The Path to Strategic Investments in West Coast Estuaries

Pacific Marine and Estuarine Fish Habitat Partnership Nursery Assessment

Pacific Marine & Estuarine Fish Habitat Partnership

Lisa A. DeBruyckere, PMEP Coordinator

Photo credit: Tillamook Estuaries Partnership

PMEP Priorities

- Protect, enhance and restore:
  - Juvenile fish habitat in nearshore marine and estuary habitats

  - Tidal wetland-intertidal-subtidal-nearshore connectivity; and

  - Water quality and quantity in estuaries and nearshore marine environments.

Spatial and Temporal Analysis of Fish Assemblages in Tidal Estuarine Habitats in the South Slough and Coos Estuary (Oregon). Photo credit: Bree Yednock.

Three Inter-related West Coast Assessments

PMEP Nursery Habitat Assessment

- Build an online database of existing data on juvenile fish presence, abundance & distribution.

- Characterize nursery roles of estuaries for focal group of 15 spp.

- Improve knowledge of habitat requirements of these species to improve management.

NFHP National Estuary Assessment

- Assess threats to fish habitats across the United States.

- Provide national perspective on prioritizing habitat restoration and protection.

Nearshore Forage Fish Assessment

- Determine whether nearshore restoration actions can ameliorate habitat conditions for forage fish stocks.

- Improve our understanding of anthropogenic impacts on forage fish, and potential effects on recreational fisheries caused by changing food supply.

- Support prioritization of restoration and protection actions that have the greatest benefits to the food chain of recreational fishes.

PMEP's Overall Goal

Work with partners to:

- Enhance ecological function and resilience of West Coast estuaries.

  - Objective 1 : Create a prioritization scheme to guide conservation and restoration actions supporting fish habitat functions in West Coast estuaries

  - Objective 2: Measure the effectiveness of the scheme and adapt the scheme to meet new needs as they arise.

Juvenile Hood Canal summer chum, federally listed as Threatened, will benefit from additional rearing habitat in Tarboo Bay. Photo credit: NW Watershed Institute. Restoration of salt marsh shoreline within the Dabob Bay Natural Area (Washington). Photo credit: Lowell Jons

Lessons Learned in the Application of CMECS to Oregon Estuary Habitats

Andy Lanier[1], Tanya Haddad[1], Laura Brophy[2], Patty Snow[1]

[1]Oregon Coastal Management Program - Oregon Department of Land Conservation and Development

[2]Greenpoint Consulting Inc.

CERF Conference, November 12, 2015

Digital Resources:

- Data was compiled into an estuary specific data catalog through an extensive survey of Agency partners, and online resources.

- The information was evaluated for it's utility to discern habitat features related to any of the CMECS components or settings.

2007-2009 LiDAR

2011 ShoreZone Photographs

2014 National Wetland Inventory

2009 High-Resolution Orthophotos

2009-2011 Dikes and Levees Inventory

NRCS Soils
CCAP vegetation
And many more…

Use Criteria:

Data Set extent must cover the entire study area.

CMECS – woohoo!

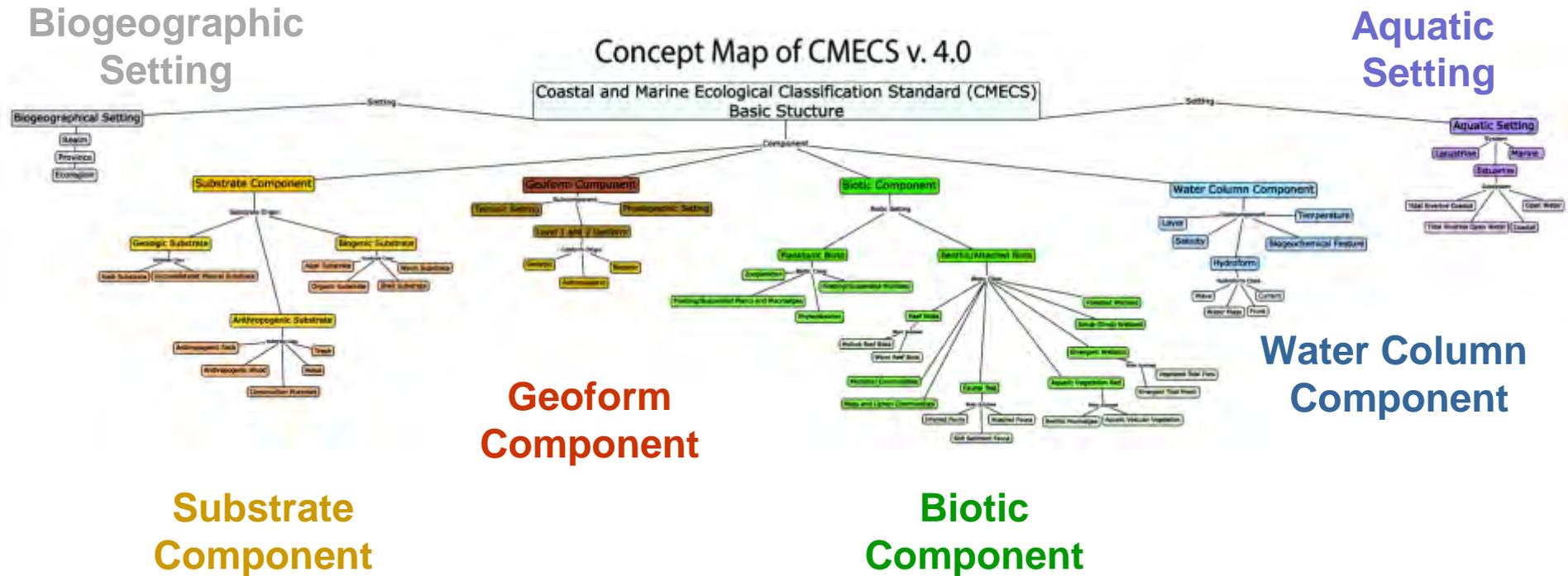**Coastal and Marine Ecological Classification Standard**
STRUCTURE: SETTINGS AND COMPONENTS

BIOGEOGRAPHIC SETTING
Ecoregions defined by climate, geology, and evolutionary history

AQUATIC SETTING
Zones defined by salinity, coastal proximity, and tidal regime

Water Column Component
Structure and Characteristics of the Water Column

Geoform Component
Geomporphic Structural Character of the Coast or Seafloor

Substrate Component
Character and Composition of Surface and Near-Surface Substrates

Biotic Component
Assemblages of Benthic or Suspended/Floating Biota

BIOTOPE Combination of abiotic habitat and associated species

Digital Coast

CMECS

- Released June 2012

- CMECS offers a standard framework and common terminology for describing natural and human influenced ecosystems from the upper tidal reaches of estuaries to the deepest portions of the ocean

FGDC-STD-018-2012

fgdc
FederalGeographicDataCommittee

Coastal and Marine Ecological Classification Standard

Marine and Coastal Spatial Data Subcommittee
Federal Geographic Data Committee

June, 2012

CMECS Untangled

Biogeographic Setting

Aquatic Setting

Concept Map of CMECS v. 4.0

Coastal and Marine Ecological Classification Standard (CMECS) Basic Stucture

Geoform Component

Water Column Component

Substrate Component

Biotic Component

- Simplifying the CMECS options to those most applicable in Oregon was a big step
- We used this diagram to organize the hunt for relevant data

Diagram created with Cmap software: http://cmap.ihmc.us/

Cinamon Moffet, OCMP

Substrate Component

Describes the origin and composition of estuary substrates

Substrate Origin:
- Geologic
- Biogenic
- Anthropogenic
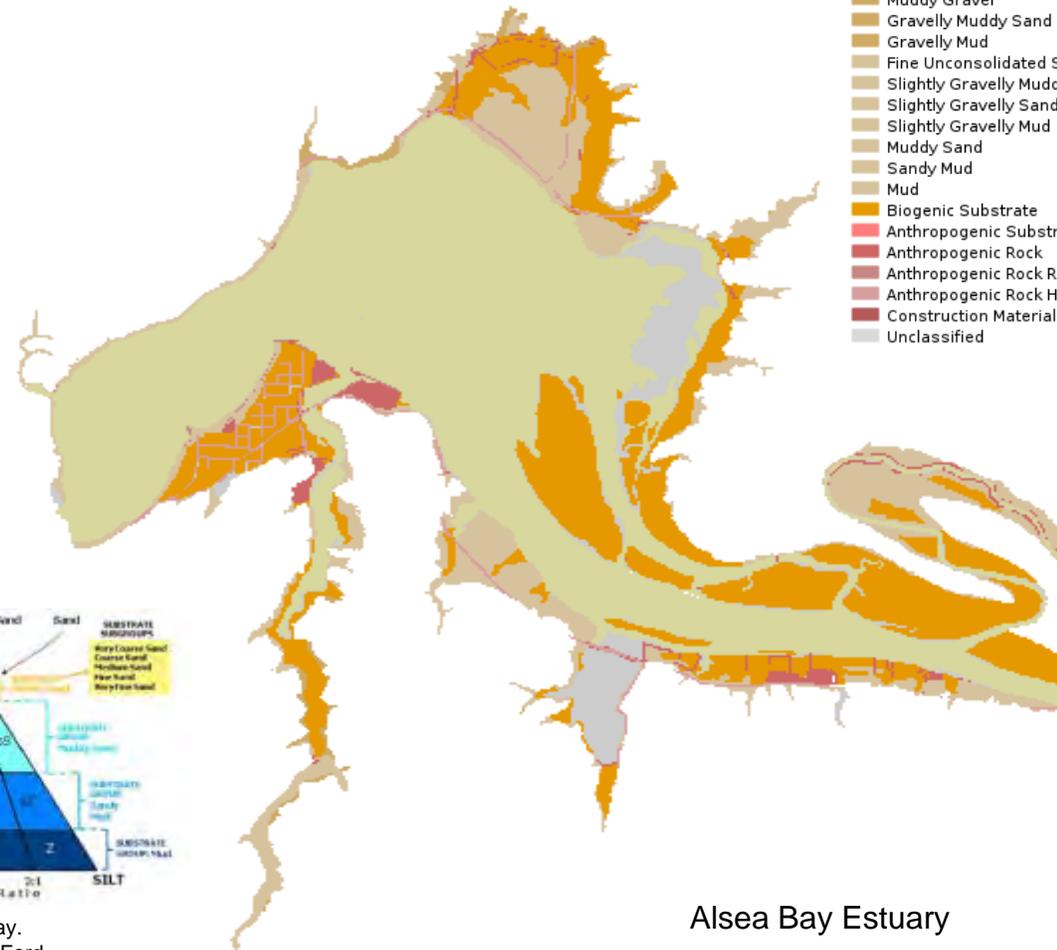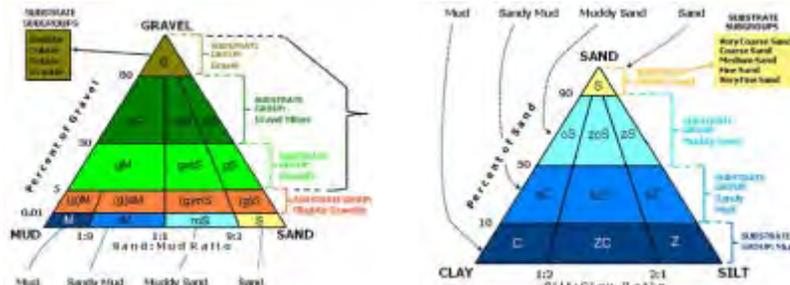
Ternary Diagrams for Gravel-Sand-Mud and Sand-Silt-Clay.
and for Sand-Silt-Clay, adapted from Folk (1954). Image: K. Ford.

Alsea Bay Estuary

Geoform Component

Describes the major geomorphic and structural characteristics of the coast.

There are 4 sub-components that can be used alone or in combination:

- Tectonic
- Physiographic
- Geoform level I
- Geoform level II

Nehalem Estuary

- Channel
- Slough
- Fan
- Shoreline Fan
- Flat
- Island
- Marsh Platform
- Natural Levees
- Natural Levees w Fill
- Shore
- Artificial Levee
- Breached Dike (new code)
- Dock / Pier
- Dredge Deposit
- Fill Area
- Harbor
- Marina / Boat Ramp
- Rip Rap Deposit
- Unclassified

Biotic Component

A hierarchical classification that identifies:

- composition of coastal attached biota and benthos
- composition of floating and suspended biota

Example:
Biotic Setting: Benthic/Attached Biota
   Biotic Class: Emergent Wetland
     Biotic Subclass: Emergent Tidal Marsh
      Biotic Group: Freshwater Tidal Marsh
       Biotic Communities: *Deschampsia caespitosa*

Aquatic Bed
Benthic Macroalgae
Aquatic Vascular Vegetation
Algal Bed
Emergent Wetland
Emergent Tidal Wetlands
Brackish Marsh
Scrub/Shrub Tidal Wetland
Scrub/Shrub Brackish Tidal
Forested Wetland
Forested Tidal Wetland
Unclassified

Siletz Bay Estuary

Results

Comprehensive GIS data of Oregon's estuaries (excludes the Columbia River):

- CMECS Habitat Layers
  - CMECS layers for 4 out of 5 components, across all of our targeted geographies
- Online Estuary Planning Atlas Tool (http://coastalatlas.net/estuarymaps/)
- Significantly improved the footprint of mapping in individual estuaries.

- We tackled CMECS and survived!
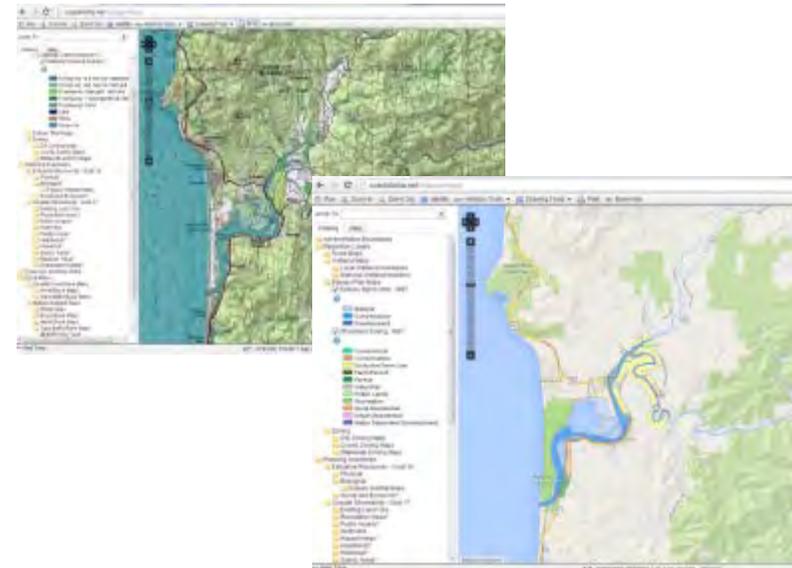
Next Steps

- Excited to start our CMECS phase II
- Revisit these high quality site-specific data that were passed over in phase I,
- work with data stewards to create CMECS crosswalks to bring in important missing data

Oregon Project Data Links

- Flyer:
http://www.coastalatlas.net/documents/cmecs/1pager_CMECS_Flyer.pdf

- Core GIS Methods Document::
http://www.coastalatlas.net/documents/cmecs/EPSM_CoreGISMethods.pdf

- GIS layers
http://www.coastalatlas.net/cmecs

- Interactive Map:
http://coastalatlas.net/estuarymaps/
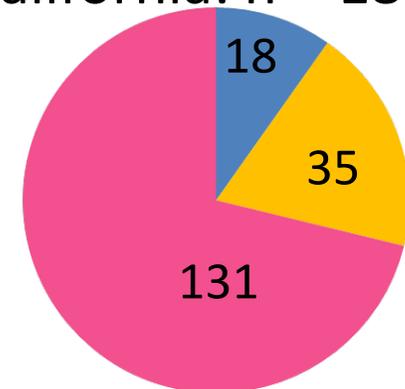
An Inventory and Classification of West Coast Estuaries

Washington: n = 47

Oregon: n = 72

California: n = 534
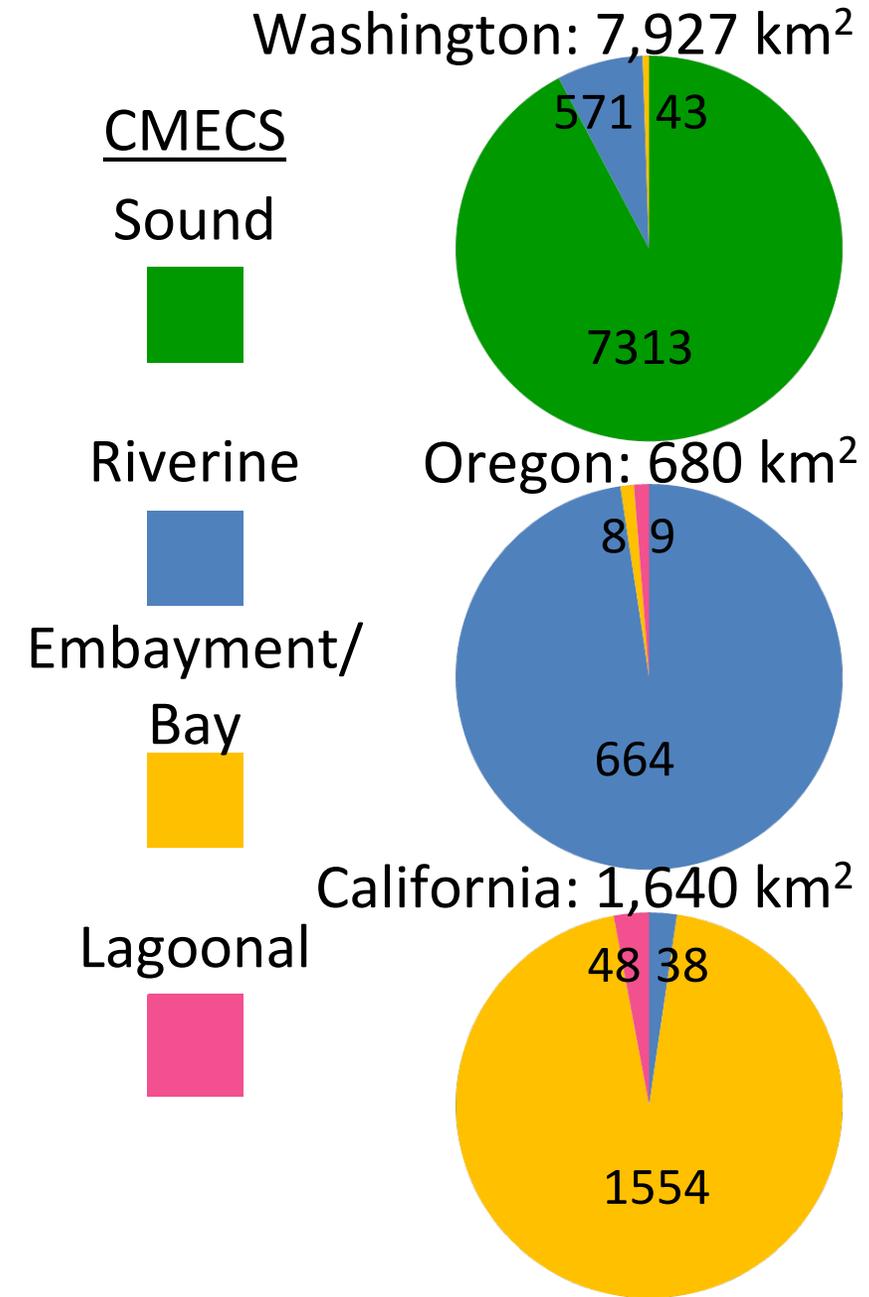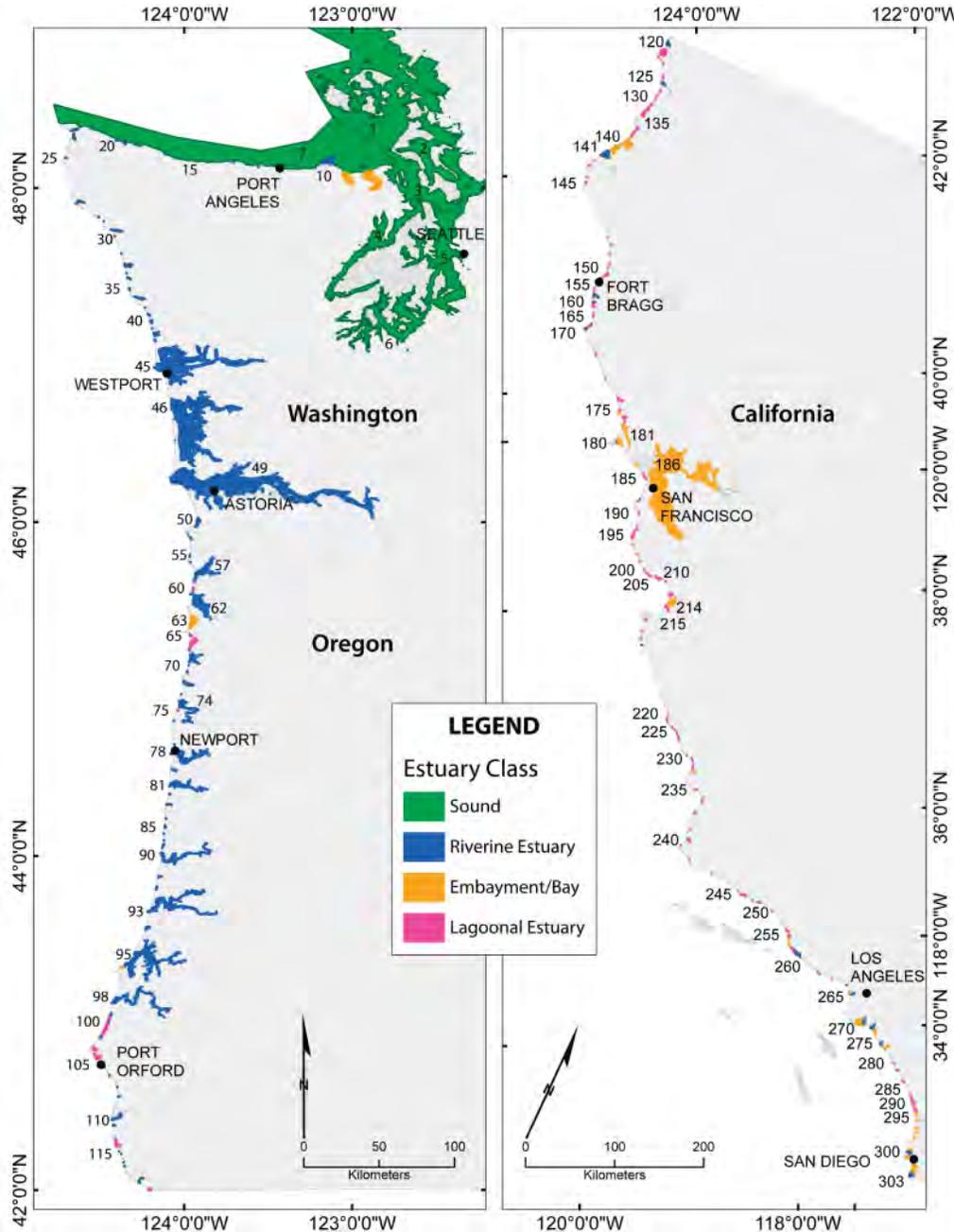
Subsample confluences of probable nursery value

Master Inventory of CA Coastal Confluences
n = 572

1: "Urban drains"
n = 34

6: Harbors
n = 4

Natural CA Coastal Confluences
n = 534

2: True lagoons & depressions
n = 10

Fluvial CA Coastal Confluences
n = 524

3: Unidentified streams
n = 112
&
4: Confluences lacking NWI
n = 59

Fluvial CA Coastal Confluences
n = 353

5: Confluence + marsh plain
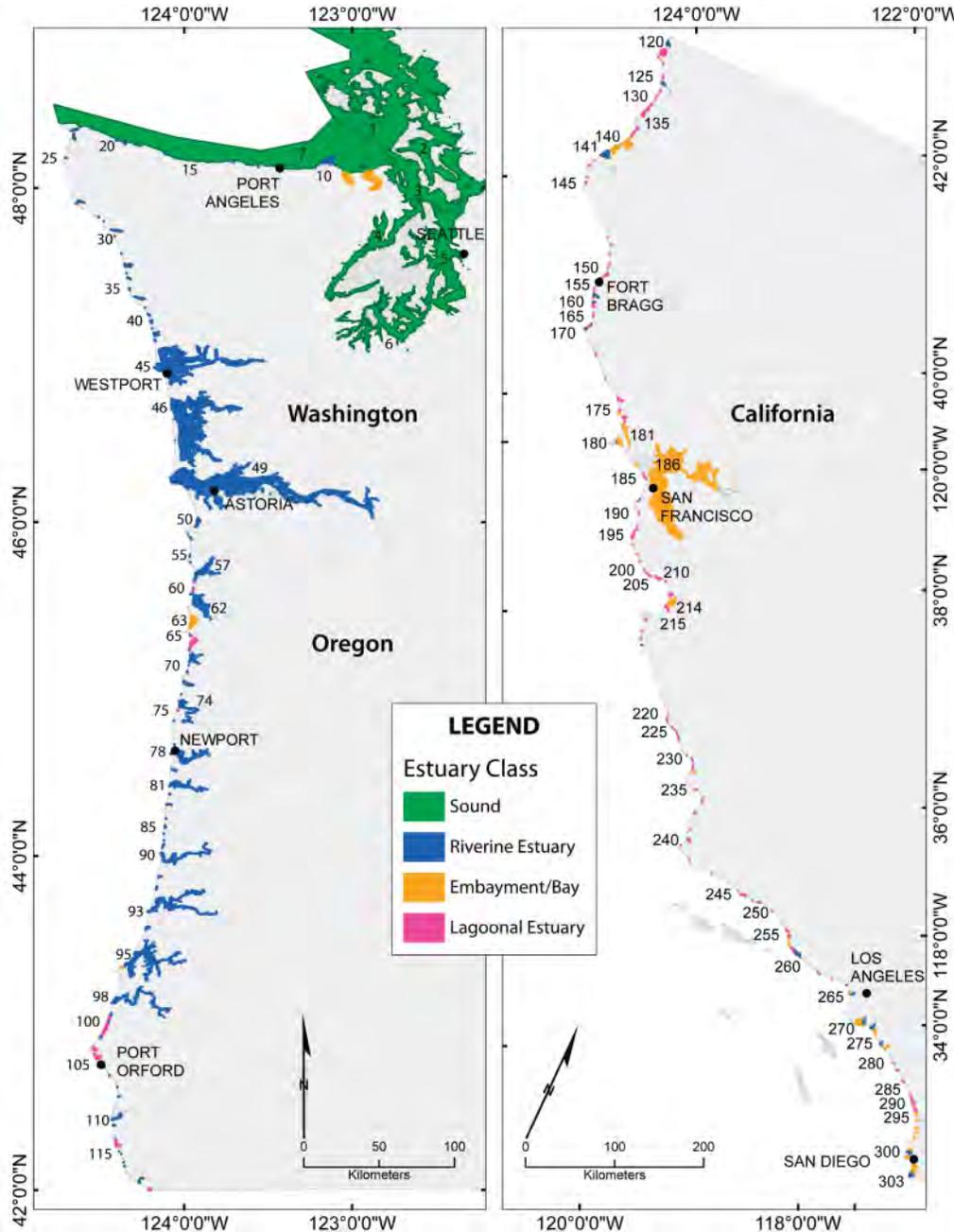< 0.4 hectare polygon
n = 169

CA Coast Estuaries for Nursery Assessment
n = 184

Assessment of Nursery Function of West Coast Estuaries

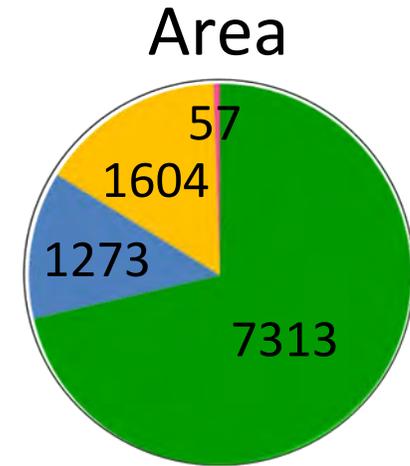# Assessment of Nursery Function of West Coast Estuaries

Assessment of Nursery Function of West Coast Estuaries
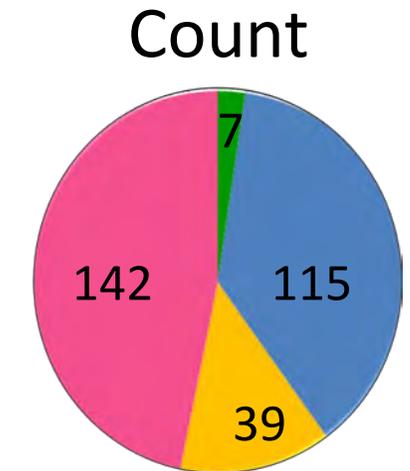
Our Progress to Date
State of Knowledge Report

- Information on juvenile nursery requirements of 15 focal species
  - Juveniles of 11 of the 15 focal species were documented in 113 of 303 estuaries (15 of the 113 were smaller estuaries – less than 100 ha)

- All four estuary classes (lagoonal, riverine, embayment and sound) are import systems for juvenile of some or all of the 15 focal species.

- Four important estuarine subclasses used by 11 of 15 focal species:
  - Estuarine coastal subtidal, tidal channel/creek, slough, and lagoon

NURSERY FUNCTIONS OF U.S. WEST COAST ESTUARIES: THE STATE OF KNOWLEDGE FOR JUVENILES OF FOCAL INVERTEBRATE AND FISH SPECIES

Brent B. Hughes[1], Matthew D. Levey[2], Jennifer A. Brown[3], Monique C. Fountain[4], Aaron B. Carlisle[5], Steven Y. Litvin[5], Correigh M. Greene[6], Walter N. Heady[7] and Mary G. Gleason[7]

1 University of California Santa Cruz; 2 SeaSpatial Consulting; 3 Monterey Bay National Marine Sanctuary; 4 Elkhorn Slough National Estuarine Research Reserve; 5 Hopkins Marine Station, Stanford University; 6 NOAA Northwest Fisheries Science Center; 7 The Nature Conservancy

Prepared by SeaSpatial Consulting LLC: for The Nature Conservancy and the Pacific Marine and Estuarine Fish Habitat Partnership.

15 Focal Species

Dungeness crab
Bay shrimp
Leopard shark
Bat ray
Green sturgeon
Chinook salmon
Coho salmon
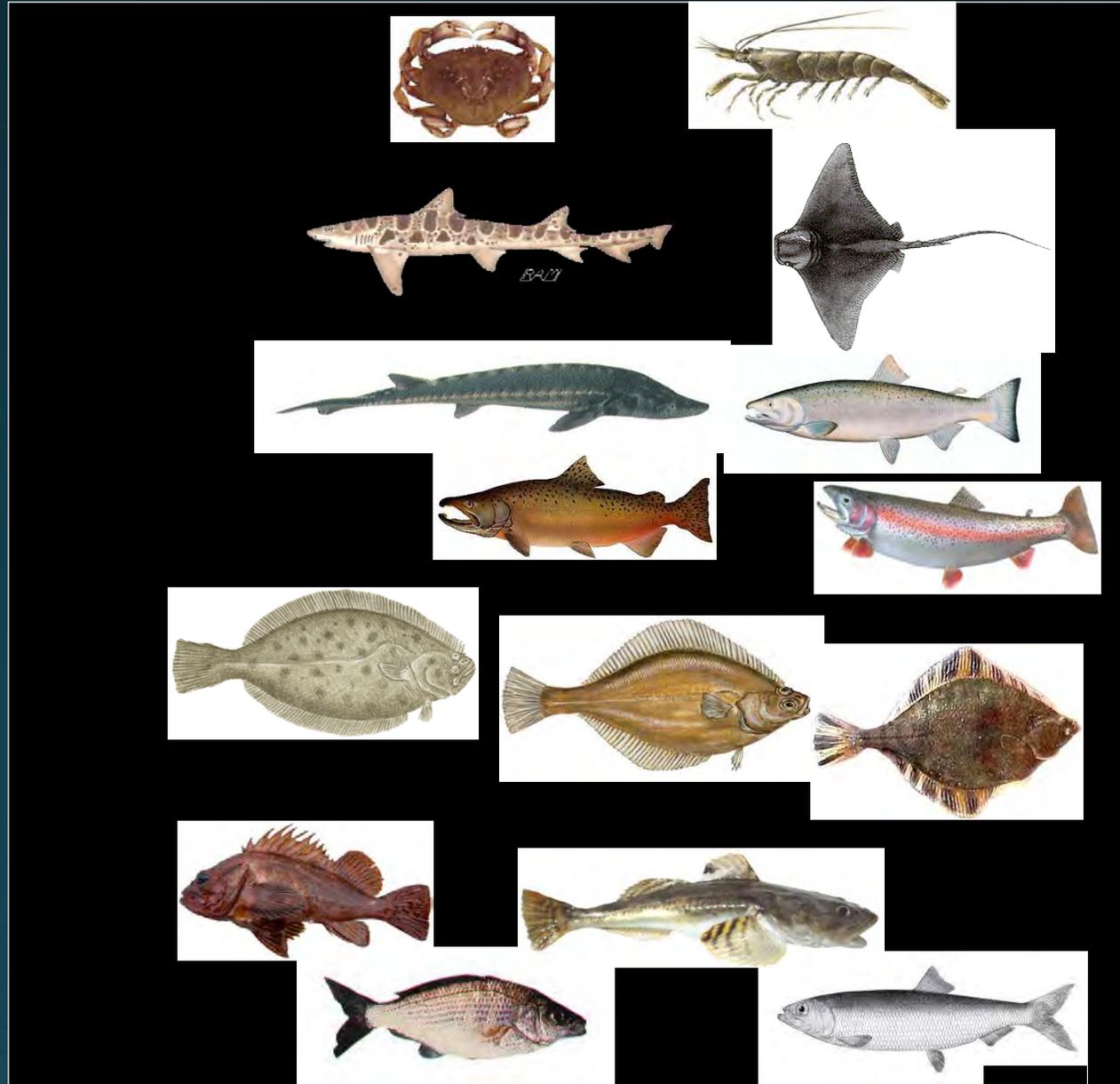Steelhead trout
California halibut
English sole
Starry flounder
Brown rockfish
Staghorn sculpin
Shiner perch
Pacific herring

Conclusions

- Documented presence of juveniles in many systems
    - 113 estuaries for 15 focal species
    - www.pacificfishhabitat.org/products

- Juveniles use the full diversity of estuary types and natural habitats available on the West Coast

- Demonstrated nursery value of estuaries for some species
    - faster growth, higher survival, higher contribution

- Knowledge gaps for smaller systems and species of lower economic value

- Numerous threats to estuarine nursery function, but not as much information as one would expect

- SOK report useful for informing management at many scales
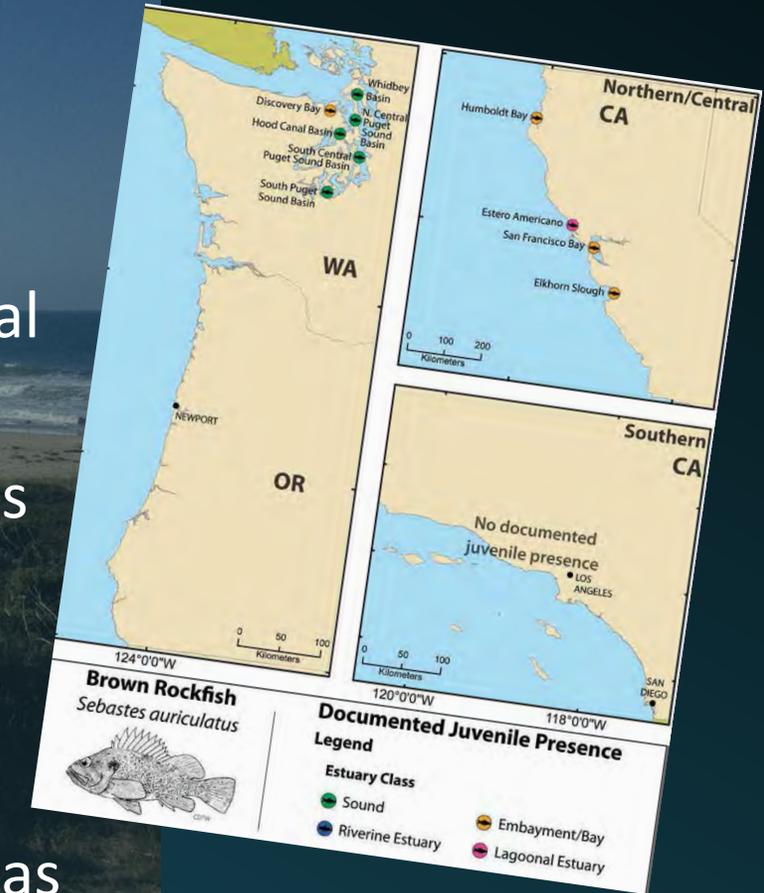
Geodatabase shows potential nursery extent in estuaries

Mapping the extent of West Coast tidal wetlands using extreme water level data and LIDAR

Van Hare[1] Brett Holycross[1] Laura Brophy[2,3] Hiroo Imaki[4]

[1]**Pacific States Marine Fisheries Commission**
[2]**Estuary Technical Group, Institute for Applied Ecology**
[3]**Marine Resource Management Program, College of Earth, Ocean, and Atmospheric Sciences, Oregon State Univ.**
[4]**NOAA NMFS**

Why are we doing this?

Provide improved spatial data on estuary habitats to support west coast fish assessments, including:

- Evaluation of condition/impacts
- Evaluation and prioritization of restoration and conservation opportunities

What's our general approach?

Map full spatial extent of estuaries

- Including all tidal wetlands to head of tide
- Including freshwater tidal zone, "surge plain"
- Definition of "tidal wetland" = inundation due to tidal forces at least 1X/yr

Map current and historic tidal wetlands

- Historic wetland mapping informs restoration planning
- "Historic" = pre-European settlement

Conclusions

The new West Coast tidal wetland maps:

- Greatly improve and expand our understanding of West Coast estuaries

- Provide comprehensive coverage with improved accuracy and suitability for restoration planning

- Have been positively reviewed by experts, and match very closely to historic wetland maps

- Provide a solid base layer for West-coast-scale analysis of wetland losses, restoration and conservation opportunities

Next steps

- Finalization of spatial data
- Final review
- Classification of habitats
- Release of products

Our Progress to Date
Prioritization Scheme

- **Goal:** Enhance ecological function and resilience of West Coast estuaries.

  - **Objective 1 :** Create a prioritization scheme to guide conservation and restoration actions supporting fish habitat functions in West Coast estuaries

  - **Objective 2:** Measure the effectiveness of the scheme and adapt the scheme to meet new needs as they arise.

Juvenile Hood Canal summer chum, federally listed as Threatened, will benefit from additional rearing habitat in Tarboo Bay. Photo credit: NW Watershed Institute. Restoration of salt marsh shoreline within the Dabob Bay Natural Area (Washington). Photo credit: Lowell Jons

Setting Priorities Across Coastal Landscapes: A review of prioritization methods for estuary restoration and protection

John Bragg, South Slough National Estuarine Research Reserve
Kiira Siitari, Pacific States Marine Fisheries Commission

Goals

Overall Project Goal:

Create a prioritization scheme to guide conservation and restoration actions supporting fish habitat functions in West Coast estuaries.

Key First Step:

Review, compile and summarize past methods and literature for setting ecological priorities for restoration and habitat protection within estuaries.

© Laura S. Brophy

Step Three – Alternative Approaches

A West Coast Estuary Prioritization Scheme should:

- Have clearly defined goals
- Have clear and thorough documentation
- Answer these questions:

  - What is the desired outcome of the prioritization?
  - Who are the users?
  - What is the scale of the prioritization? Specially, what are the units you want to rank?
  - How does this work align with other work or assessments (e.g., PMEP's Nursery Assessment)?
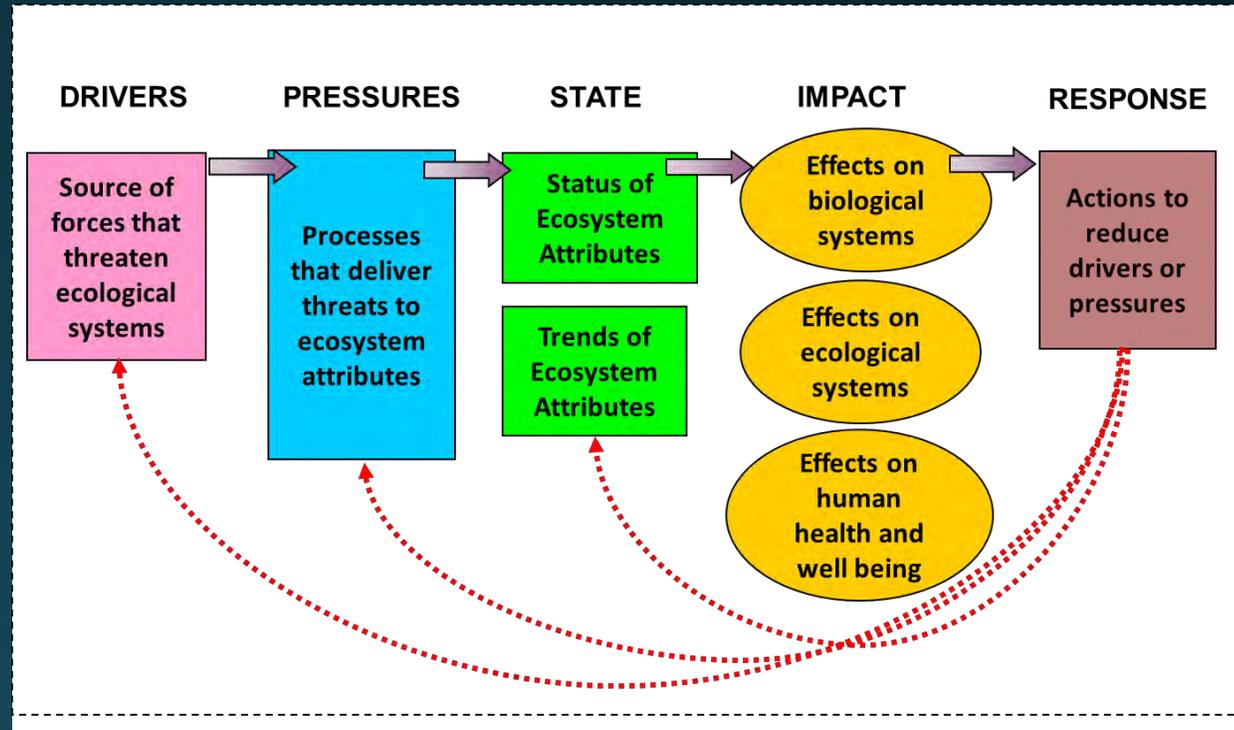
Answers to these questions will help shape the prioritization process and provide direction in refining criteria and weighing alternative approaches

© Morgan H. Bond

Organizing the Prioritization Work
The DPSIR Model

Conceptual DPSIR model linking drivers and pressures to the ecosystem state, impacts to ecosystem components, and adaptive feedback for response actions (Ruckelshaus et al. 2008).

Incorporating the DPSIR Model for the PMEP Nursery Assessment

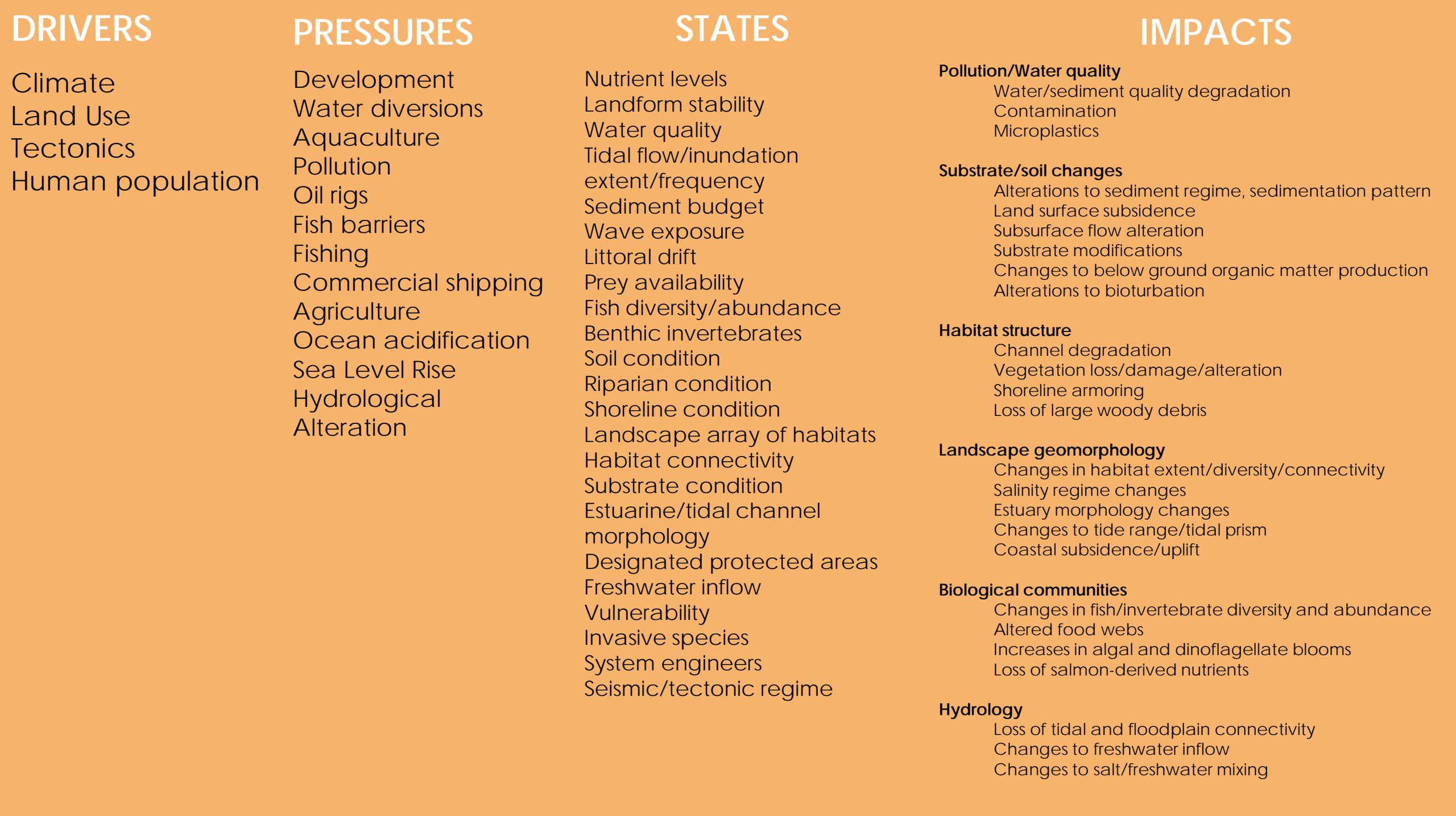| Drivers	Pressures	State	Impact

• Climate
• Land Use
• Tectonics
• Humans
	• Development
	• Aquaculture
	• Pollution
	• Fish Barriers
	• Ocean acidification
	• Sea Level Rise
	• Hydrological Alteration
		• Landform Stability
		• Littoral Drift
		• Sediment Budget
		• Habitat Connectivity
		• Tidal flow/Inundation Extent/Frequency
		• Soil Condition
			• **Habitat Structure**
			  • Shoreline Armoring (H)
			  • Loss of Large Woody Debris (H)
			• **Hydrology**
			  • Loss of Tidal and Floodplain Connectivity (H)
			  • Changes to Freshwater Flow (H)
			  • Loss of Salt/Freshwater Mixing (M)

DRIVERS

Climate
Land Use
Tectonics
Human population

PRESSURES

Development
Water diversions
Aquaculture
Pollution
Oil rigs
Fish barriers
Fishing
Commercial shipping
Agriculture
Ocean acidification
Sea Level Rise
Hydrological
Alteration

STATES

Nutrient levels
Landform stability
Water quality
Tidal flow/inundation
extent/frequency
Sediment budget
Wave exposure
Littoral drift
Prey availability
Fish diversity/abundance
Benthic invertebrates
Soil condition
Riparian condition
Shoreline condition
Landscape array of habitats
Habitat connectivity
Substrate condition
Estuarine/tidal channel
morphology
Designated protected areas
Freshwater inflow
Vulnerability
Invasive species
System engineers
Seismic/tectonic regime

IMPACTS

Pollution/Water quality
Water/sediment quality degradation
Contamination
Microplastics

Substrate/soil changes
Alterations to sediment regime, sedimentation pattern
Land surface subsidence
Subsurface flow alteration
Substrate modifications
Changes to below ground organic matter production
Alterations to bioturbation

Habitat structure
Channel degradation
Vegetation loss/damage/alteration
Shoreline armoring
Loss of large woody debris

Landscape geomorphology
Changes in habitat extent/diversity/connectivity
Salinity regime changes
Estuary morphology changes
Changes to tide range/tidal prism
Coastal subsidence/uplift

Biological communities
Changes in fish/invertebrate diversity and abundance
Altered food webs
Increases in algal and dinoflagellate blooms
Loss of salmon-derived nutrients

Hydrology
Loss of tidal and floodplain connectivity
Changes to freshwater inflow
Changes to salt/freshwater mixing

PMEP Priorities Situation Diagram/Conceptual Model
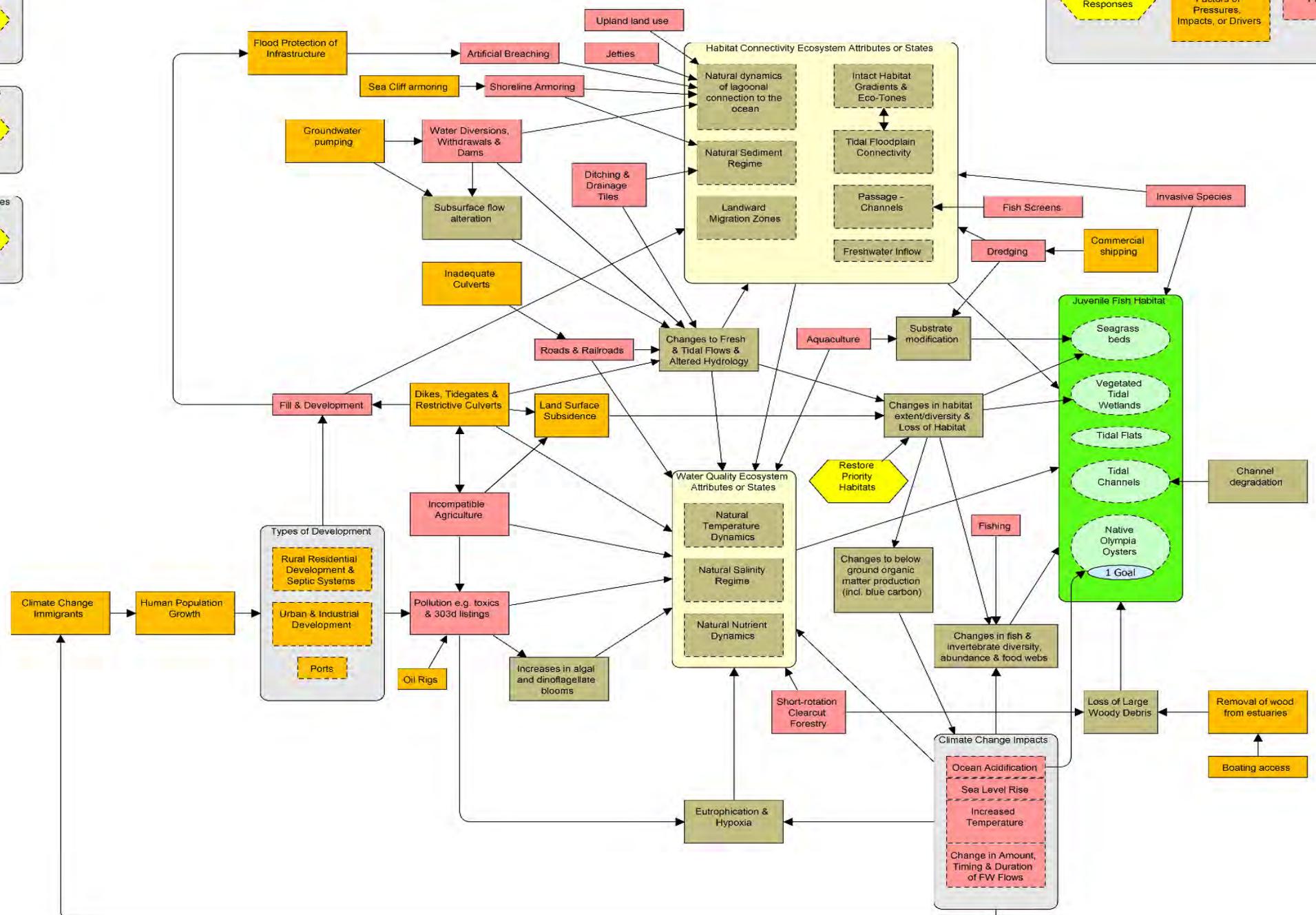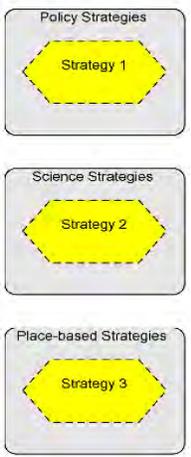
Nursery Functions of West Coast Estuaries: Data Assessment for Juveniles of 15 Focal Fish and Crustacean Species

Jason Toft, Stuart Munsch, Jeff Cordell
University of Washington, School of Aquatic and Fishery Sciences

Kiira Siitari, Van Hare, Brett Holycross
Pacific States Marine Fisheries Commission

Lisa DeBruyckere
Pacific Marine and Estuarine Fish Habitat Partnership

Correigh Greene
Northwest Fisheries Science Center, National Marine Fisheries Service

Objectives

Synthesize the available data into a common format allowing for:

(1) Creation of maps displaying species location, average frequency of occurrence, and average catch per unit effort (CPUE).

(2) Comparison of the data, using the best quality portions of the dataset, to presumed habitat impacts measured by estuarine stressor scores.

Data Call (Tier 1 and Tier 2)

WHAT KINDS OF DATA WERE COLLECTED AND OVER WHAT TIME PERIOD WAS THE DATA COLLECTED?

	ONE SEASON	MULTIPLE SEASONS IN ONE YEAR	MULTIPLE YEARS
PRESENCE/ABSENCE	○	○	○
CATCH PER UNIT EFFORT (CPUE)	○	○	○
DENSITY	○	○	○
LENGTHS	○	○	○
WEIGHTS	○	○	○
MARK/RECAPTURE	○	○	○
BEHAVIOR	○	○	○
PHYSICAL (e.g., dissolved oxygen, salinity, habitat)	○	○	○
SPATIAL (e.g., GIS framework)	○	○	○

WHAT ESTUARY OR ESTUARIES WAS THE DATA COLLECTED FROM?

- ☐ SALISH SEA (Washington, Puget Sound to Cape Flattery)
- ☐ OREGON/WASHINGTON COAST (Cape Flattery to Cape Mendocino)
- ☐ CENTRAL CALIFORNIA (Cape Mendocino to Point Conception)
- ☐ SOUTHERN CALIFORNIA BIGHT (California South of Point Conception)
- ☐ OR, SPECIFY ESTUARIES

IN WHAT FORMATS ARE YOU WILLING TO SHARE DATA?

- ☐ SUMMARIES (e.g., by habitat type, by year, by location, by species)
- ☐ SPREADSHEETS/DATABASE
- ☐ GIS DATABASE
- ☐ HARD COPIES OF DATA
- ☐ OTHER COMMENTS ON DATA SHARING:

Pacific Marine and Estuarine Fish Habitat Partnership Data Request

Assessment Overview: The overarching goal of the PMEP assessment is to demonstrate how conserving and restoring juvenile fish habitat in estuaries contributes to the overall ecological health and economic sustainability of commercial and recreational fisheries. Our primary deliverable from this assessment is to produce a peer-reviewed report that allows funding agencies to prioritize where key strategic investments could and should be made. In tandem with this call for fish data, PMEP is currently delineating and classifying West Coast estuaries to serve as the underlying GIS framework for a regional analysis of fish use of estuarine nursery habitat. Detailed information is available at http://www.pacificfishhabitat.org.

What we are looking for: The Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) is currently compiling fish and shellfish data from California, Oregon, and Washington estuaries. We are focusing on spatially referenced presence, absence, and abundance information for 15 focal species (below) sampled within estuarine waters. High priority data has records of fish life stage as well as location, count, and species.

How the data will be used: Your data will be standardized to a database owned by PMEP, housed at the Pacific States Marine Fisheries Commission. Use is restricted to PMEP Steering and Science and Data Committee members and PMEP contracted scientists. There are three assessments planned that may use data from this PMEP database: the PMEP Nursery Assessment, the National Fish Habitat Partnership (NFHP) National Estuary Assessment, and a NOAA-led Pacific Forage Fish Assessment. Assessments will include both peer-reviewed reports and journal articles. Outside requests to access assessment inputs are reviewed on a case-by-case basis. Your dataset will be acknowledged in all PMEP and NFHP publications that use your data. Publically available data, as indicated by the data originator, may be shared outside of PMEP provided that end-users acknowledge both PMEP and original source (ODBC-By attribution license). Please let me know if you have any data sharing stipulations; **we are willing to work with you to develop an individual data sharing agreement.**

15 focal fish and shellfish species for nursery habitat assessment: The species selected are intended to represent major fish guilds, fish of commercial, recreational, and cultural importance, and fish whose life histories span all or a portion of West Coast estuaries:

- Dungeness crab (*Cancer magister*)
- Bay shrimp (*Crangon franciscorum*)
- Leopard shark (*Triakis semifasciata*)
- Bat ray (*Myliobatis californica*)
- Green sturgeon (*Acipenser medirostris*)
- Steelhead trout (*Oncorhynchus mykiss*)
- Coho salmon (*Oncorhynchus kisutch*)
- Chinook salmon (*Oncorhynchus tshawytscha*)
- California halibut (*Paralichthys californicus*)
- English sole (*Parophrys vetulus*)
- Starry flounder (*Platichthys stellatus*)
- Brown rockfish (*Sebastes auriculatus*)
- Staghorn sculpin (*Leptocottus armatus*)
- Shiner perch (*Cymatogaster aggregata*)
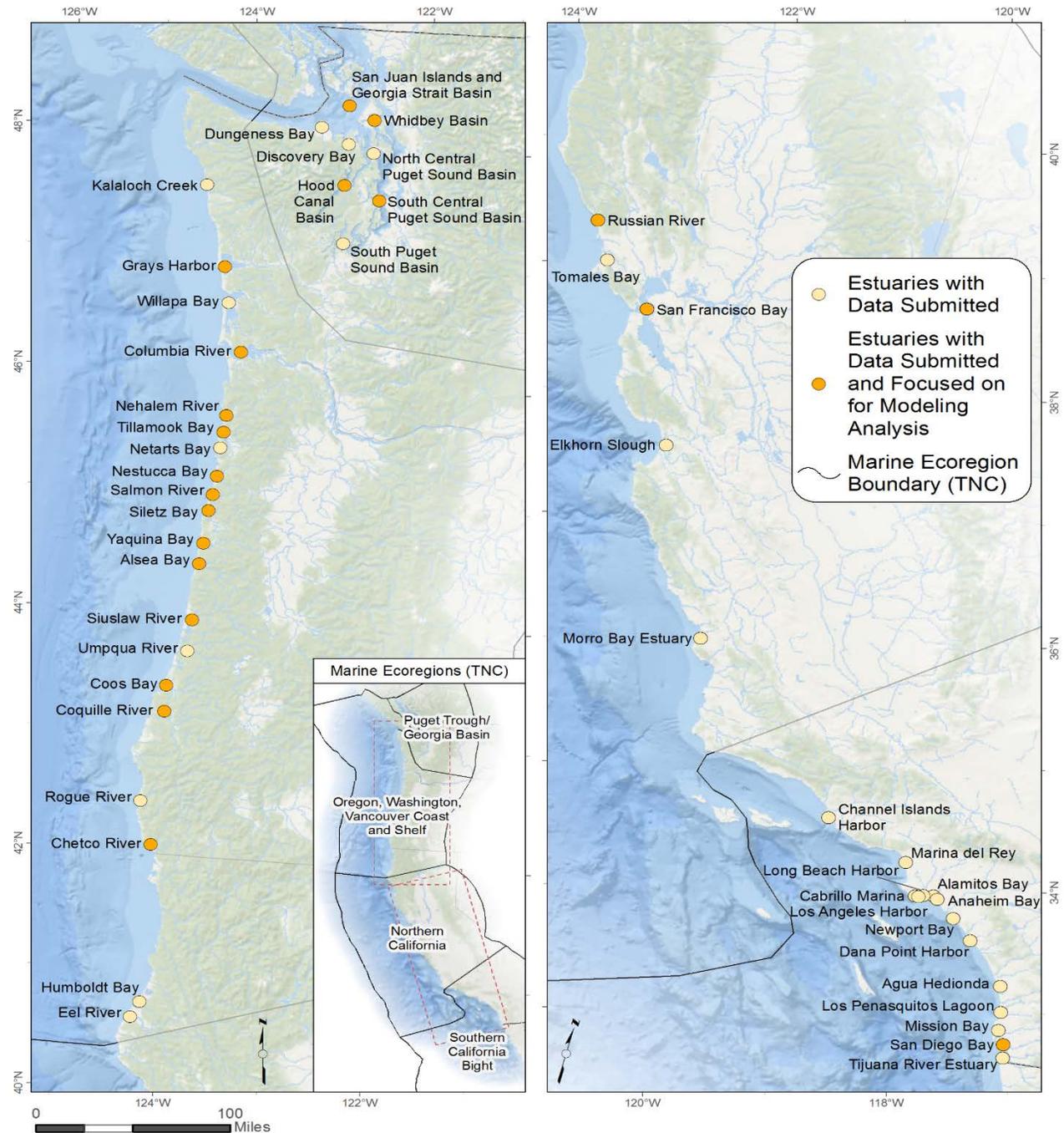- Pacific herring (*Clupea pallasi*)

Data variability and constraints:

1. Data coverage
2. Gear types
3. Metrics of abundance
4. Temporal frequency of sampling
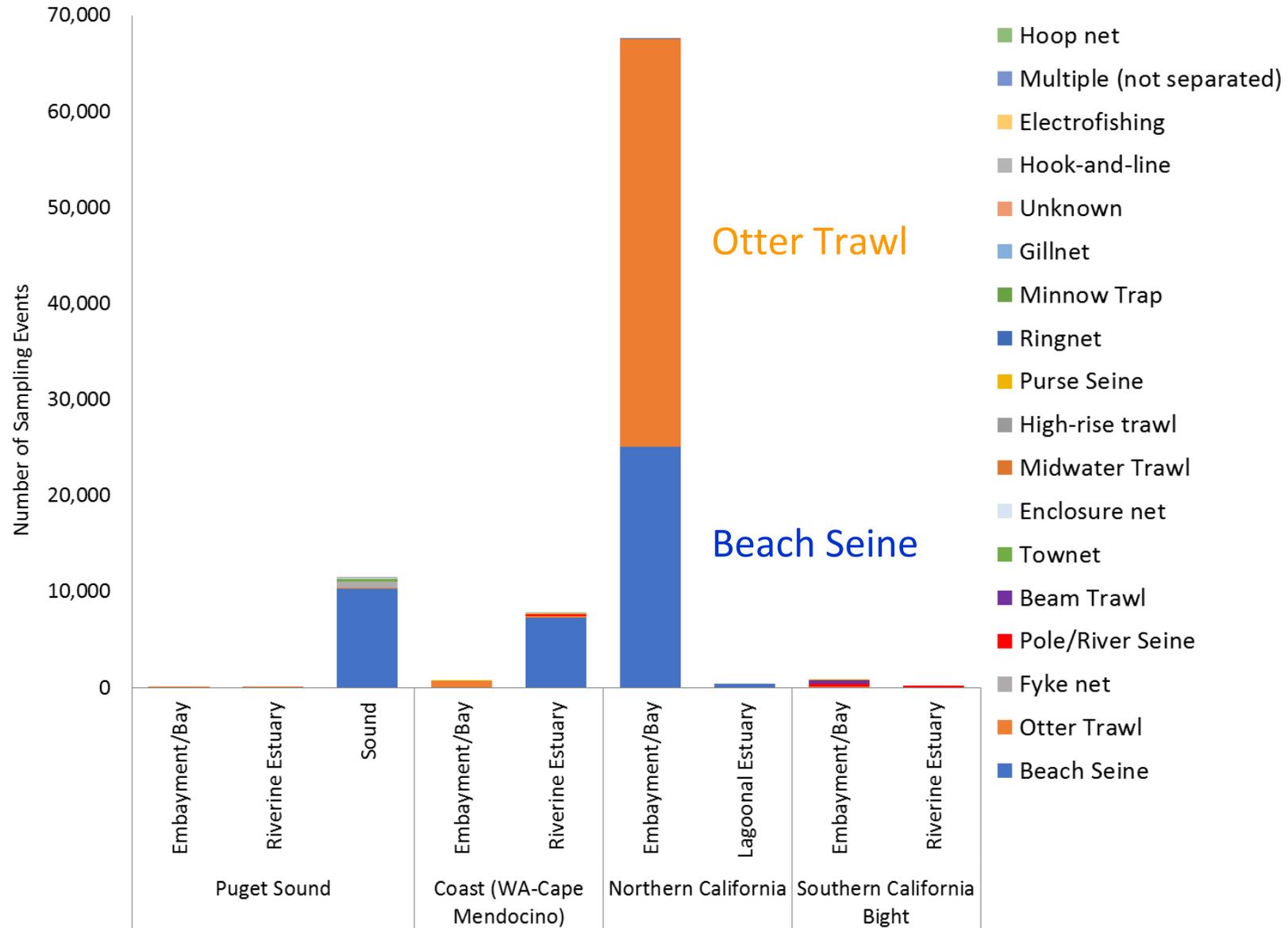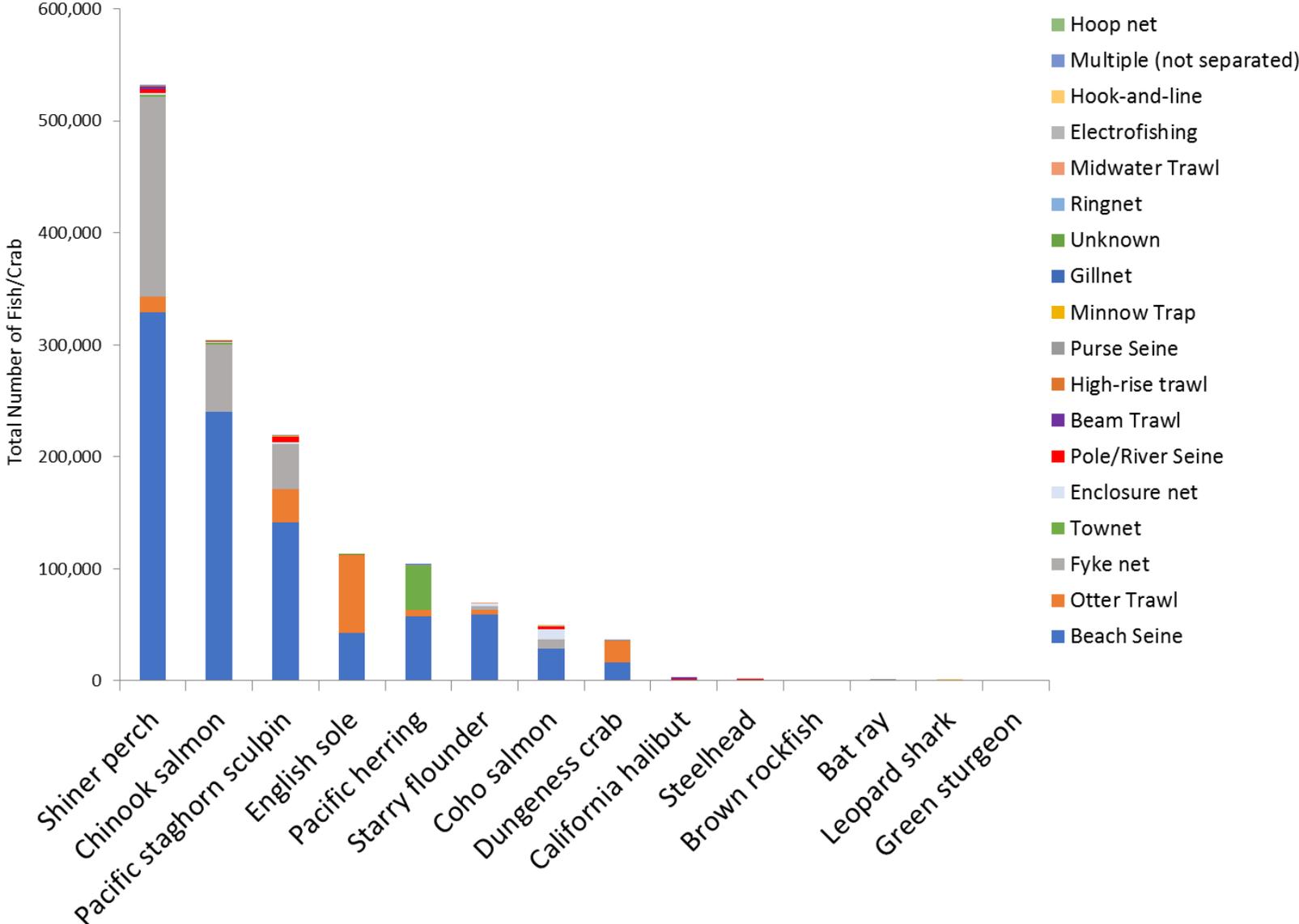5. Spatial precision

Estuaries

47 estuaries total

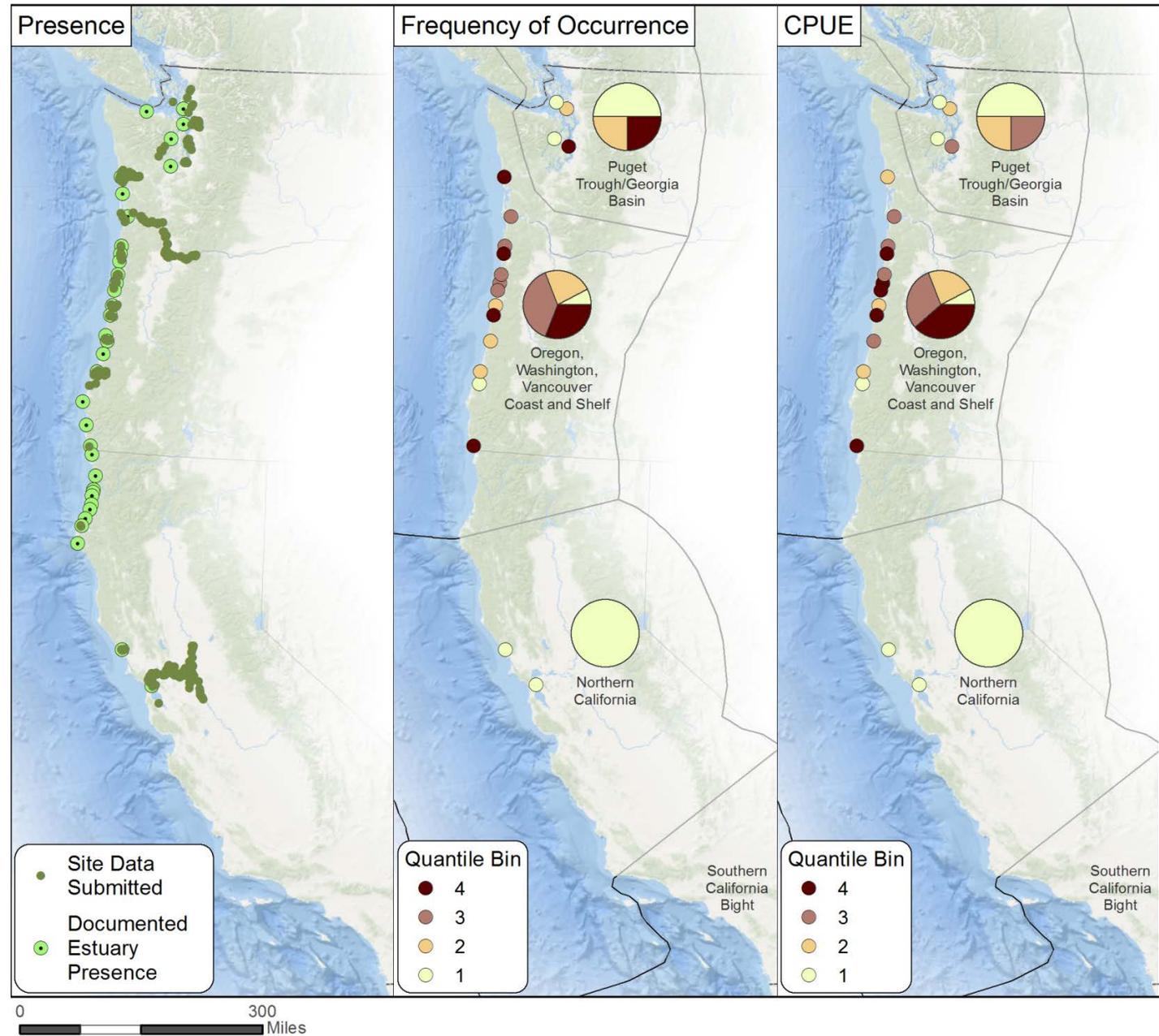20 estuaries:
modelling
analysis

Gear Type by Region

Species by Gear Type

Maps

Example of
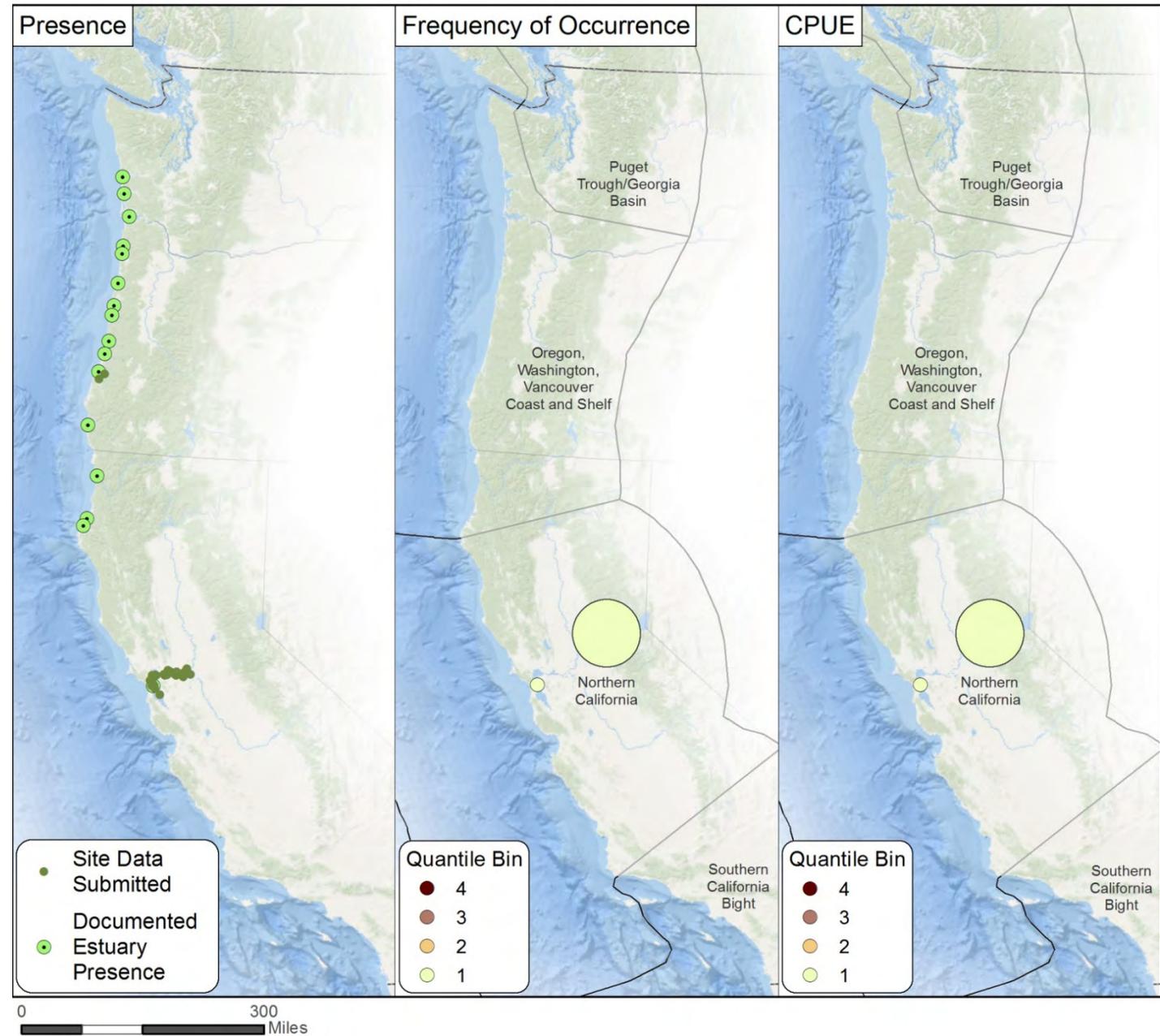good data
coverage

Chinook Salmon

Maps

Example of poor data coverage

Green Sturgeon

Recommendations (Habitat)

- Standard habitat classification categories should be used so that labeling of sampled habitats are consistent (CMECS).

- Major habitat types (emergent tidal marshes, tidal flats, seagrass beds) and species with rich datasets (Chinook salmon, coho salmon, Pacific herring, and English sole), would be best suited for analyzing broad-scale habitat patterns in shallow waters.

- Improved spatial data of sampling locations along with current and historic habitat types and habitat losses would allow future data synthesis efforts to accomplish more precise analyses and habitat linkages.

Recommendations (Stressors)

- Chinook salmon, coho salmon, Pacific herring, and English sole: Most impacted by estuarine stressors, largest benefit from restoration efforts (*shallow water, beach seines, data limitations).

- Future analysis: Isolate effects of individual vs cumulative estuarine stressors, and conduct concurrent fish sampling with updating of stressors to illustrate dynamic trends.

- Acquiring specific measures of nursery function that target changes due to anthropogenic modifications, restoration actions, and sea level rise, will help us to predict the potential for improving and maintaining nursery functions given climate change scenarios.
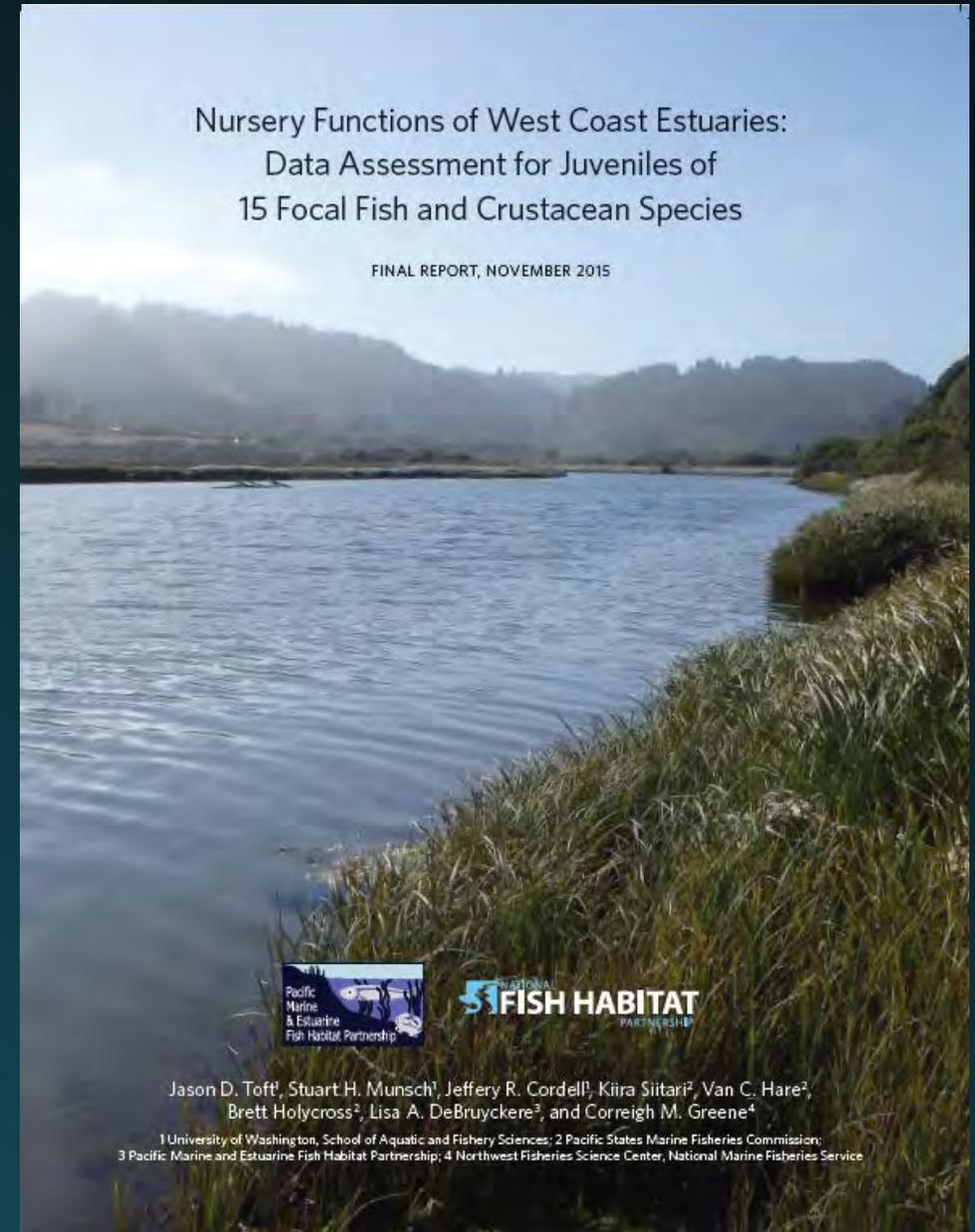
Our Progress to Date
PMEP Nursery Assessment Report

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Synthesize the available data into a common format allowing for:

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Nursery Functions of West Coast Estuaries:
Data Assessment for Juveniles of
15 Focal Fish and Crustacean Species

FINAL REPORT, NOVEMBER 2015

FISH HABITAT
PARTNERSHIP

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