An overview of a risk analysis framework

Purpose of this talk:

- Risk analysis is under development
- Illustrate nature of information to be provided--examples
- Schedule and next steps

A framework for risk analyses for the Puget Sound ecosystem

(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

Purpose: to provide spatial information to help in assessing current status and informing priority strategies for PSP Action Agenda

Risk analysis technical steering committee

- Helen Berry, Tom Mumford (WA DNR)
- Wayne Palsson, Jim West, Craig Busack, Pete Hahn (WDFW)
- Philip Bloch (WA DOT)
- Molly Ingraham, Jacques White (TNC)
- Mary Mahaffey (USFWS)
- Joe Joy (WA DOE)
- Mike Letourneau (EPA)

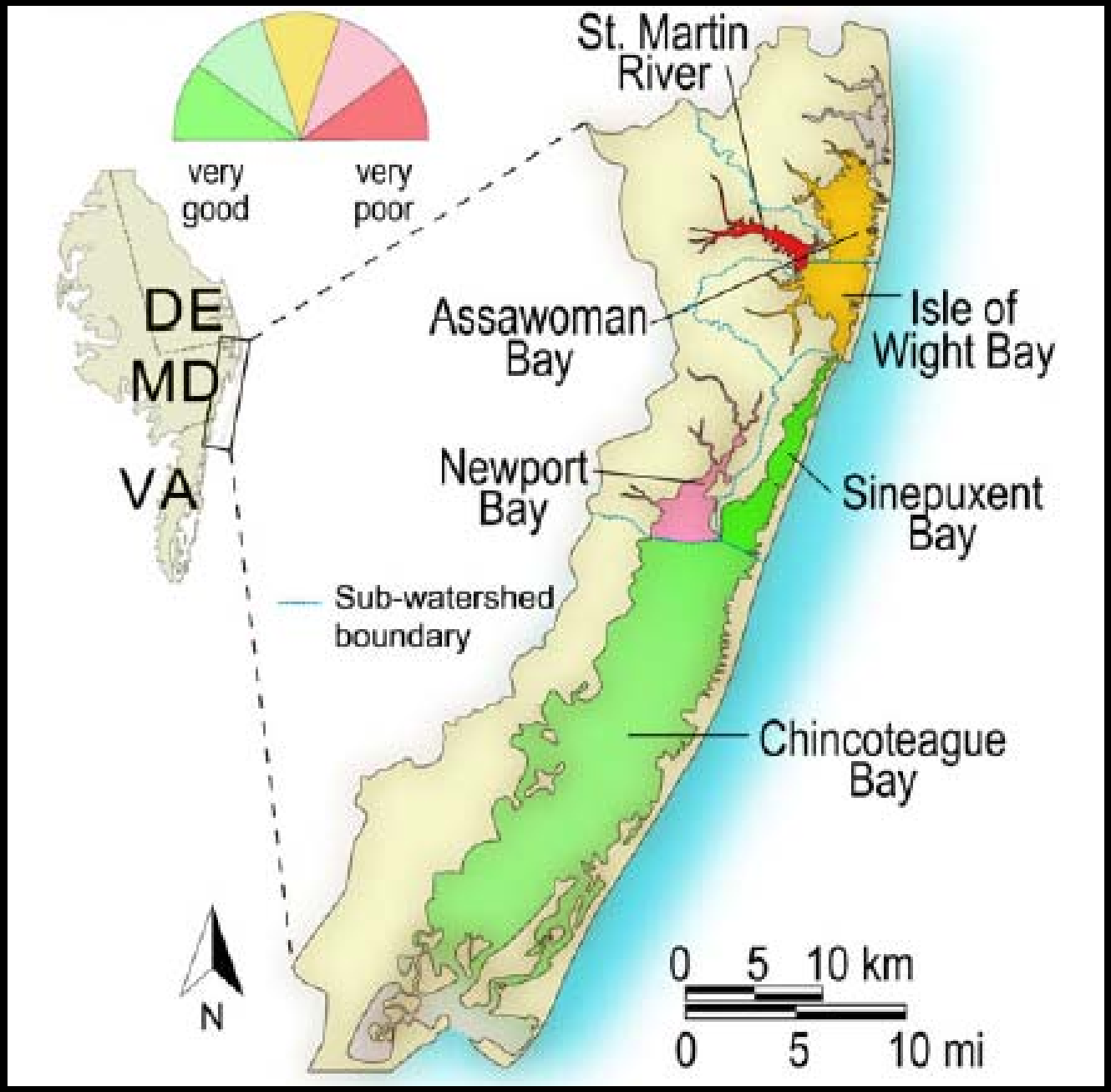
6 ecosystem goals by 2020

- Healthy people supported by healthy Puget Sound
- Quality of human life sustained by a healthy Puget Sound
- Puget Sound species and the web of life thrive
- Puget Sound habitat is protected and restored
- Puget Sound rivers and streams flowing at levels that support people, fish and wildlife and the environment
- Puget Sound marine and freshwater are clean

GOOD ESTUARINE HEALTH → POOR ESTUARINE HEALTH

Estuarine health index	0.9	0.7	0.6	0.5	0.4	0.1
	Sinepuxent Bay	Chincoteague Bay	Assawoman Bay	Isle of Wight Bay	Newport Bay	St. Martin River
Water quality						
Water quality index[1]	0.85	0.74	0.33	0.53	0.35	0.33
Chlorophyll *a* (μg L^{-1})[2]	5	5	15	11	15	16
Total nitrogen (mg L^{-1})[2]	0.35	0.54	1.19	0.84	2.08	1.93
Total phosphorus (mg L^{-1})[2]	0.04	0.04	0.05	0.05	0.07	0.09
Dissolved oxygen (mg L^{-1})[2]	6.1	6.1	6.1	5.6	6.0	5.5
Brown tide (max. cells μL^{-1})[3]	35-200	>200	35-200	35-200	>200	35-200
Macroalgal biomass (max. g m^{-2})[4]	50	320	100	250	10	390
Living resources						
Benthic index[5]	3.5	3.6	3.4	3.1	3.4	2.2
Hard clam density (clams m^{-2})[6]	0.32	0.27	0.16	0.28	0.14	0.04
Sediment toxicity[7]	10	8	12	11	13	19
Habitat						
Seagrass area (% of bay)[8]	36	32	8	5	4	<1
Wetland area (% of watershed)[9]	61	45	45	16	23	16
Natural shoreline (% of total)[10]	81	98	72	35	96	52

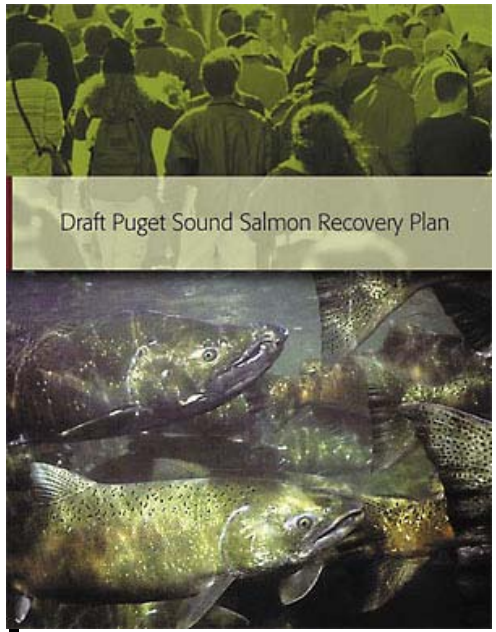
Dennison et al. 2007 Front Ecol Environ 5(6): pp307-314

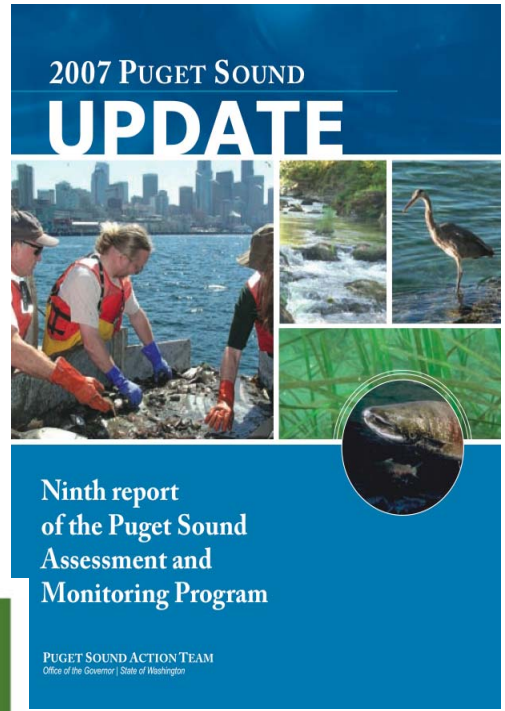


Dennison et al. 2007 Front Ecol Environ 5(6): pp307-314

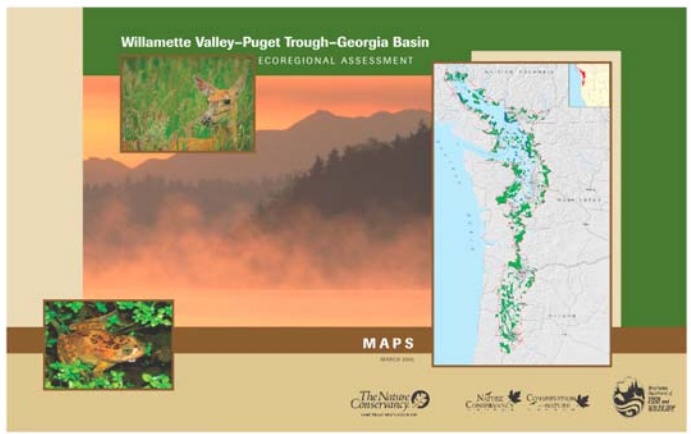
Sources for qualitative risk analysis

- Existing assessments





- Simple spatial analyses



Some Terms

- **Attribute/indicator**
- **Status**: Status of a component or attribute can be estimated by such indicators as its abundance, trend, productivity, spatial distribution or extent, diversity, some indicator of its quality, or an estimate of the likelihood of its persistence or condition into the future.
- **Threat/driver**: Activities or natural processes that have the potential to affect the status of an ecosystem component. (related terms: pressures, stressors)

Summarizing status: Examples

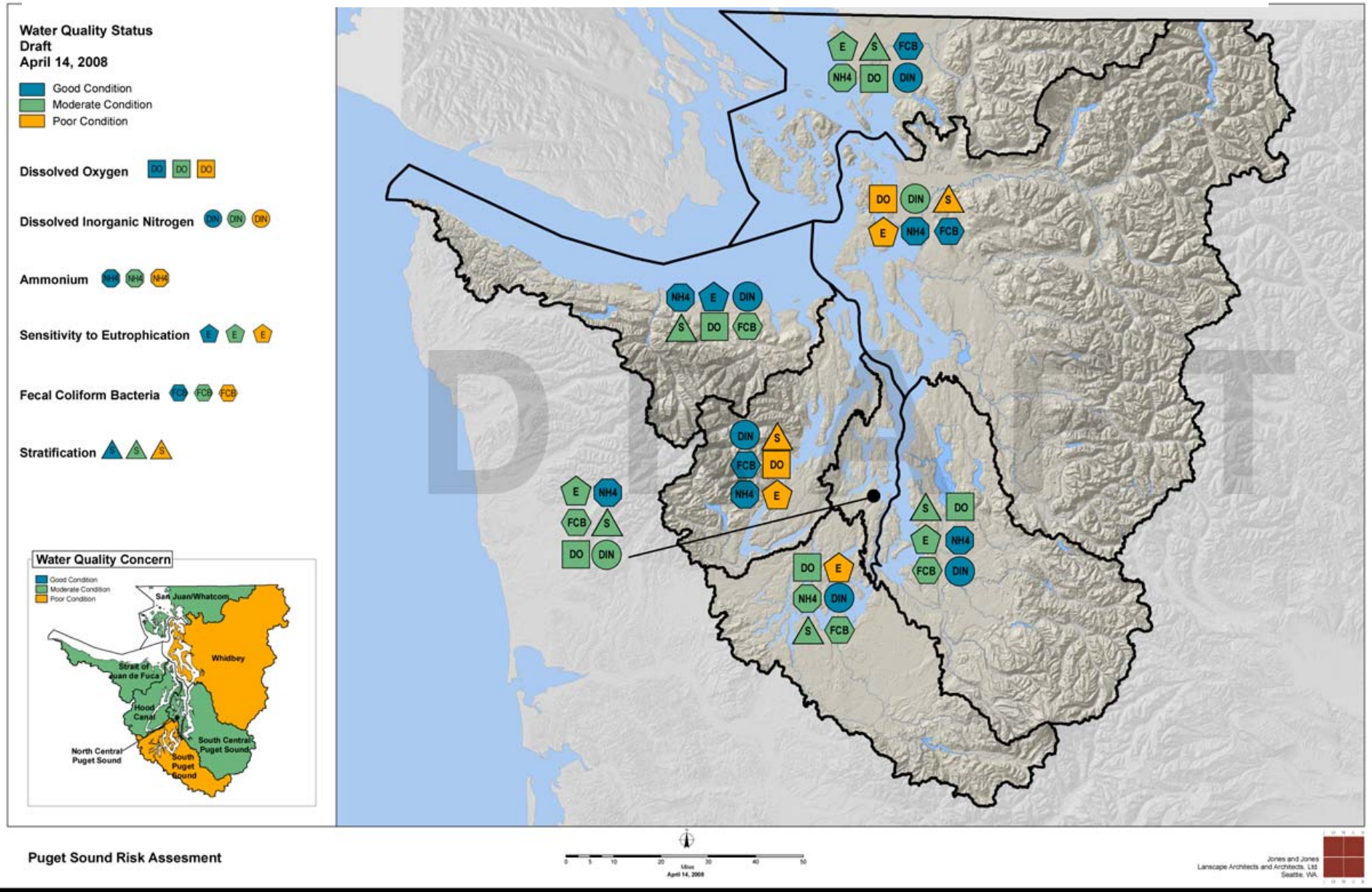
Ecosystem component	**Status Attributes**
Species/food web	Shorebird & seabird colonies, salmon, herring, marine fish, intertidal species richness, bald eagle, cutthroat trout, Golden paintbrush
Habitat	Eelgrass, sub-alpine grasslands, shrublands and woodlands, herbaceous wetland, oak prairie and grasslands, wet- and dry-Douglas Fir, montane mixed, riparian systems
Water quality	Water quality index and 6 sub-components
Water quantity	Peak and low stream flows
Human health	Shellfish bed pollution
Human well being	Landscape value, commercial catch of marine species, recreational use patterns (SCUBA and sites)

Compilation of available information

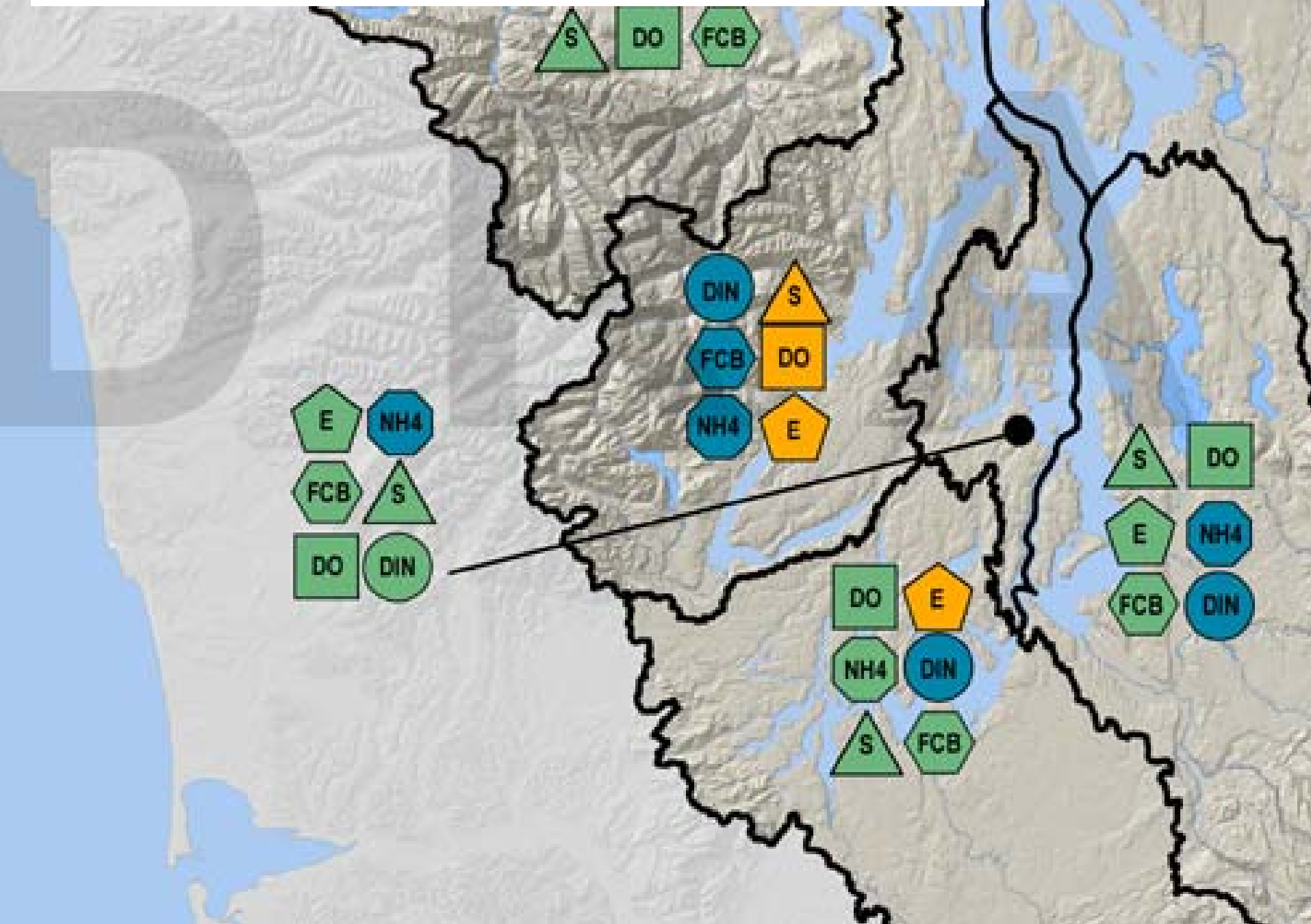
Standardized data format for all attributes--e.g., water quality:

Water Quality--DOE's 303d MARINE-BASED points	Description of Assessment (data source, summary method, etc)	Metric or ranking method	Hood Canal	North Central Puget Sound	San Juan Islands	South Central Puget Sound	South Puget Sound	Strait of Juan de Fuca	Whidbey Basin
raw metric value or score	*Data from WA DOE's 303d data layer were summarized by marine portions of the action*	*Count of Category 4A, 4B, and 5 points*	43	19	5	47	63	18	35
normalized value or score									
rank (high/moderate/low)		*LOW < 20; MODERATE 20 < x < 60;*	MOD	LOW	LOW	MOD	HIGH	LOW	MOD
reference condition			UNK	UNK	UNK	UNK	UNK	UNK	UNK
trend metric value or score			UNK	UNK	UNK	UNK	UNK	UNK	UNK
trend rank (increasing/stable/declining)			UNK	UNK	UNK	UNK	UNK	UNK	UNK

Marine Water Quality Status: Example summary graphic



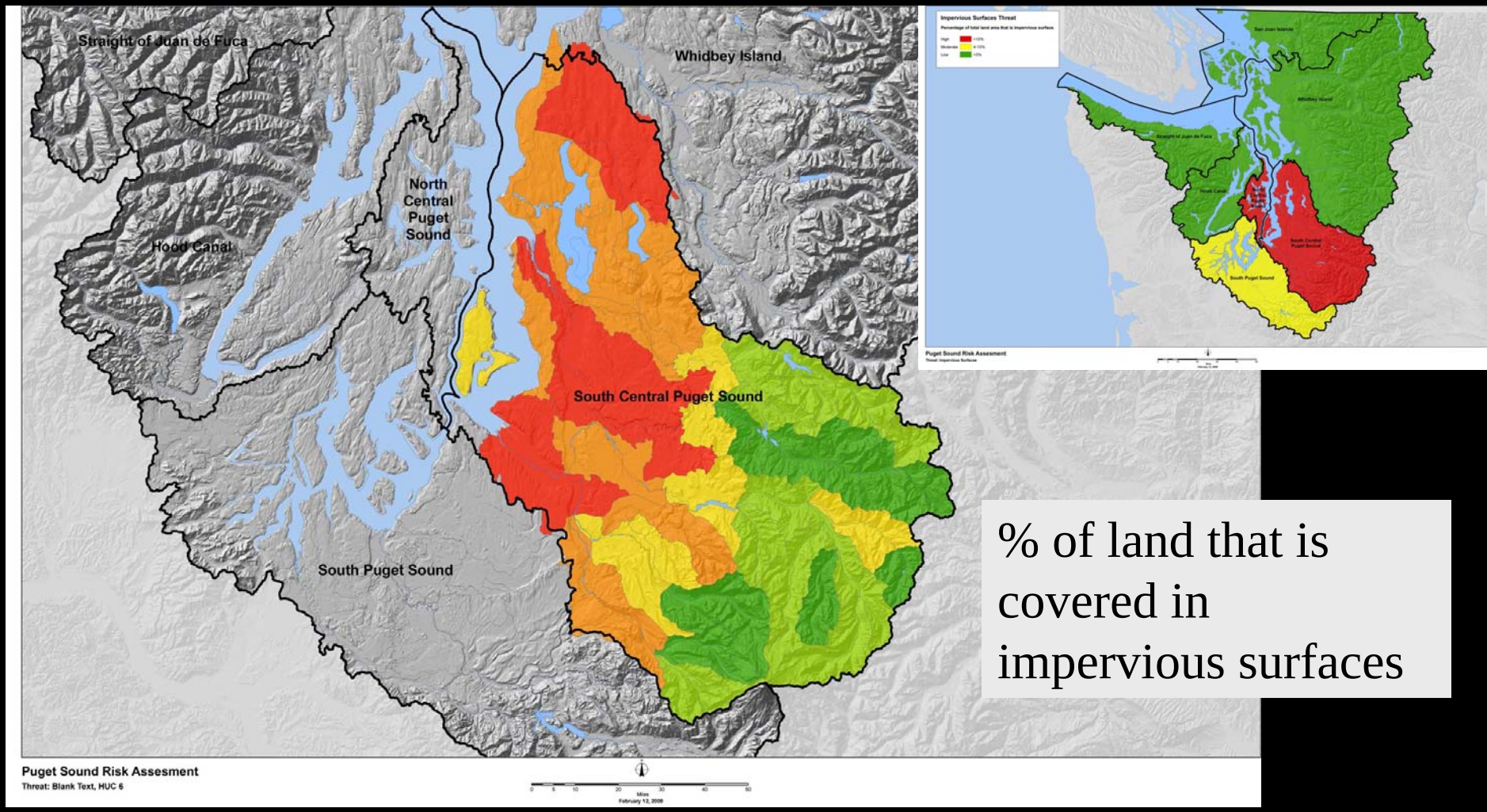
Water Quality Status: Example summary graphic



Summarizing threats/drivers: examples

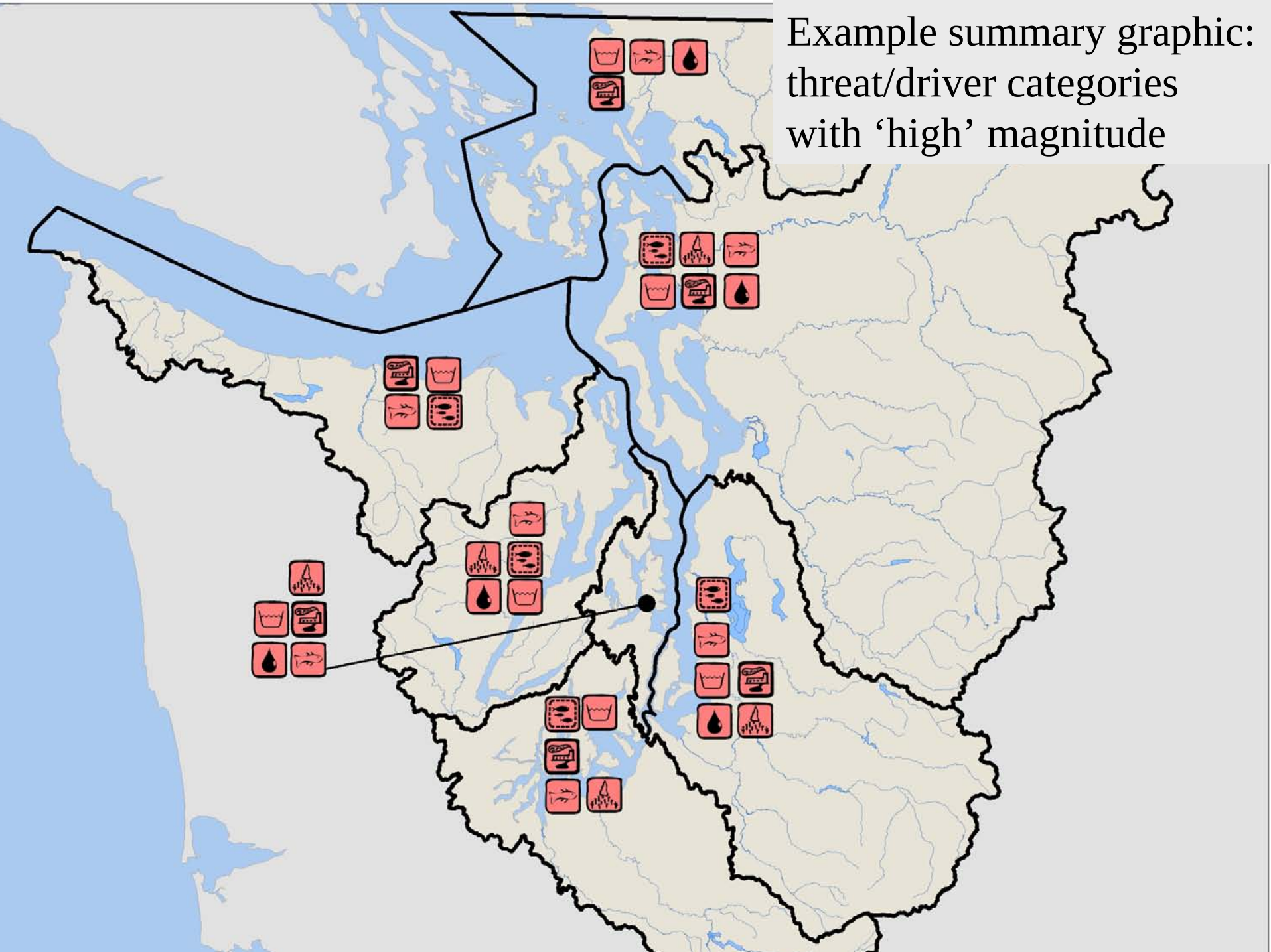
Threat type	Threat Attributes
Habitat alterations	Shoreline modification, forest cover, overwater structures, impervious surfaces, shoreline ownership
Surface/groundwater impacts	Surface and groundwater withdrawals
Pollution	Hazardous waste generators, oil spill likelihood, toxics in biota
Artificial propagation	Salmon hatchery releases
Harvest	Marine harvest (crab, groundfish, salmon, shellfish)
Species invasion	NA for today
Natural drivers	Sea level rise

Example: scales of reporting drivers and pressures



% of land that is covered in impervious surfaces

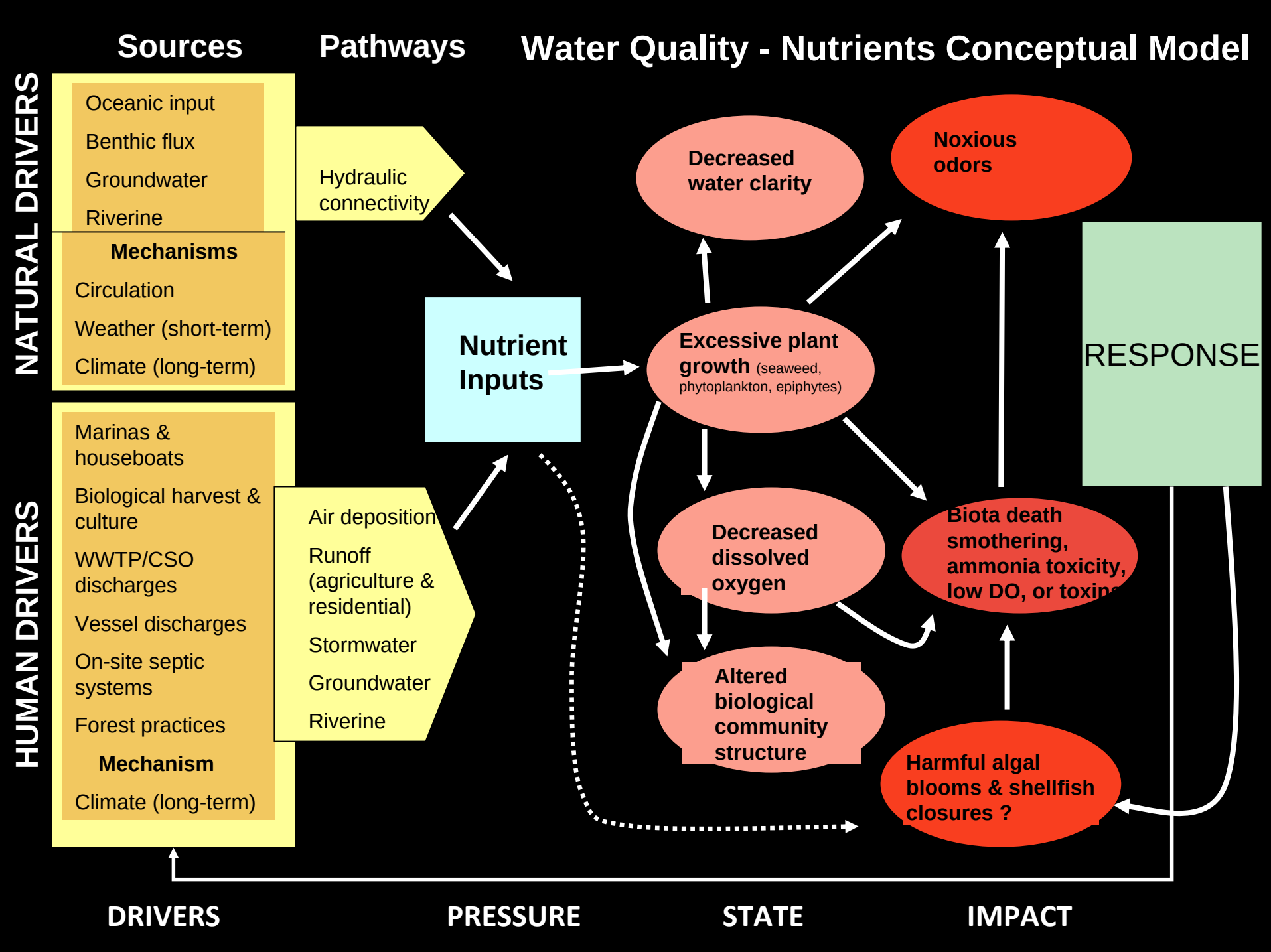
Threat: Impervious Surface, South Central Puget Sound: sub-watershed (HUC6)

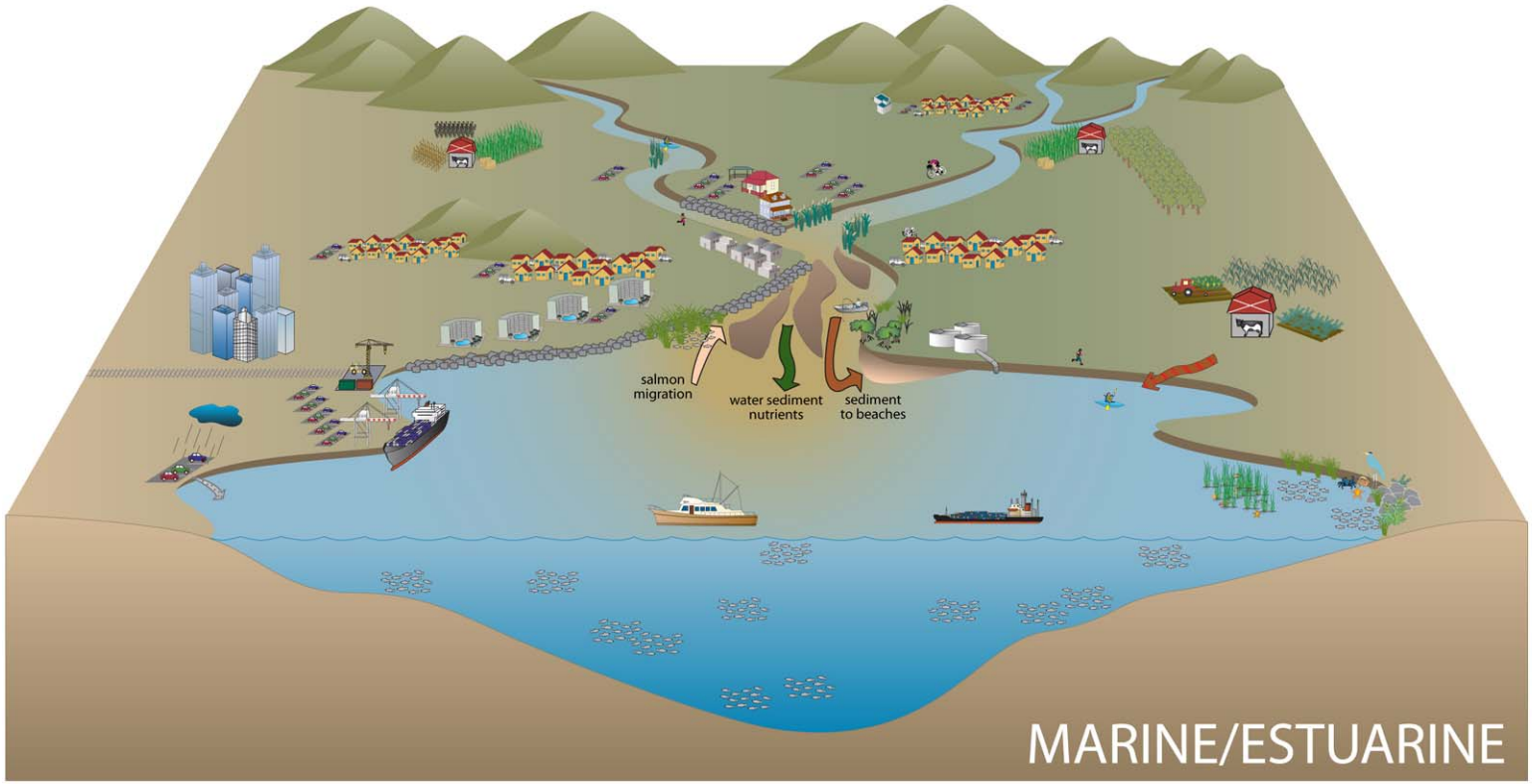


Example summary graphic: threat/driver categories with ‘high’ magnitude

Linking status and threats: conceptual models

Water Quality - Nutrients Conceptual Model





KEY ECOSYSTEM COMPONENTS/SERVICES

Estuaries support high primary production and provide important habitat for fish and other aquatic species (refs).

Estuaries regulate flooding and improve water quality (refs).

Shorelines provide important habitat for marine plants and animals, as well as aesthetic and recreational opportunities for humans (refs). Shorelines also represent an important transition zone between upland/terrestrial habitats and nearshore marine habitats; regulating transfer of organic and inorganic matter both upstream and downstream (refs).

Marine ecosystems support high primary productivity and species abundance, as well as managed aquaculture, commercial and recreational harvests (refs). Marine systems also provide aesthetic and recreational opportunities (refs).

MAJOR THREATS/DRIVERS

Invasive species; development; point and non-point sources of water pollution (e.g., from agriculture, stormwater, septic systems, etc.; sea level rise (refs).

Floodplain conversion to industrial, commercial, urban, and agricultural land uses results in changed hydrology and degraded habitat and water quality conditions. (refs).

Shoreline armoring and structures; shoreline development; stormwater and other discharges; unmanaged shoreline recreation, natural disturbance regimes (i.e., extreme weather events) (refs).

Invasive species; spills and discharges; channel dredging and boat operation; natural disturbance regimes (i.e., extreme weather events) (refs).

MANAGEMENT PRIORITIES

Next steps for risk analysis

- Develop summaries of attribute status for each of PSP 6 goals and threat/driver categories
- Draft results for peer review by summer 2008
- Appendix to Action Agenda in Dec. 2008

Puget Sound Partnership

Water Quality Topic Forum

Overview of Science Papers (1,2) and Policy Paper 1

PugetSoundPartnership

our sound, our community, our chance

Major Tensions

- Water Quality (Ecosystem) vs. water quality
- Footprint (urbanization/land use/population) vs. footprint (individual choices)
- Expertise of the team vs. Breadth of the Issue
- Knowing enough vs. Action
- Limits of time vs. Giving it our best shot
- “Is this time really different” vs. Moving the ball forward
- Why haven’t we already arrived vs. tangible progress

The big question

- What can we credibly suggest to deal with the level of population (or climate change) projected for this area in our lifetimes?

Team Members

- Pam Bissonnette, Bissonnette Environmental Solutions (King County, City of Bellevue)
- Bill Moore, Ecology
- Dr. Derek Booth, Stillwater Consultants/University of Washington
- Dr. Randy Shuman, King County
- Bill Derry, CH2MHill
- Dr. Charles Wisdom, Parametrix
- Dr. John Ferguson , UW
- Dr. Anne Fairbrother, Parametrix/OSU Affiliation
- Attempts were made to include agricultural and tribal representation

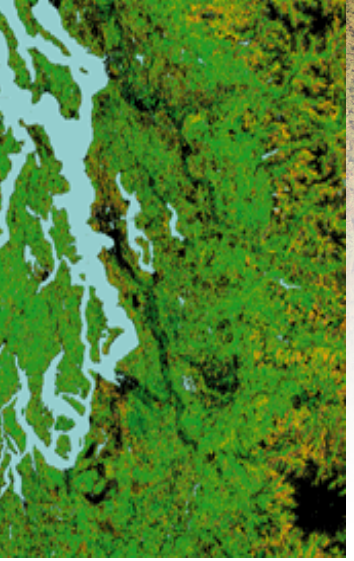
What do we know about the status and threats to Puget Sound?

Status of Fresh Water Quality in Puget Sound

- Impaired lakes, rivers and streams
  - WSWQA Year 2002: 50% stream miles by metals, 57% fecal coliform, 16% DO, 16% T
  - Lake fish consumption advisories PCBs and Mercury
  - Endocrine Disruptors, Pharm. Personal Care Products

S1 Status of Stormwater Quality in Puget Sound

- Gaps in Our Stormwater Knowledge
  - Ecosystem is complex, don’t understand interrelationships of water quality, quantity, biological activity, physical habitat
  - Effects of pollutant soup
  - How toxicity affects organisms
  - Full suite of chemicals and which ones are toxic



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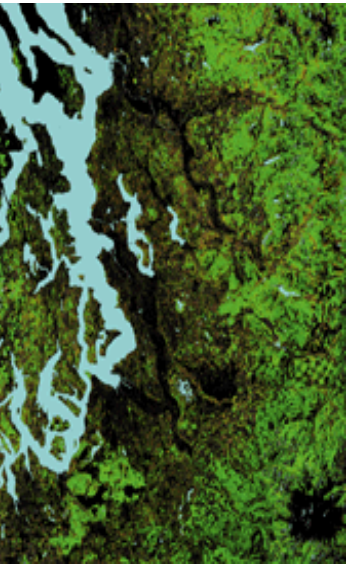

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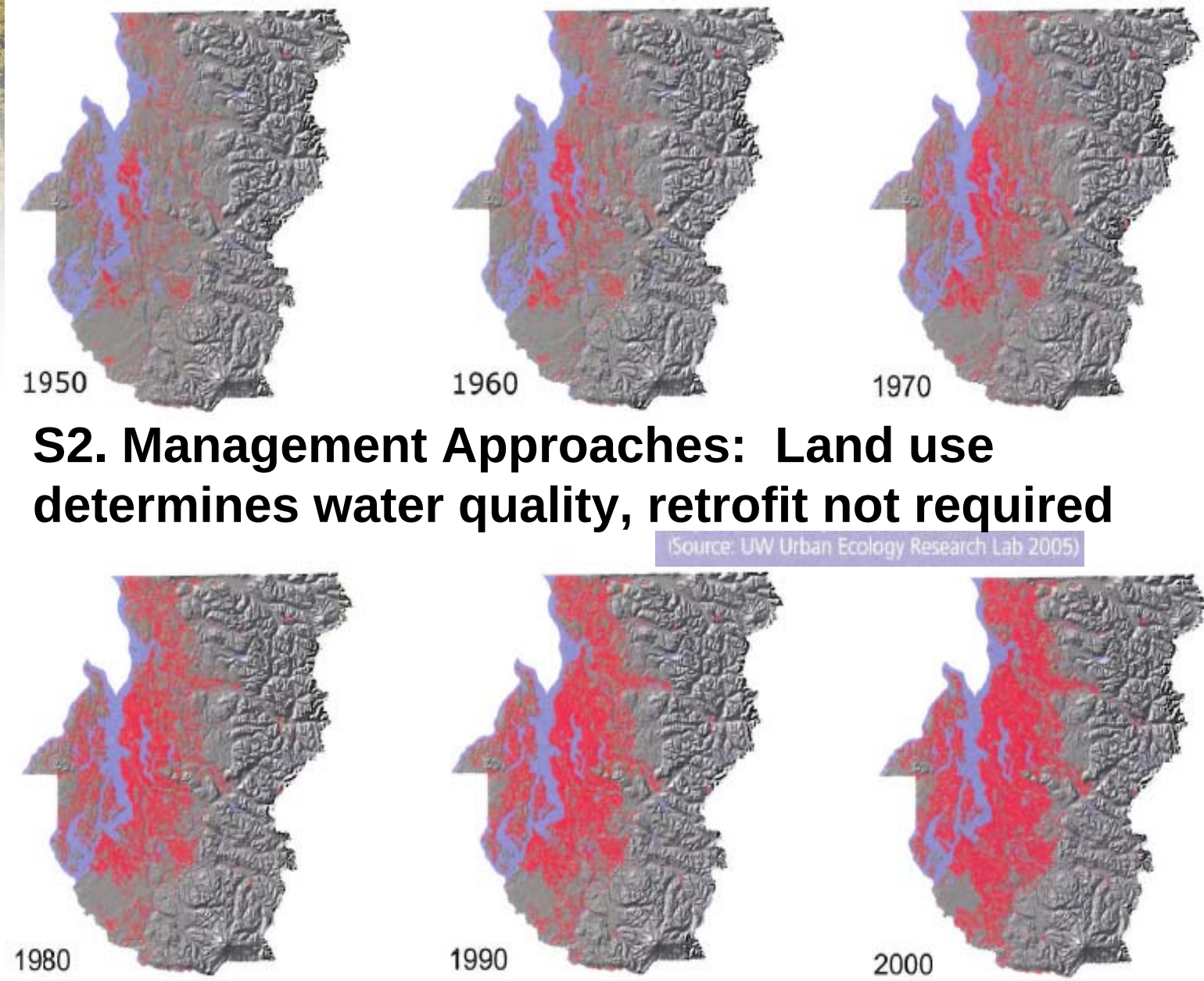

S2. Management Approaches: Land use determines water quality, retrofit not required

(Source: UW Urban Ecology Research Lab 2005)

S2 Management Approaches: documented effectiveness

- Source control
- Structural BMPs
- Regulations
- Illicit connection detection and elimination
- Public Education effectiveness not documented
- Monitoring not well focused, targeted, coordinated or available results, doesn't measure biology

S2 Management Approaches: documented effectiveness - LID

- Proven effective at flow control
- Proven effective at removing pollutants
- Uncertainty for some dissolved pollutants reaching groundwater (e.g. N)

S2 Management Approaches: documented effectiveness - LID

- Challenges include:
  - Accepted standards of practice and maintenance
  - Public vs. private systems (whose roof is it?)
  - Is volume/pollutant dispersion better in the long run?

Policy Approaches/Gaps to SW in PS

- Stormwater Utilities/NPDES Permits
- Gaps
  - NPDES primarily large areas uncovered
  - Ecology Stormwater Manual for Western Washington (2005)
  - Need much input on ag, forestry
  - Approaches remain presumptive in nature for jurisdictions and land owners
  - Standards leave many substances unaddressed

Water Quality Impairment-Sources of Information

- 2007 Puget Sound Update
- 303d list
- Sound Science
- Gaps in this information
  - Monitoring gaps
  - WQ standard gaps

Water Quality Impairment

- Ecology's 303(d) list (2004 and 2008 proposed) for Category 5 listings included *335 freshwater* and *39 marine* water bodies in Puget Sound WRIAs
- 88% of all listings were for *temperature*, *fecal coliform bacteria* and *dissolved oxygen* impairments
- Over 60% of the listings were located in 4 of the 19 Puget Sound WRIAs (1- Nooksack, 8- Lake Washington, 9- Duwamish/Green, and 15-Kitsap)
- *30,000 acres* of commercial shellfish beds remained closed in 2005 due to water pollution

Sediment Impairment

16 marine and *3 fresh* water bodies are listed on Ecology's 303(d) list for Category 5 sediment impairments (needs a TMDL)

1 marine water body (Bellingham Bay) is listed as a category 4A sediment site, that has an approved TMDL

Sediment contain a broad range of toxics, *metals*, *phthalates, PAHs, and PCBs*

Listed marine sites are in typically in *urban or industrial embayments,* Elliott Bay, Commencement Bay, etc.

What are the transport mechanisms?

- Stormwater
- Wastewater effluent (municipal and industrial)
- On-site sewage systems
- Airborne deposition (emissions)
- Groundwater
- Sediment
- Non-point runoff from agriculture and forest practices
- Marine Traffic

What are we currently doing to address the problem? What is the documented effectiveness of solutions to addressing the threats?

- Source Control
  - Minimize the use of chemicals and prevent pollutants from being transported to receiving waters
- Treatment
  - Collect and remove pollutants from stormwater or wastewater systems prior to discharge to receiving waters
- Sediment remediation of “legacy contaminants”

Gaps in our current technical approaches,

- Municipal wastewater

Designed to remove particles and pathogens

  – Limited effectiveness at removing emerging constituents [pharmaceuticals, endocrine disrupting compounds (EDCs)]
  – Limited effectiveness at removing nutrients

- On-site septic systems
  – Limited effectiveness at removing nutrients

Policy Approaches to Address the Problem

- Clean Water Act
  - NPDES, implemented by Ecology
  - Coast Guard Regulations for waste discharges in marine environment
- Endangered Species Act
- CERCLA/RCRA/MTCA
- Puget Sound Air Pollution Control Authority (PSAPCA)

Limitations of Existing Policies

- Lack of integrated planning
- Inadequate linkage to environmental degradation or improvement
- Barriers to use of reclaimed water
- Pursuit of separate goals (human or ecosystem health)
  - Human and ecosystem health objectives are not always addressed effectively in current programs

Limitations of Existing Policies, cont.

- Paradox in rural areas- increased densities are needed to fund WWTP operations locally, yet increased densities require greater levels of treatment

Limitations of Existing Policies, cont.

- Clean Air Act is not designed to address potential affects of airborne pollutants on water quality
- Land use planning is largely done by local governments with limited resources, making protection of large geographies such as Puget Sound difficult