

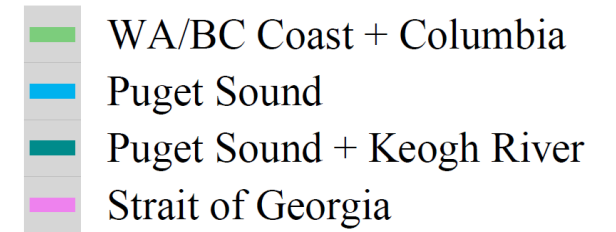
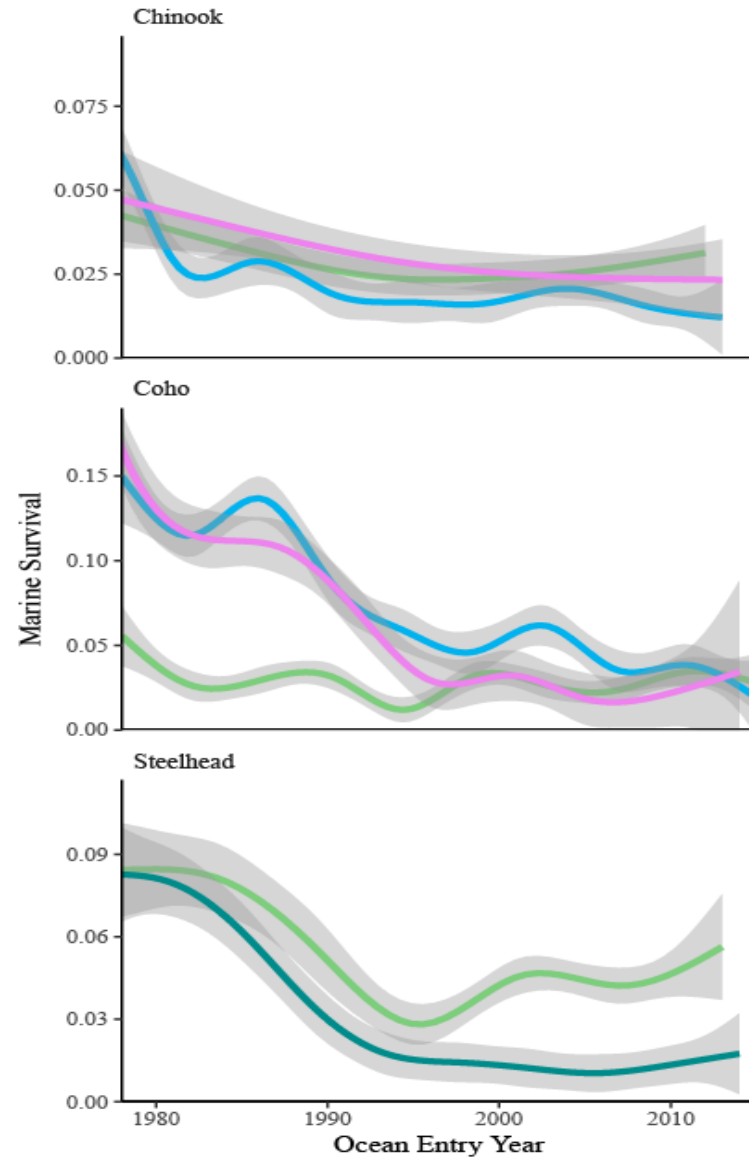


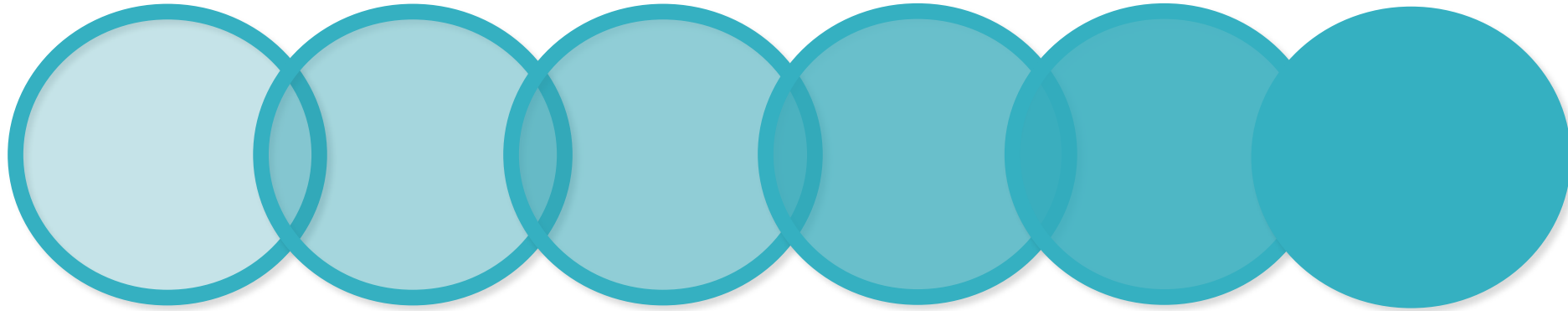
SALISH SEA

MARINE SURVIVAL PROJECT



UP TO A 10X DECLINE IN MARINE SURVIVAL RATES





200+
participants

60+
entities

\$40
million

7
years

2
countries

1
question

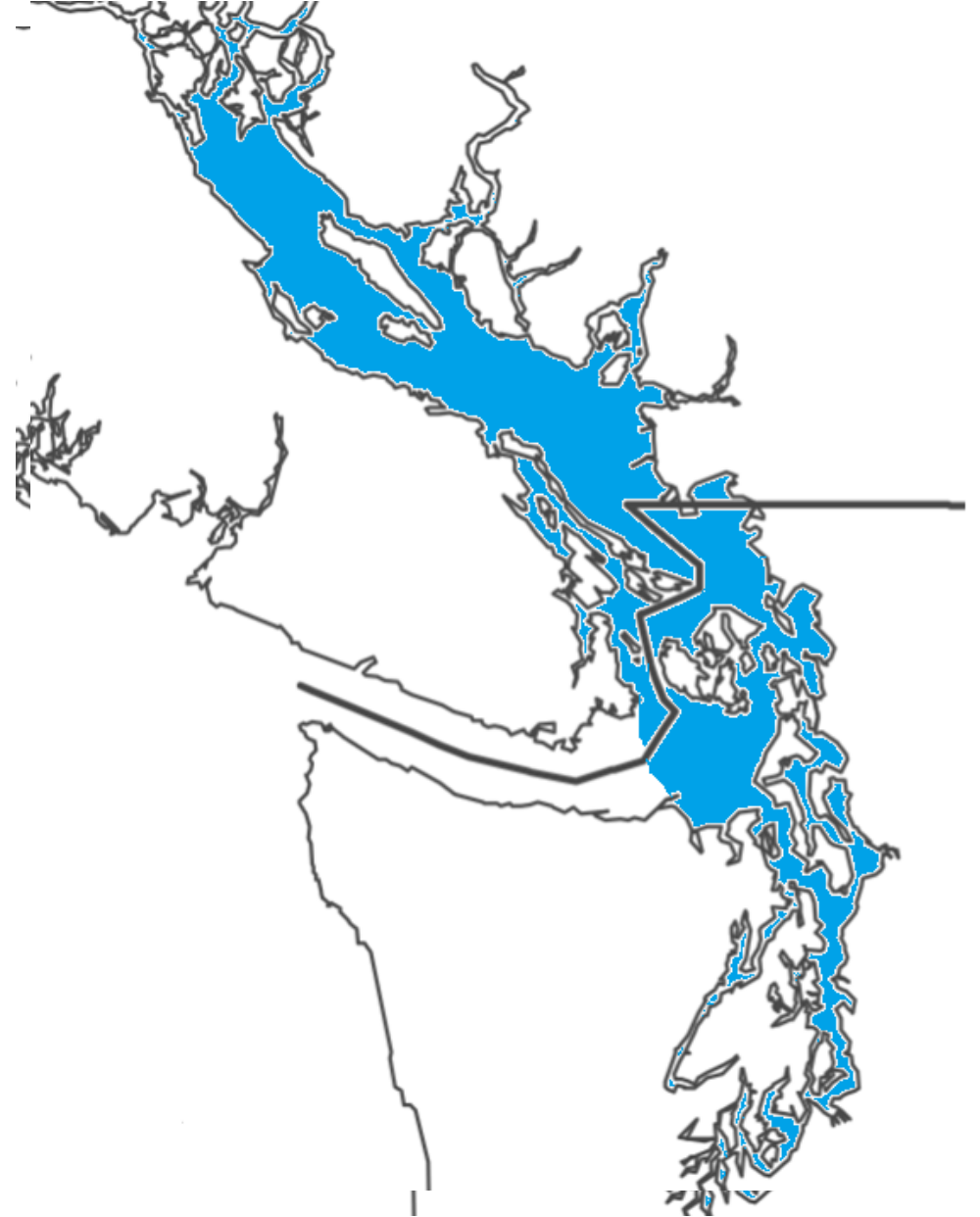
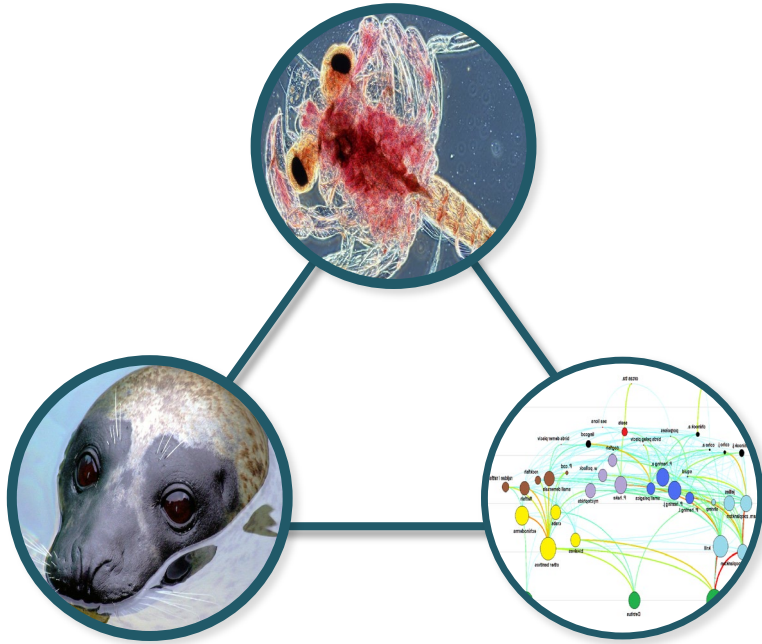
What affects the survival of
young Chinook, Coho & steelhead
in the Salish Sea?



SALISH SEA
MARINE SURVIVAL PROJECT

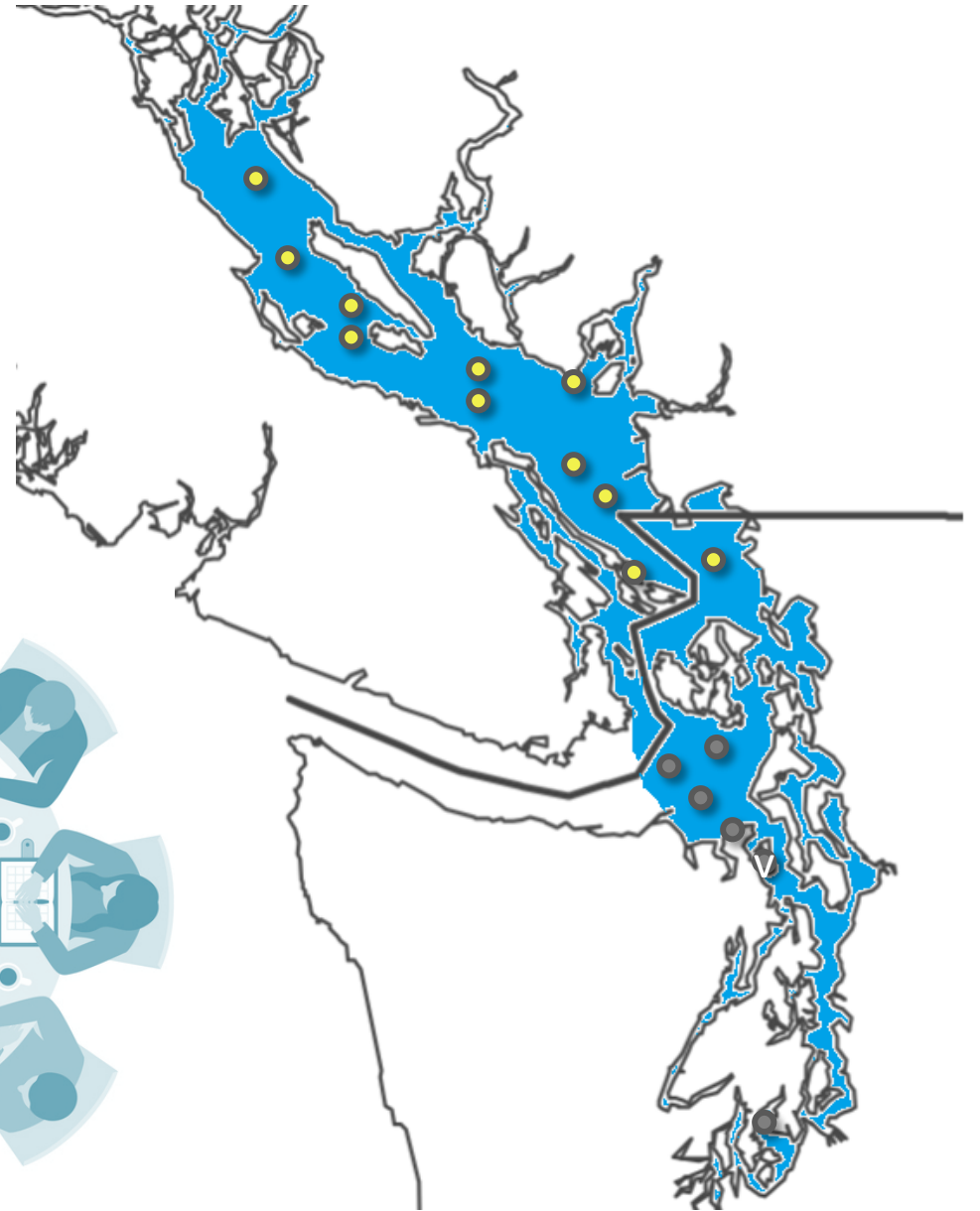
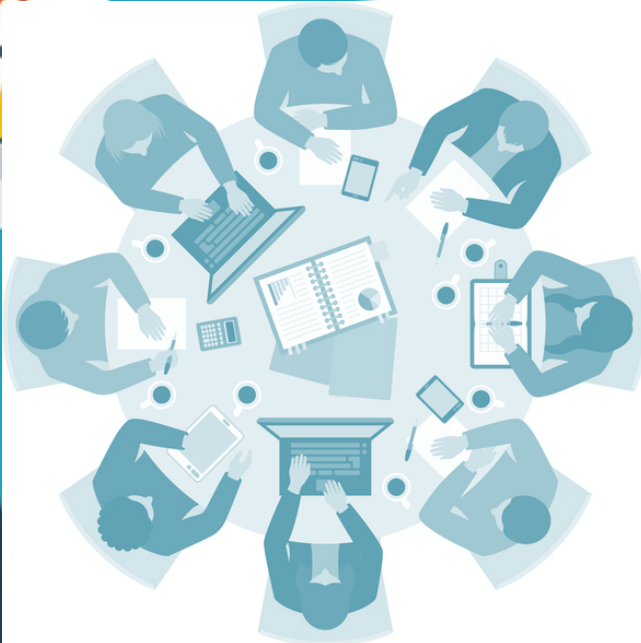
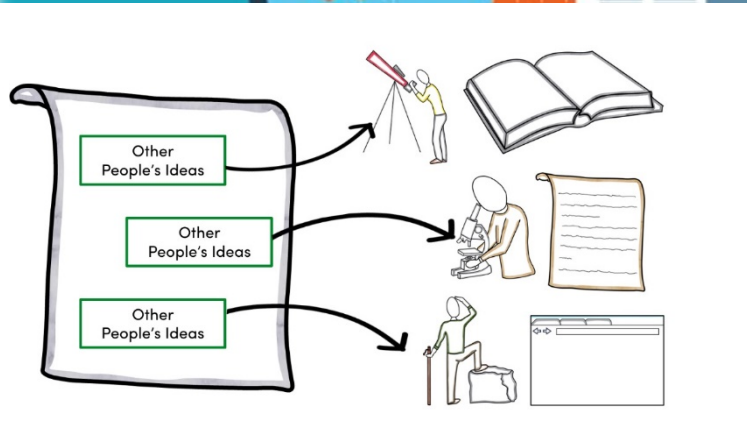


FROM 2014-PRESENT, OVER 90 STUDIES COMPLETED ACROSS THE SALISH SEA



SYNTHESIS REPORT(S) OF STUDIES COMPLETE

- Study Findings
- Opinion of Lead US – Canadian Scientists
- Recommendations for Management Actions, Research and Monitoring



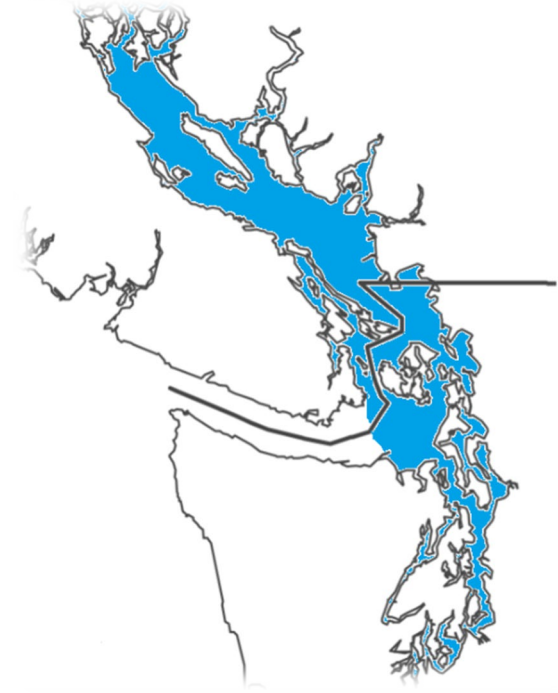
WHAT IS DRIVING LOWER MARINE SURVIVAL?



PRIMARY FACTORS SALISH SEA WIDE

Less food when young salmon
need it most

More predators, more salmon
and steelhead consumed



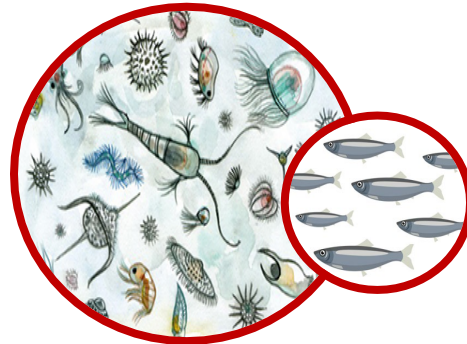
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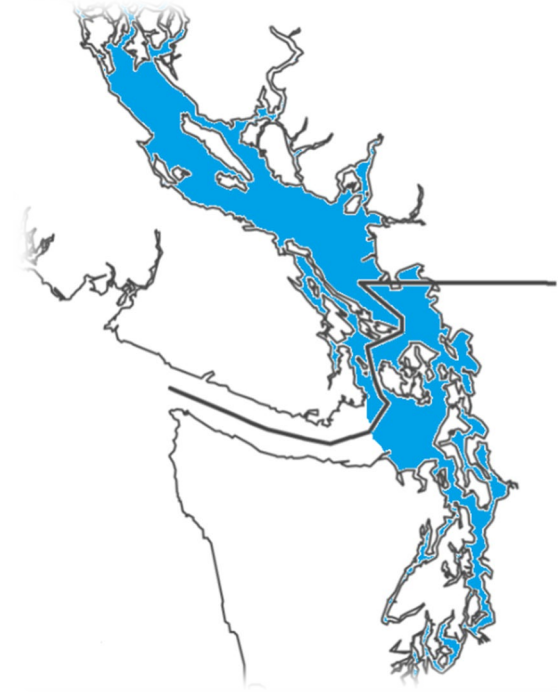
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CONTRIBUTING FACTORS BY SPECIES AND LOCATION



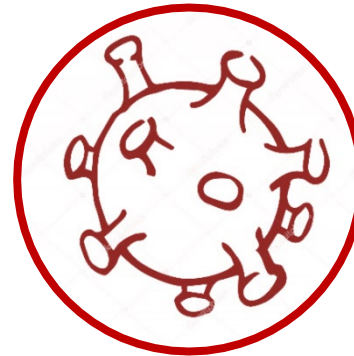
Habitat



Contaminants



Disease



Hatchery Release Timing

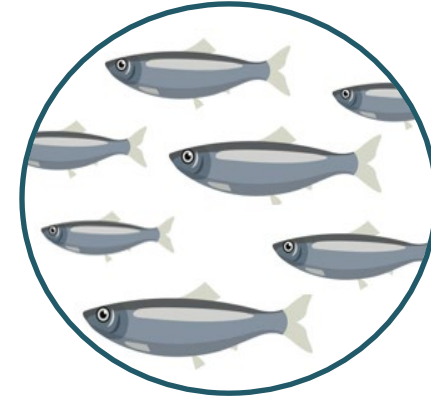


FOOD SUPPLY



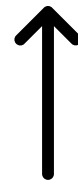
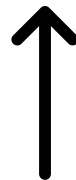
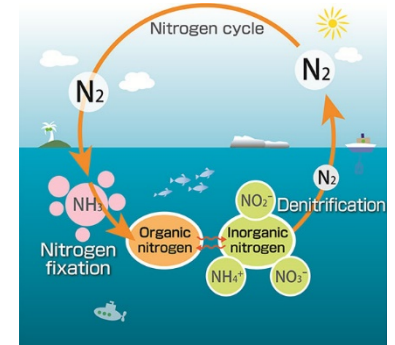
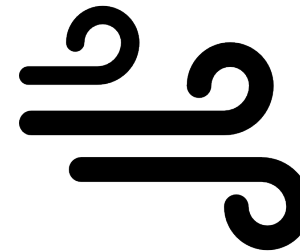
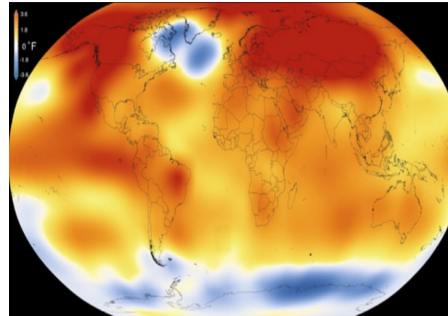
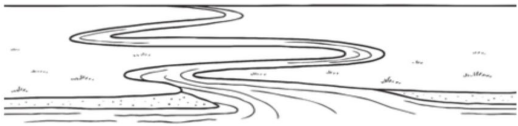
ZOOPLANKTON AND HERRING

IMPROVE GROWTH AND SURVIVAL



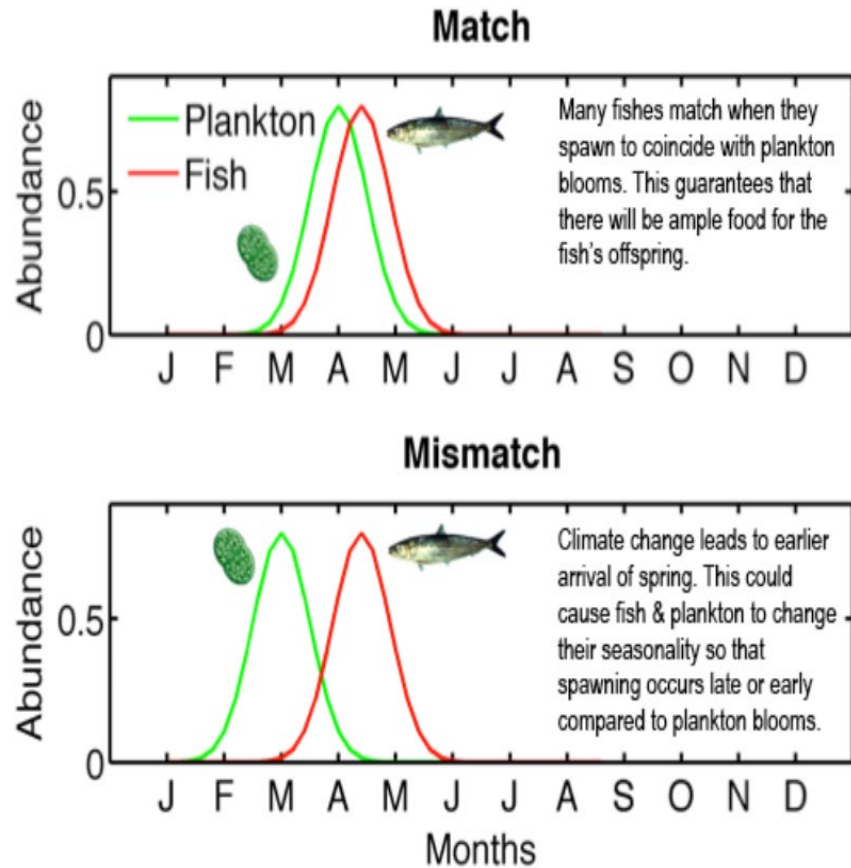


CLIMATE CHANGE AND HUMAN POPULATION GROWTH LIKELY CONTRIBUTING



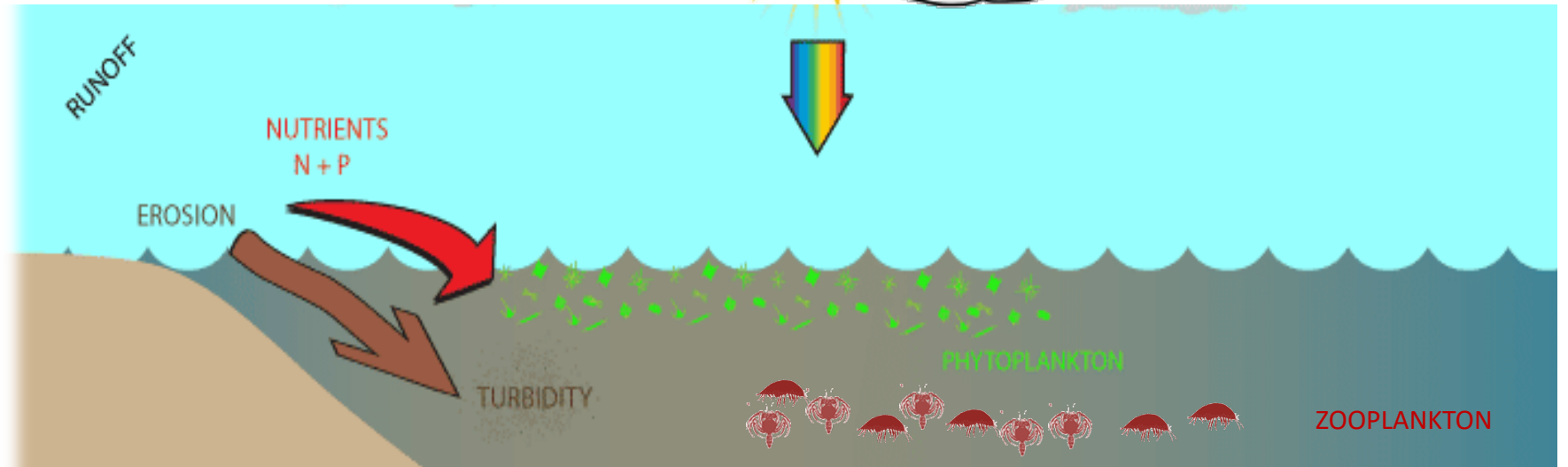
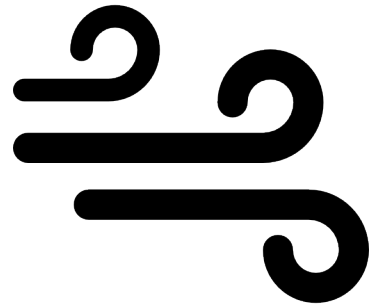
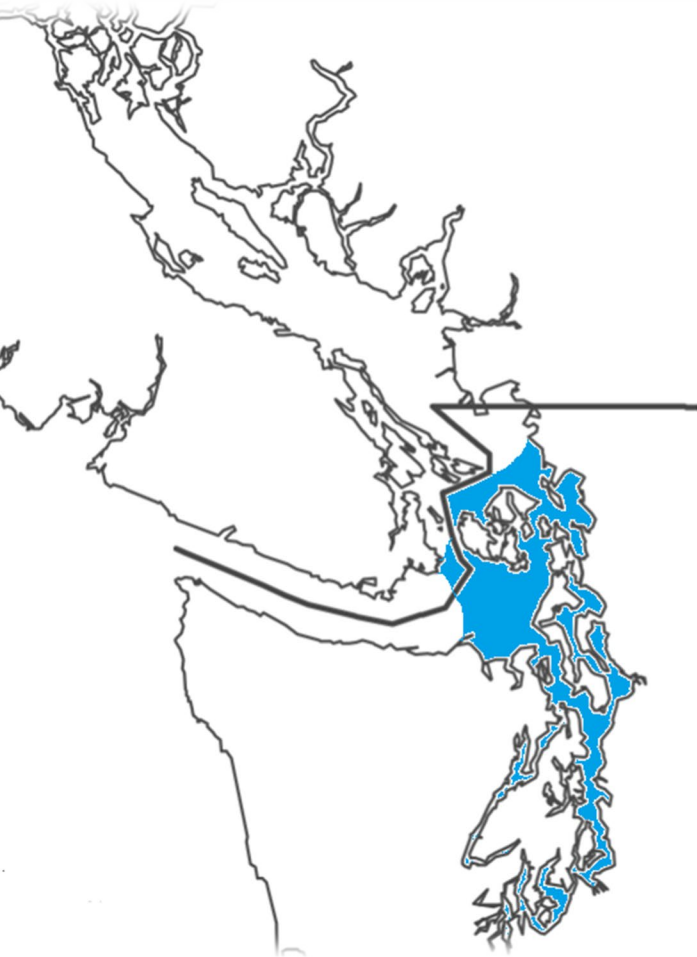


TIMING MAY BE IMPORTANT



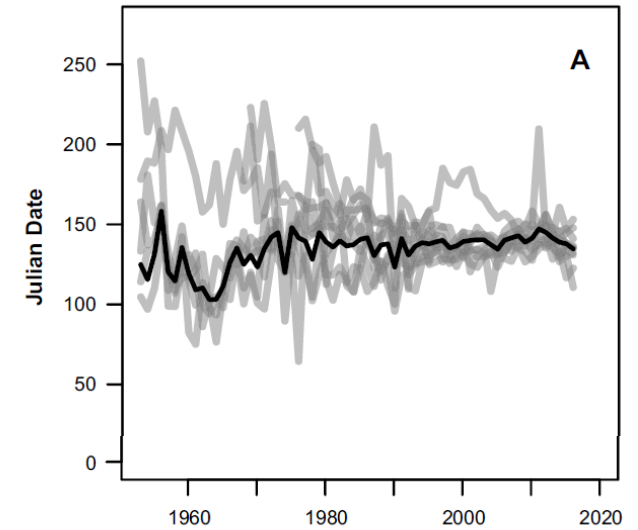
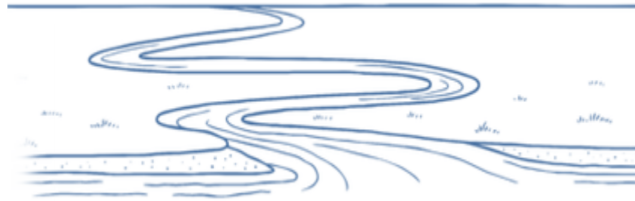


TIMING MAY BE IMPORTANT





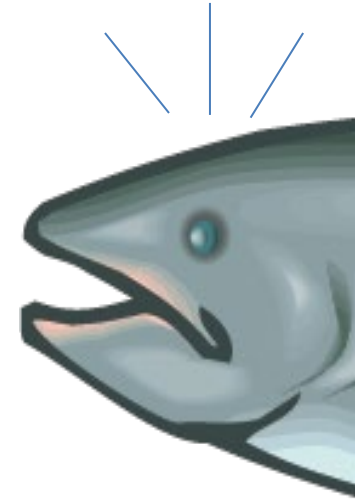
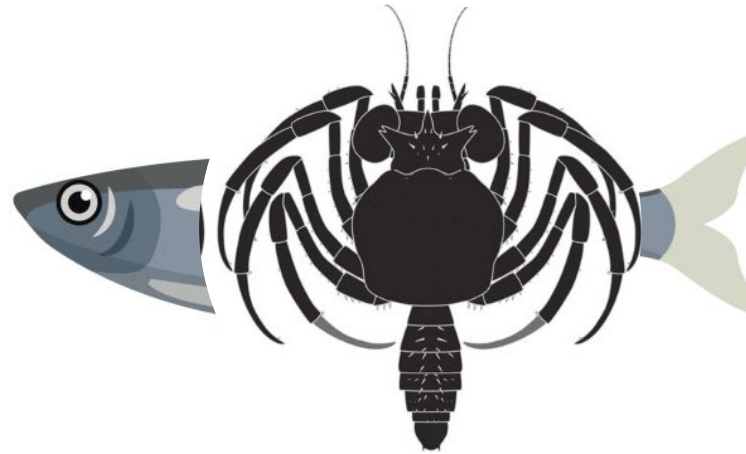
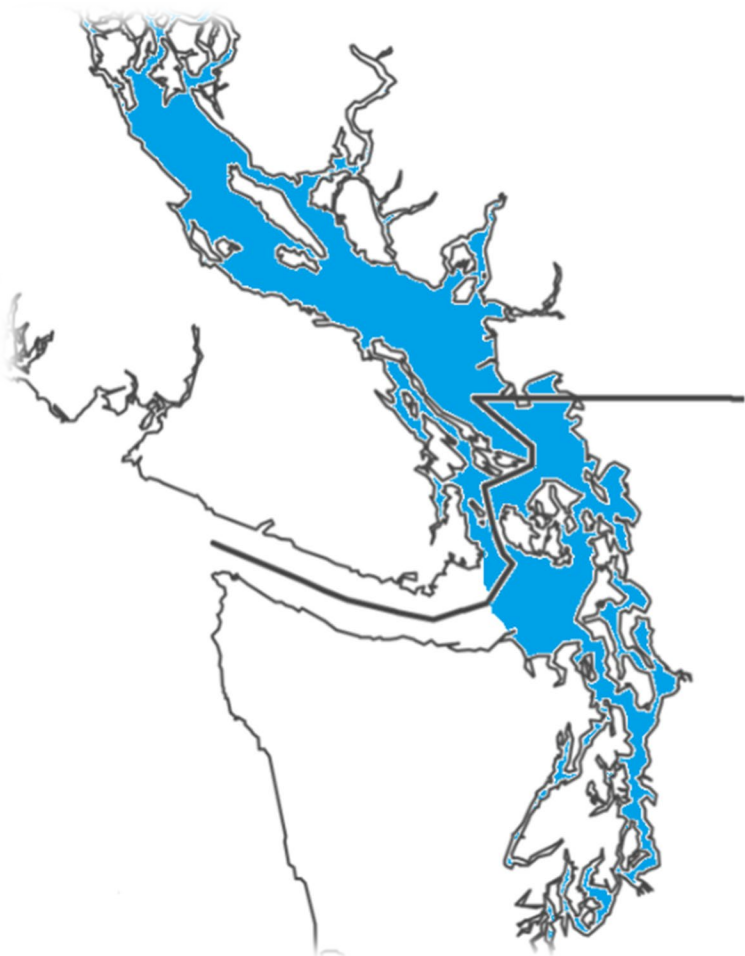
HATCHERY CHINOOK OCEAN ENTRY TIMING HAS CHANGED



Ck

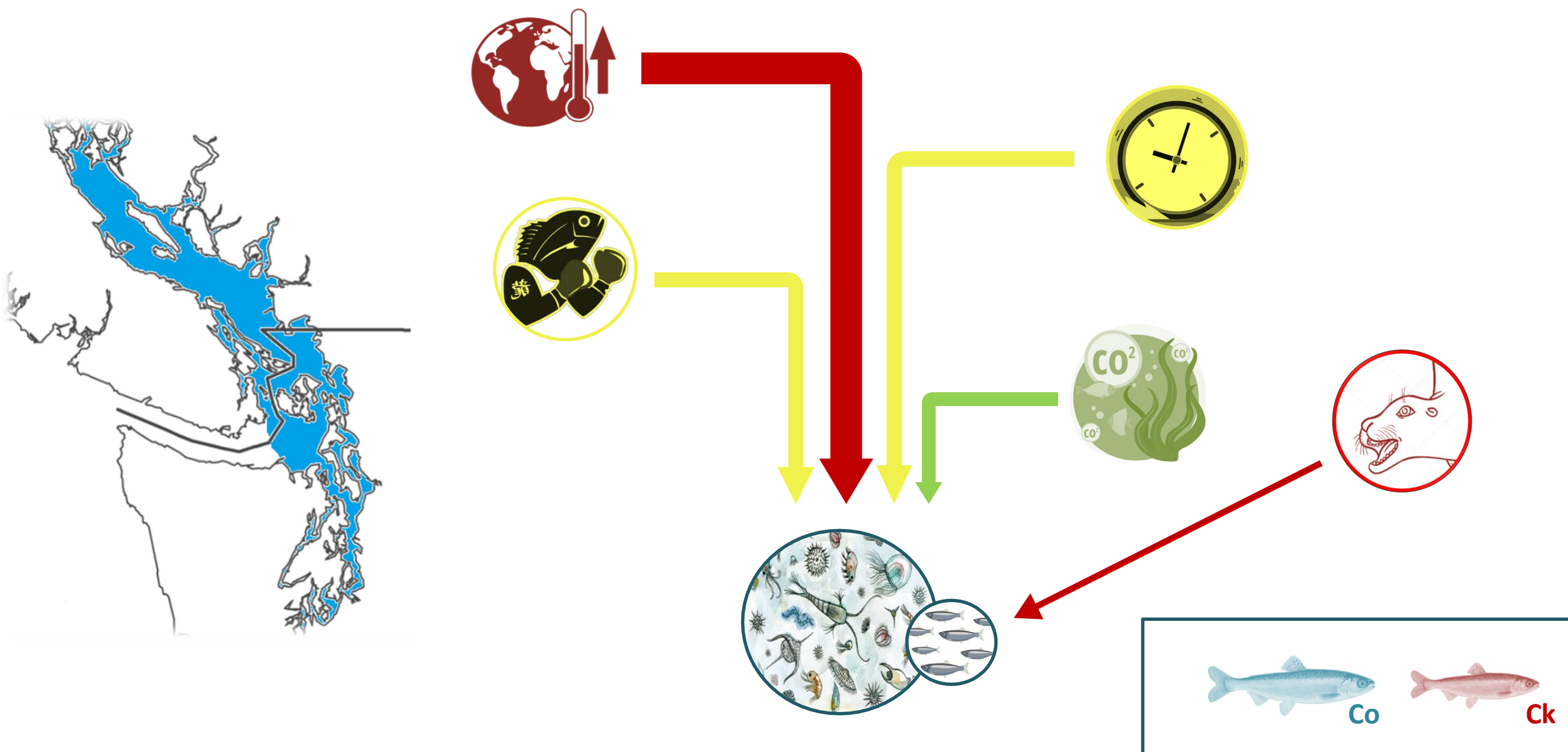


MISMATCH IN SIZE



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FOOD SUPPLY SUMMARY



PREDATION





BIG INCREASES IN HARBOR SEAL ABUNDANCE CORRELATE WITH SALMON SURVIVAL DECLINES

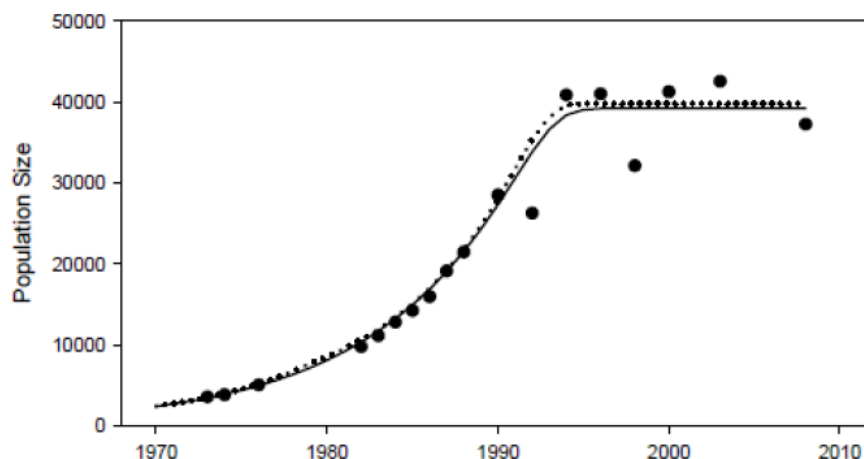
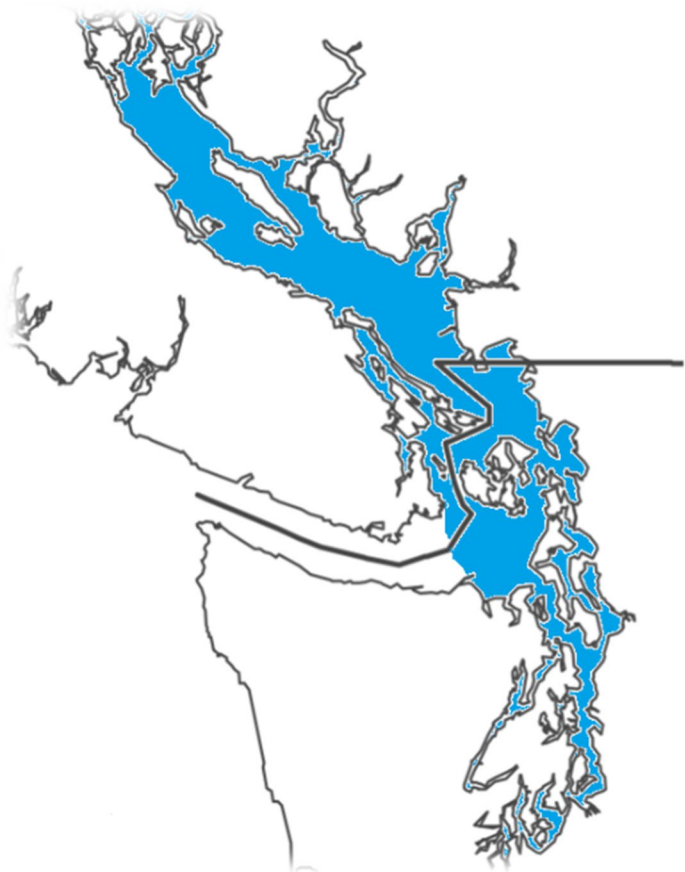


Figure 5. Population trends within the Strait of Georgia. The solid line denotes a generalized logistic model fitted by least squares, and the dashed line represents the sum of abundance estimates from generalized logistic models fitted individually to each of seven subareas (from Olesiuk 2010).



St



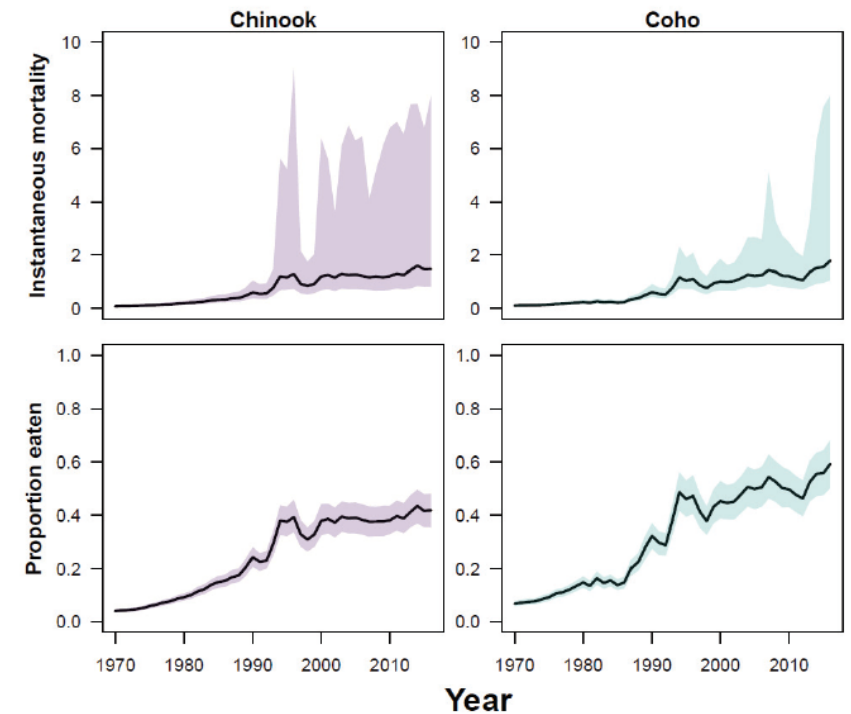
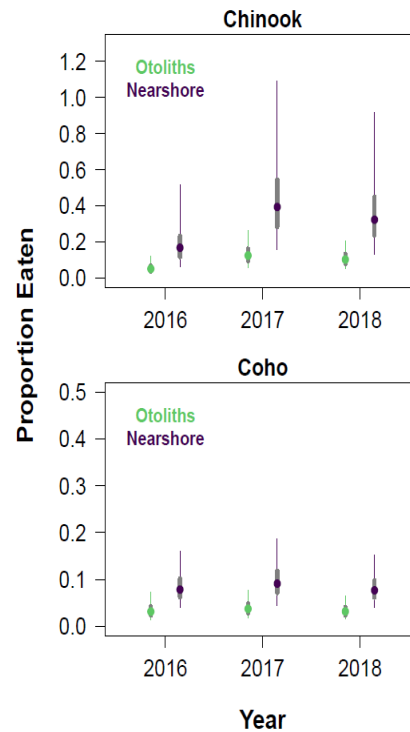
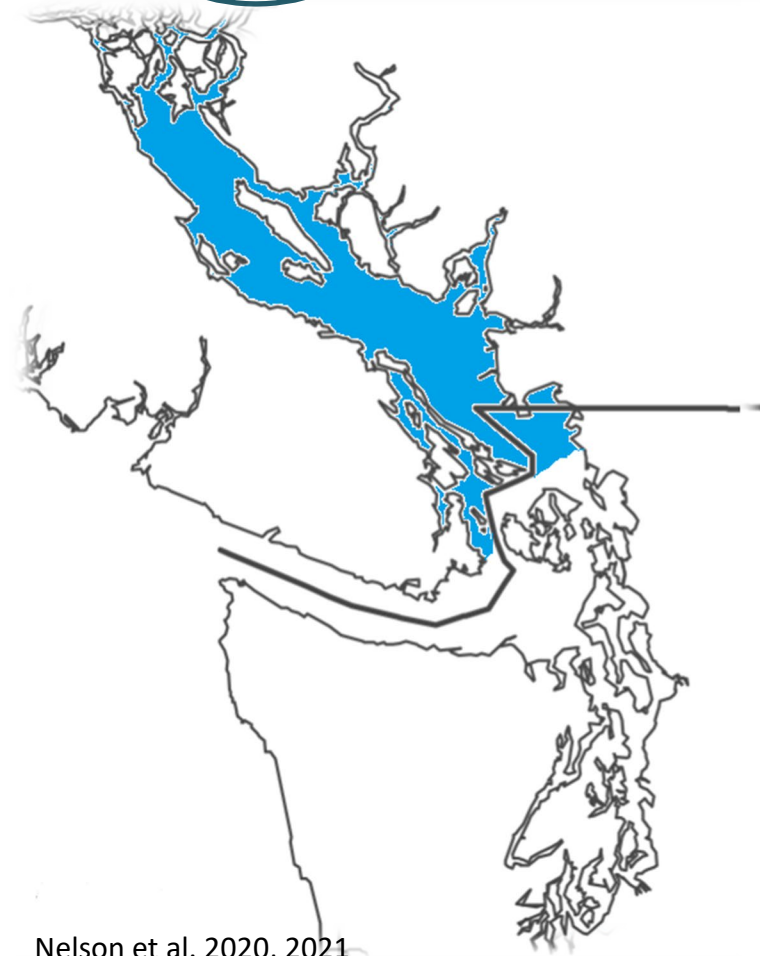
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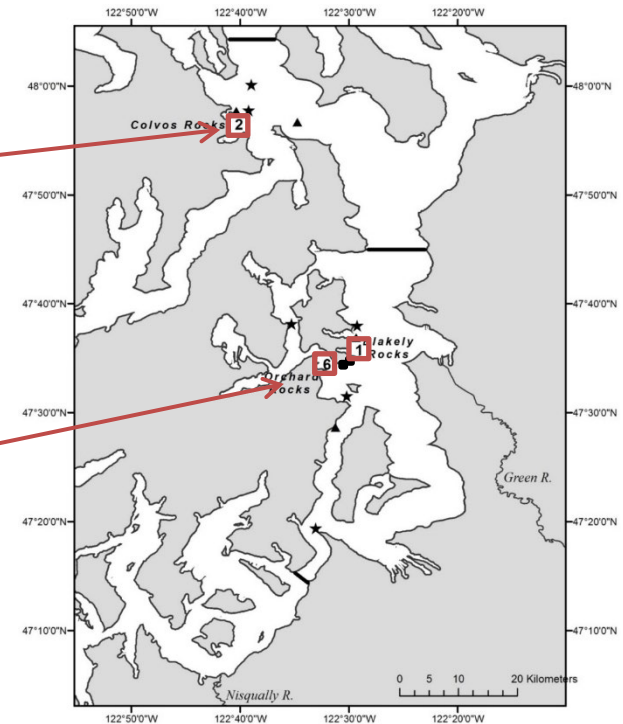
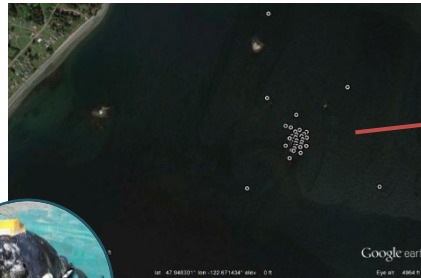
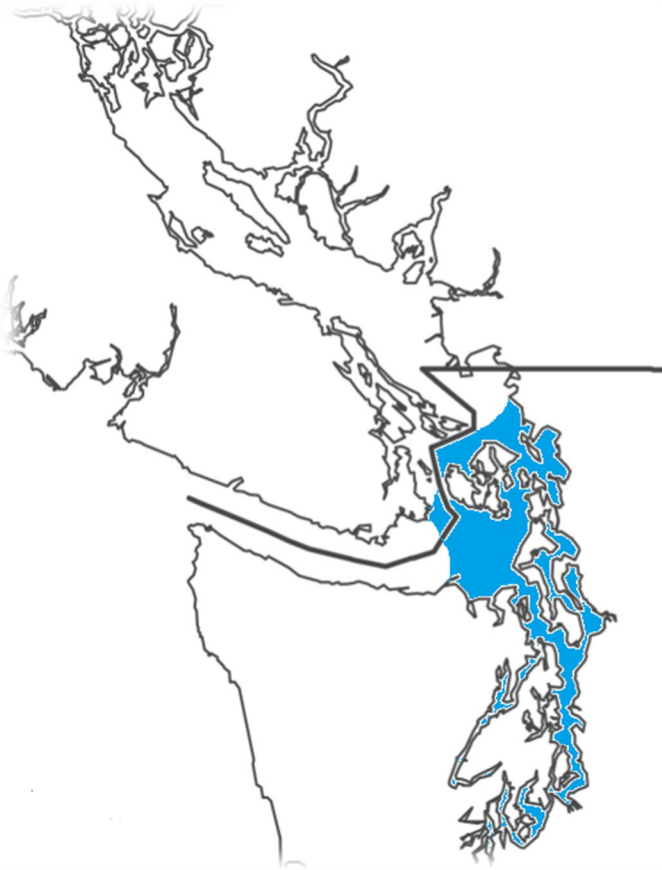


MANY SEALS EATING A FEW SALMON RESULTS IN HIGH SALMON MORTALITY





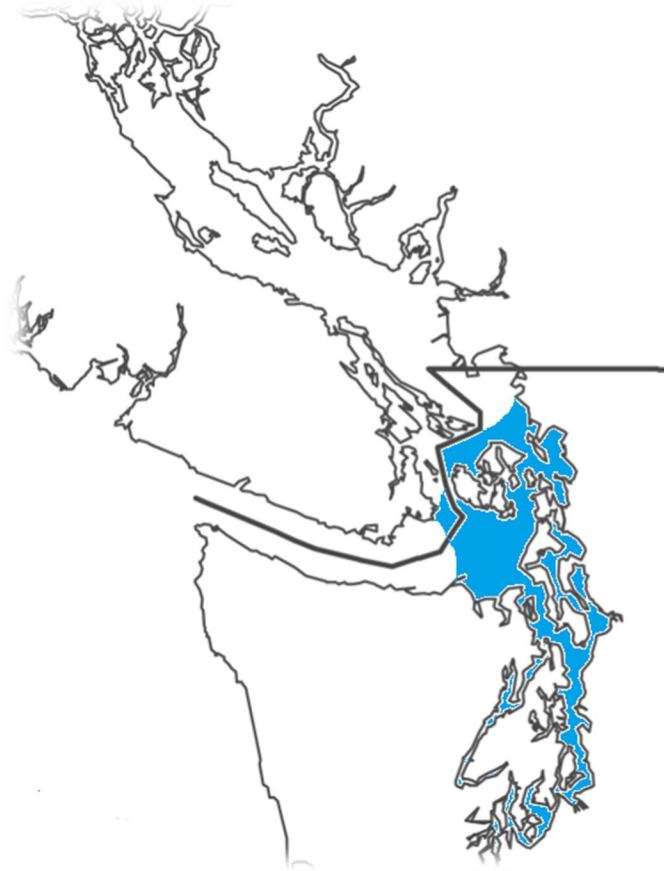
SEALS CONSUME YOUNG STEELHEAD EVEN THOUGH THERE ARE VERY FEW



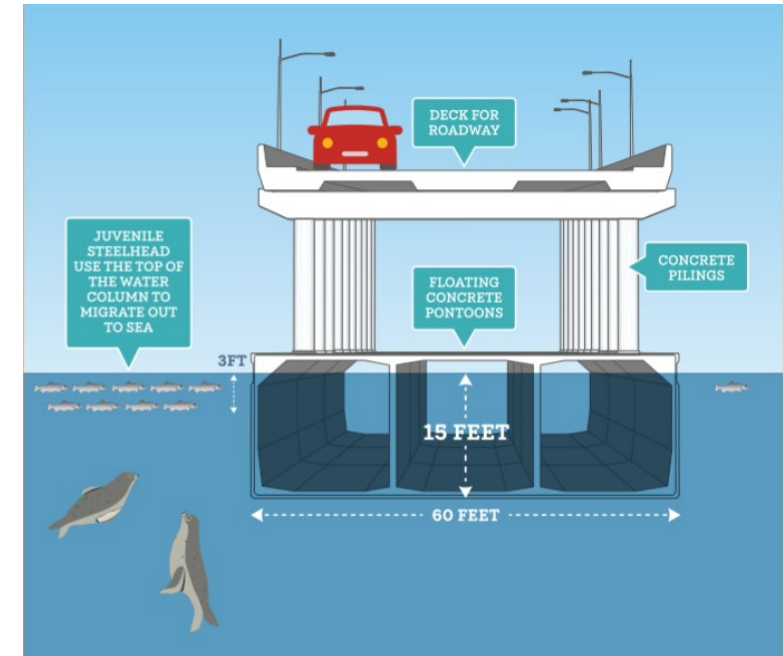
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SPECIALIZATION PRIMARILY A CONCERN AT PINCH POINTS OR MIGRATION BARRIERS



Up to 50% of juvenile steelhead that make it to the Hood Canal Bridge die there.



St



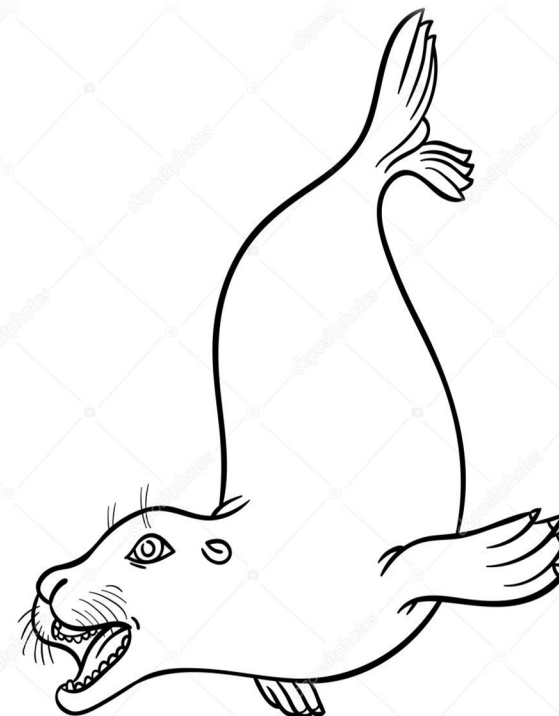
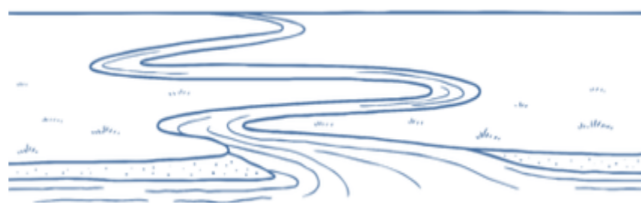
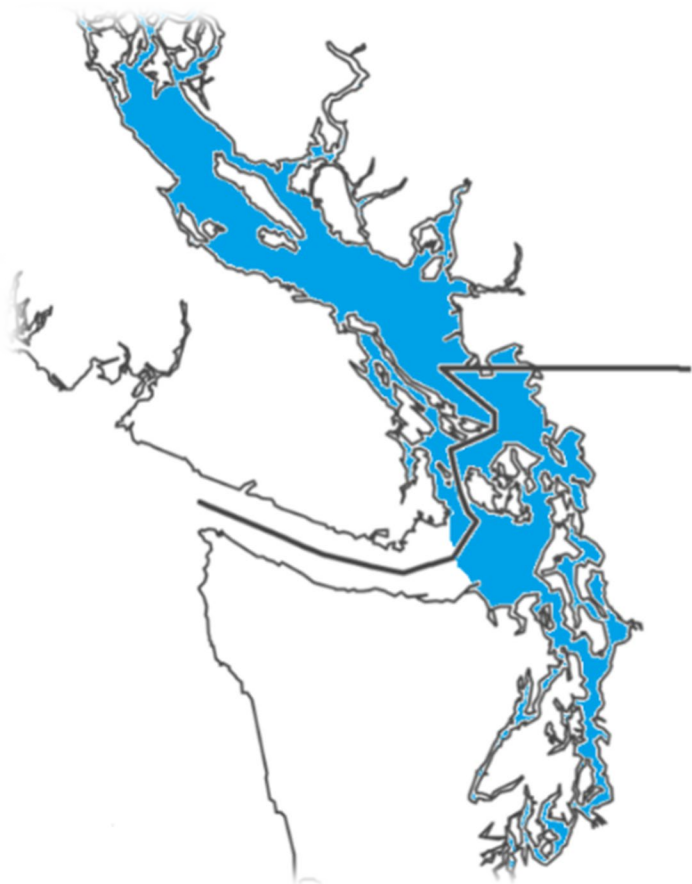
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HATCHERY PULSES COULD ATTRACT PREDATORS



St

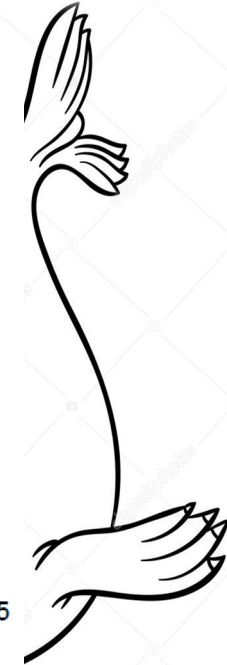
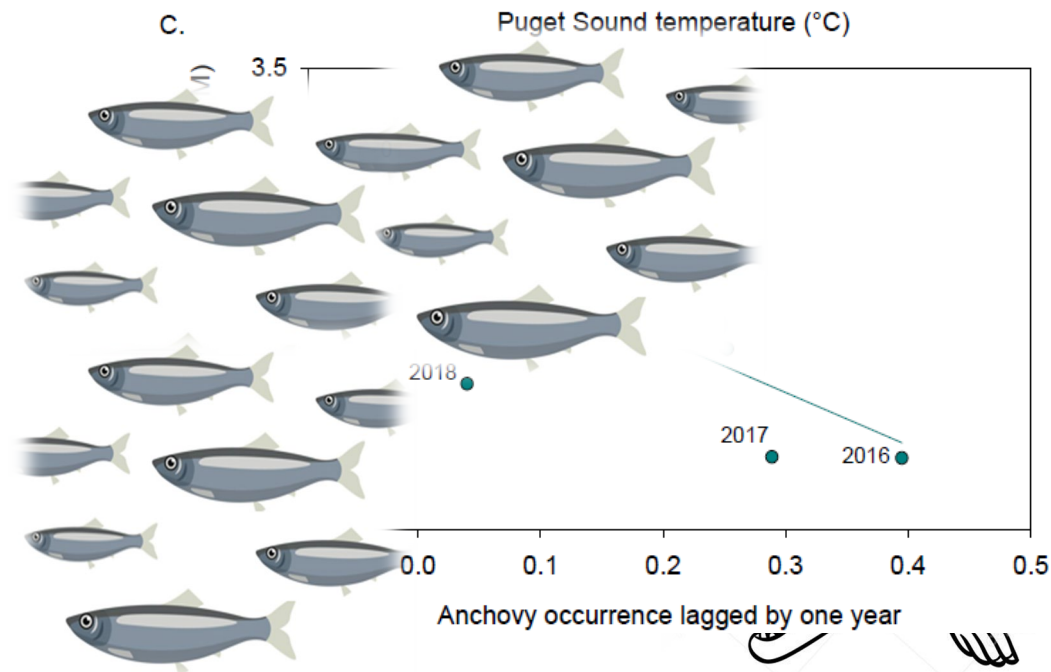
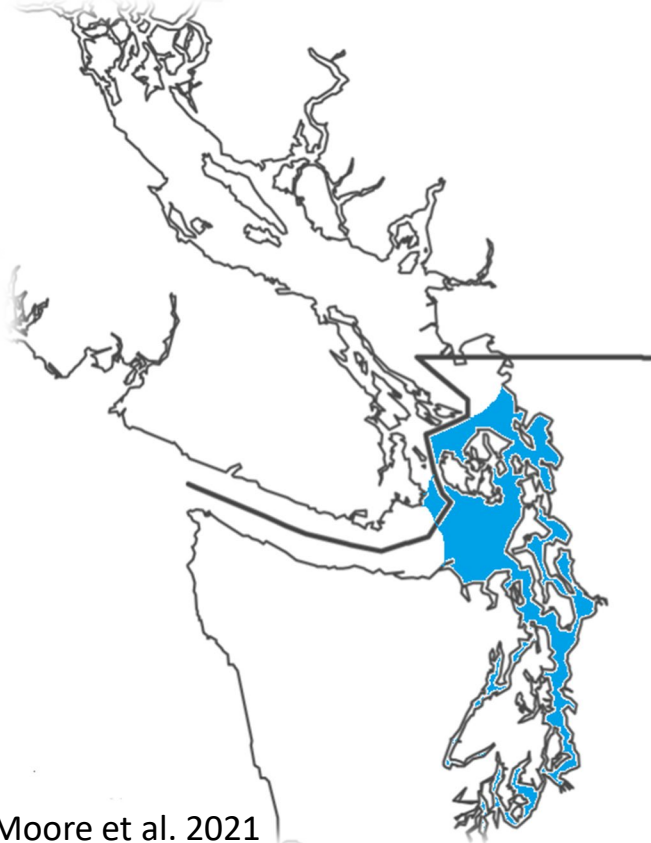
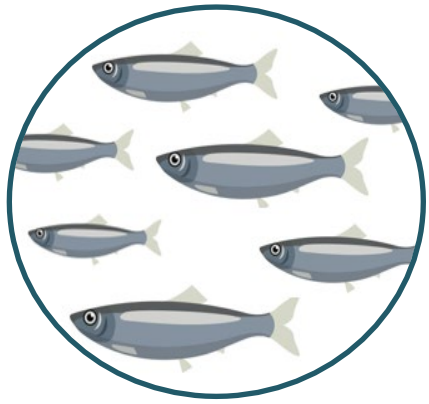


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MORE FORAGE FISH MAY REDUCE PREDATION OF JUVENILE SALMON



St

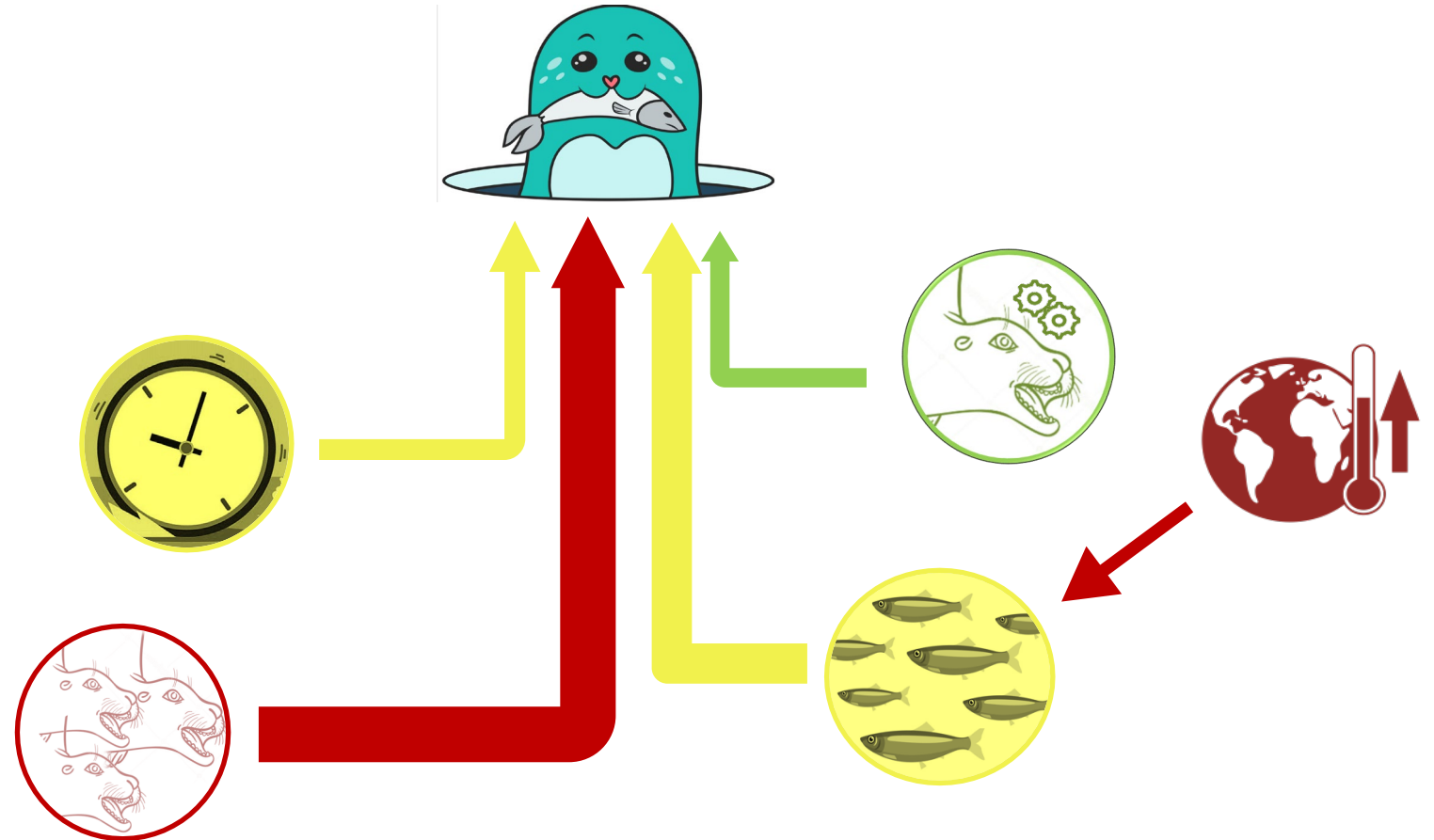
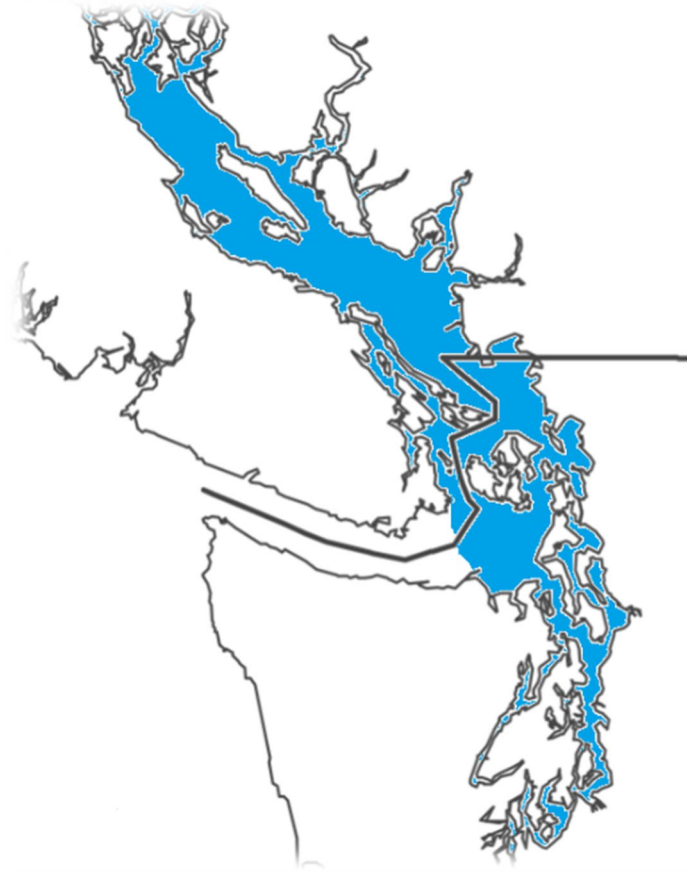


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PREDATION SUMMARY



St

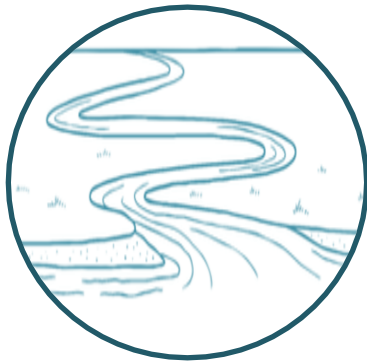


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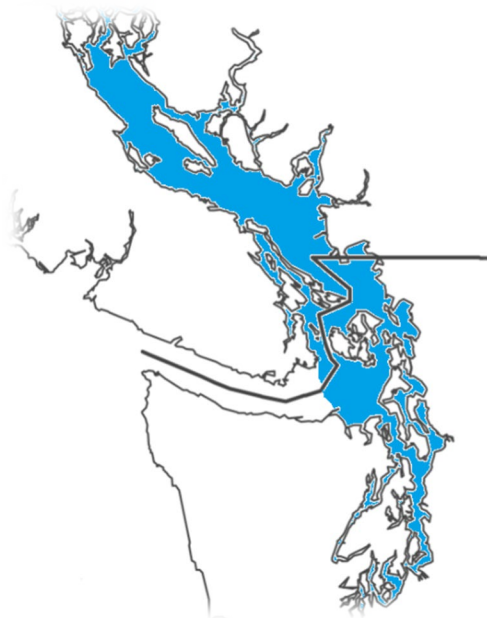
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HABITAT

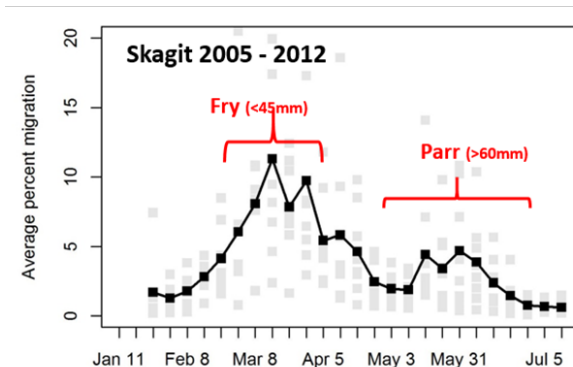
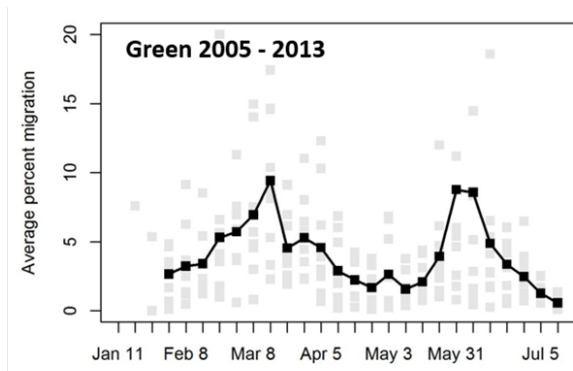




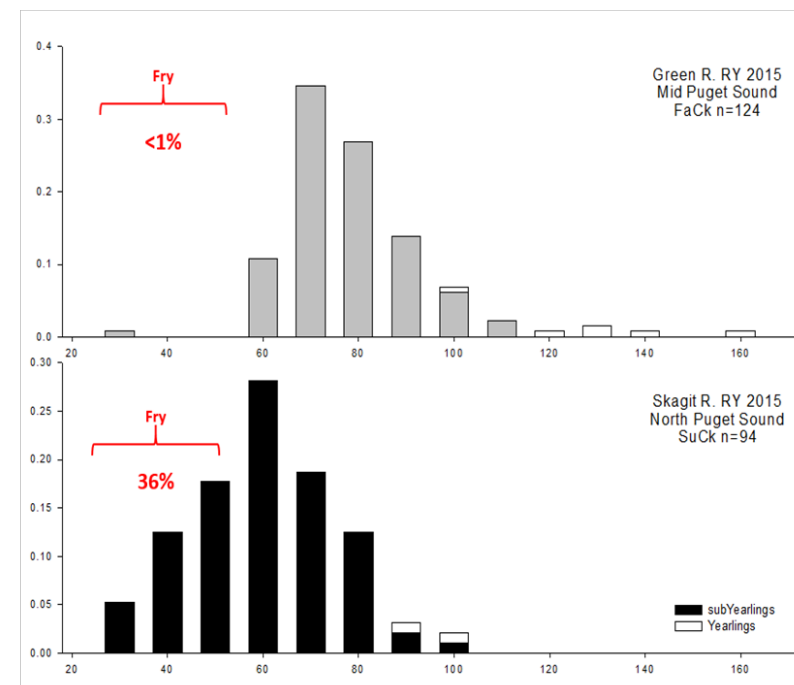
HEALTHY ESTUARIES HELP THE LITTLE ONES



Juvenile Sizes

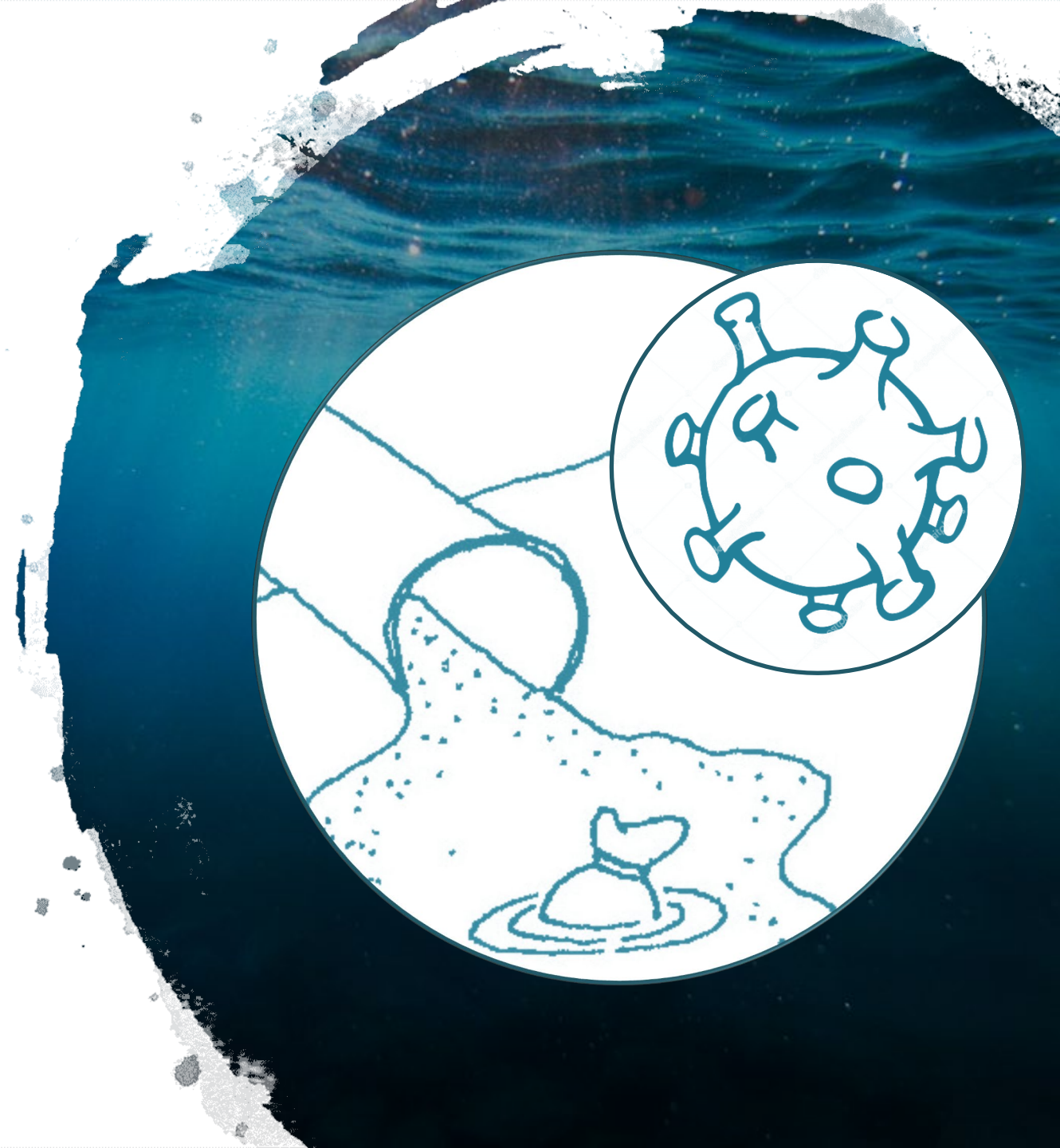


Proportion Contributing to Adult Returns



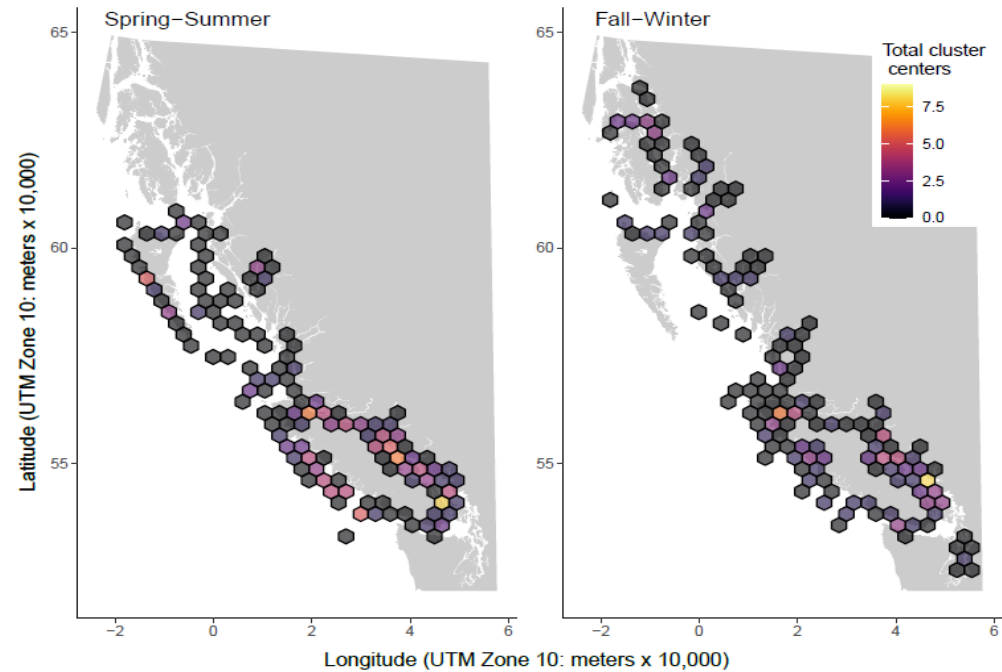
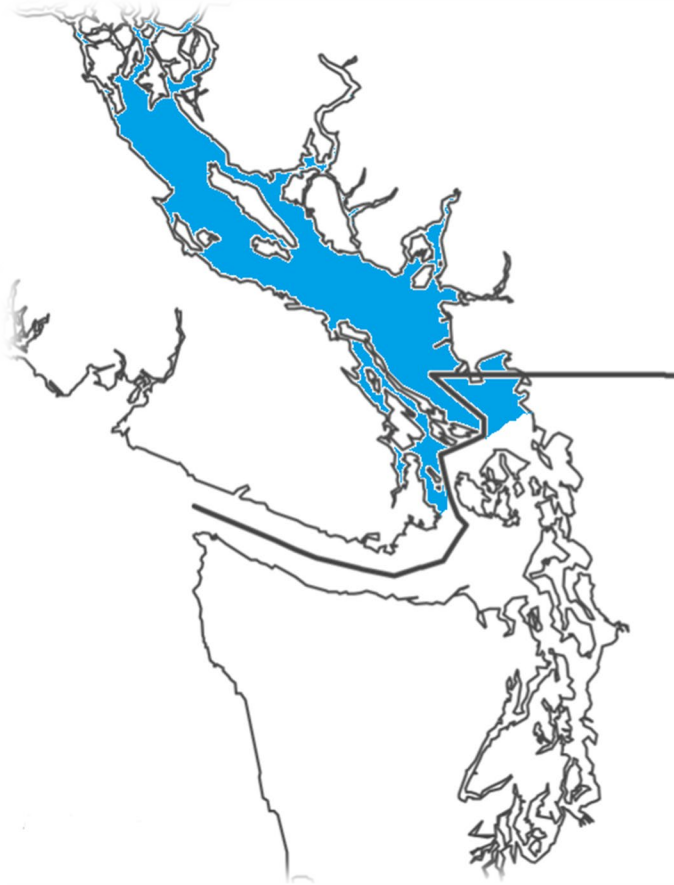
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DISEASE AND CONTAMINANTS



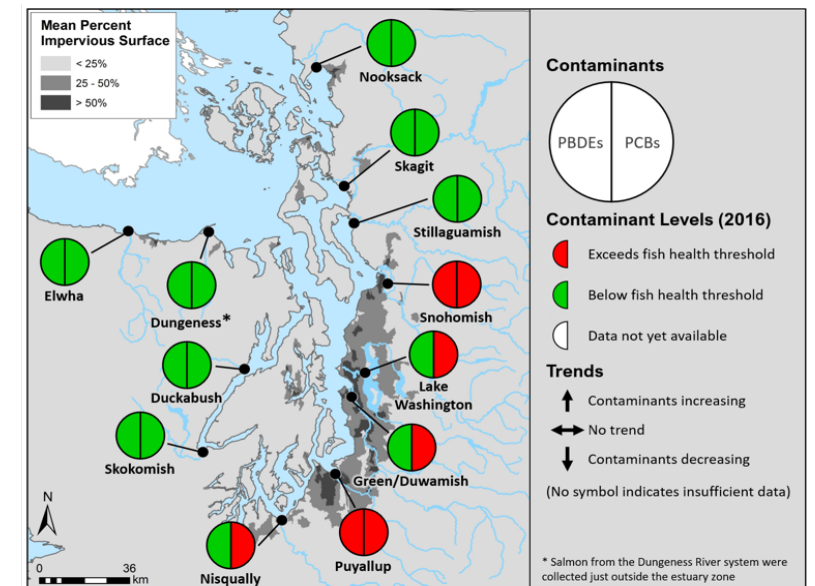
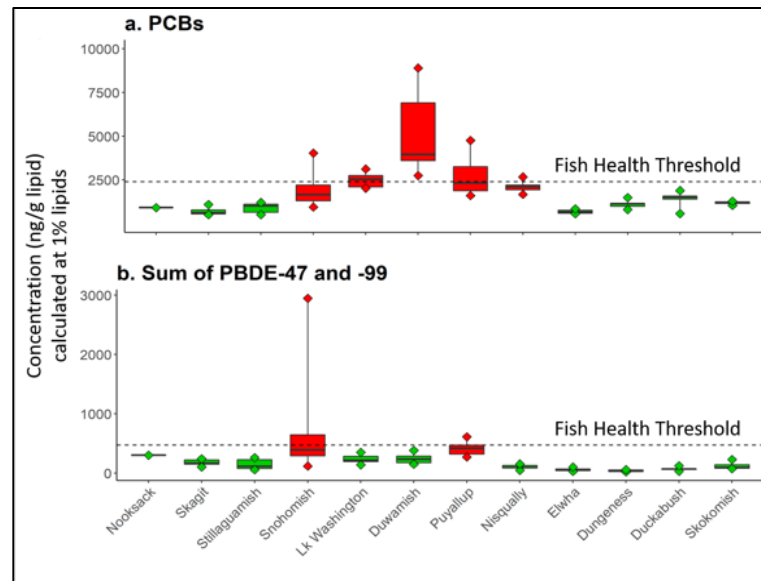
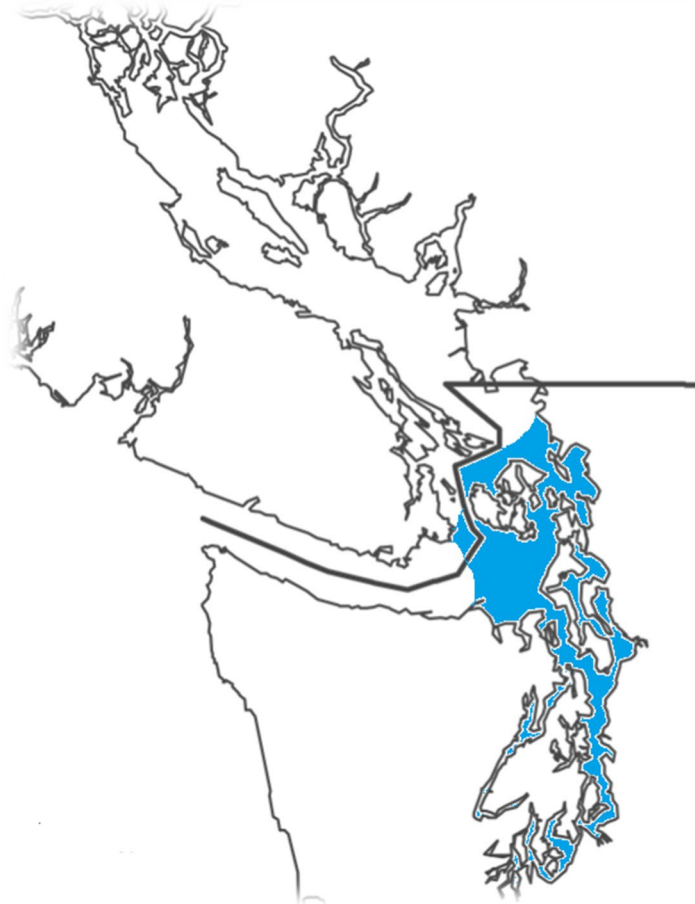


STRAIT OF GEORGIA A HOTSPOT FOR INFECTIOUS AGENTS IN SALMON



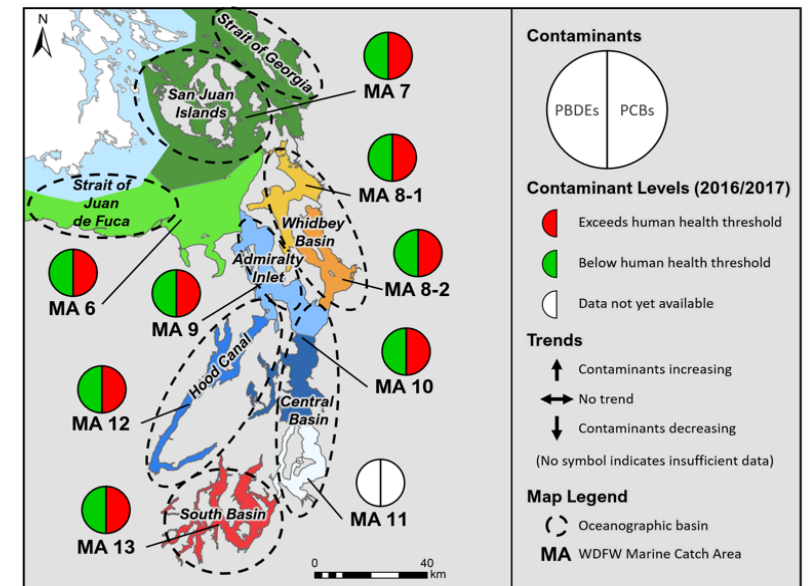
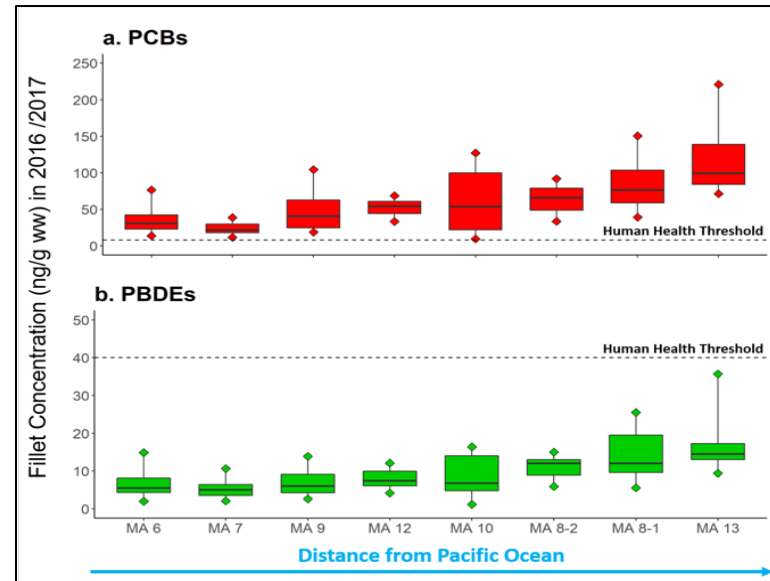
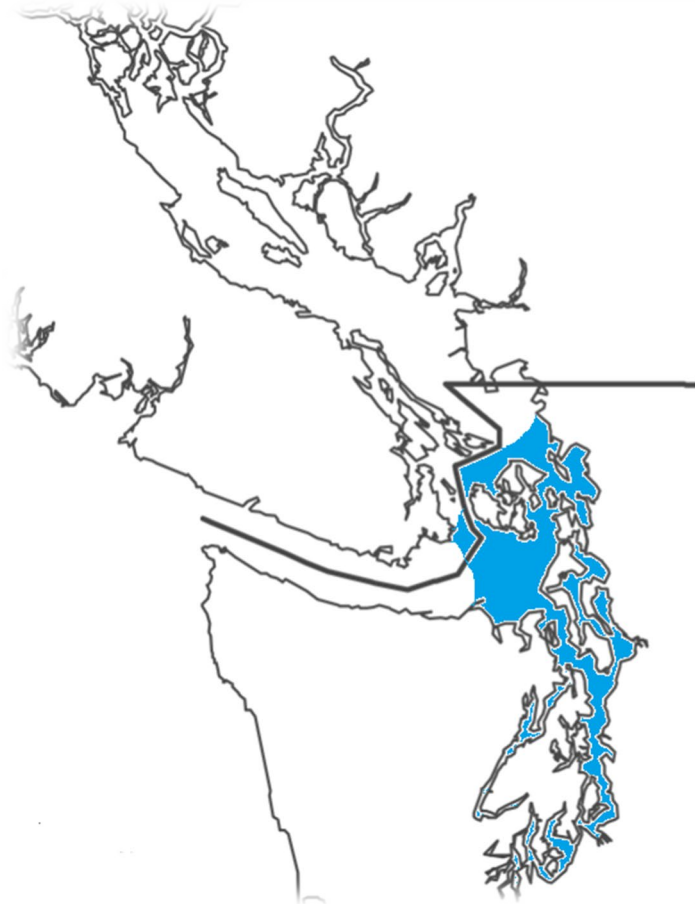


JUVENILE CHINOOK FROM URBAN STREAMS ARE CONTAMINATED





ADULT CHINOOK CONTINUE TO ACCUMULATE CONTAMINANTS



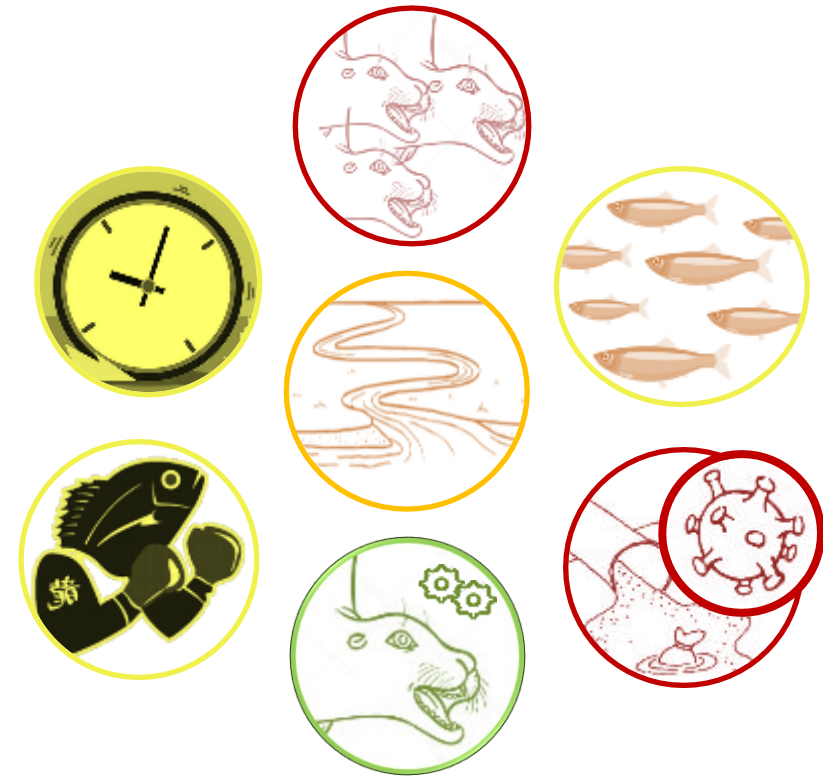
WHAT CAN WE DO TO ADDRESS LOW MARINE SURVIVAL?



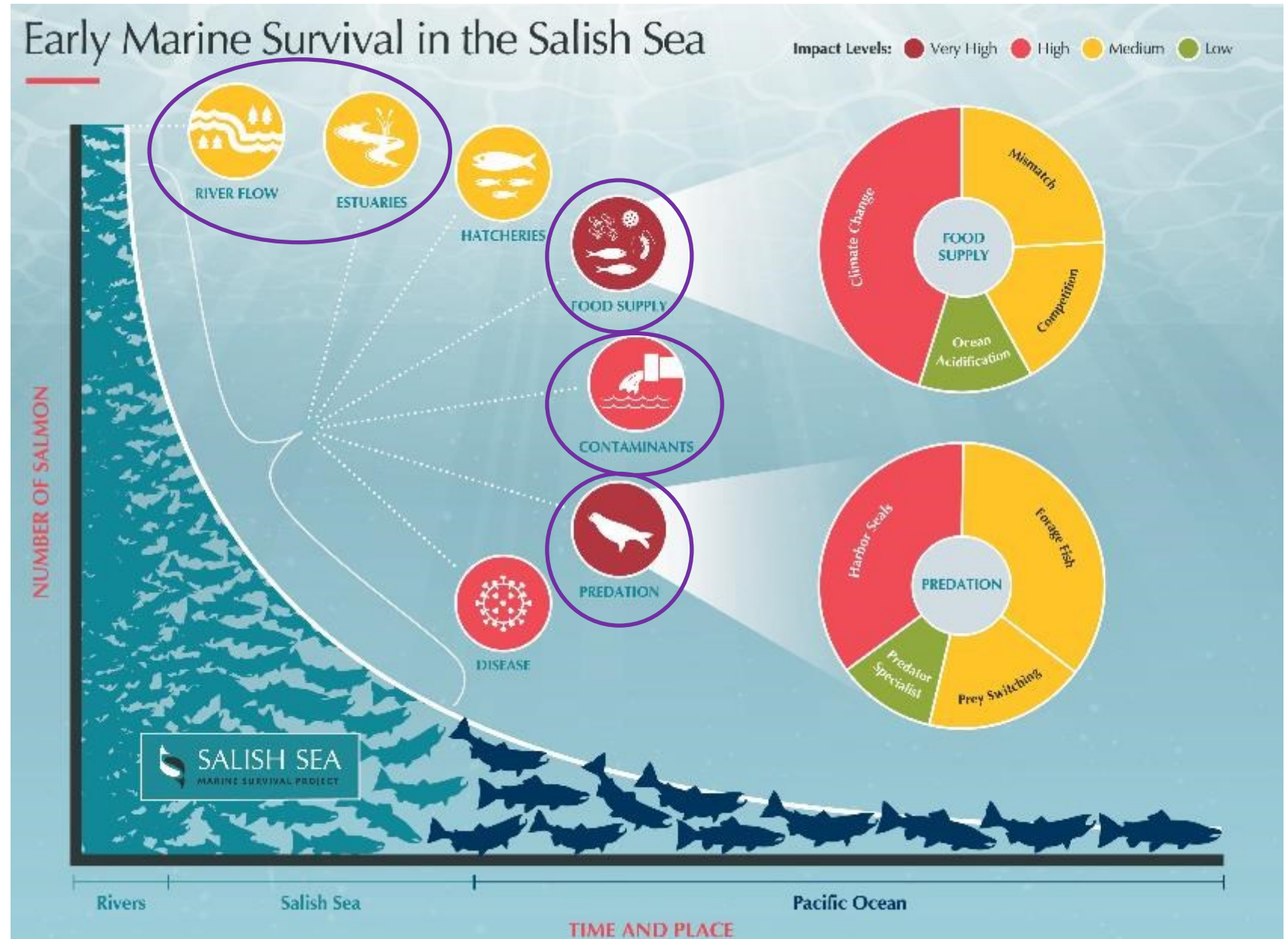
ADAPT TO GLOBAL CHANGES

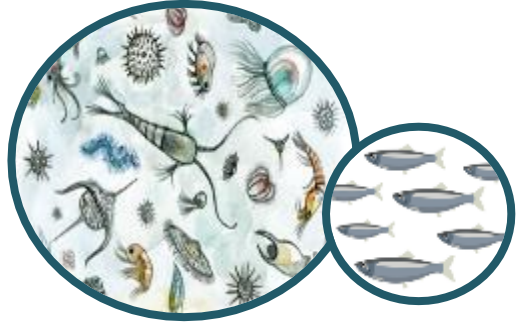


FIX LOCAL IMPACTS



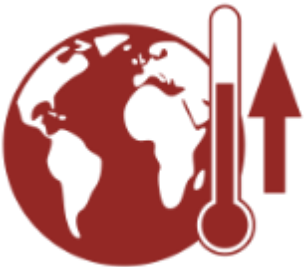
FIX LOCAL IMPACTS THROUGH ADAPTIVE MANAGEMENT IN NORTH SOUND WATERSHEDS





FOOD SUPPLY - REGIONAL

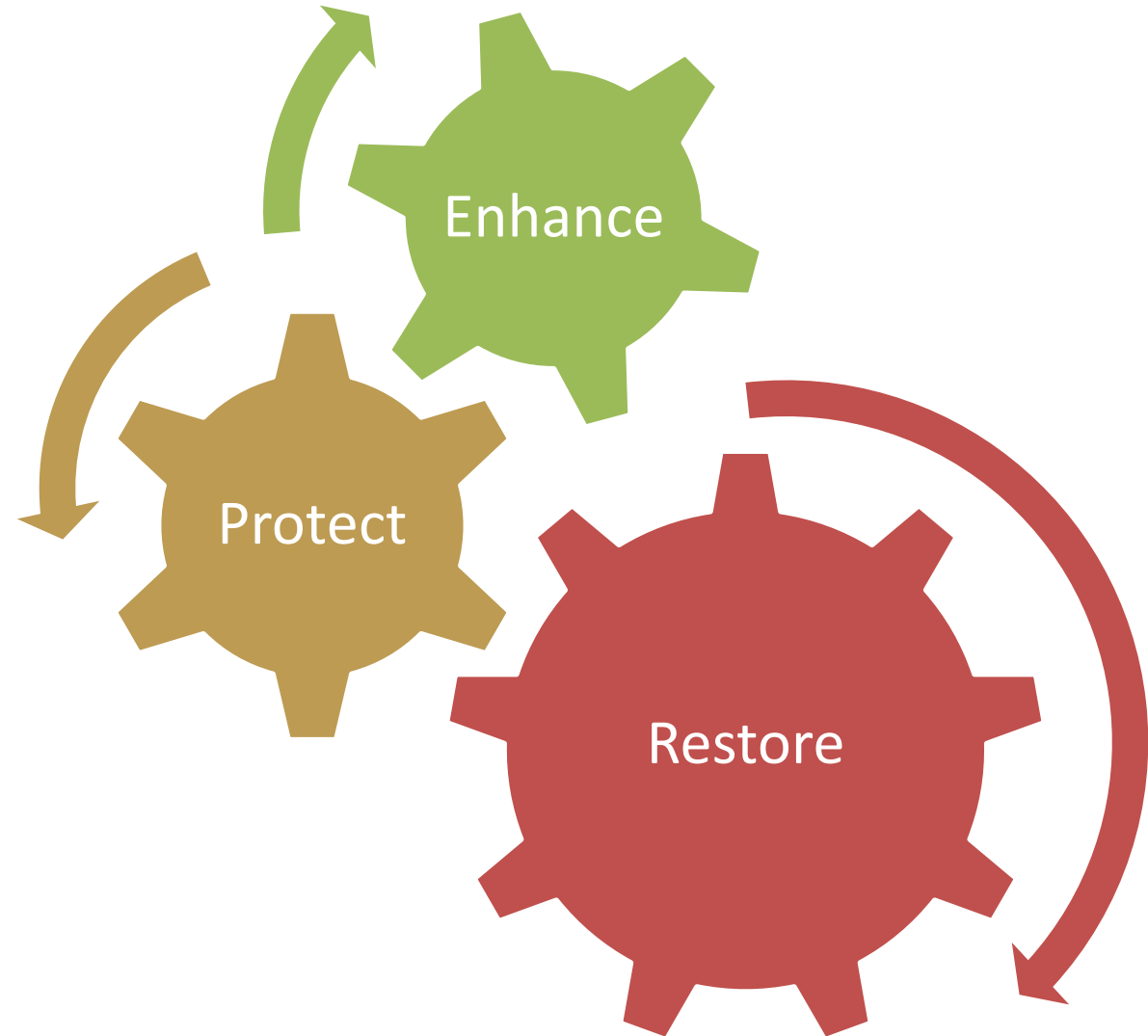
- Recognize climate and oceanic changes to salmon prey in recovery plans and climate initiatives. Develop monitoring and response strategies.
- Continue to assess juvenile Chinook and Coho growth and survival during their first summer, and add winter assessments when these salmonids appear to continue to experience high mortality
- Create an Implementation Strategy for Herring





FOOD SUPPLY - LOCAL

1. Protect and restore estuary and nearshore habitat for **salmon, Pacific herring, sandlance and crab**.
2. Support soft-shore initiatives to minimize nearshore habitat loss.
3. Enhance habitat where restoration is not feasible.
4. Restore seagrasses and kelps.
5. Assess, recover, protect and maintain diversity in herring populations
6. Improve marine water quality.



1. Protect and restore estuary and nearshore habitat for **salmon, Pacific herring, sandlance and crab**

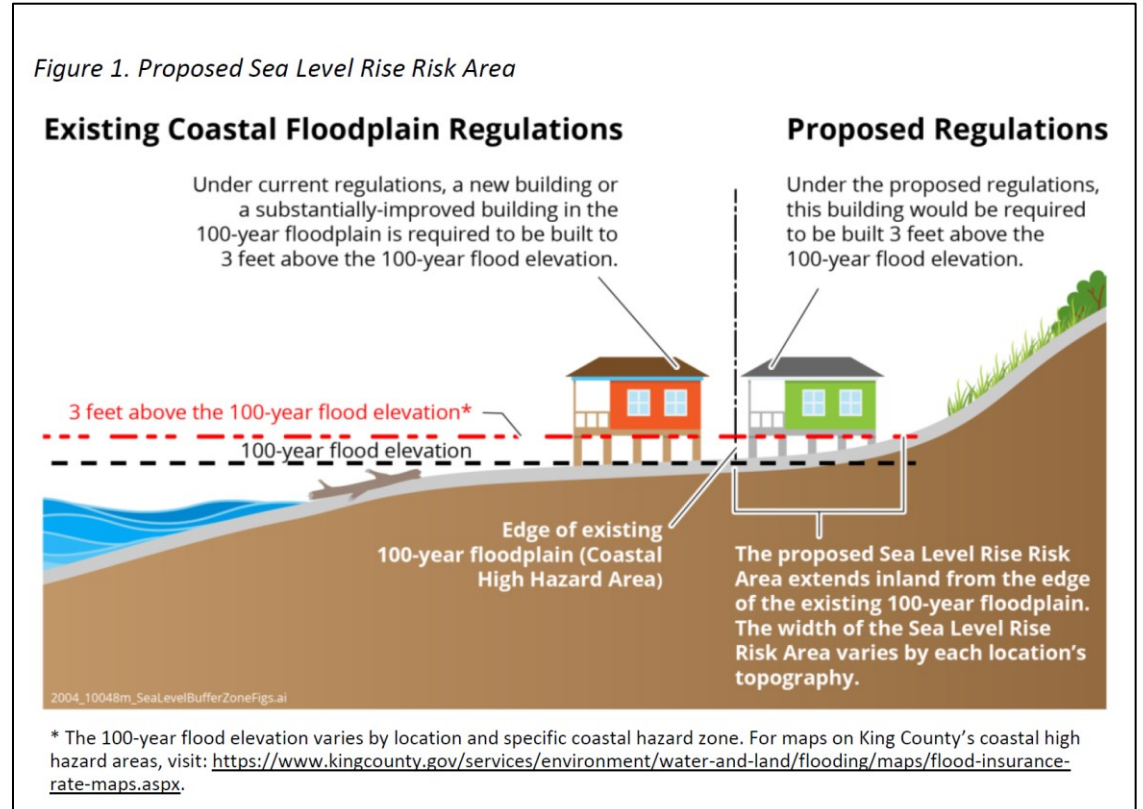
- Track non-compliant or illegal marine shoreline armoring
- Acquire high value habitat
 - Identify priority areas under threat of conversion
 - Draft an acquisition strategy for nearshore and estuary parcels to more rapidly access funding when properties become available
- Incorporate coastal squeeze and sea level rise in shoreline regulations



1. Protect and restore estuary and nearshore habitat for salmon, Pacific herring, sand lance and crab

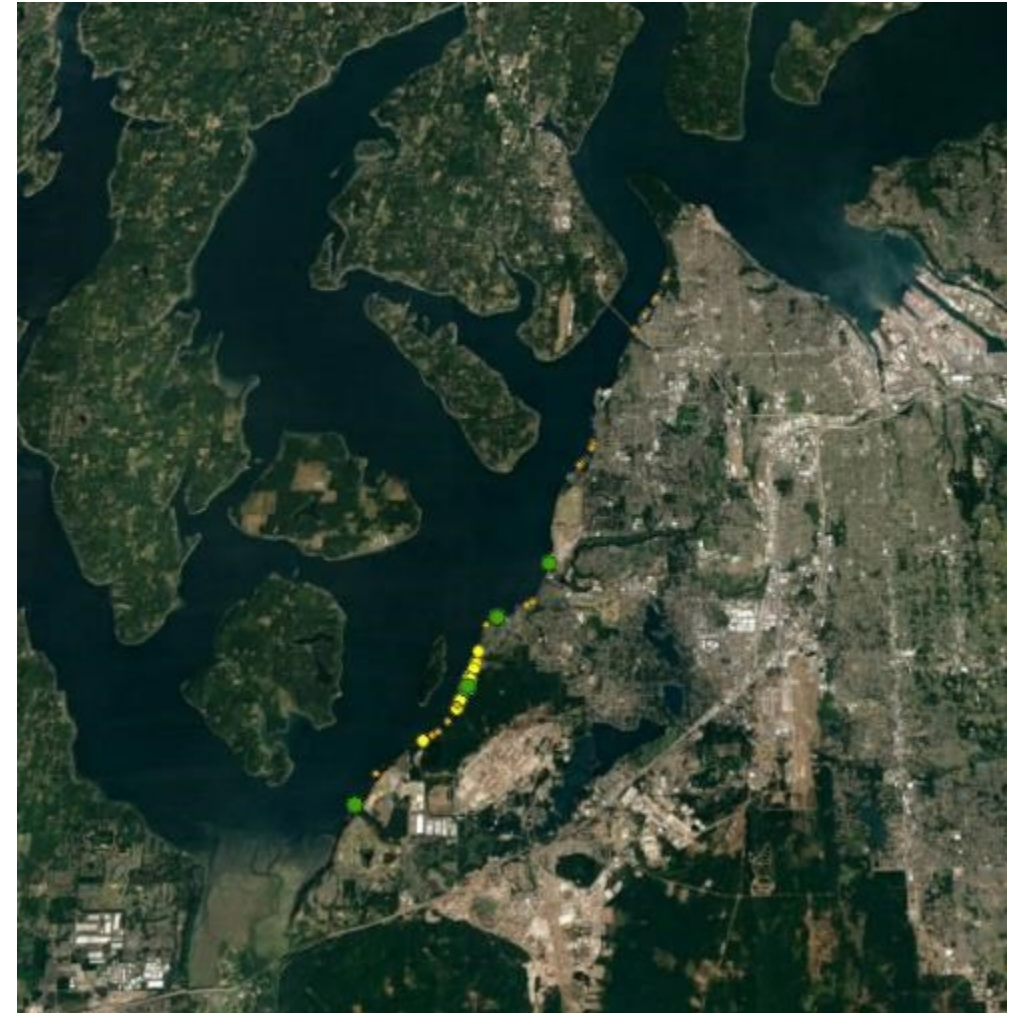
- Incorporate coastal squeeze and sea level rise in shoreline regulations

Example: King County's Sea Level Rise Risk Area



1. Protect and restore estuary and nearshore habitat for salmon, Pacific herring, sand lance and crab

- Improve sediment delivery from sources such as feeder bluffs, river and creek discharges, and sediment transport processes to support habitat formation and function
- Remove shoreline armoring
- Restore access and habitat in coastal stream mouths blocked by the railroad
 - Follow the [regional prioritization](#) for restoring coastal stream mouths along the railroad for juvenile Chinook use

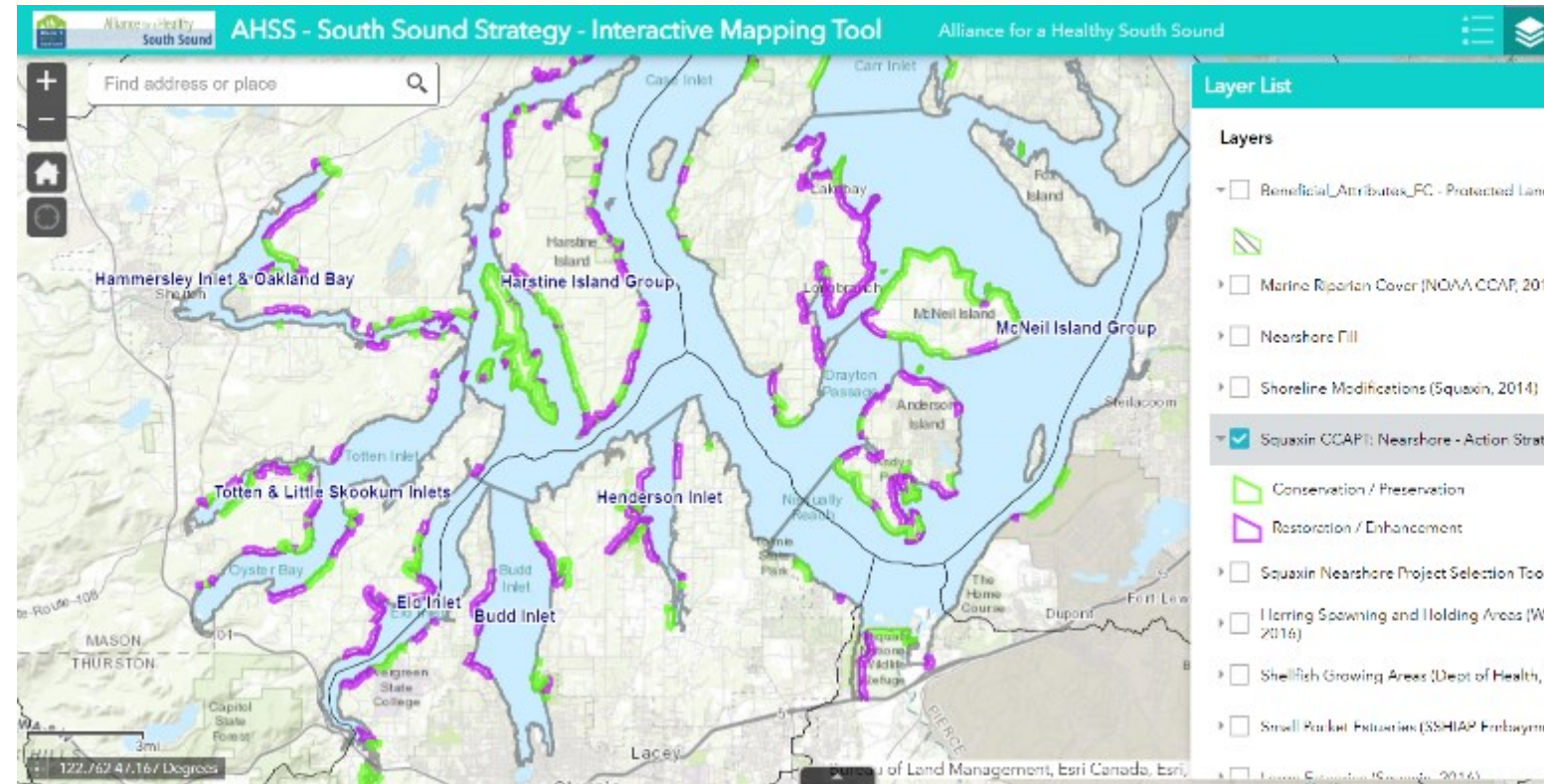


KMZ file courtesy of ESA, Paul Schlenger

1. Protect and restore estuary and nearshore habitat for salmon, Pacific herring, sandlance and crab

- Follow local level habitat protection and restoration prioritizations

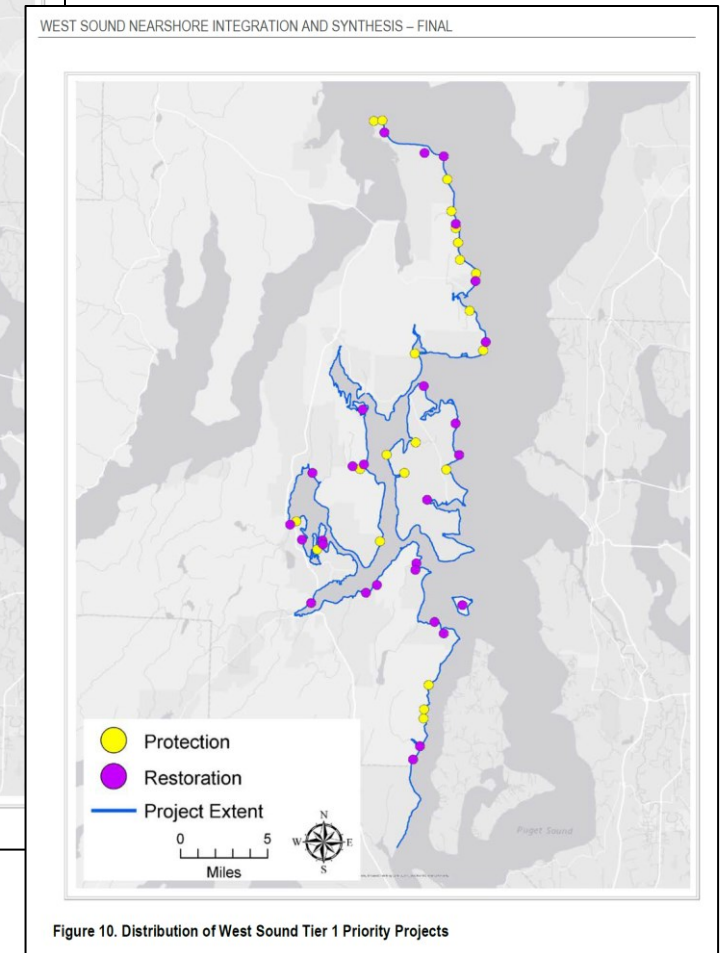
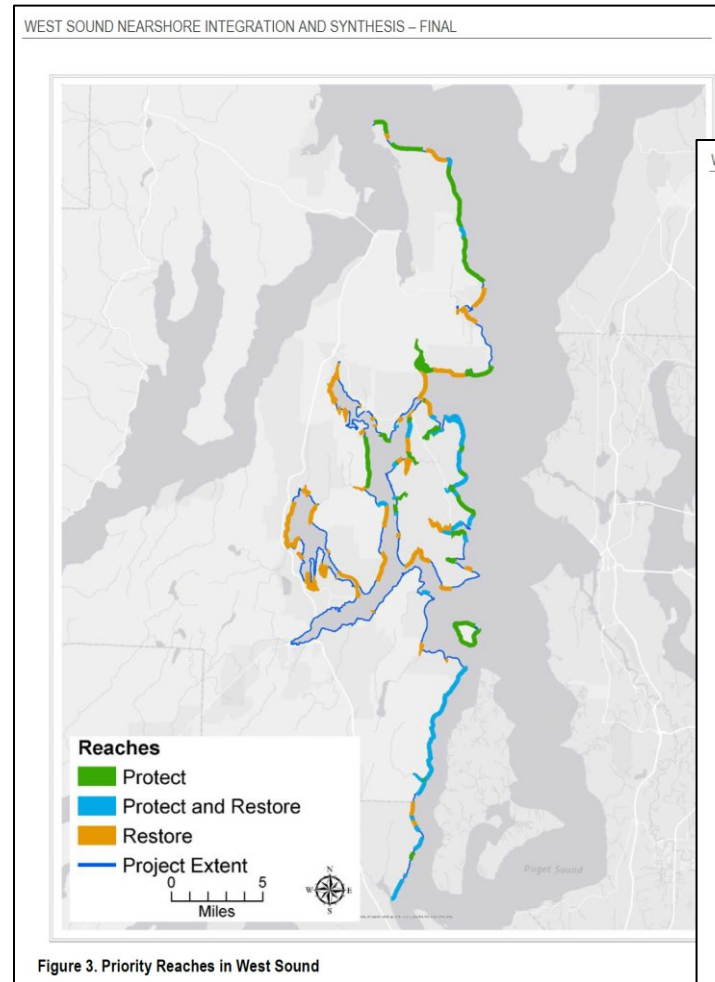
Example: South Sound Nearshore/Marine Mapping Tool



1. Protect and restore estuary and nearshore habitat for salmon, Pacific herring, sand lance and crab

- Follow local level habitat protection and restoration prioritizations

Example: West Sound
Nearshore Integration and
Synthesis of Chinook Salmon
Recovery Priorities



1. Protect and restore estuary and nearshore habitat for salmon, Pacific herring, sand lance and crab

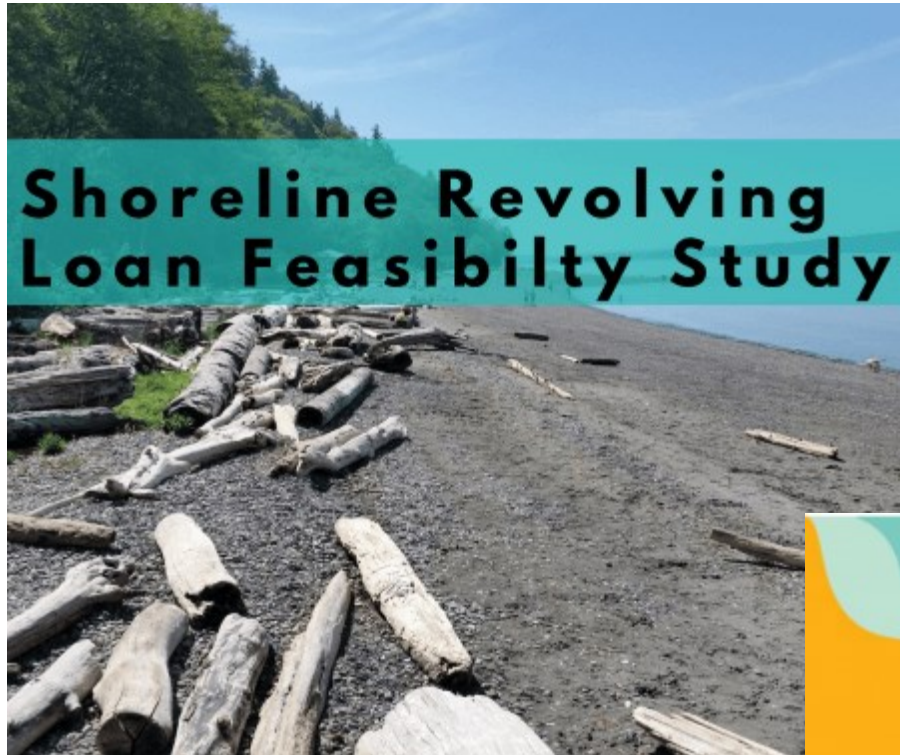
- Use adaptive management to update and revise with latest science:
 - Incorporate ESRP Nearshore Summit Proceedings into strategies and actions
 - Track and incorporate findings of PSEMP nearshore and forage fish/foodwebs work groups, ESRP learning projects, and others



Jeff Cordell and Erin Morgan survey sea wrack on a Puget Sound beach. Photo: Megan Dethier (Encyclopedia of Puget Sound)



2. Support soft-shore initiatives to minimize habitat loss



- Create incentives to nearshore landowners to protect non-armored beaches.
- Provide tools and incentives to nearshore landowners to restore habitat by using soft shore approaches and moving at-risk infrastructure that is threatened by erosion
- Educate the public on how to steward the nearshore, maintain and restore native marine riparian vegetation.
- <http://shorefriendly.org/resources/resources-in-your-area>
- <https://pugetsoundestuary.wa.gov/2021/04/09/could-a-revolving-loan-fund-help-puget-sound-shorelines/>



3. Enhance nearshore habitat where process-based restoration is not feasible

- Nourish beaches using dredge material of appropriate grain size for interim forage fish spawning habitat enhancements
- Plant trees and shrubs on armored shorelines to shade forage fish spawning sites
- Supplemental spawning substrate for forage fish
 - Example: Nisqually estuary cedar boughs



Cedar boughs in Nisqually estuary. Photo: Long Live the Kings

4. Restore seagrasses and kelps

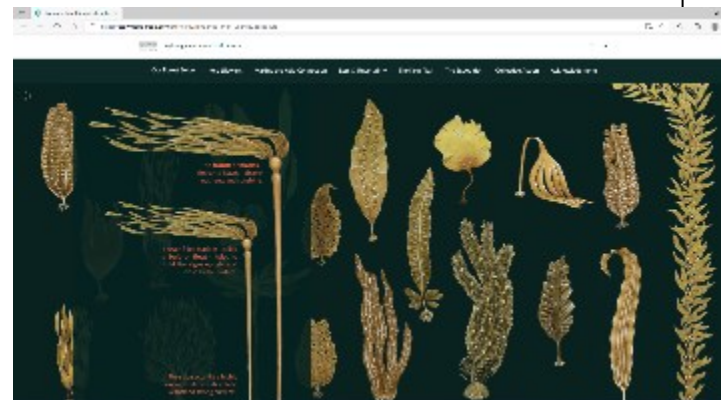
- Protect kelp habitat in existing and new reserves, refuges, and protected areas
- Develop a spatial plan identifying regions and sites for priority restoration actions
- Follow the developments of kelp restoration techniques
- Follow additional recommendations from Puget Sound Kelp Conservation and Recovery Plan



Puget Sound Kelp Conservation and Recovery Plan

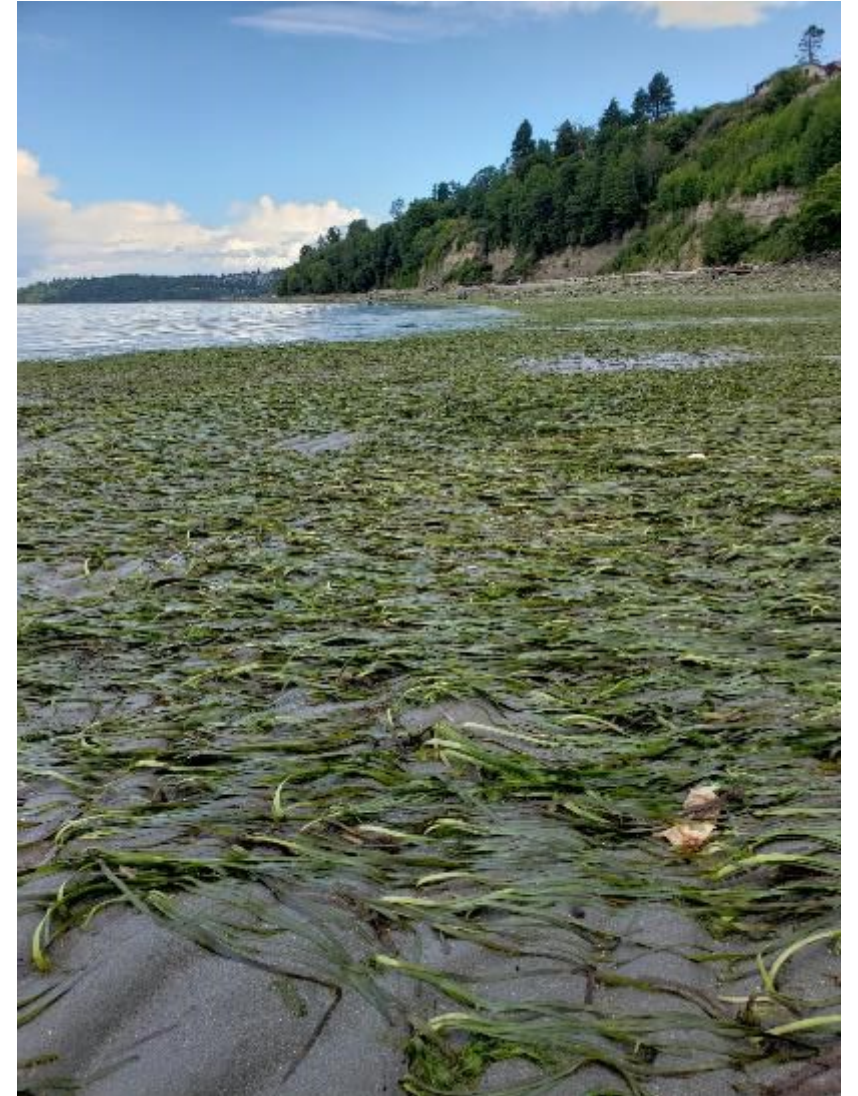
May 2020

Prepared by the Northwest Straits Commission, NOAA's National Marine Fisheries Service, Puget Sound Restoration Fund, Washington State Department of Natural Resources, and Marine Agronomics.



4. Restore seagrasses and kelps

- Follow recent findings on eelgrass restoration (PMEP/Pew):
 - Assess site suitability for eelgrass restoration
 - Select appropriate methods
 - Conduct pilot restoration
 - Evaluate, scale up
- Remove overwater structures, pilings, marine debris
- Utilize NOAA's nearshore calculator to estimate conservation credits of piling removal and other nearshore restoration actions



4. Restore eelgrass and kelp

Example: Alliance for a Healthy South Sound's Marine and Nearshore Strategy includes an emphasis on protecting and restoring eelgrass beds



Marine nearshore habitat has long been a focus of South Sound ecosystem protection efforts and will remain so. The nearshore is the transitional zone among terrestrial, freshwater, and marine ecosystems. Many of the important and unique characteristics of Puget Sound depend upon the nearshore, including its physical complexity, high productivity, complex food webs, diverse habitats, and diversity of organisms ([link](#)). Marine nearshore habitats are some of the primary places where young salmon and steelhead find refuge, food, and passage to the sea. These important rearing, feeding, and migration areas are the result of natural processes that move sediments, provide nutrients, organic matter, and DWD from plants and produce insects and similar marine animals ([link](#)).

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5. Assess, recover, protect and maintain diversity in herring populations

- Follow recommendations of the Assessment and Management of Pacific Herring in the Salish Sea report until Implementation Strategy developed:
 - Implement a landscape scale approach to understand habitat requirements for herring, particularly Squaxin Pass stock
 - Reduce predation
 - Remove creosote pilings and piers
 - Transplant herring eggs to increase survival; utilize traditional indigenous practices of herring egg transplanting
 - Reduce light pollution

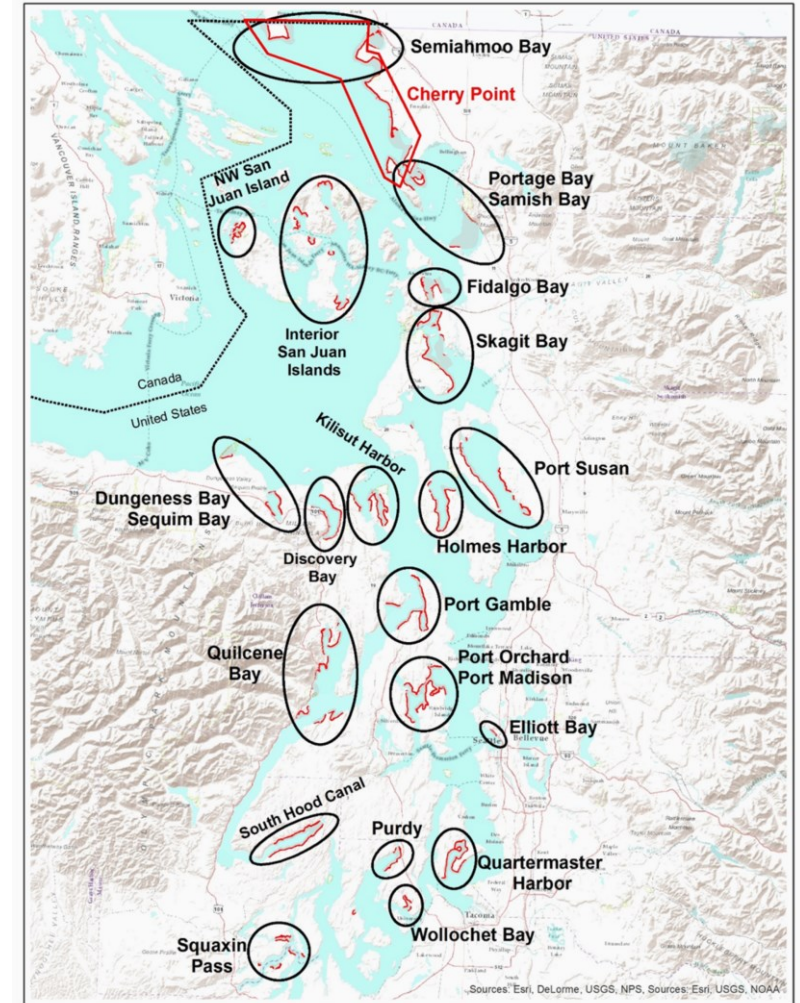
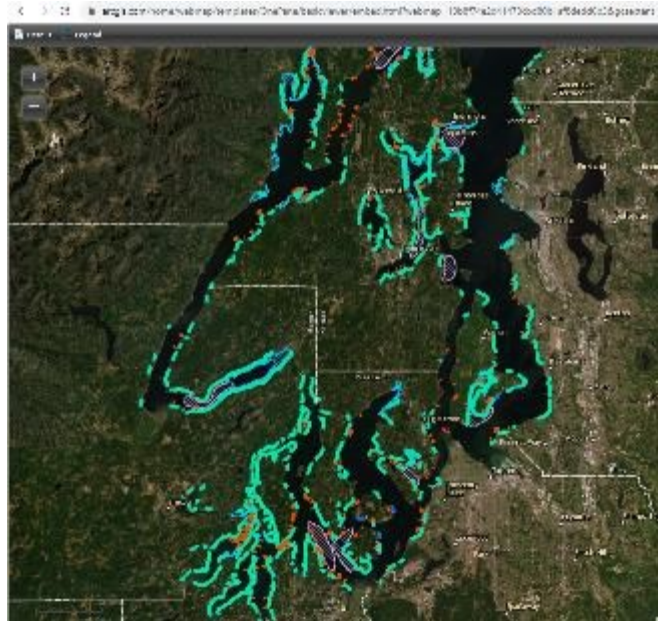


Figure 2. Known spawning stocks of Pacific herring in U.S. waters of the Salish Sea as of 2018.



5. Assess, recover, protect and maintain diversity in herring populations

- Track local research, monitoring, and adaptively manage for populations based on local data
 - Example:
 - AHSS uses WDFW datasets

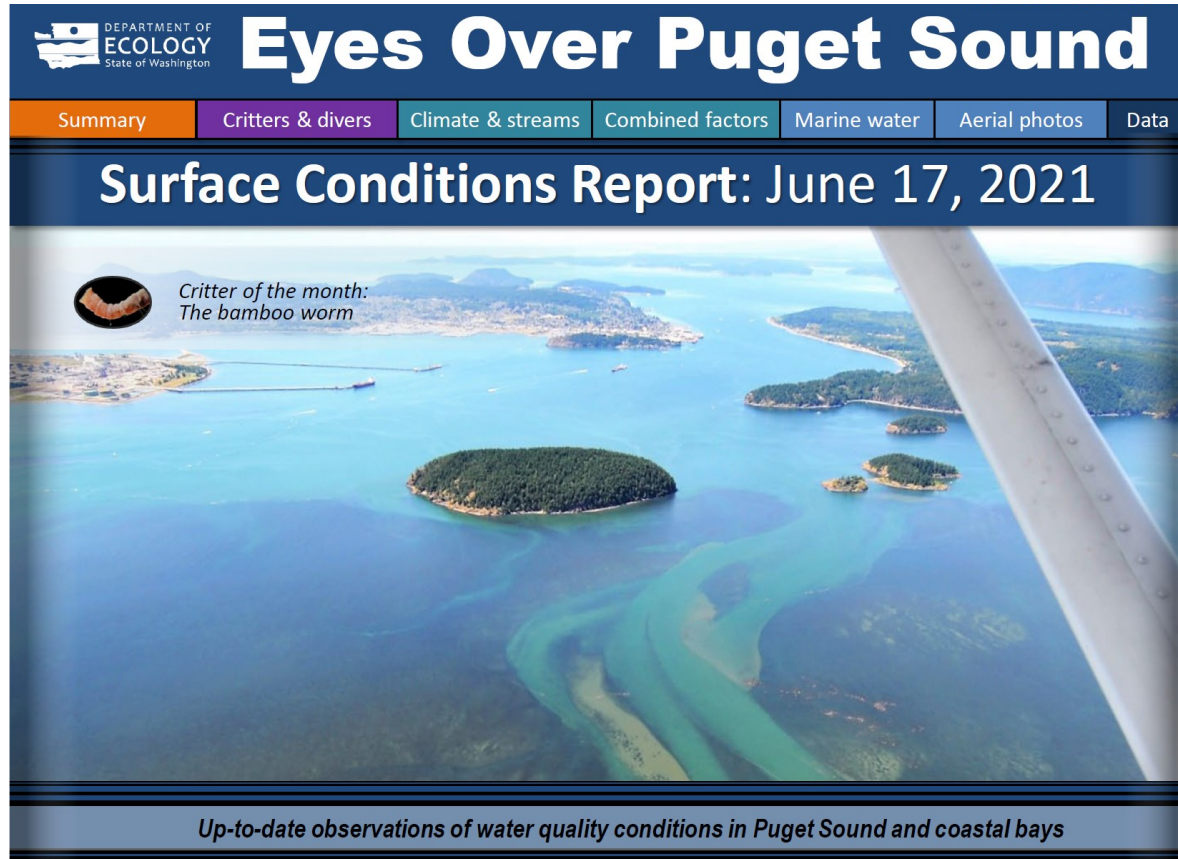


Herring Abundance and Distribution: WDFW has tracked the spawning biomass of the Squaxin Pass herring population annually since 1973. In 2015, the biomass was 324 tons. The average amount over the period of record is 710 tons, with the highest year recorded as 2002 (3,150 tons) and the lowest year in 1997 (20 tons). Hammersley Inlet & Oakland Bay Inlet/Island Group has the most herring spawning area (11%) while Carr Inlet and the Harstine Island and McNeil Inlet/Island Groups have the greatest number of herring holding areas. Several Inlet/Island Groups do not contain herring spawning or holding areas including Budd Inlet, Case Inlet, and Henderson Inlet.

Surf Smelt and Sand Lance Abundance and Distribution: Surf smelt and sand lance spawning has been documented across the South Sound (shown in Table 8.6), with the greatest amount on the beaches of Harstine Island (24.6% for surf smelt and 6.2% for sand lance). Overall, surf smelt spawning areas are more abundant than sand lance with over 100 documented miles versus 15 miles, respectively.



6. Improve marine water quality



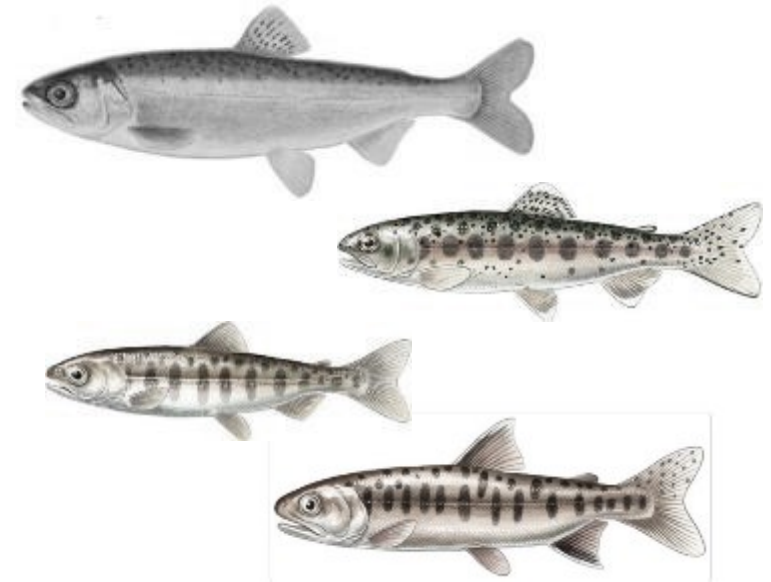
- Reduce nutrient and sediment loading
- Remove creosote piers and pilings
- Advance actions to limit nutrients and follow the Marine Water Quality Implementation Strategy
- Use resources available on 'Eyes over Puget Sound' website





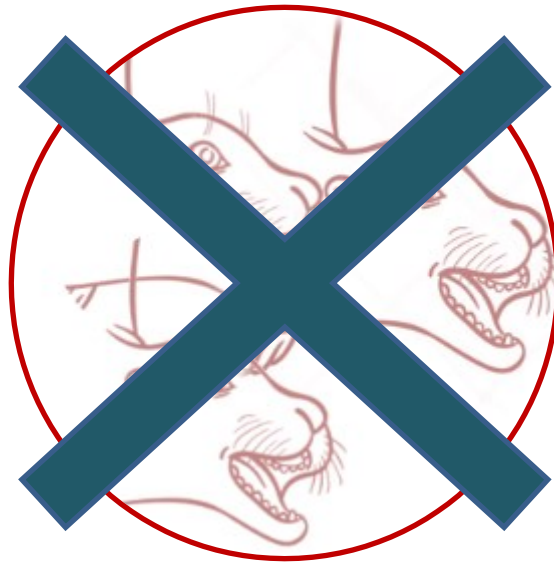
FOOD SUPPLY & PREDATION

- Support salmon life-history variability through habitat restoration, population management and experimenting with various hatchery rearing and release strategies.





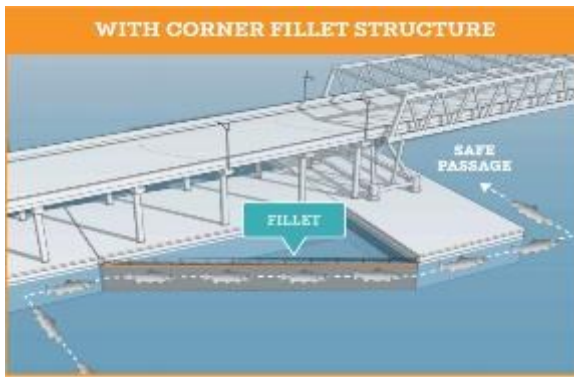
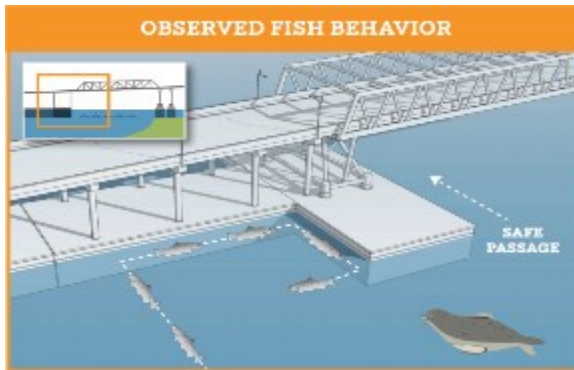
PREDATION



Increasing Marine
Survival May
Require Removal
of Over 50% of the
Population



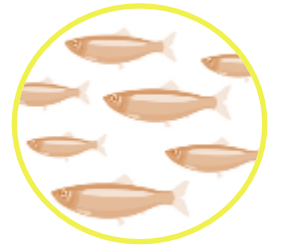
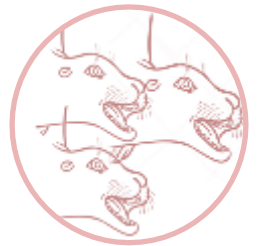
PREDATION - REGIONAL



Facilitating Steelhead Passage at Hood Canal Bridge. Source: Long Live the Kings

Investigate various approaches to reducing predation by seals, especially at predation hotspots:

- Determine hotspots, assess hatchery pulses, improve consumption estimates
- Facilitate fish passage at migration barriers
- Utilize predator deterrents
- Obstruct/remove log booms and other haulouts
- Recover forage fish
- If necessary, perform experimental removals
- Prevent low river flows (deters other predators)





PREDATION – LOCAL HOT SPOTS

Environment | Local News | Northwest | Puget Sound | Science

Researchers test underwater noisemaker to scare away seals at Ballard Locks

Oct. 4, 2020 at 6:00 am



2 of 7 | Biologist Asia Bergman with Oceans Initiative lowers the acoustic starting device next to the Ballard Locks spillway. It makes a sound that provokes a "fight or flight" reaction in seals but does not harm them. (Steve Ringman / The Seattle Times) Less

By Lynda V. Mapes

- Local actions can include removing passage barriers or human infrastructure/haulouts at mortality hotspots
 - Ballard Locks (adults and juveniles; temp, DO)
 - Pinch points in Nisqually lower river and estuary (juveniles)
- Additional justification to address both low summer streamflows, water quality, and passage barriers in your watersheds
- Food supply strategies should also be considered as buffer prey strategies



Example from WRIA 6 Plan Update



Multi-Species Salmon Recovery Plan Update

WRIA 6
(Whidbey and Camano Islands)
December 2019

Objective 3:

Quantify and evaluate impacts of predation by marine mammals and other wildlife on salmonid and forage fish populations (e.g. Orca, Sea Lion, Harbor Seal, Heron, Cormorants, Mergansers, Humans, etc.)

Action 2.3.1 - Encourage the state and federal agencies to determine if it would be appropriate for NOAA Fisheries to transfer management oversight of pinnipeds to the WA Department of Fish and Wildlife

N/A*

Action 2.3.2 - Assist a study of predation (seals, sea lions, and other wildlife) in WRIA 6 on salmonids and forage fish (by species/stock) and collaborate with neighboring watershed groups on projects specific to their stocks

N/A*

Action 2.3.3 - Assist with WDFW to identify realistic levels of predation on salmon and forage fish

N/A*

Action 2.3.4 - Collaborate with WDFW to identify sustainable predator population levels and methods to achieve these levels

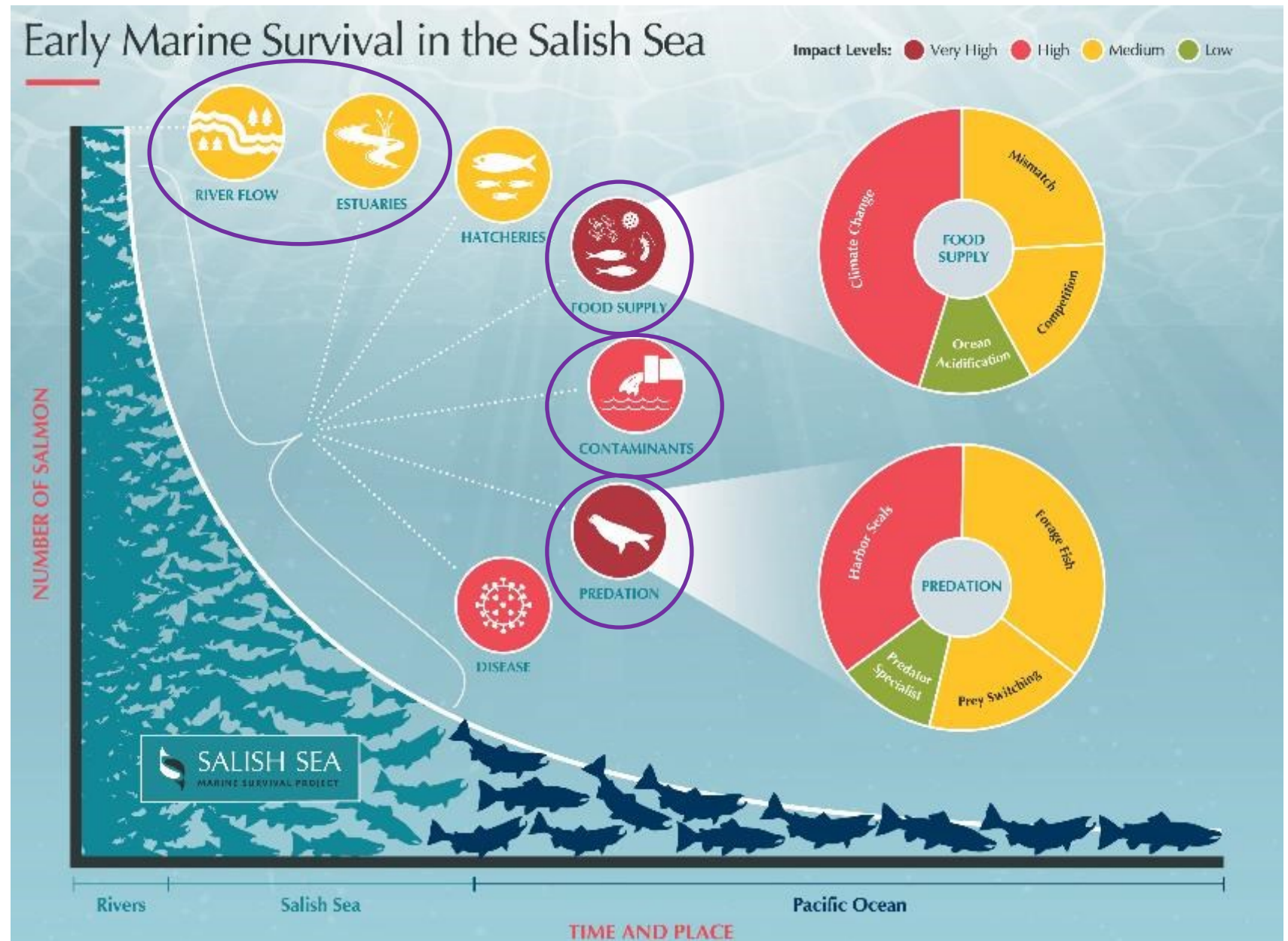
N/A*

Action 2.3.5 - Compare the impacts on salmon caused by predation versus the impacts caused by habitat loss/degradation

N/A*

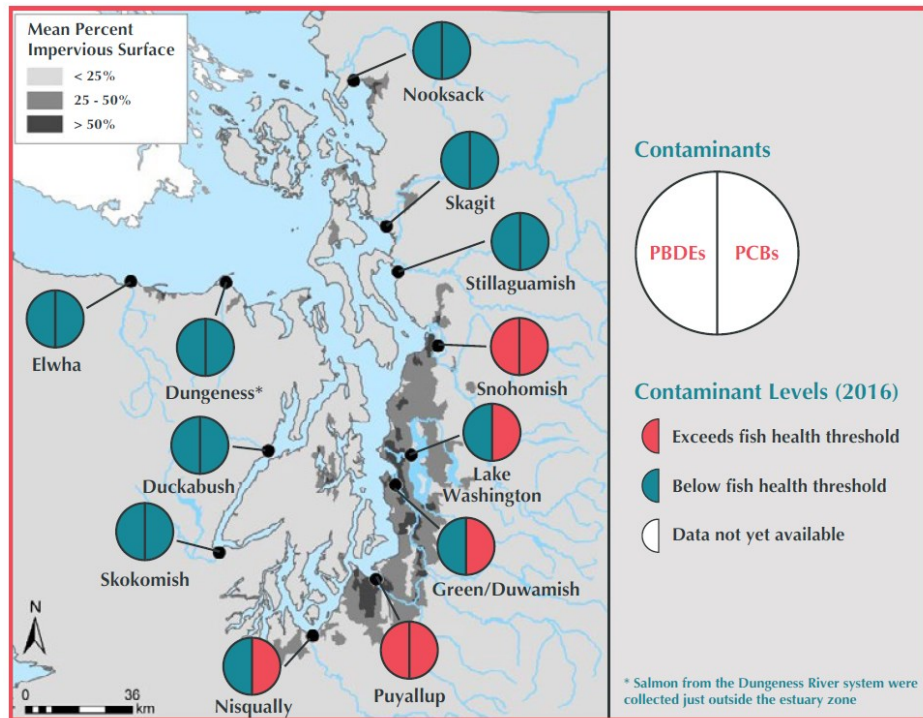
(*) These actions were identified in the 2005 Salmon Recovery Plan. However, since then, strategies and efforts to address predation have been determined to fall outside of local Lead Entity control and should be enacted upon at the regional level by entities like the Puget Sound Partnership, NOAA, WDFW and other co-managers.

FIX LOCAL IMPACTS THROUGH ADAPTIVE MANAGEMENT IN NORTH SOUND WATERSHEDS





STRATEGICALLY ADDRESS CONTAMINANTS - REGIONAL



- Reduce contaminant burdens where impacts are greatest
- Determine PCB pathways in Puget Sound food web. Focus larger-scale remediation efforts on PCB hotspots for Chinook residing in Puget Sound.
- Assess contaminants in Strait of Georgia, esp. Fraser Basin. DFO science reengaging in contaminant research.
- Assess Contaminants of Emerging Concern (CECs), support actions to reduce URMS, etc.



INCREASE PACE OF ESTUARY RESTORATION

Targets

+ INTACT FEEDER BLUFFS/SEDIMENT SUPPLY

+ MARINE RIPARIAN VEGETATION

+ INTACT LARGE ESTUARIES

— INTACT SMALL/POCKET ESTUARIES

1. Protect all intact small pocket estuary shoreline throughout South Sound, 85 miles, of which 82.4 miles are in the areas identified as a priority in the Coastal Catchment Assessment and/or the NPST for Juvenile Salmon

2. Restore 14.3 miles of degraded small estuary habitat in the areas identified as a priority in the Coastal Catchment Assessment and/or the NPST for Juvenile Salmon.

+ EELGRASS BEDS

+ SURF SMELT AND SAND LANCE ABUNDANCE AND DISTRIBUTION

- Create habitat for fry migrants, esp in urbanized estuaries
- Prioritize projects for acquisition and restoration
- Model future sea level rise and build into targets, prioritization and project design
- Utilize SSMSP findings to elevate priority of estuary restoration actions
- Example:
 - Alliance for a Healthy South Sound



INCORPORATE FLOW IN RECOVERY CHAPTERS



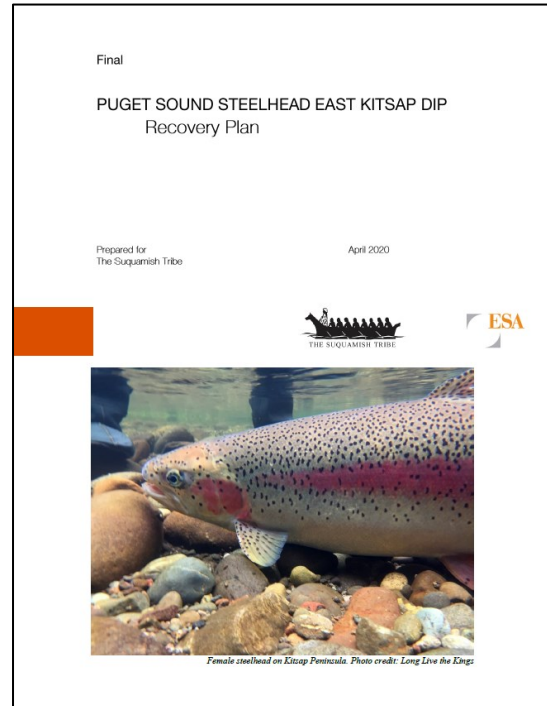
- When setting or managing for flow, consider impacts to marine foodweb and instream predation
- Incorporate issue in dam management and FERC relicensing
- Build out policy and capital project actions to take locally
 - See regional recovery plan update
 - See Steelhead recovery plan



INCORPORATE FLOW IN RECOVERY CHAPTERS

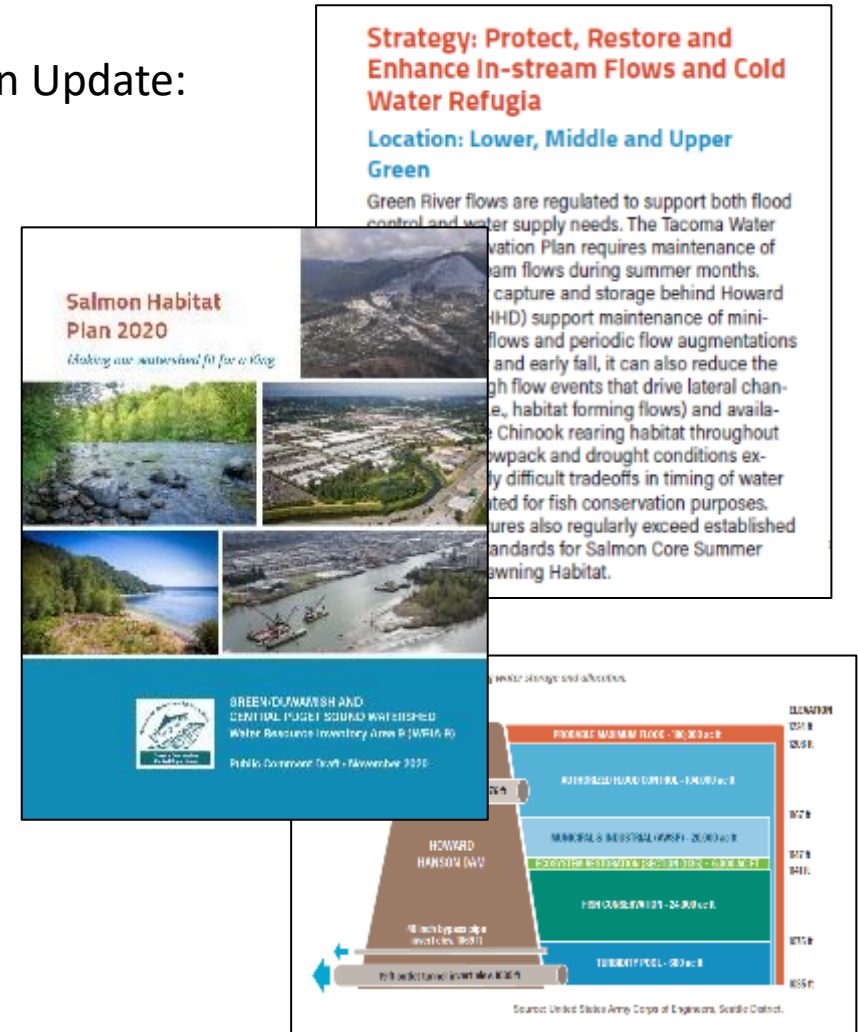
Local Examples:

East Kitsap Steelhead Recovery Plan

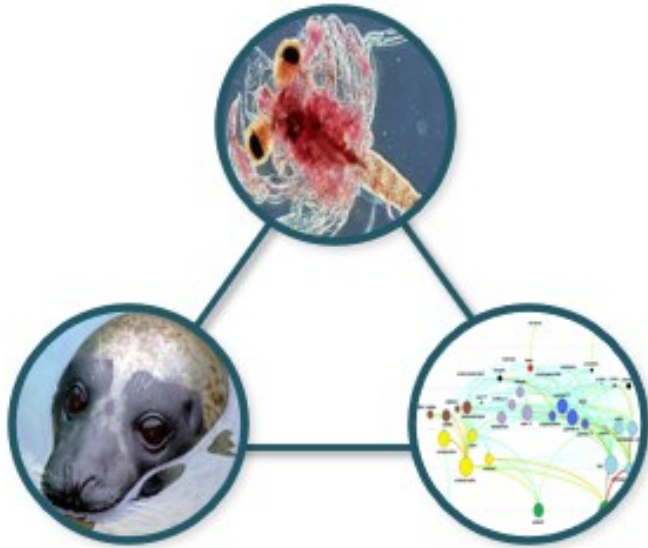


Nisqually: Mashel River VELMA modeling

WRIA 9 Plan Update:



MAINTAIN AND IMPROVE MONITORING – REGIONAL AND LOCAL

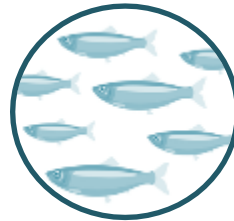
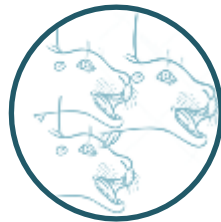
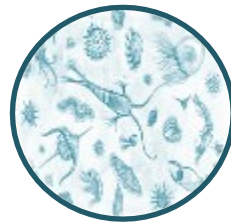


In particular:

- Oceanography
- Zooplankton
- Juvenile salmon and herring
- Seal and sea lion demographics and diets



IMPROVE FORECASTING AND RECOVERY WITH NEW ECOSYSTEM DATA AND MODELS



DISCUSSION & OTHER LOCAL EXAMPLES

