

Integrated Ecosystem Assessment (IEA)

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| What does a healthy ecosystem look like? How can we measure progress? | Identify ecosystem goals, indicators, and targets |
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Developing an ecosystem assessment for PSP work

- To conduct an IEA, we need an ecosystem model.
- The ecosystem model is under development, but it will take approximately 2 years before it is complete.
- In the meantime, the scientific community can provide qualitative or semi-quantitative results from existing and new assessments.

Ecosystem components in Puget Sound

- Species and food webs
- Habitats and processes
- Water quality
- Water quantity
- Human health and well being





Atmospheric Exchange

e.g. Pollutant deposition, carbon dioxide absorption, warming temperatures



Human Uses, Impacts (health impacts, well being)

A B

e.g. Harvest, aquaculture, consuming seafood, recreation, etc.

e.g., Harmful algal blooms, changing ocean properties



Marine/ Estuarine Species and Food Webs

C

e.g., Salmon, bald eagles



Aquatic/ Terrestrial Food Webs

C

e.g. Nutrient inputs, toxic impacts on food webs

e.g. Vegetative cover in riparian zone, aquatic insect abundance and diversity

Ocean Exchange

e.g. Eelgrass shelter for Dungeness crab, herring spawn on kelp fronds

e.g. Contaminants in Orcas, pathogen transfer



Water Quality

F

e.g. Contaminant loadings, freshwater impacts on marine circulation



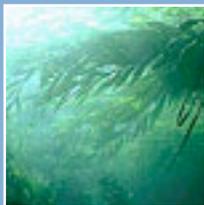
Freshwater Flows/Quality

E F

e.g. Salmon spawning capacity, amphibian abundance

e.g. Suspended sediments reduce light for eelgrass, kelp beds filter particulates

e.g. Beach nourishment from stream sediments, stream flows balance salinity and sustain marsh plants



Habitat Quality and Quantity, Processes

D

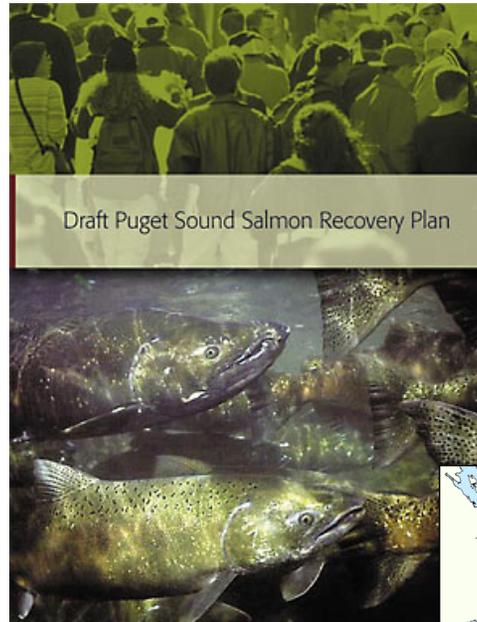
Risk analyses for the Puget Sound ecosystem

Qualitative --> quantitative approaches

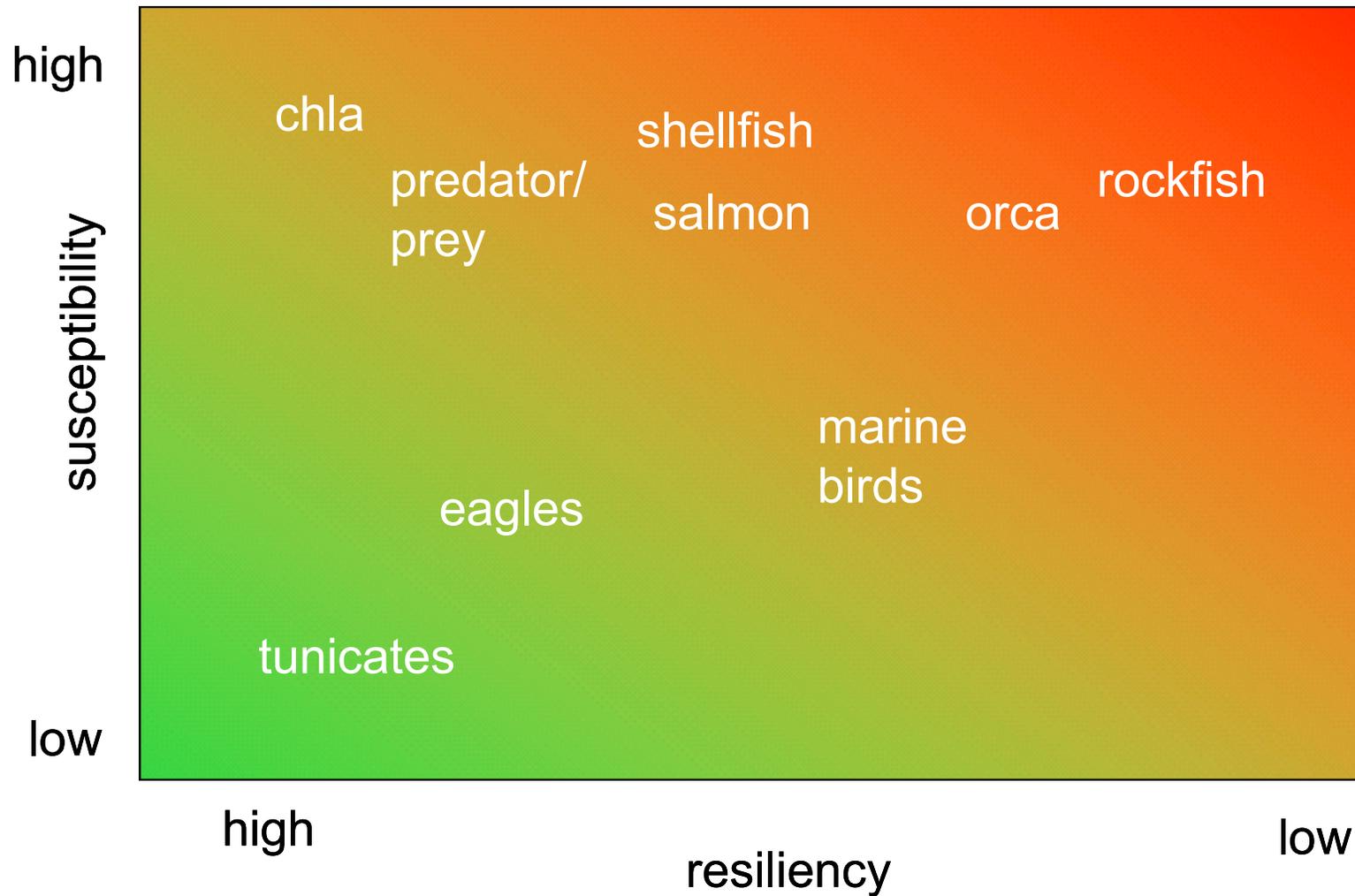
(1) estimating the current status of each of the ecosystem components, and (2) conducting a vulnerability assessment to ascertain the degree of threats facing each component and the resiliency of the components

Sources for qualitative risk analysis

- Existing assessments
- Simple spatial analyses

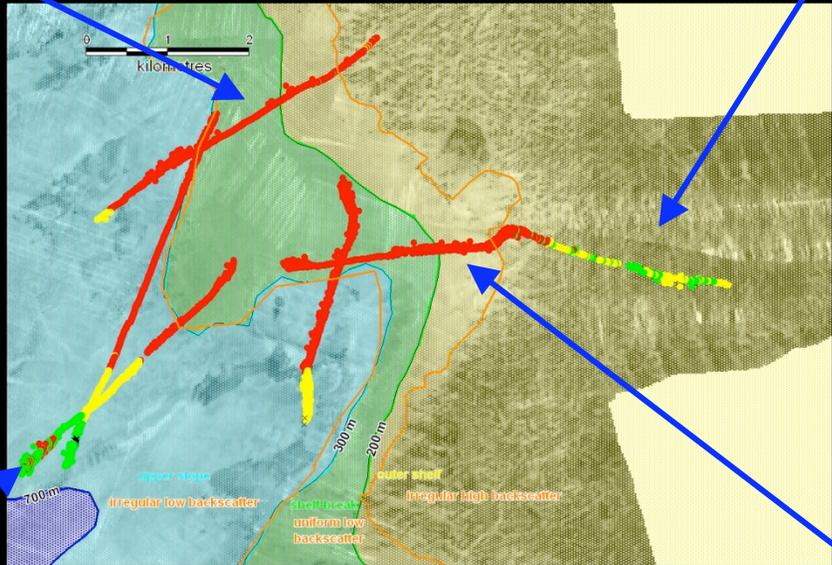


Result from risk analysis: categories of vulnerability

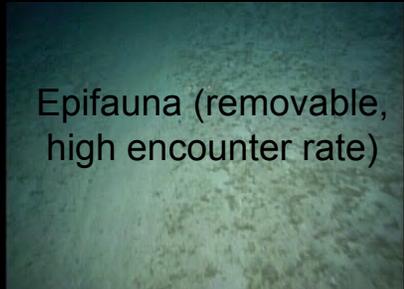


Example Risk Assessment Product

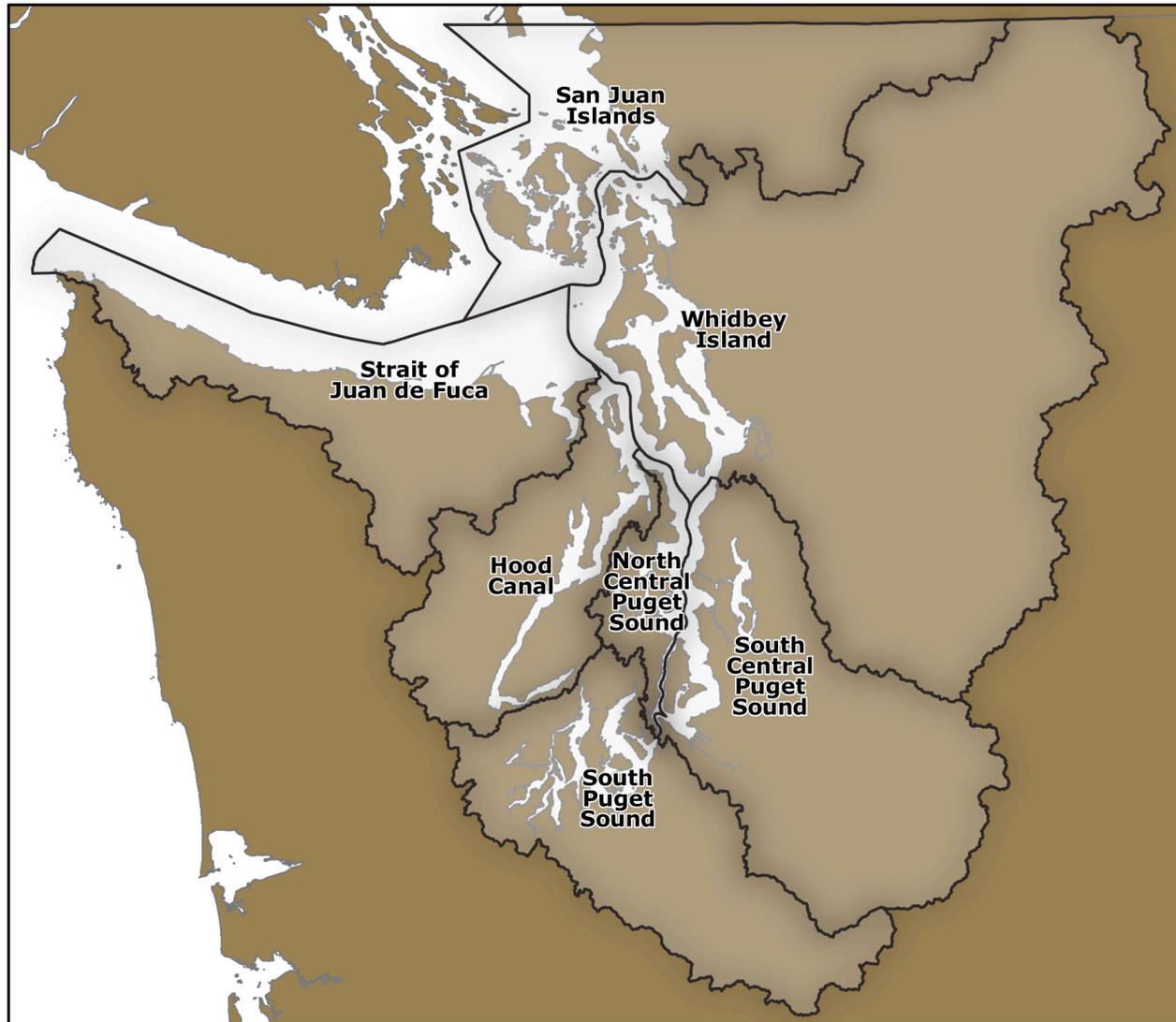
Habitat in Australia, courtesy Beth Fulton CSIRO



- low
- medium
- high



PSP Action Areas



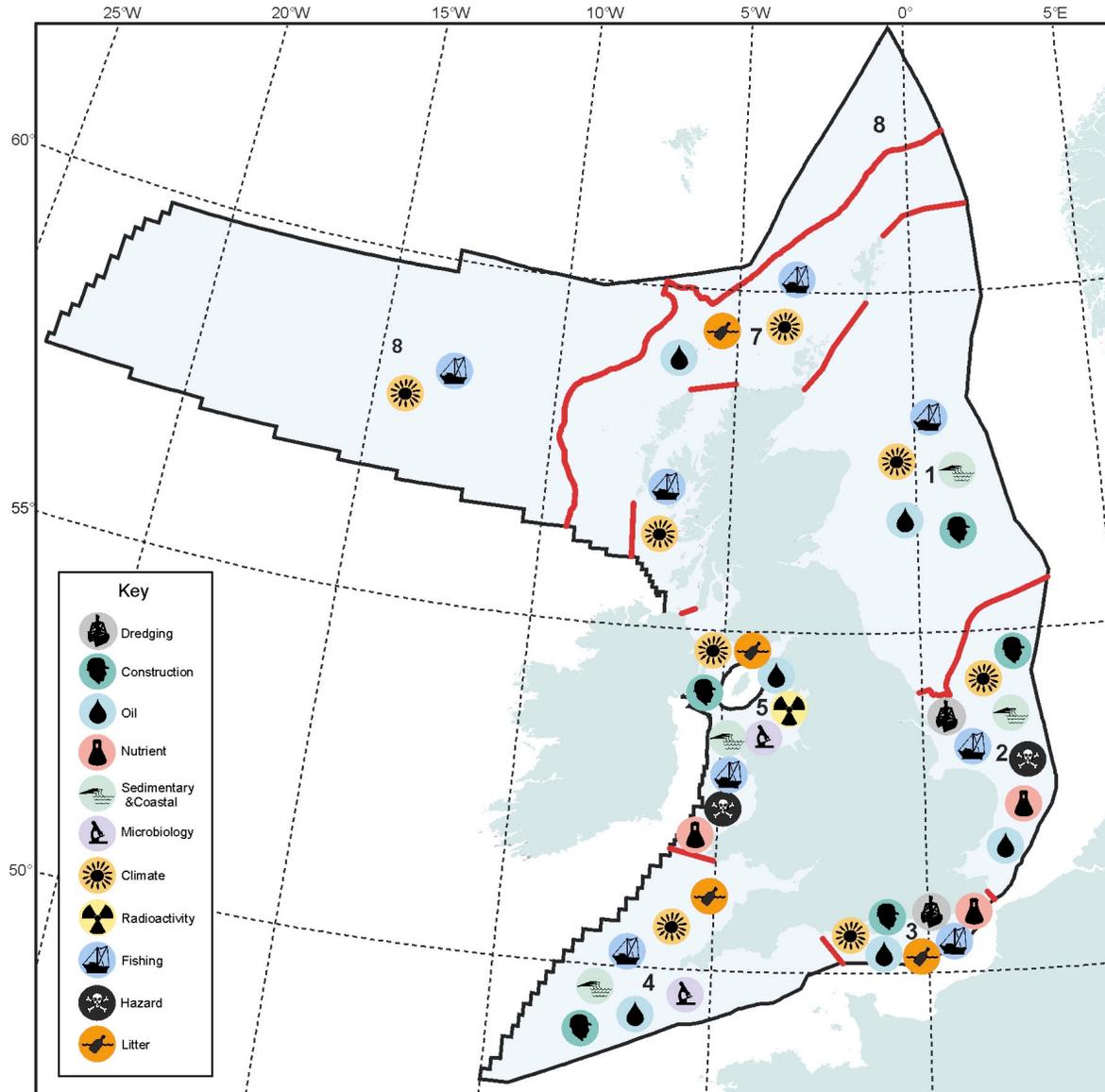
Key threats by sub-region of ecosystem--example from UK

| Region | 1. North Sea | 2. Southern North Sea | 3. Eastern English Channel | 4. Channel and Approaches | 5. Irish Sea | 6. Western Scotland | 7. Scottish Continental | 8. Scottish Offshore |
|---------------------------------|--------------|-----------------------|----------------------------|---------------------------|--------------|---------------------|-------------------------|----------------------|
| Climate Impacts | | | | | | | | |
| Fisheries | | | | | | | | |
| Nutrients | | Coastal | | | | | | |
| Microbiological Contaminants | | | | | | | | |
| Hazardous Substances | | | | | | | | |
| All oil Industry | | | | | | | | |
| Radioactivity | | | | | | | | |
| Construction | | | | | | | | |
| Dredging | | | | | | | | |
| Sedimentary and Coastal Erosion | | | | | | | | |
| Litter | | | | | | | | |

Orange shading indicates the impacts from activities (rows) are considered to be important in the corresponding regions (columns)

<http://www.defra.gov.uk/environment/water/marine/uk/stateofsea/chartprogress.pdf>

Key threats by sub-region of ecosystem--example from UK

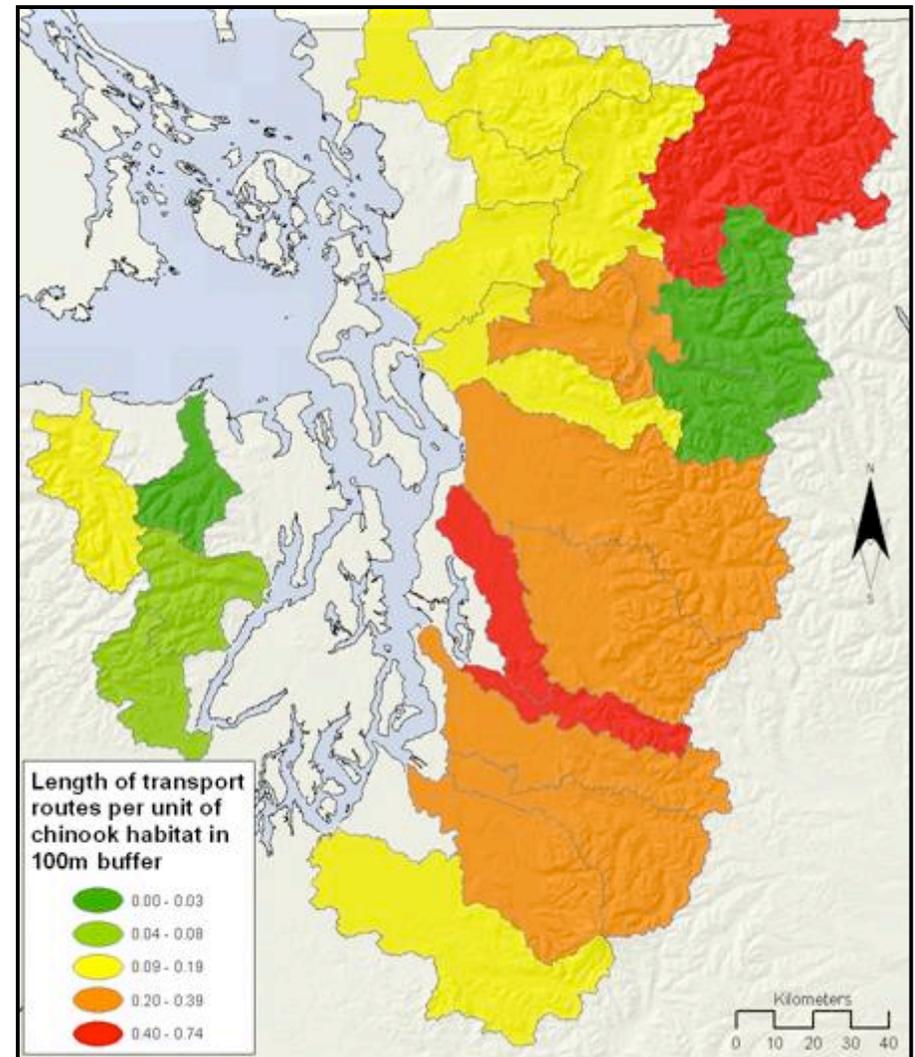
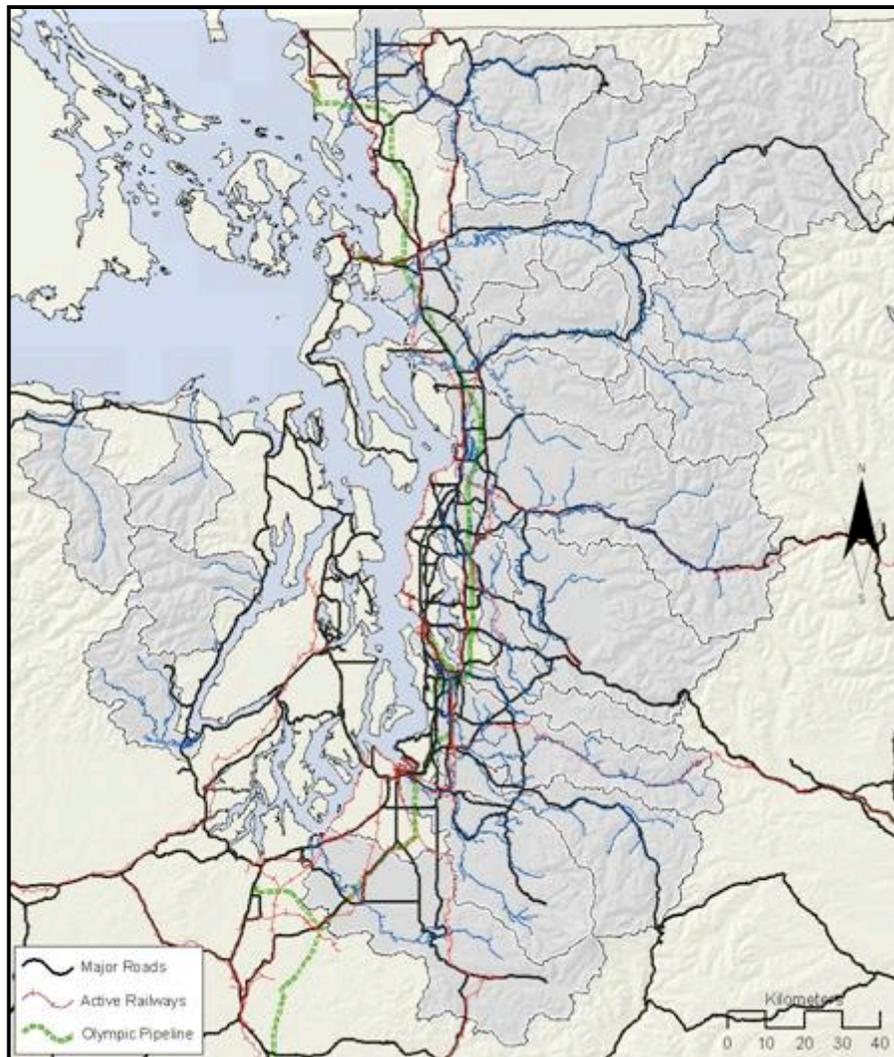


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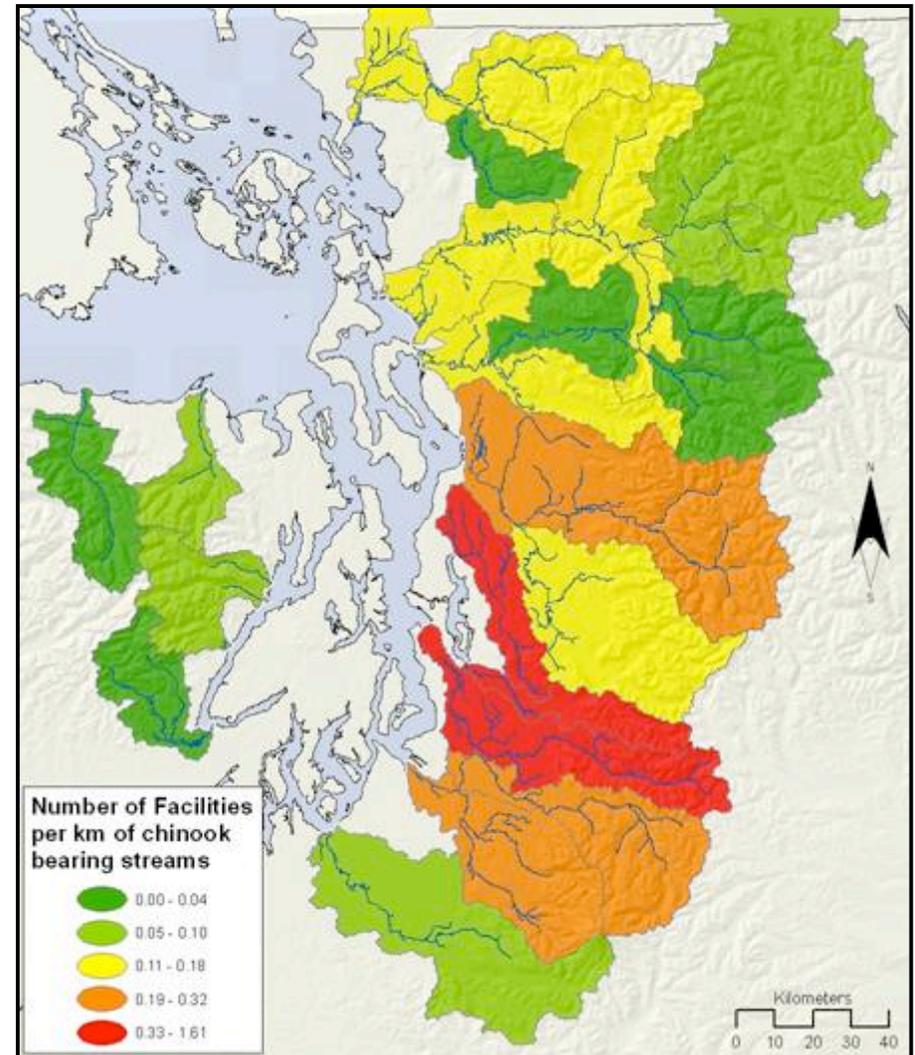
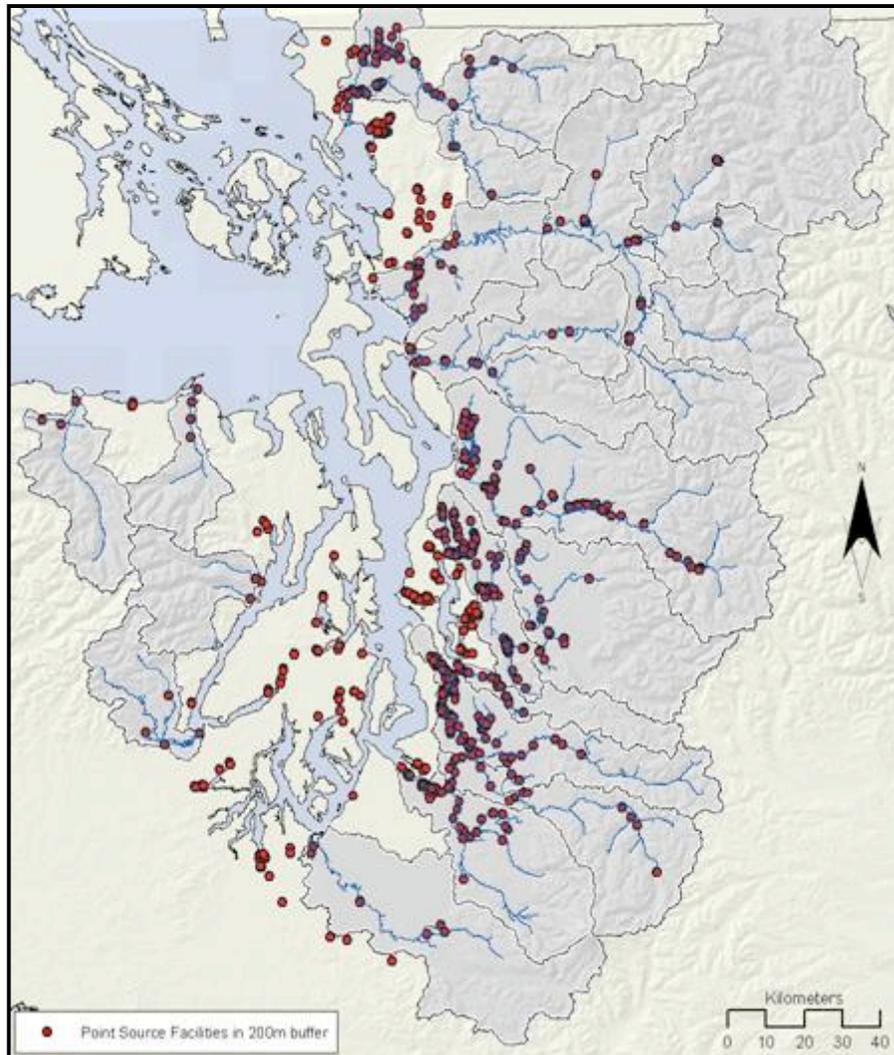
Simplified Puget Sound Sub-basin Threats Tables

| Threat group | Threat activity | Sub-Basin | | | | | | |
|---------------------|--|-----------|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Habitat alterations | Existence or operation of offshore, shoreline, and benthic structures | | | | | | | |
| Habitat alterations | Construction or repair of offshore, shoreline, and benthic structures | | | | | | | |
| Habitat alterations | Operation of vehicles / vessels (i.e., sound pollution, wakes, collisions) | | | | | | | |
| Habitat alterations | Log booming, log grounding, floating log storage, and log rafts | | | | | | | |
| Habitat alterations | Dredging, capping, and disposal of dredged sediments | | | | | | | |
| Habitat alterations | Mining | | | | | | | |
| Habitat alterations | Littering (i.e., terrestrial trash, marine debris, derelict fishing gear) | | | | | | | |
| Habitat alterations | Land conversion due to forest practices, agriculture, or urbanization | | | | | | | |
| Habitat alterations | Activities contributing to air pollution | | | | | | | |
| Habitat alterations | Activities contributing to climate change | | | | | | | |
| Habitat alterations | Recreation and ecotourism | | | | | | | |
| Surface / ground wa | Floodplain drainage and disconnection | | | | | | | |
| Surface / ground wa | Alteration of stream flows due to channeling, damming, withdrawing, or diverting water | | | | | | | |
| Surface / ground wa | Depletion of aquifers / groundwater | | | | | | | |
| Surface / ground wa | Contamination of aquifers / groundwater | | | | | | | |
| Pollution | Stormwater spills/discharges | | | | | | | |
| Pollution | Wastewater spills/discharges | | | | | | | |
| Pollution | Toxics or oil spills/discharges | | | | | | | |
| Pollution | Sewage, greywater, bilge, and ballast discharges from boats | | | | | | | |
| Pollution | Mis-use of on-site sewage treatment | | | | | | | |
| Pollution | Agricultural runoff | | | | | | | |
| Aquaculture | Benthic aquaculture | | | | | | | |
| Aquaculture | Pelagic aquaculture / hatcheries | | | | | | | |
| Harvest | By-catch, accidental death | | | | | | | |
| Harvest | Demersal fishing (i.e., bottom trawling, longline, set net, spearfishing, pot fishing) | | | | | | | |
| Harvest | Pelagic fishing (i.e., gillnet, purse seine, angling) | | | | | | | |
| Harvest | Hunting | | | | | | | |
| Species Invasion | Exotic species introduction and subsequent invasion | | | | | | | |

Example spatial analysis of threats: Toxic Spills (Transport)



Example spatial analysis of threats: Potential Point Source Leaks/Spills



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Risk analysis results--e.g., single species

- What are the biggest impediments to orca health?
 - contaminant levels in orcas
 - not enough salmon prey
 - physiological stress
- Where should we focus our strategies first?
 - Identify and reduce primary sources of toxic contaminants in orcas. Determine (1) primary sources of toxics into environment, (2) transport of those toxics, and (3) fate: primary routes through which they get into orcas.
 - Increase salmon prey. (1) improve protection of and restore key freshwater, estuarine and nearshore habitats, (2) reduce negative impacts of hatchery and harvest practices
 - Reduce physiological stress. (1) improve practices of whale-watching boats and kayakers and (2) improve quality and availability of prey

Risk analysis results--e.g., water quality

- Toxics

- loadings--relative magnitude, locations (WA DOE report)

- Strategies--prioritize source control, clean up existing sites based on loadings results

- Nutrients and pathogens, others

- Much less certain about loadings, sources

- Strategies--focus where impacts most likely

Puget Sound food web model

