state, federal)

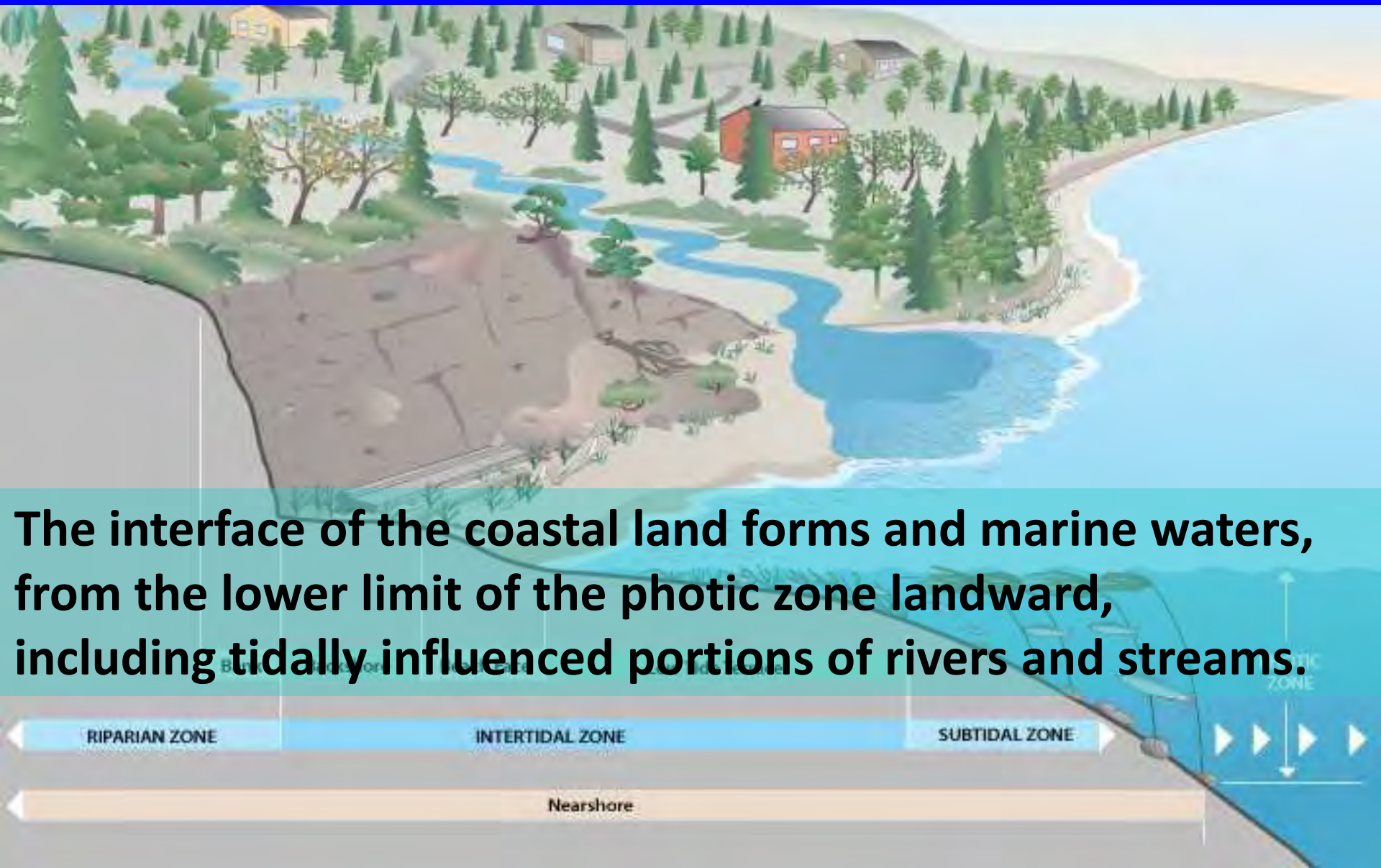
THE PUGET SOUND NEARSHORE ECOSYSTEM



ECOSYSTEM

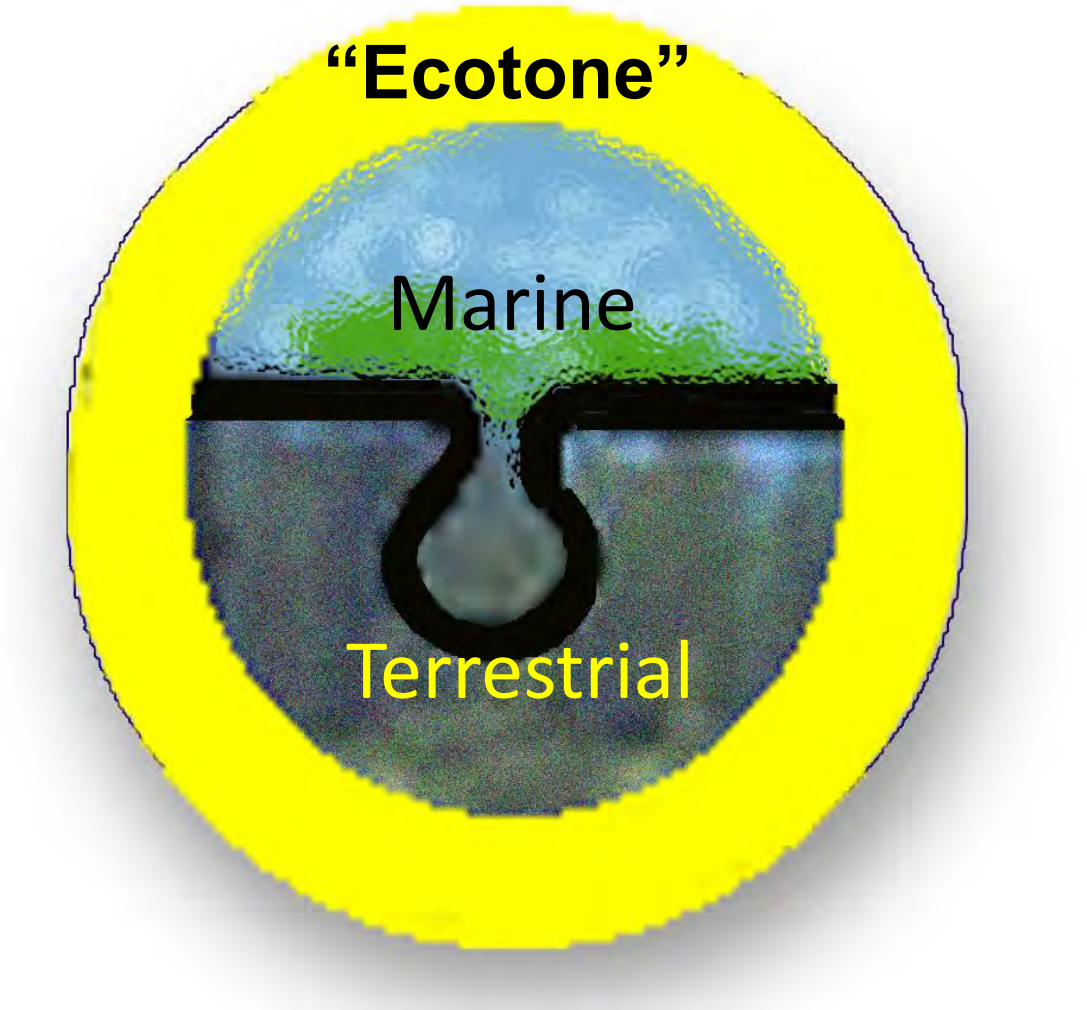
BIOTIC COMMUNITIES INTERACTING WITH ABIOTIC (non-living) COMPONENTS

What Is the Nearshore?

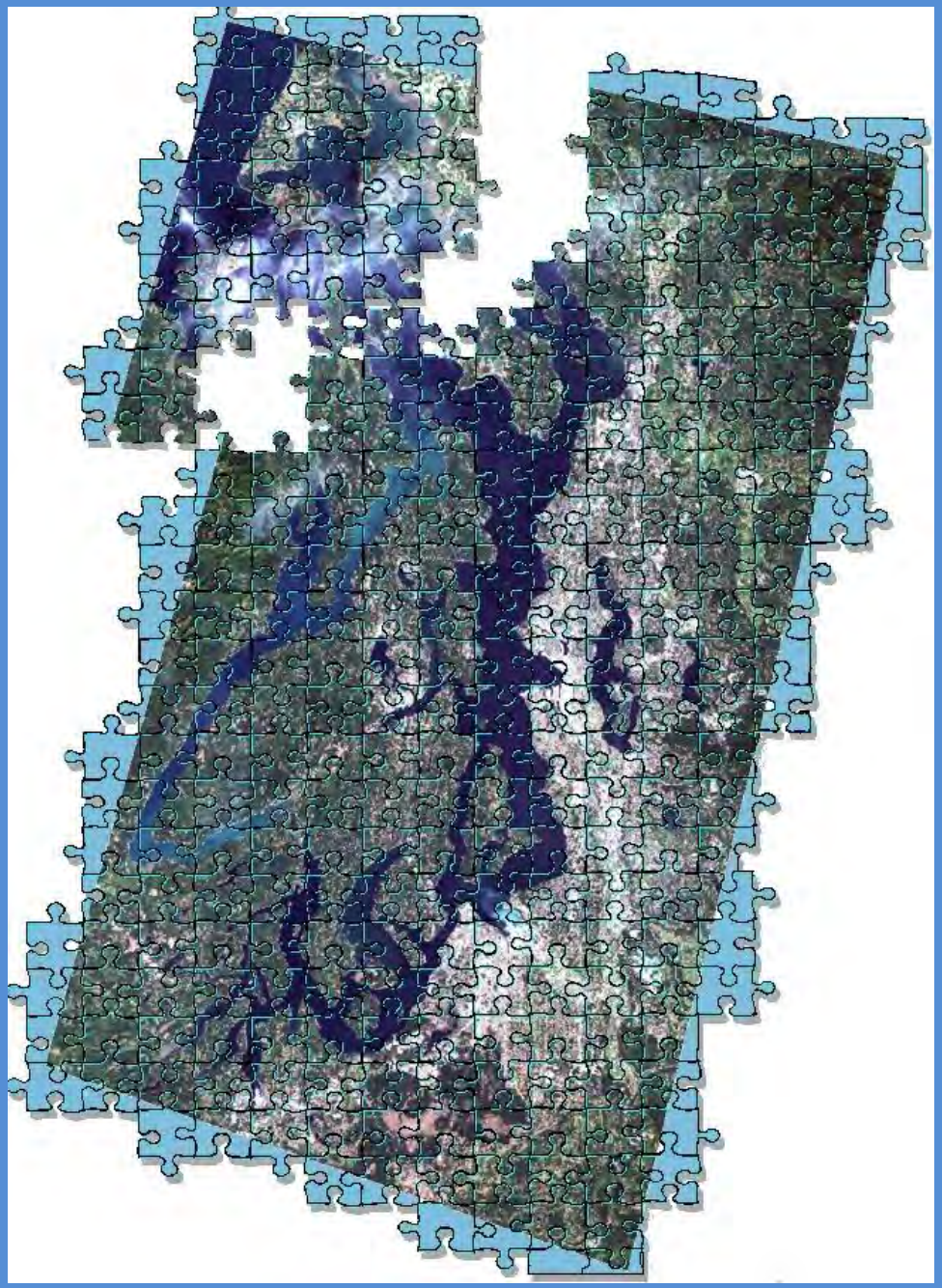


The interface of the coastal land forms and marine waters, from the lower limit of the photic zone landward, including tidally influenced portions of rivers and streams.

Interface/Transition Zone



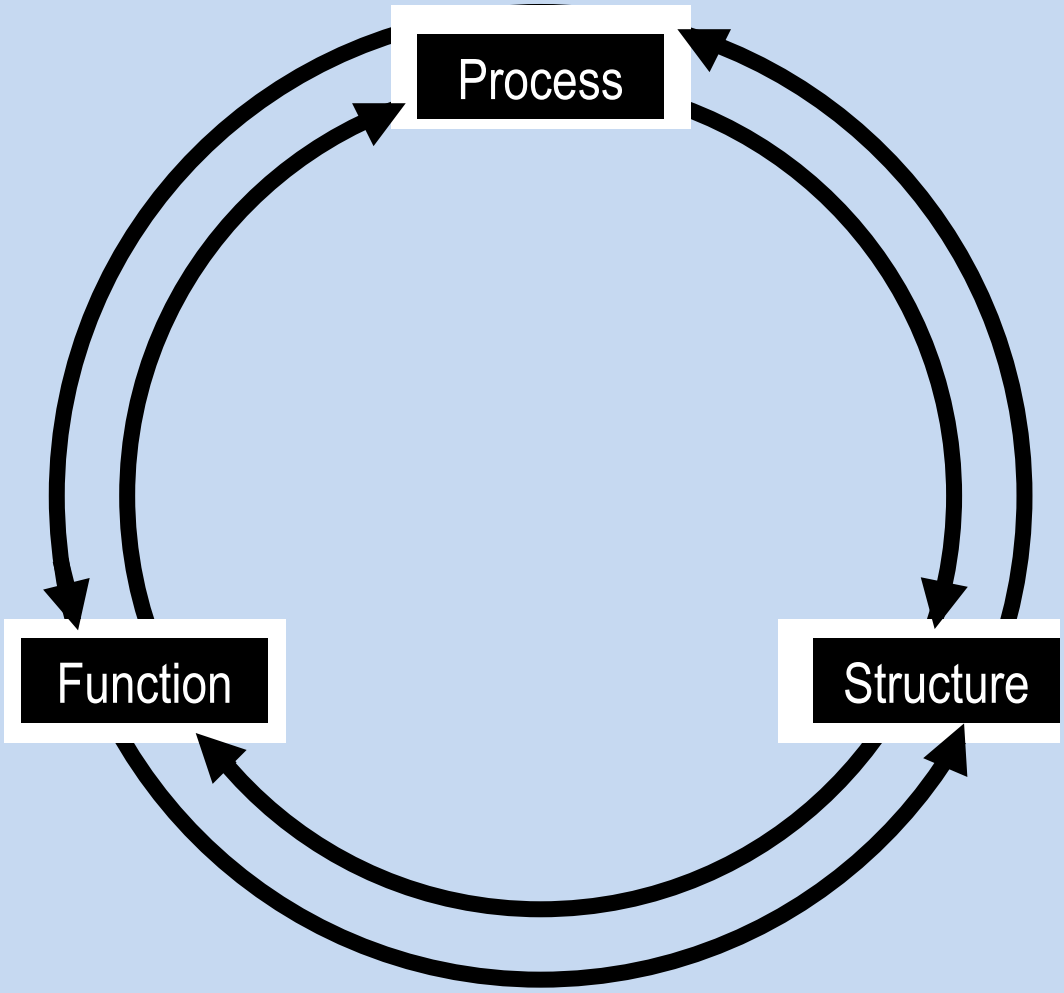
THE “NEARSHORE” IS THEREFORE A COMPLEX OF ECOSYSTEMS



The Puget Sound Ecosystem Puzzle

Lots of Parts:
All Connected

Ecological Interactions/Linkages



Occur at various spatial and temporal scales

Processes

- physical
- chemical
- biological

Structure

-sediment/substrates

-vegetation

Functions

-species diversity

-harvestable resources

-water purification

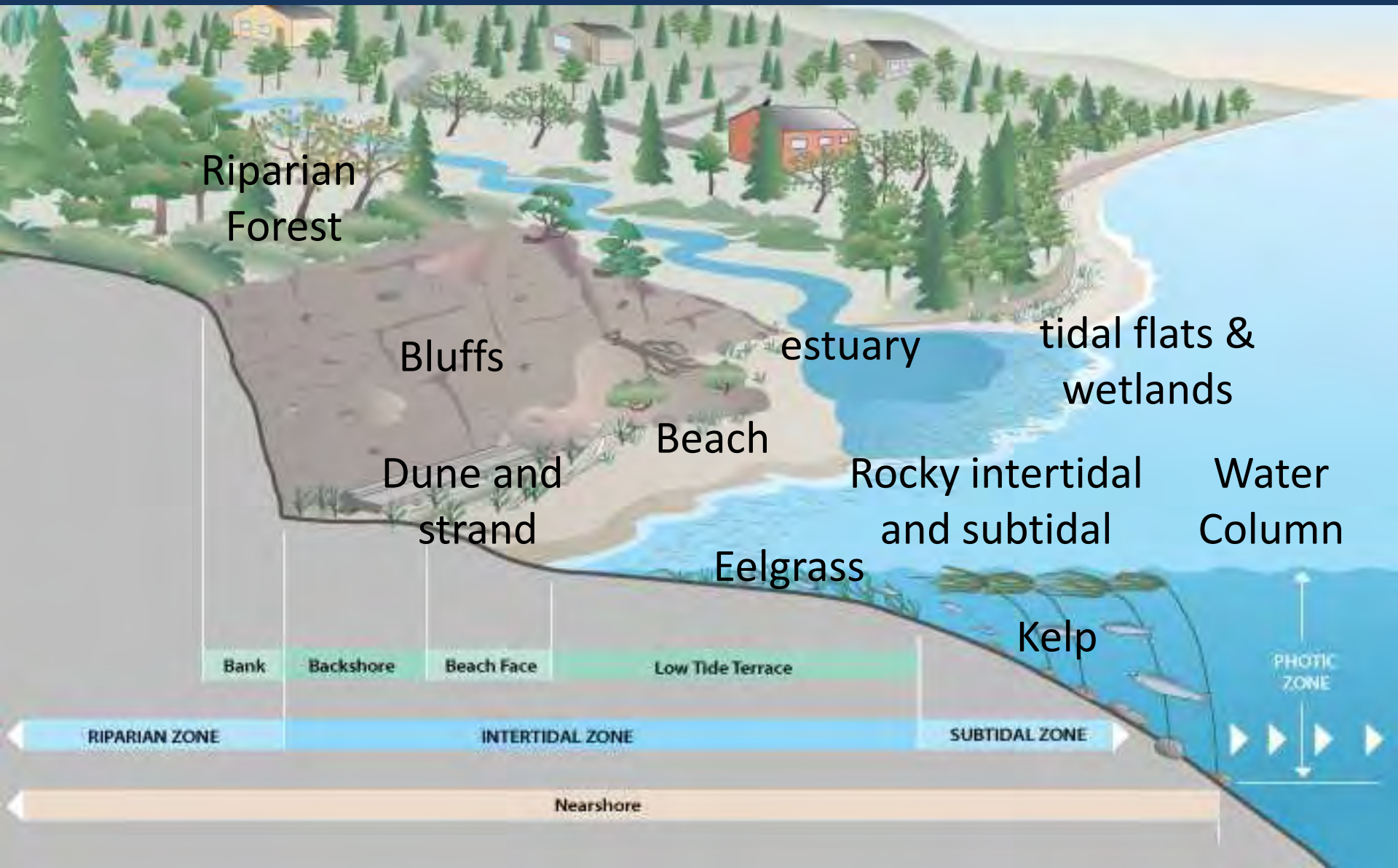
-soil stability

-habitat

-Other human values/uses

Photo by Wolf Bauer

Nearshore Habitats



HABITAT

A PLACE WHERE SOMETHING LIVES

Organisms live in a certain place (habitat) under conditions in which they evolved and are adapted to thrive

ECOSYSTEM HEALTH

Healthy Systems are typically diverse

- **BIOLOGICALLY**
- **STRUCTURALLY**
- **HABITAT COMPLEXITY (VS HOMOGENEITY)**
- **CONNECTIVITY (VS FRAGMENTATION)**
- **STABILITY**

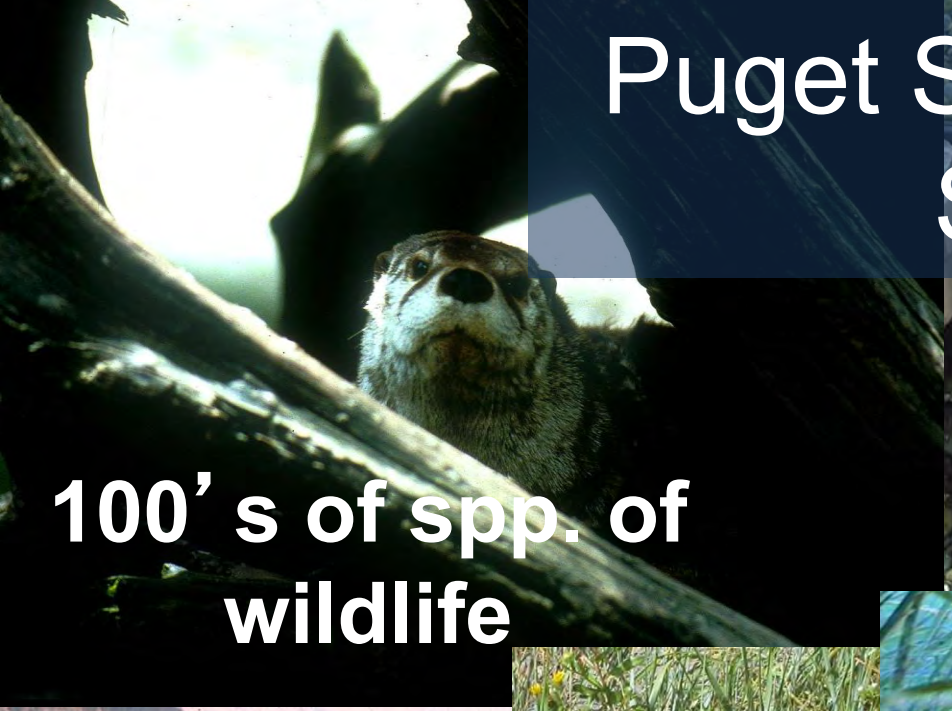
ATTRIBUTES ARE FORMED AND MAINTAINED BY LOCAL CONDITIONS (Internal/external forces)

Nearshore Habitat Diversity

HABITAT DIVERSITY DRIVES SPECIES DIVERSITY AND ABUNDANCE

- Marine and freshwater fishes
- Marine and terrestrial birds
- Marine and terrestrial mammals
- Amphibians
- Reptiles
- Marine and terrestrial plants
- Marine and terrestrial invertebrates

Puget Sound Habitats Support



100’s of spp. of wildlife

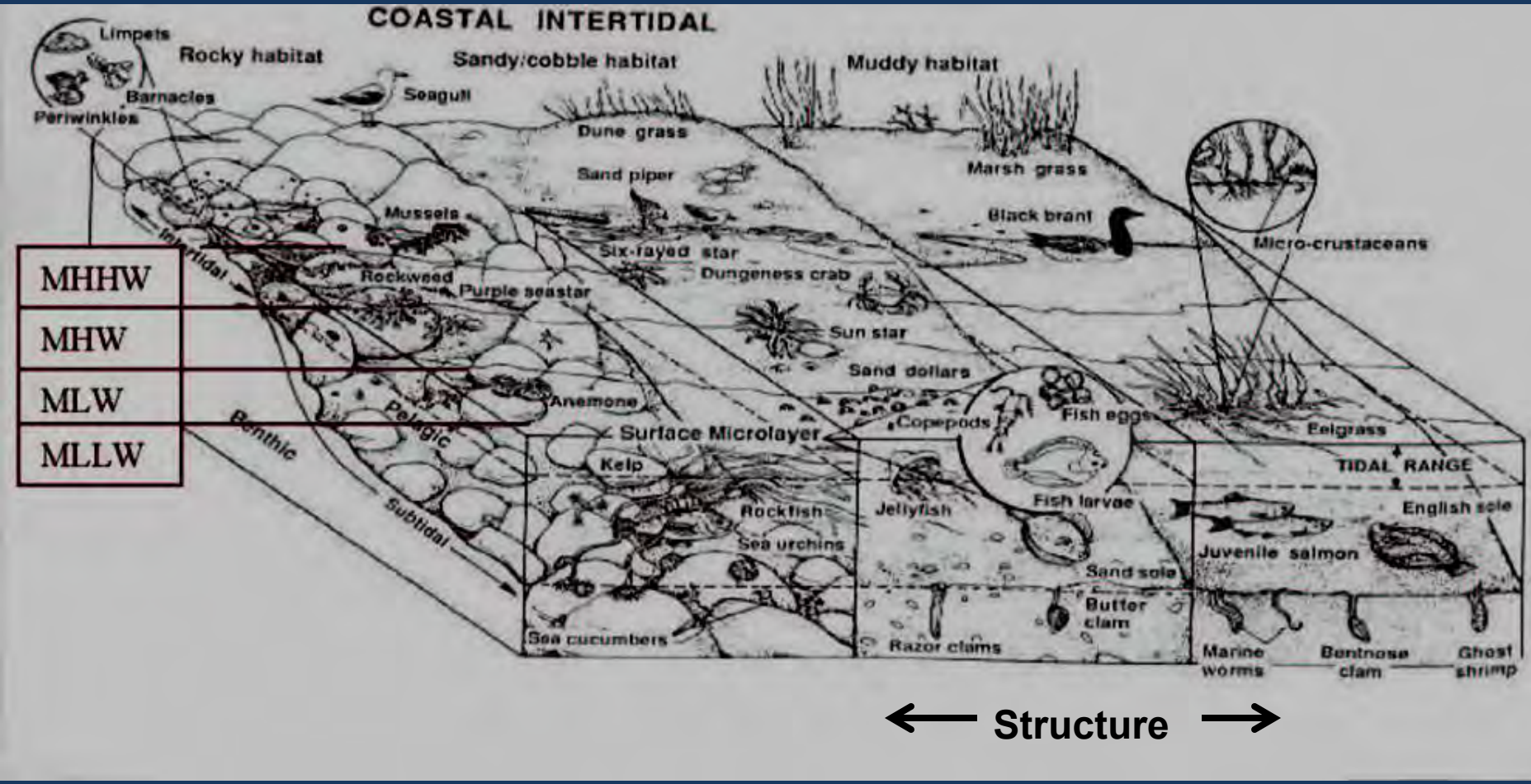
Over 200 spp. of fishes

100’s of marine & terrestrial plants

>15 spp. of marine mammals

1000’s of spp. of aquatic invertebrates

BEACH VARIABILITY

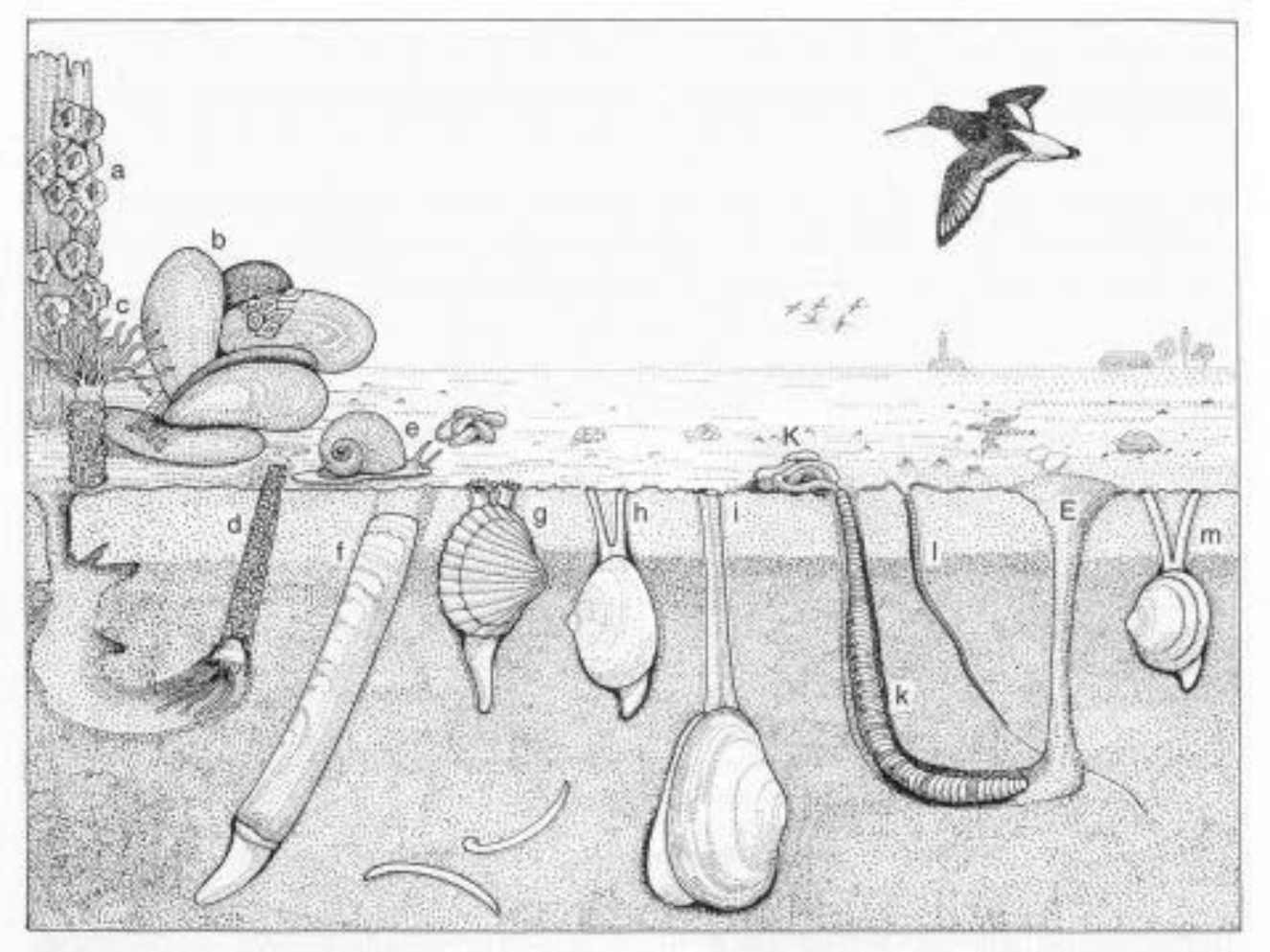


Composition of substrate, energy, exposure, salinity, tides, species, etc. determined by controlling factors

HABITAT FUNCTIONS

A FEW EXAMPLES

Benthos

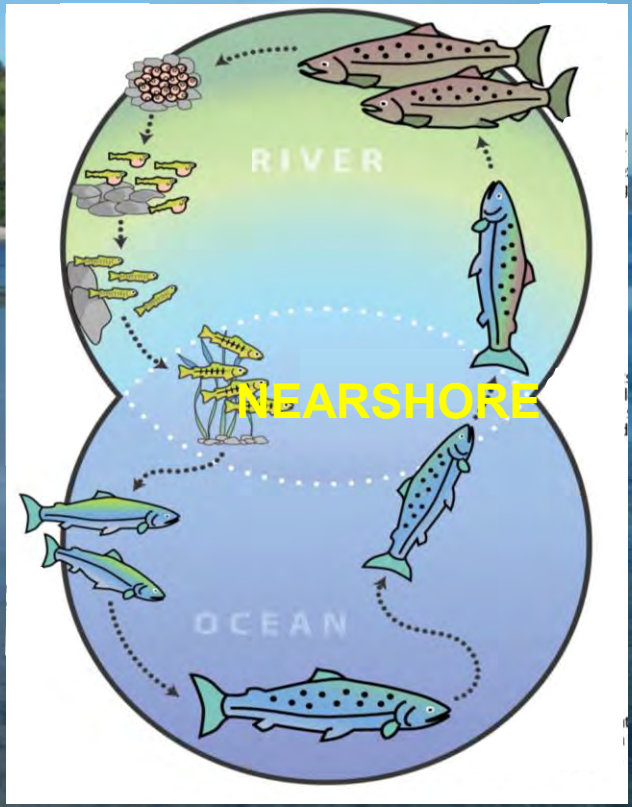


Functions: Feeding, refuge, reproduction, productivity

Reproduction

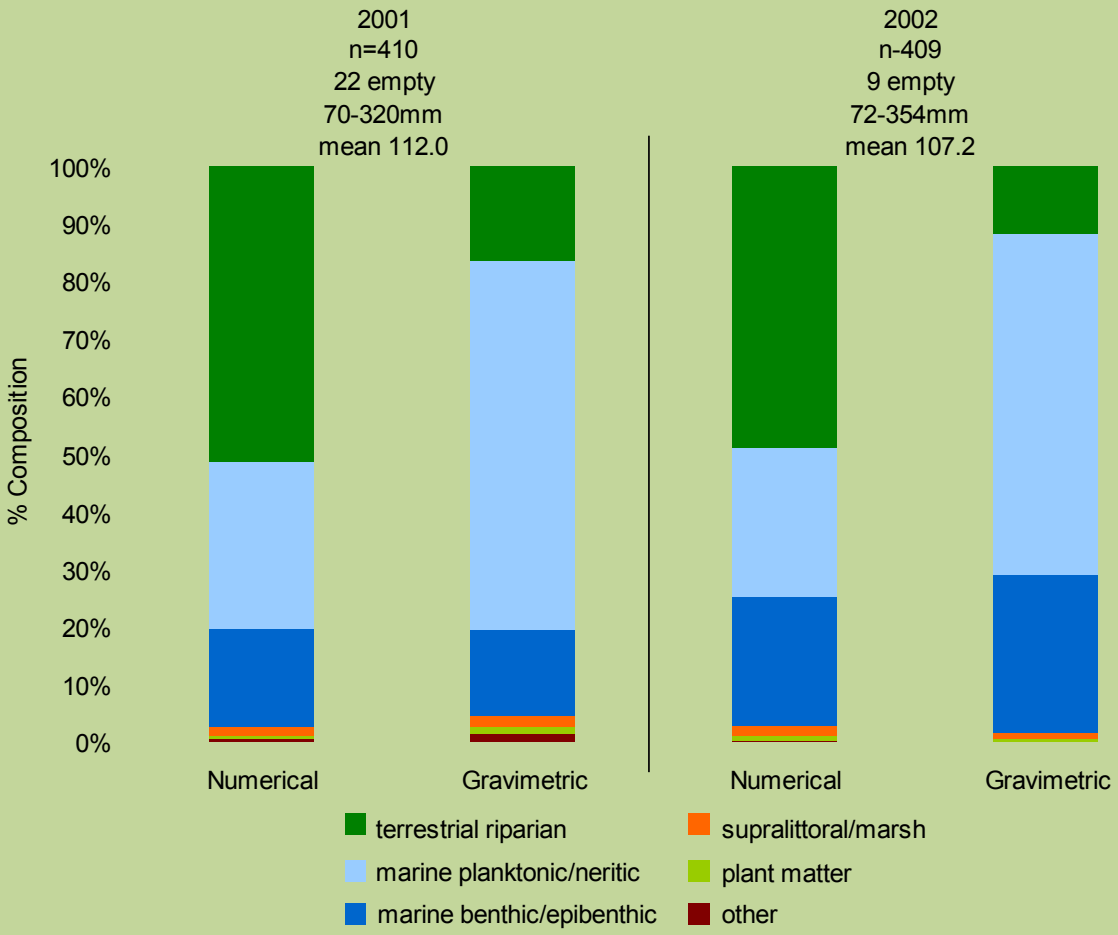
Salmonid Nearshore Dependence

- **Rearing**
- **Feeding**
- **Refuge**
- **Migration**
- **Physiological transition**

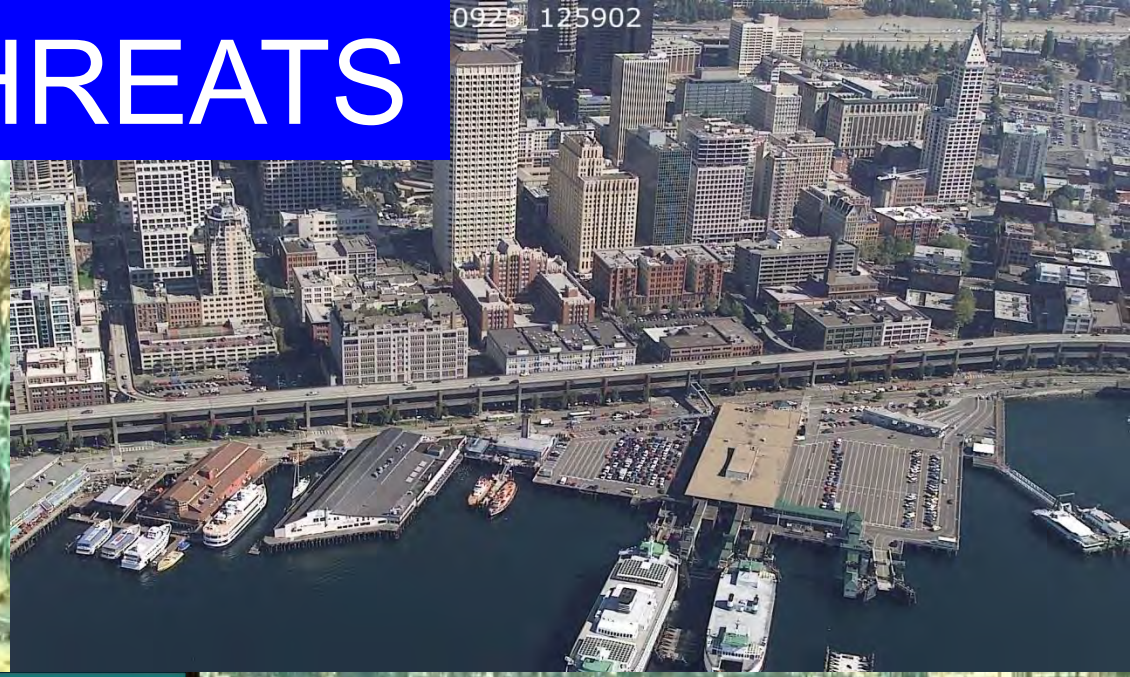


4. 25. 2001

Overall diet composition based on prey ecology for juvenile Puget Sound chinook



THREATS



Shoreline Modifications (alterations, disturbances, stressors)

Basic Principle

Shoreline modifications alter habitats and species resulting in a change in ecosystem functions

COMMONLY IDENTIFIED THREATS

- SHORE ARMOR
- OVERWATER STRUCTURES
- FILLING
- DREDGING
- DIKES
- POLLUTION
- RIPARIAN ALTERATIONS

PROBLEM INDICATORS

- **SPECIES POPULATION DECLINES; ESA Listings**
- **HABITAT MODIFICATION & LOSS**
- **BANK STABILITY**
- **REDUCED WATER QUALITY**
- **INVASIVE SPECIES**
- **LOW DISSOLVED OXYGEN (e.g., Hood Canal)**
- **AIR QUALITY**
- **RISKS TO HUMAN HEALTH AND SAFETY, RECREATION OPPORTUNITIES, AESTHETICS, OTHER SOCIETAL VALUES**

Addressing The Threats

- Regulatory (e.g., SEPA; Updates of SMPs)
- Use of Science to Inform Decision Making (e.g., PSNERP; Analysis and Reporting)
- Development of Alternative Methods
- Restoration
- Increased Regional and National Programs (e.g., Puget Sound Partnership)
- Ecosystem Based Management

ALL EFFORTS TO INCREASE PROTECTION AND RESTORATION

HABITAT MODIFICATIONS ALTERATIONS, STRESSORS….

ANTHROPOGENIC “CHANGE”

AQUACULTURE
AN EMERGING THREAT

- As the supply of seafood has decreased and demand for food sources has increased, aquaculture has expanded globally, nationally, and regionally in recent decades
- Aquaculture has been identified as a threat by scientists, managers, conservation organizations, and the general public
- Impacts of aquaculture have not been adequately evaluated, or mitigated

Studies/Results

Aquaculture is an increasing threat/stressor to nearshore ecosystem health, integrity, and function by altering the natural physical, chemical, and biological processes.

References: DeFur and Raider 1995;Krukeberg 1995; Hastings 1995; Simenstad and Fresh 1996; Drake 1997; Dethier 2006; Penttila 2007; Bendel and Wan 2010; Bouwman et al. 2013; Diana et al. 2013

OUTLINE PART II
IMPACT ASSESSMENT

- Methods for review
- Review of proposed project and procedures
- Impacts associated with individual activities
- Associated Impacts

EVALUATION METHODS

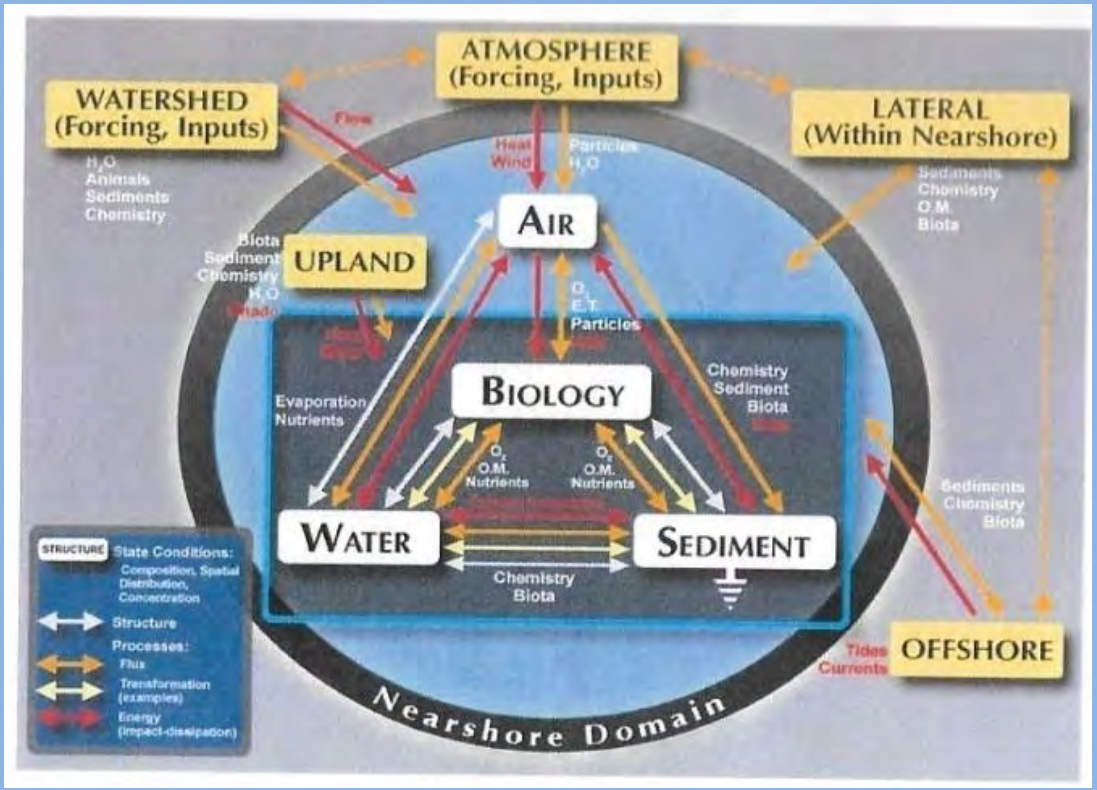
- LITERATURE REVIEW
- NATURAL RESOURCE MANAGEMENT
- FAMILIARITY WITH SHELLFISH AQUACULTURE PRACTICES
- PROFESSIONAL NEARSHORE EXPERIENCE & EXPERTISE
- PUGET SOUND NEARSHORE CONCEPTUAL MODEL

GENERAL QUESTIONS

- Do geoduck aquaculture practices result in impacts?
- If so, what is the likelihood, intensity, and duration?
- Are the impacts “significant”
- Are the impacts individual/independent, or cumulative?
- What can be learned from the literature?
- Which fishes, invertebrates, plants, and wildlife are associated with beaches where geoduck aquaculture occurs?
- Are the impacts to be mitigated? If so, are they appropriate/adequate?
- Has the County conducted an adequate level of environmental analysis in making their determination?
- Is the determination aligned with management goals and objectives (e.g., SMA, ESA, SEPA, etc)?

Puget Sound Nearshore Conceptual Model

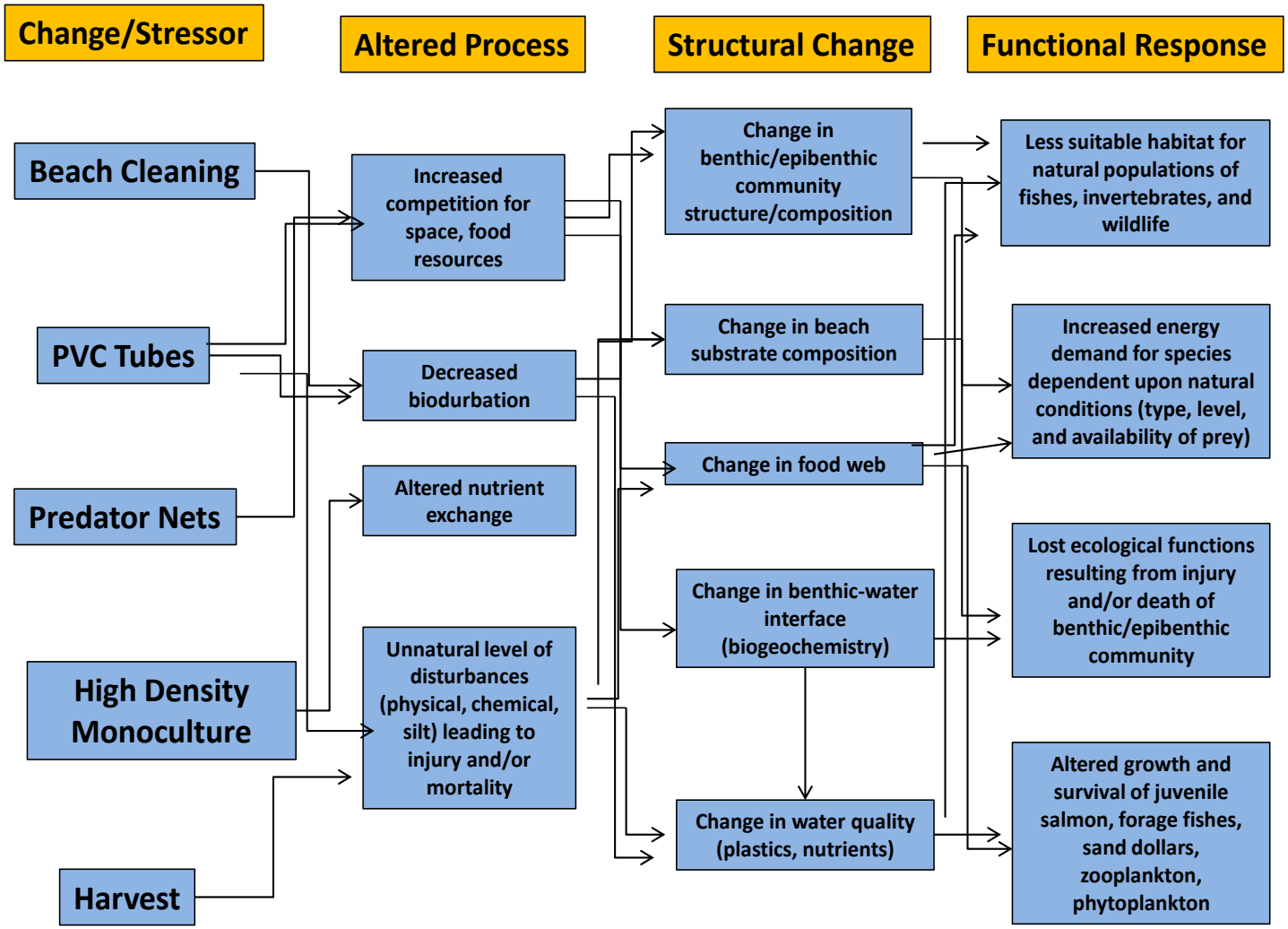
A synthesis tool for understanding nearshore systems and their response to stressors



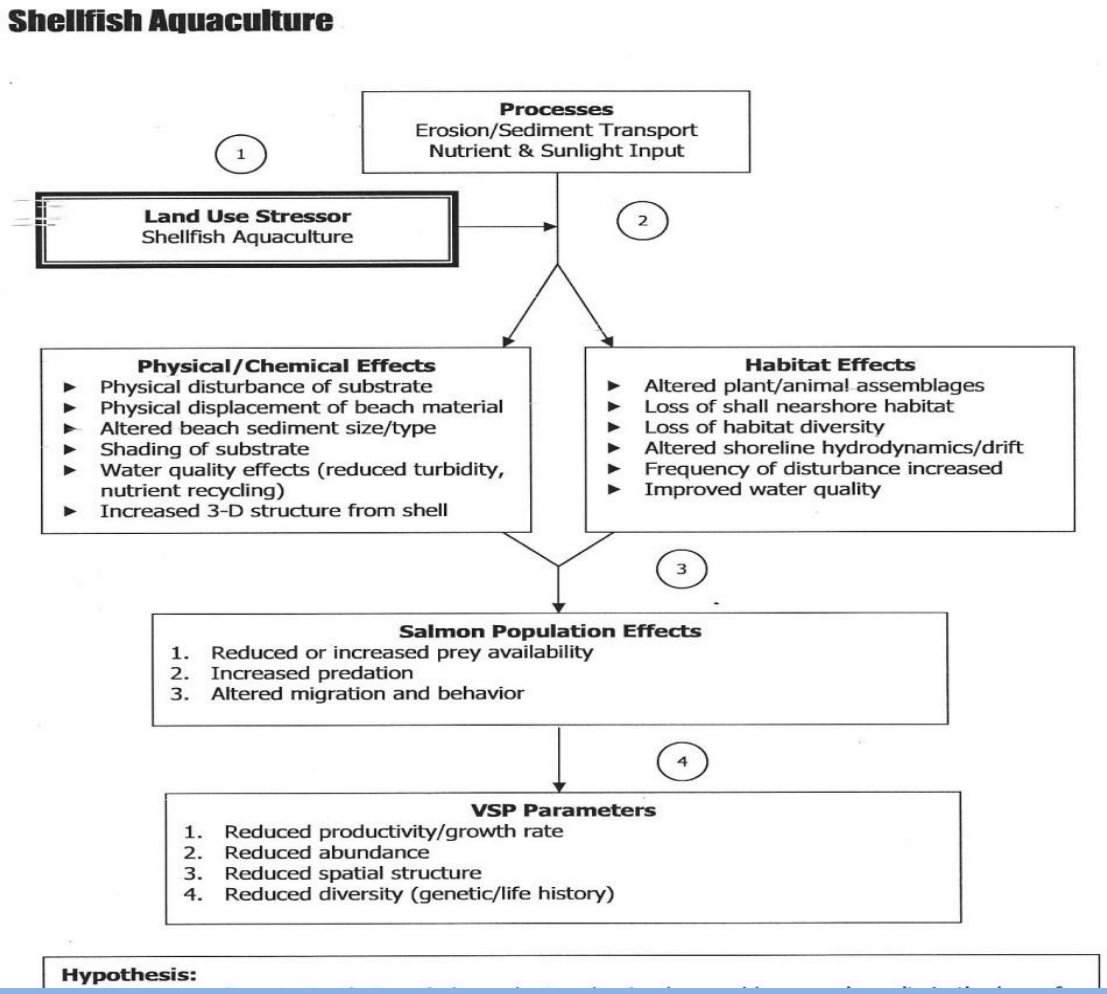
Underlying assumption is that alterations of natural hydrologic, geomorphologic, and ecological processes impair ecosystem structure and function.

Source: Simenstad et al. 2006.

Conceptual Sub-model Geoduck Aquaculture



Enables one to evaluate mechanisms of change, predict response, and examine linkages between nearshore ecosystems



Similar Model Developed for Chinook and Bull Trout Recovery Plan, So. Puget Sound

(submitted to NOAA Fisheries and adopted in 2005 Ch. 4)

"Shellfish aquaculture in South Sound alters plant and animal assemblages and results in the loss of shallow water habitat and habitat diversity important to salmon resources. … We hypothesize that shellfish aquaculture reduces productivity, abundance, spatial structure and diversity of salmon populations."

So. Sound Recovery Plan

"The deterministic factors that influence properly functioning nearshore habitats are natural processes. In South Puget Sound, human activities have dramatically disrupted the function of many natural processes. These disruptions change habitat, and ultimately, the ecosystem that Chinook and bull trout have adapted to through evolutionary development. On a temporal scale, many of these human induced stressors have been sudden, creating significant impacts that have lead to declines in the viability of both species."

Source: South Puget Sound Recovery Group (Squaxin & Nisqually Tribes; WDFW; DOE; Pierce & Thurston Counties)

Kantz et al. The Development of Nearshore Stressor Conceptual Models for Chinook Recovery Planning in South Puget Sound. Proceedings of the 2005 Puget Sound Georgia Basin Research Conference:
http://depts.washington.edu/uwconf/2005psgb/2005proceedings/papers/P4_KANTZ.pdf

Geoduck Aquaculture

1. Beach Preparation – “Cleaning”
2. Insertion of PVC Tubes – Pred. Exclusion device
3. Seeding
4. Installation of predator nets (individual and/or blanket)
5. Maintenance
6. Harvest

- Repeat…

Beach Preparation – “Cleaning”

Removal of wood, rocks, debris, or organisms that would impede planting operations.

Summary

BEACH CLEANING IMPACTS

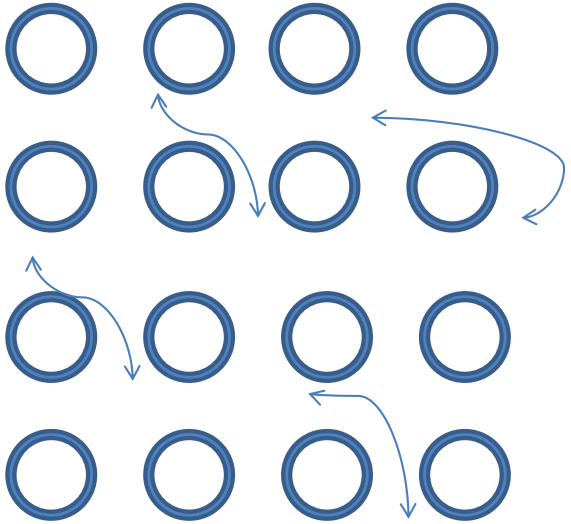
- Organisms are not adapted to this type/intensity of disturbance (months of “preparation”)
- Loss of habitat structure
- Change in physical structure & biotic processes, benthic/epibenthic community structure and function
- Likely injury and/or death for non-mobile, or slow moving organisms
- Alteration of food web
- Inconsistent with other permitted activities
- Impacts not evaluated or mitigated

PVC TUBE IMPACTS

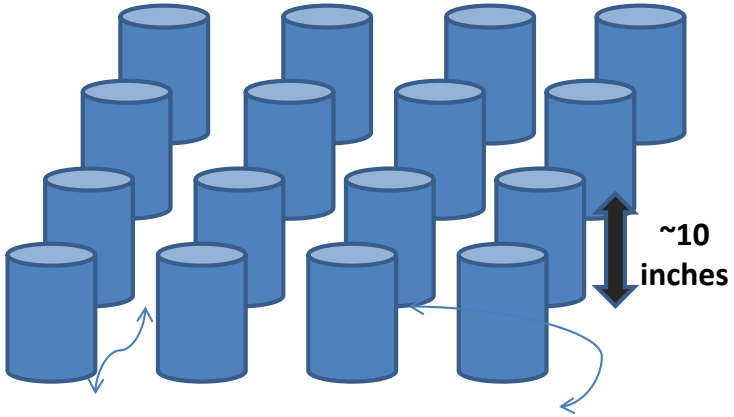
- **Foot traffic, delivery/dragging of equipment**
- **Placement (“stomping”) of tubes**
- **Injury or death of infauna/epifauna**
- **Aerial coverage (~ 43,000 tubes/acre, ~473,000 for the farm) (>75 miles of PVC pipe)**
- **Aerial loss/Impediment to movement, feeding, etc.**



Tubes impede movement of water, sediments, food resources, biota; reduce area available for biota and associated ecological functions



Plan view of tubes in beach



Cross section view of tubes in beach

43,560 ft^2 per acre @ 1 tube/ft^2

36,300 ft of tube/acre X 11 acres = 399,300 ft of PVC pipe

75.63 miles of PVC pipe

Illustration of how tube placement in the beach for geoduck planting is likely to impede benthic faunal utilization of the beach. Calculations of amount of PVC pipe required to plant the proposed 11 acres is also provided. Netting impediment not included.

PVC TUBE IMPACTS Cont'

- Alteration of physical structure
- Alteration of physical processes
- Alteration of benthos and community structure
- High potential for and loss into the marine environment (plastic pollution)
- Potential for impacts to juvenile salmonids
- Aesthetics

NETTING IMPACTS

Multiple studies of netting on bivalve culture

Bendell-Young (2006):

- **Lower species richness, different bivalve composition, abundance, distribution**
- **Change in benthic community composition**
- **Greater accumulations of organic matter and silt, suggesting simplification of benthic community**
- **Fouling with dense layers of algae further alter habitat**
- **Netting is possibly the most invasive of all aquaculture practices**

NETTING IMPACTS CONT'

Spencer et al. (2011)

- **Netting led to a change in benthic community composition consistent with organic enrichment**
- **Suggest that inter-specific competition is a likely outcome of netting-induced changes in benthic community**

Simenstad and Fresh (1995)

- **Mean grain size finer (muddier) from decreased resuspension and trapping of fines**
- **Distinct differences in species composition between netted and control plots, attributed to presence of nets**

Entanglements: A Known Impact

Summary

PREDATOR NET IMPACTS

- Structural impacts similar to other aquaculture structures
- Modification of physical and biological processes
- Modification of benthic structure, community, and associated functions
- Loss of prey availability/feeding opportunities
- Modification to food web, energetics, nutrient exchange
- Entanglement, injury, or death
- Threat to water quality (plastics in addition to changes in sediment and water chemistry)
- No mitigation

MAINTENANCE IMPACTS

- Pressure washing and/or brushing of netting to remove living “biofouling” organisms, including algae, invertebrates, eggs, and other living matter
- If activity is conducted on the beach, organic matter is left to rot
- If done on dry beach, or uplands, exposure will desiccate organisms
- Increases susceptibility to predation
- Increased nutrient loading
- Disturbance to wildlife, trampling

Summary
MAINTENANCE IMPACTS

- Alteration of benthic structure and community composition
- Highly likely lethal or sublethal effects to organisms removed, additional trampling impacts
- Potential increase in nutrient input
- Potential disturbance to wildlife
- Known loss of equipment (i.e., maintenance does not prevent the loss of some materials)
- No mitigation

HARVEST IMPACTS

- Liquefaction of the beach
- Walking, dragging equipment, placement of equipment, vehicles/vessels on beach all have the potential to crush or injure infauna/epifauna
- Change in benthic community composition and soil structure
- Siltation/water quality

Taylor Foss operation water jet harvest, obvious sediment plume, northern edge of Foss property. 8/14/07

HARVEST IMPACTS CONT'

Commercial geoduck harvest: summary of impacts from Willner (2006) and DNR (2001)

- **Organisms are exposed to predation, may be crushed, injured, displaced, or killed;**
- **Habitats are destroyed by breaking up habitat structural complexity and cohesiveness of the substrate;**
- **Late successional assemblages of organisms are reduced, resulting in a change in species diversity and functions;**
- **Long-term changes (many months) in community structure and dynamics can be expected;**
- **A change in benthic systems results in a change in pelagic systems (i.e., feeding, growth, survival)**
- **The release of eggs and cysts stored in sediments may upset the pelagic community (e.g., low DO, increased HABs, food web interactions)**

Summary
HARVEST IMPACTS

- Benthic communities are not adapted to this type or intensity of disturbance (equivalent to a large earthquake or tsunami)
- Causes injury, death, or relocation of benthic organisms
- Increases susceptibility to predation, injury, or death
- Substantial time is required to recolonize to a natural state (not likely to occur)
- Loss of ecosystem functions
- No mitigation

ASSOCIATED RISKS

CLAM DENSITY

- Do not occur naturally in these densities
- Competition for food/space resources; zooplankton consumption

DISEASE AND PARASITES

- Proximity and concentration increases risk
- Ease of transmission through water

GENETIC RISKS

- Selection of brood stock not the same as natural selection
- Likely to result in lower genetic variability
- Likely to cross breed with cultured and wild stocks

ASSOCIATED IMPACTS

- BIRDS
- FISHES
- BENTHIC COMMUNITIES
- MARINE MAMMALS
- WATER QUALITY
- AESTHETICS
- PUBLIC ACCESS

Shorebirds

http://upload.wikimedia.org/wikipedia/commons/4/43/Calidris_alpina_juv.jpg

http://upload.wikimedia.org/wikipedia/commons/1/10/Melanitta_perspicillata.jpg

- Over 70 species of P.S. nearshore birds listed by Buchanan (2006)
- Many species are in decline
- All have direct or indirect associations with beaches (food production/feeding, breeding, resting, roosting, refuge, migration)
- All are sensitive to disturbance and habitat alterations
- In addition to intrinsic values, bird-watching is a significant economic activity in Washington

Shorebird Impacts

- Change in potential prey species abundance
- Exclusion; reduction in prey availability
- Disturbance
- Increased energy demand seeking food, shelter, etc elsewhere
- Potential entanglement in gear
- Potential ingestion of plastics

Summary
FISH IMPACTS

- Nearshore fishes utilize nearshore habitats for feeding, reproduction, refuge, and migration. Alteration of nearshore habitats can alter prey production/availability and reduce opportunities for reproduction and refuge.
- As nursery areas, the addition of structure could increase risk of predation to juvenile fishes.

BENTHIC COMMUNITY

- **Benthic infauna and epifauna comprise a diverse assemblage of taxa; play important roles in the food web, community dynamics, and provision of ecosystem processes and functions**
- **Anthropogenic stressors (e.g., physical disturbance, changes in habitat or habitat conditions) are known to effect the viability, stability, productivity and provision of ecosystem functions (Williams et al. 2001; Dethier 2006; and others)**
- **It has already been established that each of the geoduck mariculture activities impose a suite of stressors**

Sand Dollars

Dentraster excentricus

- Sand dollars are native, patchy, and may be in decline
- They are important ecosystem engineers
- They are fragile and have specific habitat requirements
- Were found in very high density (dominant) at site

>One Million per acre

Sample #	Collection point	Tidal Elevation	Sand Dollar Count
1	South	0.0	96
2	South	-2.0	64
3	North	+2.0	11
4	North	0.0	74
5	North	-2.0	62

Summary
BENTHIC/EPIBENTHIC IMPACTS

- Organisms will be crushed, cut, trampled, injured, or killed
- Organisms will be relocated, or otherwise displaced
- Habitat will be altered
- Benthic community structure and dynamics will be changed
- Activities will result in competition for food and space resources
- Result will be an alteration/loss of ecological processes, structure, and functions
- No Mitigation

Summary
NEARSHORE MAMMAL IMPACTS

- Altered habitat, food availability and supply
- Exclusion from food supply and foraging or resting area as a result of disturbance (people, vessels) & alteration of beach
- Entanglement in nets

IMPACTS – WATER QUALITY

- **Aquaculture can be a significant contributor of plastics debris in the ocean; the most likely site for generation of microplastics in the marine environment is the beach (Andrady et al. 2011)**
- **Biodeposition and artificial structures alter sediment chemistry and composition (Straus et al. 2008)**
- **Harvest releases silt, eggs and cysts (Willner 2008)**
- **Microplastics laden with high levels of POPs can be ingested by marine biota (Andrady et al 2011)**
- **Activities result in altered nutrient exchange/loading**

Summary
WATER QUALITY IMPACTS

- Intensive cultivation of geoduck clams has a high likelihood of adverse impacts to both sediment and water quality.
- The large amount of plastics used in intensive geoduck farming is highly likely to result in the release of plastic particles, meso- and microplastics into the marine environment, especially considering their position in the intertidal and shallow subtidal nearshore environment, where wind, waves, currents, sand abrasion, ultraviolet light, driftwood and other debris are likely to cause degradation and loss of plastics.
- Alteration of sediment and water chemistry changes habitat conditions, which is likely to result in a change in species composition and habitat utilization.

Summary
WATER QUALITY IMPACTS CONT'

- Cultivated geoduck clams may contribute (via biodeposition of feces and pseudofeces) to altered sediment conditions (chemistry, habitat quality for other organisms), including higher sediment ammonia concentrations, increased organic carbon, sediment oxygen demand, anoxia, increased dissolved nutrients in the water.
- Mariculture is an important vector for diseases and parasites, especially with intensive, high density operations. Such operations are highly likely to greatly increase the risk of disease and parasites in cultured and wild stocks.
- No Mitigation

Summary
AESTHETIC IMPACTS

- The aesthetics of the nearshore will be modified as a result of the modification of the beach and placement of predator exclusion structures
- It is likely that wildlife viewing may be altered as a result of geoduck mariculture disturbances
- No specific studies; No Mitigation

Summary
PUBLIC ACCESS IMPACTS

"Mariculture projects require that such public waters be closed to public access. However, coastal waters have traditionally been considered public property, with access and harvesting (both recreational and commercial) available to all." (Hastings and Heinle 1995)

- **Public access will be restricted/removed, including walking, navigation, fishing/harvesting, and other forms of recreation.**
- **No Mitigation**

SUMMARY OF IMPACTS AND DETERMINATION OF SIGNIFICANCE

ACTIVITY	IMPACTS	MITIGATION	SIGNIFICANT
Beach Preparation	YES	None proposed	Likely
Predator Tubes	YES	Inadequate	YES
Predator Nets	YES	None proposed	YES
Maintenance	YES	None proposed	Likely
Harvest	YES	None Proposed	YES
<u>Associated Impacts</u>			
• Birds	YES	None proposed	NO
• Fishes	YES	None proposed	Likely
• Benthos	YES	None proposed	Likely
• Mar. Mammals	YES	None proposed	NO
• Water Qual.	YES	None proposed	YES
• Aesthetics	YES	None proposed	YES
• Public Access	YES	None proposed	Likely
<u>Associated Risks</u>			
Clam density	YES	None proposed	Possibly
Disease and Parasites	YES	None proposed	NO
Genetic	YES	None proposed	Possibly

CYCLE OF MODIFICATION/DISTURBANCE

- **Each activity in the process of geoduck aquaculture has its own set of impacts, which results in various temporal and spatial effects**
- **These individual activity effects are likely to be additive or synergistic with other activities, resulting in cumulative impacts and causing further alteration to nearshore ecosystems, likely beyond the temporal and spatial scale of the farm**
- **Since it can be anticipated that the farm will not be used for a single planting-to-harvest cycle, the modifications, and resulting changes in nearshore processes, structure, and functions, will likely be altered beyond the life and area of the project.**

CUMULATIVE IMPACTS

- Includes additive and synergistic effects
- Considers type, intensity, and duration
- Considers scale; both spatial and temporal

SUMMARY

The proposed geoduck farm is highly likely to result in significant cumulative impacts on environmental quality when accounting for additive and synergistic effects both within and beyond the site.

Part III
Additional Review and Comments

- Geoduck research: What it tells us, and what it doesn't
- Hearing Examiner's decision
- Summary and Conclusions

Harvest Impacts

Van Blaricom et al.

Results

Only modest effects on infaunal communities from harvest

Some species showed reduction in abundance

Some species showed increases, while other showed decreases in different plots at different times.

VanBlaricom et al. Caveats

- Caution that the projection of results to larger spatial or temporal scales may be inappropriate, including surface areas larger than a single plot
- Data may not provide sufficient basis for extrapolation to series of successive aquaculture cycles

Additionally, location, time period, contrasting results with other studies, sampling methods, and attributed differences leaves many gaps and questions.

PVC TUBE and NET IMPACTS

Aquaculture structures are known to cause a modification of habitat and resulting changes to the benthic sediment composition, sediment chemistry, species composition, nutrient exchange, porosity of sediments, permeability, oxygen content, bacterial content, and other effects (Simenstad and Fresh 1995; Spencer et al. 1996; Spencer et al. 1997; Goulletquer et al. 1999; Bendell-Young 2006; Dumbauld et al. 2009; Straus et al. 2011).

McDonald et al.

Tube & Net Impacts

Results:

- **A significant difference in transient fish and macroinvertebrate communities between culture and reference plots.**
- **The structured phase of geoduck aquaculture significantly impacts the abundances and composition of mobile fauna.**
- **Density of resident infauna and epifauna lower on culture plots (contrast w/VB study)**
- **Differences attributed to structure and other possible physical/chemical alterations.**
- **Recovery over time after gear removal.**

McDonald et al.
Caveats

- Not measuring all faunal changes associated with aquaculture gear –therefore not a good measure of community composition.
- Physical and chemical variables (e.g., sediment grain size, pore water nutrients) that may contribute to site-specific differences were not examined in the present study – further study needed.
- The habitat value of unstructured areas to certain taxa cannot be overstated.
- Does not account for repeated, or longer term changes (e.g., cumulative impacts)

McPeek et al.

Staghorn sculpin feeding

Results:

- **The structured phase of geoduck aquaculture initiated some changes to staghorn sculpin ecology**
- **General food web function of sculpin remained unchanged**

McPeek et al. Caveats

- It is important to note that the present study is based on data from one prevalent member of the fish community with a generalized diet. Nearshore fishes with specialized diets may experience more dramatic impacts compared to staghorn sculpin. For example, a specialist feeder seeking corophium amphipods could be more limited in aquaculture areas compared to the opportunistic staghorn sculpin.
- Results cannot be extrapolated to forecast the impacts of geoduck aquaculture operations in close proximity or repeated farming activities in the same location
- Aquaculture structures likely caused a sampling bias
- with increasing density, disturbances from geoduck aquaculture could exceed the natural disturbance regime of the system and significantly impact trophic dynamics
- structures will reduce preferred habitat and foraging efficiency of certain organisms

Hearing Examiner's Determination

Counties review of environmental impacts was thorough

Marine debris impacts mitigated by permit condition

Appellate did not comment on proposed conditions of SDP or regulatory role of other agencies

Coalition equates possible "relocation" with "removal" of wildlife: county advised that removal was not permitted, but minimal relocation of creatures such as sand dollars and sea stars could occur

Beach cleaning/preparation: Proponent responded that no beach cleaning would occur; photos used as examples were of oyster harvest.

Habitat and benthic community structural changes: Proponent argued that data were based upon studies of other shellfish, not geoduck. Van Blaricom testified that the Sea Grant research showed no significant change in species composition or diversity.

Maintenance impacts to benthos, water quality, and attached organisms: Proponent responded that nets are not cleaned in place, but removed to uplands.

Potential impacts to juvenile salmon and other fishes: Decision primarily focused on prey resources for juvenile salmon – accepted testimony of VanBlaricom, who stated that the SG research showed gear did not significantly change salmon prey (not part of the SG studies).

Hearing Examiner's Determination cont'

Despite the witnesses and physical evidence of plastic pollution (along with professional testimony regarding the issues relative to marine plastics) H.E. accepted testimony of applicants witnesses and evidence of no plastics in stomachs of sculpins. Neither testimony had expertise in plastics or plastic pollution, and ignored literature.

Dismissed evidence and personal experience witnessing entanglements

Examiner is persuaded that the mitigation conditions along with the applicants' adherence to those conditions and the various Codes of Ethics, and commitment to cleaning up beaches, will satisfactorily mitigate the impact of any marine debris generated from the site.

Cumulative Impact analysis not necessary because future development (proximal) not yet proposed.

All witnesses professional, forthright, sincere, conscientious and credible in their testimony.(ignored perjury, among other invalid statements)

Expertise in geoduck aquaculture (applicants witnesses) overshadowed nearshore experience and expertise.

Essence of SMA

- **"(…to prevent the inherent harm in development of the state's shorelines"**
- **"…to balance both utilization and protection of shoreline areas throughout the state"**
- ***"…*<u>prevention</u> of damage to the <u>natural</u> environment… the land and its vegetation and wildlife, and the waters of the state and their aquatic life. . ." (emphasis added)**
- **Mitigation**

Summary
SEPA REVIEW

- **The Project applicant and County apparently failed to identify or conduct an adequate review of probable impacts**
- **The County apparently made a determination of non significance based upon misinformation, or a lack of information**
- **The County did not require mitigation for the large number of probable and known impacts associated with the project; required mitigation is inadequate**
- **The applicant and County made no effort to account for and mitigate cumulative impacts (including aquaculture and non-aquaculture, additive and/or synergistic effects)**

Summary

- **The proposed modifications are a conversion/change from natural, functional habitat to industrial aquaculture.**
- **The proposed activities are known stressors, which will result in multiple impacts (not singular) at a large scale (11 acres) and will be repeated perpetually.**
- **There is a high probability that impacts will include both additive and synergistic effects.**
- **Cumulative adverse impacts have not been addressed and are highly likely to be significant.**

Summary continued

- **The SG research, while informative, was narrowly focused and has limits on its usefulness for management.**
- **The County's own Salmon Recovery TAC identifies aquaculture as a stressor**
- **Permit allows multiple activities that will alter the beach, yet county code does not allow beach alterations/modifications.**
- **The County erred in their assumptions, did not conduct an adequate environmental review, and did not require adequate mitigation. Therefore, their determination was invalid.**

CONCLUSIONS

- **The proposed activities will result in a loss of natural habitat, creating fragmentation and a more homogeneous beach.**
- **Repeated events may surpass the ability of the ecosystem to recover and retain its reference state (as stated in Sea Grant Studies)**
- **Letters of concurrence (NMFS; USFWS; USACOE) and consultant report are not based upon any detailed analysis, and only focus on ESA listed spp. and EFH – Not Comprehensive**

CONCLUSIONS

- **SMA requires protection and restoration of shorelines. The proposed actions will result in a modification/change of nearshore habitats and species, perpetually, with zero or inadequate mitigation, and, in my professional opinion, will result in significant impacts at multiple scales**
- **Based upon my review of the literature, proposed practices, familiarity with nearshore ecosystems, and professional experience, the proposed geoduck farm is highly likely to result in significant impacts (> a moderate level), both from individual activities and cumulative effects.**

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Other Exhibits Reviewed:

31. Glen Van Blaricom-Effects of Predator Exclusion Structures As Agents of Ecological Disturbance to Infaunal Communities in Geoduck Clam Aquaculture Plots in Southern Puget Sound
32. Van Blaricom, Evaluation of ecological effects of the harvest phase of geoduck clam aquaculture on infaunal communities in Southern Puget Sound
33. McPeek-Aquaculture Disturbance Impacts the Diet but not Ecological Linkages of a Ubiquitous Predatory Fish
39. Email from WDFW to Risvold-Canopy Netting
40. Power point pictures-Includes pictures of Taylor clearing nearshore for oysters, clams, geoducks, Taylor Shellfish marine plastic debris
41. DeFrancesco et al. Pest Management Strategic Plan for Bivalves in Oregon and Washington (2010)
118. Beverly McCallum February 2015, pictures.
131. Dorn-Longbranch Habitat Assessment Report
141. Applicants SEPA Application
146. Two Pierce County Letters regarding Dutcher Cove-critical salmon habitat
148. Pierce County Hearings Examiner Decision
158. South Puget Sound Recovery Group Chinook & Bull Trout Recovery Approach for the South Puget Sound Nearshore (2000)
160. Email from Sanguinetti-Washington Shellfish/Dutcher Cove Proposed 8.4 Acre Geoduck Operation
162. Simon Fasier-Bendel-November 14 Letter-Response to Environ Analysis
172. NMFS Haley Consulation letter dated November 15, 2013-Respondents Exhibit #5
183. Notice of Application for Taylor/Kingman Case Cove 5 acre clam, geoduck, oyster operation
185. Email from Dept of Ecology-Cumulative Impacts Records request
186. Ecology-Public Records Request-Haley No net loss analysis