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PACIFIC MARINE & ESTUARINE
FISH HABITAT PARTNERSHIP

Eelgrass Habitat on the West Coast: State of the Knowledge

Overview of the Final Report

Jan 31, 2018 Webinar

Purpose of Project

Inform restoration and management by reviewing the "state of knowledge." Compile the best available data and information from experts on:

1. Current and historic spatial extent of eelgrass in West Coast estuaries;
2. Ecosystem services of eelgrass (including fish use of eelgrass);
3. Threats to eelgrass systems;
4. Key data gaps and recommendations to inform restoration and management of estuarine habitats.

Products Coming Soon

1. State of the Knowledge Report synthesizing:
   a. Presence and extent of eelgrass
   b. Ecosystem services provided by eelgrass habitats
   c. Important and emerging threats
   d. Knowledge and data gaps
   e. Management strategies to conserve and restore habitat and function

2. Geodatabase of Eelgrass Data
   a. Point dataset (estuaries)
   b. Standardized Eelgrass Extent dataset (estuaries and nearshore areas)

Specific to the U.S. West Cost
Available online & in a webmap viewer

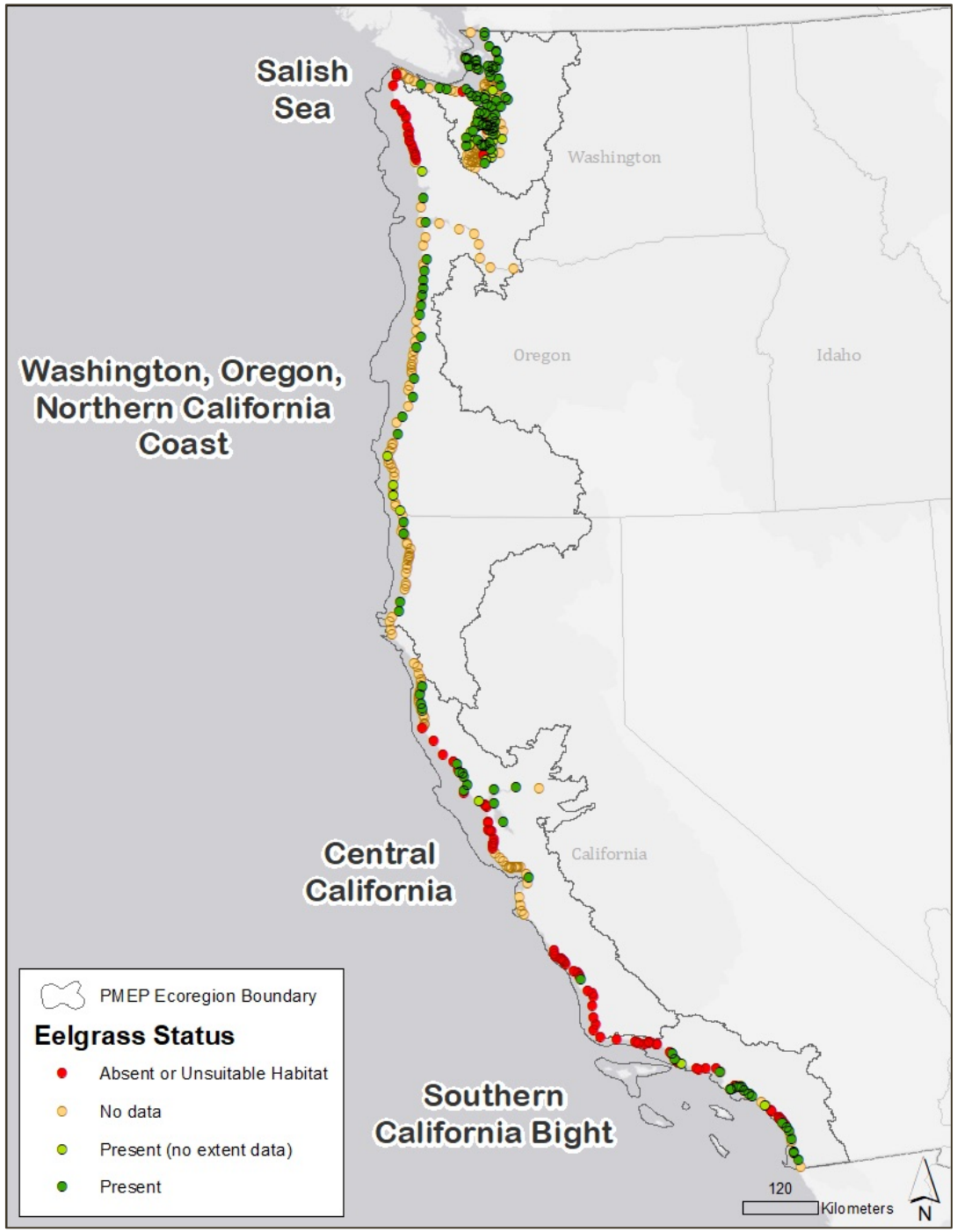
Methods

Information Compiled:

- Literature review - over 550 pieces of literature
- Data call - 130 datasets compiled and standardized
- Outreach to experts: webinars, surveys, and email

- Data (eelgrass) inventoried by estuary
  - PMEP's spatial data system: 444 estuaries along the coast
  - Nearshore beds included

- Results (eelgrass, ecosystem services, and threats) organized by region
  - Salish Sea
  - Washington, Oregon, Northern California Coast
  - Central California
  - Southern California Bight



West Coast Summary:

- Present: 165 estuaries (37%);
- Absent or unsuitable habitat: 23% of estuaries;
- No data: 40% of estuaries.

Estuary point attributes include:

- Species presence (3 species: Zm, Zj, Zp)
- Maximum observed extent (acres) – calculated from results
- Current acres – from source data
- Current data collection year
- Other years for data collection
- Count of datasets available by estuary

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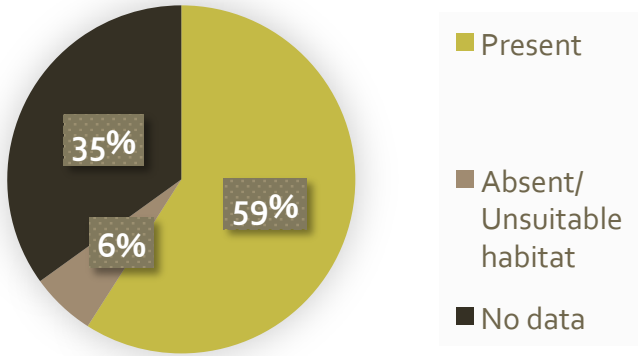
Eelgrass Data Overview:

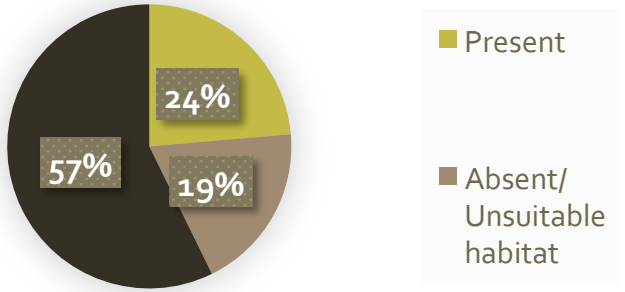
Point Dataset

Eelgrass Presence/Absence in Estuaries by Region

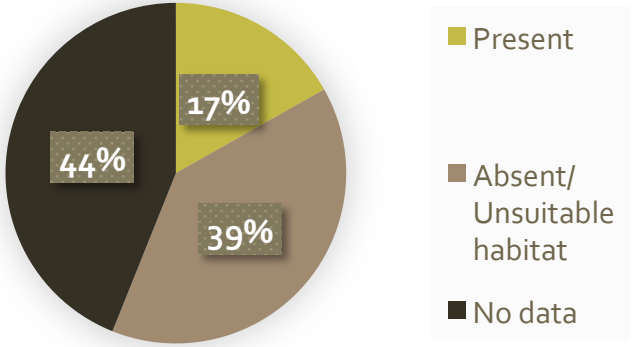
Salish Sea



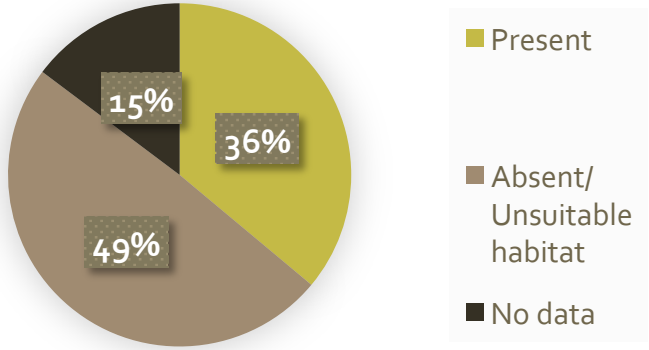
Washington, Oregon, Northern California



Central California



Southern California Bight



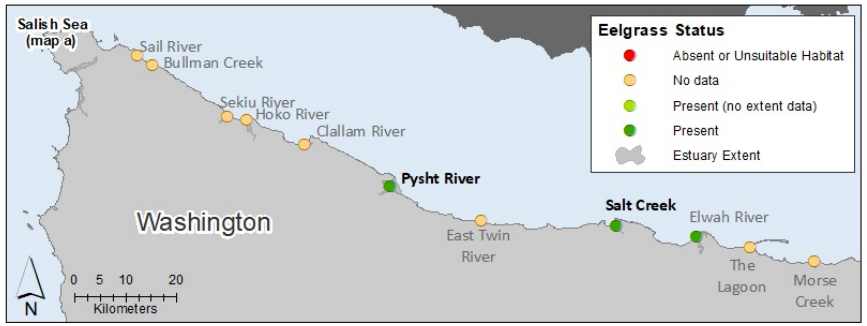
Eelgrass Data Overview:

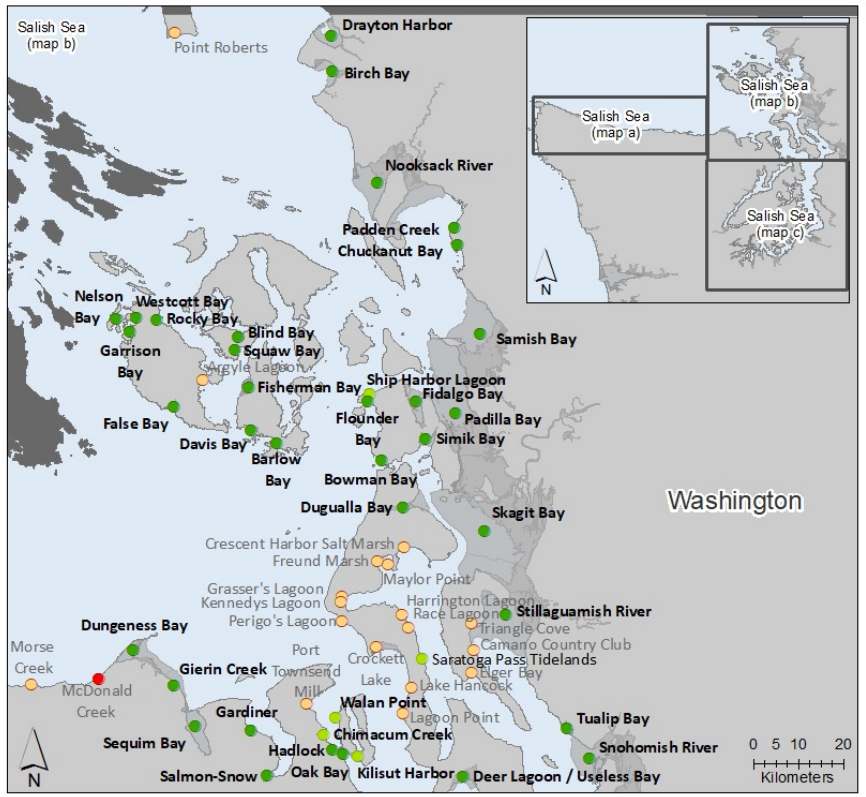
Ecoregion Summary

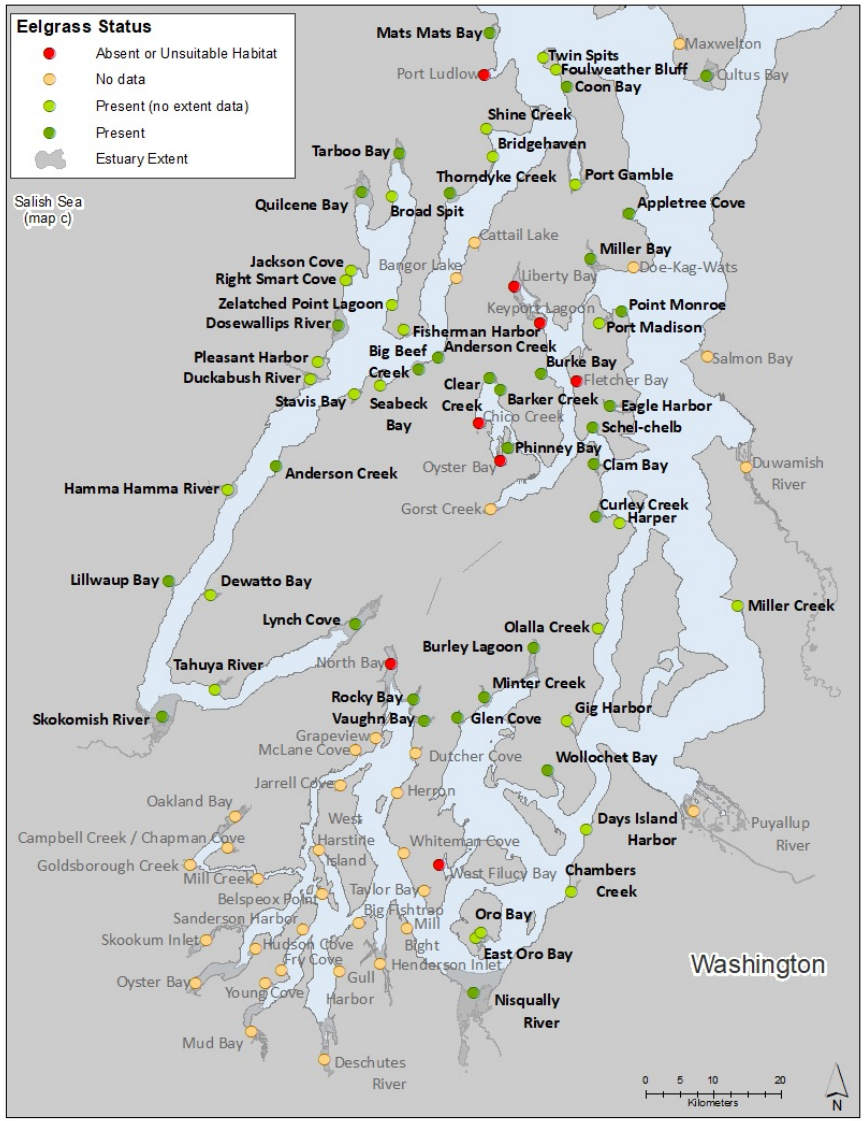
Ecoregion	Salish Sea	Washington, Oregon, Northern California	Central California	Southern California Bight
Nearshore eelgrass presence	Present	NA	Present	Present
Species present	Zostera marina, Zostera japonica	Zostera marina, Zostera japonica	Zostera marina, Zostera japonica	Zostera marina, Zostera pacifica (Channel Islands, nearshore mainland)
Depth range	Eelgrass (both Zostera marina and Zostera japonica): -11m to +1.4m MLLW	Zostera marina: -2.1m to +2.1m MLLW; Zostera japonica: +1.5m to +1.8m MLLW	Limited data: -4m to 0.4m MLLW	Zostera marina (in estuaries): -3.7 to +0.1m MLLW; Zostera marina (in nearshore of Channel Islands and mainland): -22m to -3m MLLW
Eelgrass extent data availability	Well documented extent throughout Salish Sea	Limited extent data	Well documented extent for a few estuaries, Limited extent data for many estuaries	Well documented extent for a few estuaries, limited extent data for many estuaries
Other eelgrass data	Well documented (Shorezone, WDFW Herring Spawning Surveys)	Shorezone (Washington and Oregon only)	NOAA ESI	NOAA ESI

Eelgrass Data Overview:

Salish Sea



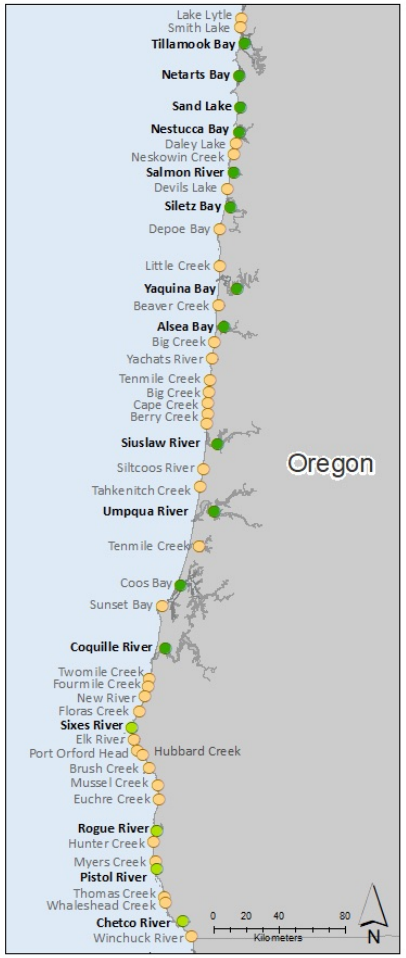


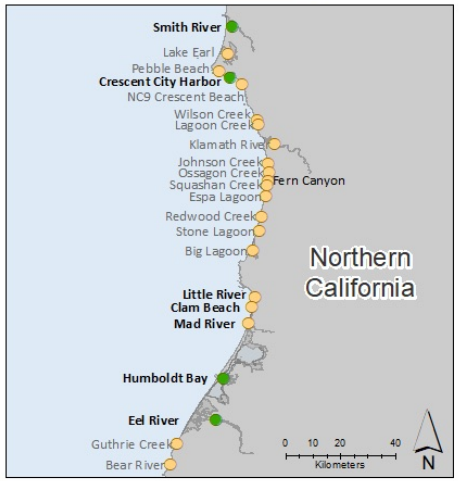


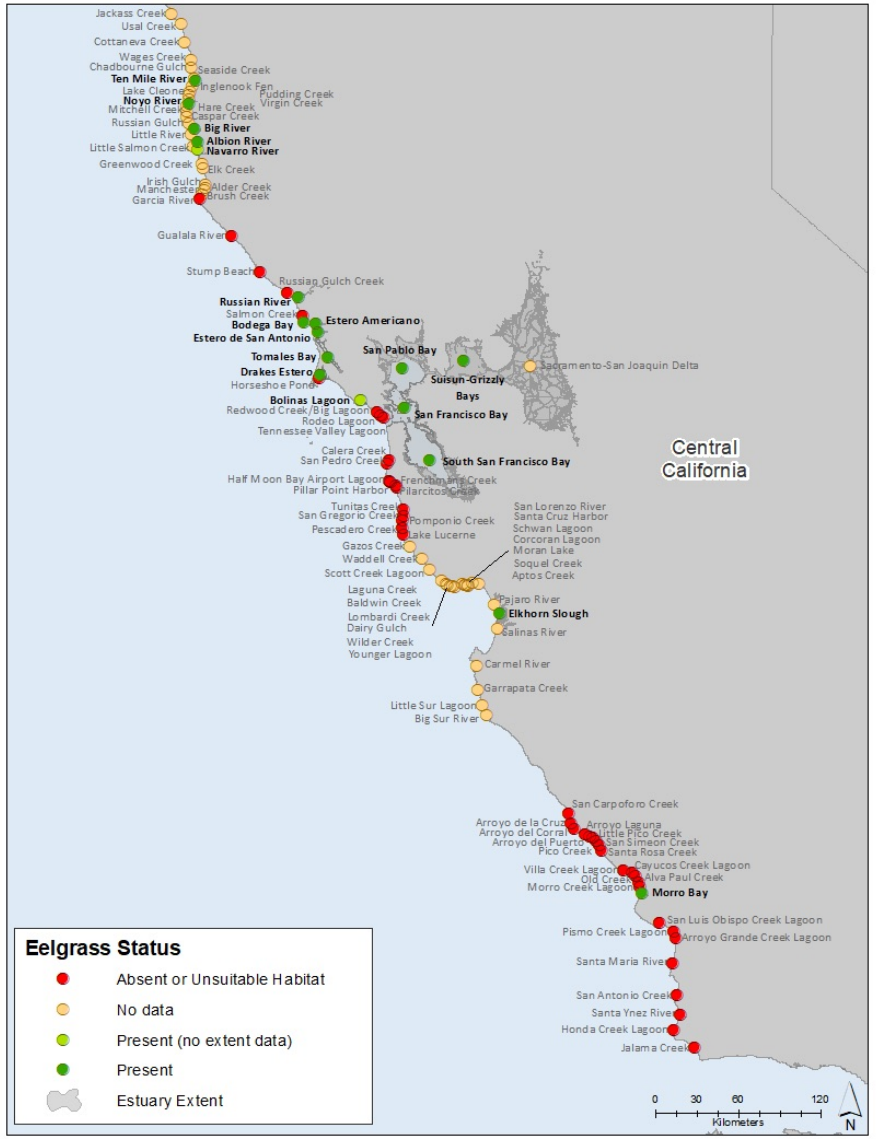
Eelgrass Data Overview:

Washington, Oregon, Northern California Coast

Central California

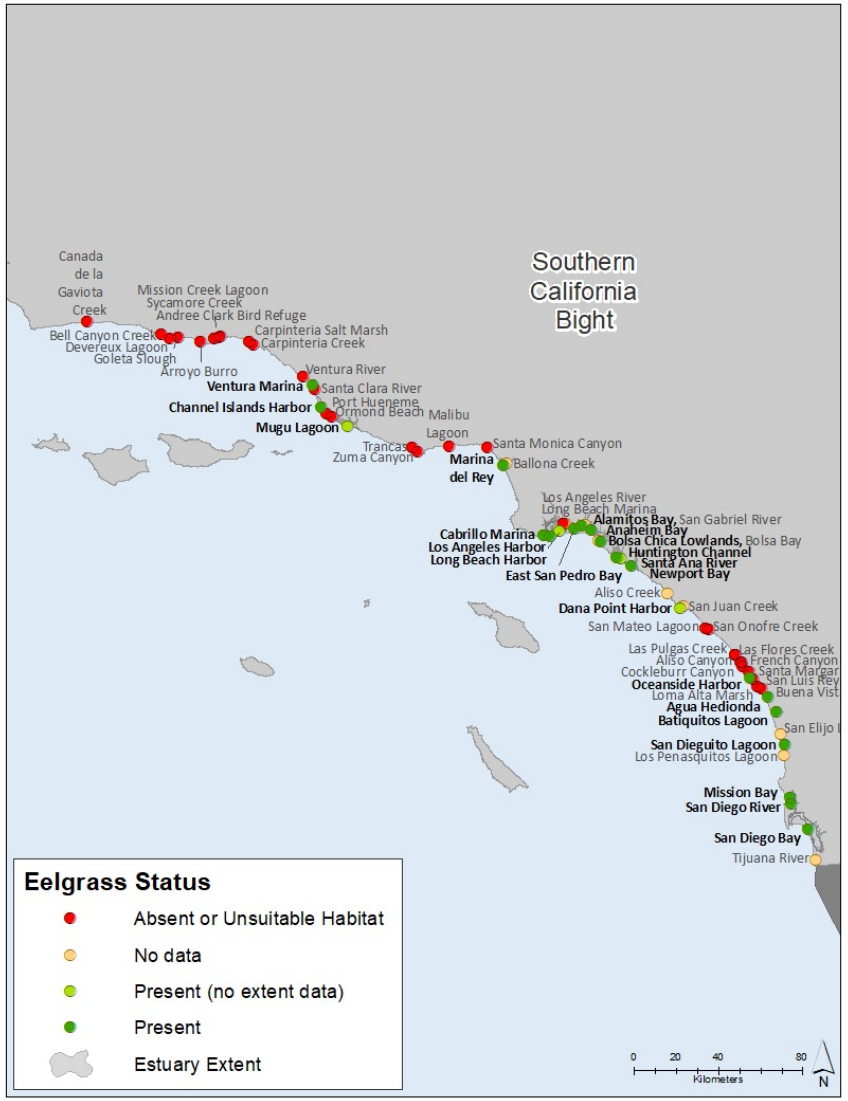






Eelgrass Data Overview:

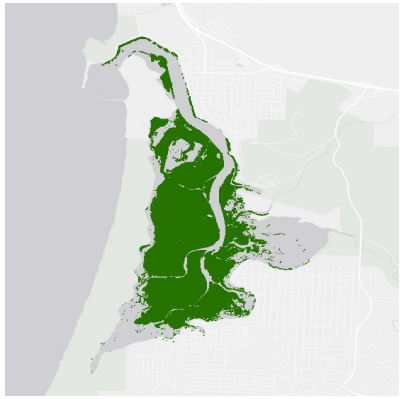
Southern California Bight

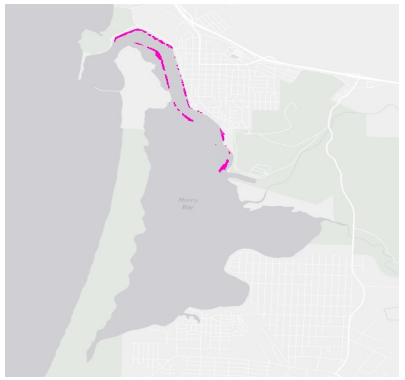


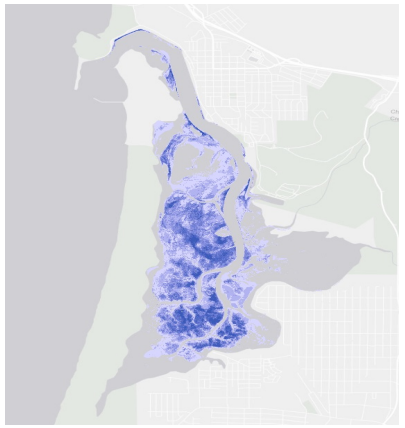
Eelgrass Data Overview:

Extent Data

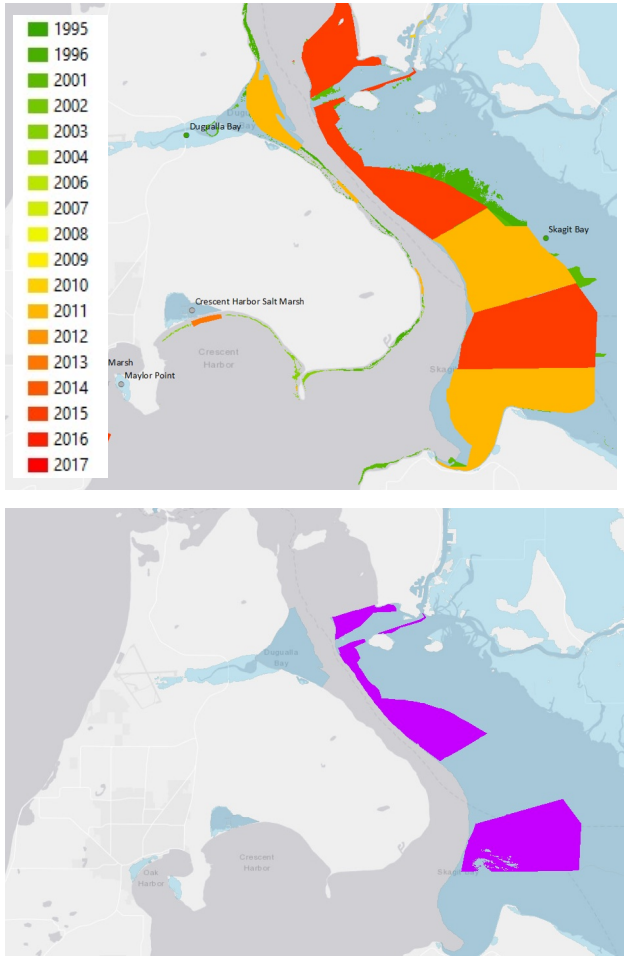
- Eelgrass extent dataset:
  - Maximum observed extent
    - all available data showing extent of eelgrass, including estuaries and nearshore areas
  - Years of data collection
    - including most current year
  - Frequency of occurrence
    - count of datasets





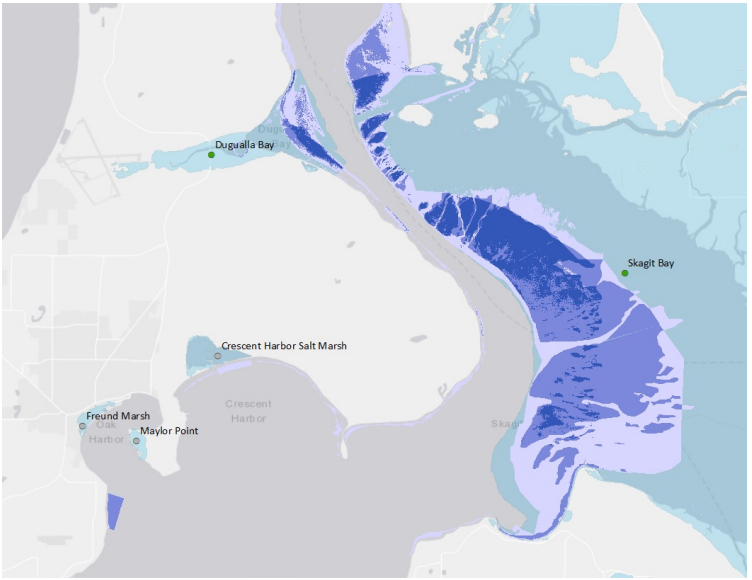


Example of Extent Data
Skagit Bay, Washington



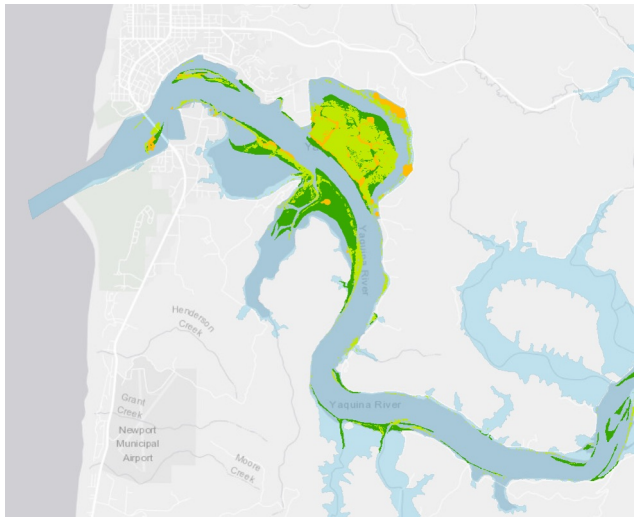
Years of data collection
Current year extent

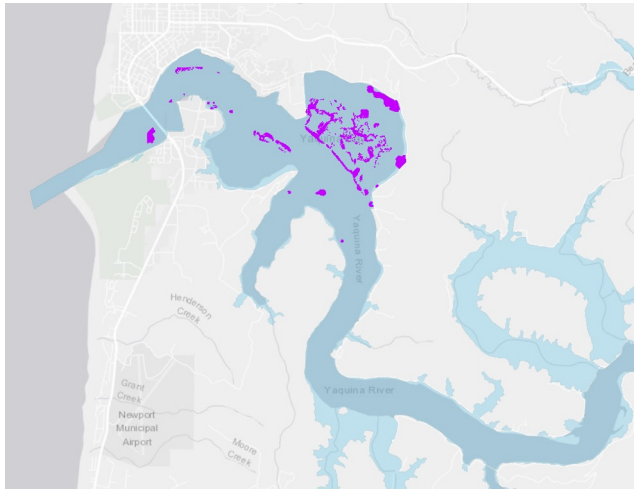
Maximum observed extent



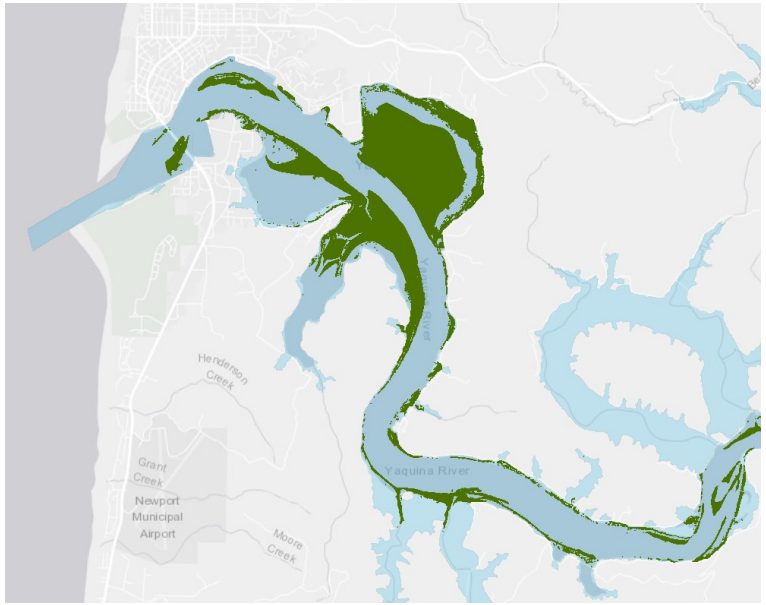
Frequency of occurrence
(dataset count)

Example of Extent Data
Yaquina Bay, Oregon

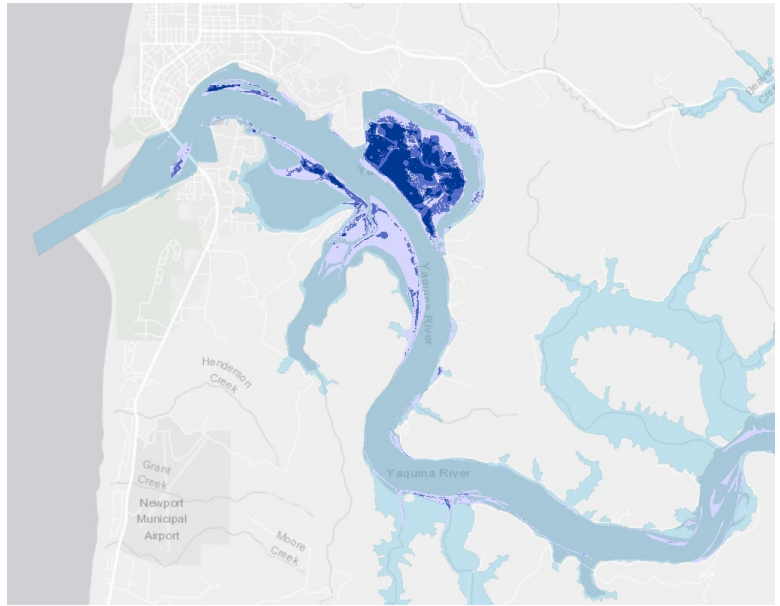




Years of data collection
Current year extent



Maximum observed extent



Frequency of occurrence
(dataset count)

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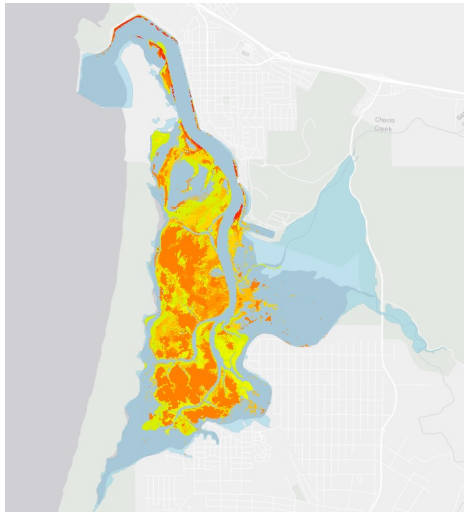
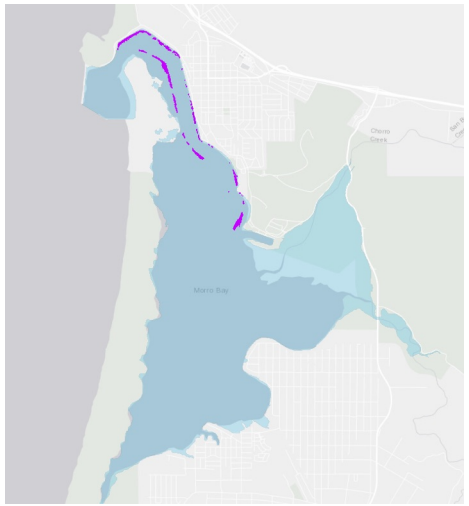
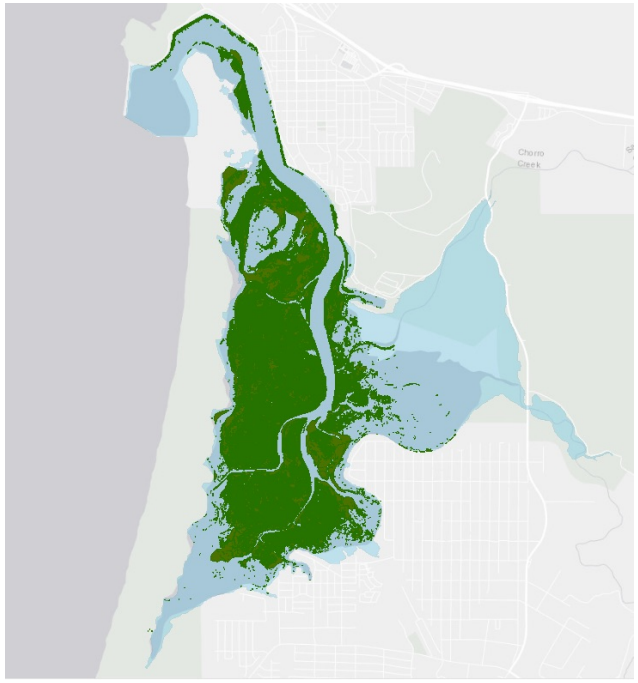
Example of Extent Data
Morro Bay, California

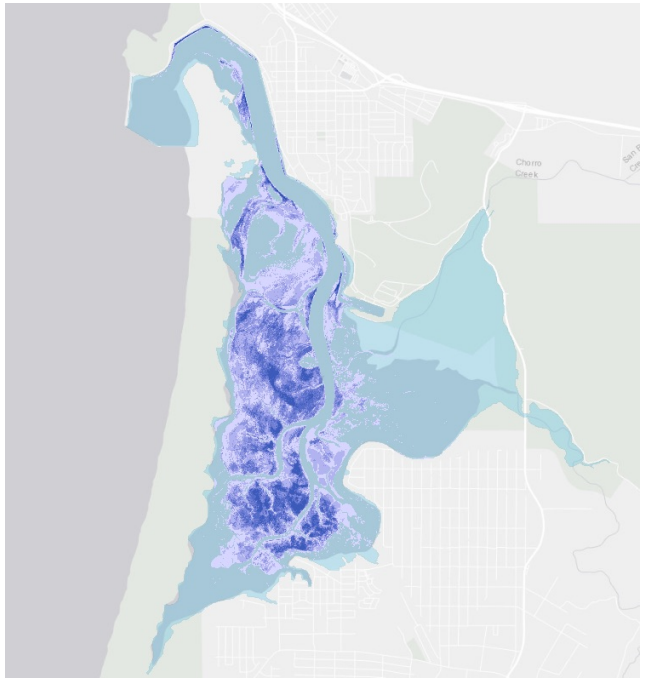




Years of data collection
Current year extent

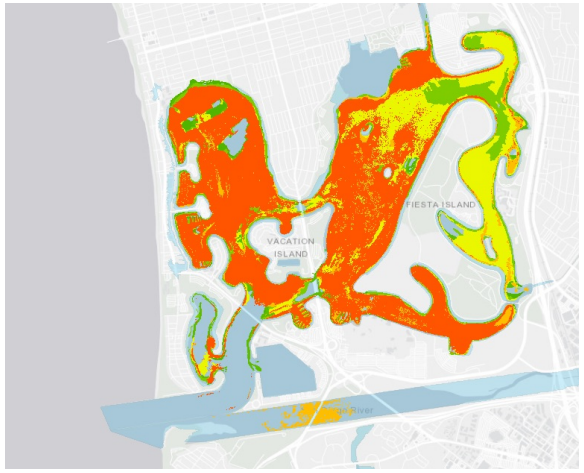


Maximum observed extent



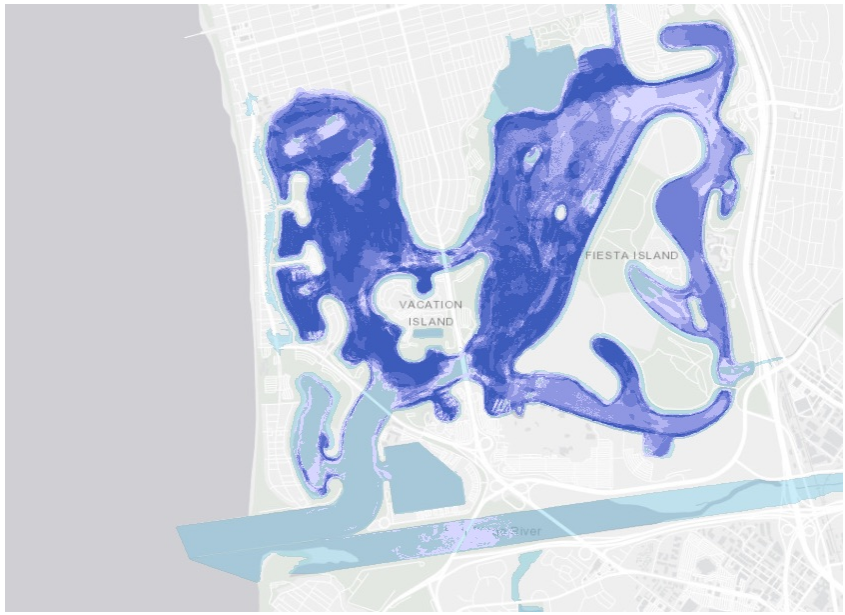
Frequency of occurrence
(dataset count)

Example of Extent Data
Mission Bay, California



Years of data collection
Current year extent

Maximum observed extent



Frequency of occurrence
(dataset count)

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Estuary Data Overview:

Extent data sources

PMEP Estuary (with eelgrass present)	Regional Eelgrass Extent Summary Datasets					Other Local Data Sources	Literature Only
	NOAA ESI	Ocean Imaging (MPA)	CDFW	NOAA	Merkel and Associates	Estuary Specific Extent Data Source	Historic Observations
Ten Mile River	2007		2016				
Noyo River	2007					2017 (Merkel and Associates)	
Big River	2007		2015				
Albion River	2007		2014, 2015				
Navarro River	2007						
Russian River		2010					
Bodega Bay	2007	2010					
Estero Americano	2007	2010	2014, 2016				
Estero de San Antonio		2010	2016				
Tomales Bay	2005	2010	2010, 2013	1992, 1994, 2000, 2002	2015		1985 (CDFG)
Drakes Estero	1994	2010				2005 (Point Reyes National Seashore)	
Bolinas Lagoon	1994*						
San Francisco Bay							
San Francisco Bay	1987*, 1998				2003, 2009, 2013		
South San Francisco Bay	1987*, 1998				2003, 2009, 2013		
San Pablo Bay	1987*, 1998				2003, 2009, 2013		
Suisun-Grizzly Bays					2013		
Elkhorn Slough	2005					1931, 1397; 1356, 1966, 1976; 1980, 1987, 1992; 2000 (Palacios and Zimmerman 2000); 2000, 2003, 2005 (Van Dyke 2005); 2007-2009 (Grant 2009); 2014-2015; 2016 (ESNERR 2016).	
Morro Bay	2005				2005*, 2006, 2007, 2009, 2013, 2015	2002, 2003 (Golden State Aerial), 2004, 2006, 2007, 2009, 2010 (Ocean Imaging)	1960 (CDFG), 1970, 1988, 1994, 1997, 1999

West Coast Eelgrass:

Ecosystem Services

- 17 Ecosystem Services including:
  - Supporting Services
    - Primary production, habitat provision and food web support (nursery habitat, refuge, enhanced reproduction, forage areas, trophic subsidy).
    - *Example: species assemblages in estuaries (habitat provision), species diversity (twice as high in eelgrass habitats than unvegetated).*
  - Regulating Services
    - Shoreline protection, climate change regulation, improvement of water quality
    - *Example: carbon sequestration in Puget Sound: 11,722 tons of CO2 annually.*
  - Provisioning Services
    - Fish and shellfish as food, eelgrass as food, insulation and fertilizer
    - Example: presence of commercially important fish species in eelgrass beds.
  - Cultural & Amenity Services
    - Recreation, aesthetic value, existence value
    - Example: knowing fish exist and have habitat is valued.

Ecosystem Service:

Habitat Provision

Habitat Use of Eelgrass by species

- Commercially , recreationally, or ecologically important species on the West Coast

Table adapted from Phillips, 1984, with updates to species list from Emmett et al, 1991 & Hughes et al, 2014.

Scientific Name	Common name	Resident or Transient	Abundance	Living mode	Feeding Habits
Invertebrates					
Mytilus edulis	Blue mussel	R	X	S	SF
Crassostrea gigas	Pacific oyster	R	U	S	SF
Tresus capax	Horseneck gaper	R	C	B	SF
Tresus nuttalli	Pacific gaper	R	C	B	SF
Tagelus californianus	California jackknife clam	R	C-U	B	SF
Leukoma staminea	Native littleneck clams	R	C	B	SF
Venerupis phillippinarum	Manila clam	R	C	B	SF
Mya arenaria	Softshell clam	R	C	B	SF
Panopea abrupta	Geoduck	R	A-U	B	SF
Cancer magister	Dungeness crab	R	A	S-B	C
Fish					
Clupea harengus pallasi	Pacific herring	T	C	N	C
Clupea larvae		R**, T**	C	OB	X
Engraulis mordax	Northern anchovy	T	A-U	N	C
Anchoa delicatissima	Slough anchovy	?	C-U	N	X
Pleuronectes vetulus	English sole	R	A	S	C
Pleuronectes vetulus (juv)	English sole	R	A	S	C
Platichthys stellatus	Stary flounder	T	U	S	C
Paralichthys californicus	California halibut	R	C	N	C

West Coast Eelgrass:

Threats

	Ecoregion			
Threat	**Salish Sea**	**Washington/Oregon,/Northern California Coast**	**Central California**	**Southern California Bight**
Biological and Chemical				
Invasive species	Thom et al. 2011; WA DNR 2015		Carr et al. 2011	PMEP Survey 2016
Nutrient-driven harmful algal blooms (HAB)	Thom et al. 2011; WA DNR 2015			Bernstein et al. 2011
Overfishing	Thom et al. 2011; WA DNR 2015			
Disease	Thom et al. 2011; WA DNR 2015		Boyer & Wyllie-Echeverria 2010; PMEP Survey 2016	Bernstein et al. 2011; PMEP Survey 2016
Herbivory	Thom et al. 2011		Boyer & Wyllie-Echeverria 2010	
Bioturbation	Thom et al. 2011; WA DNR 2015			Bernstein et al. 2011
Anthropogenic contaminants	Thom et al. 2011; WA DNR 2015; PMEP Survey 2016	PMEP Survey 2016		Bernstein et al. 2011; Huntington 2007
Physical and Land/Water Use				
Aquaculture	Thom et al. 2011; WA DNR 2015; PMEP Survey 2016	Tallis et al. 2009; PMEP Survey 2016		
Dredging & filling	Thom et al. 2011; WA DNR 2015			Bernstein et al. 2011; Melrose et al. 2015;
Freshwater input changes	Thom et al. 2011; WA DNR 2015			
Increased sedimentation	Thom et al. 2011; WA DNR 2015	PMEP Survey 2016	PMEP Survey 2016	PMEP Survey 2016
Coastal development	PMEP Survey 2016; Thom et al. 2011; WA DNR 2015; Fresh et al. 1995; Nightingale and Lynch 2001; Thom et al. 2011	PMEP Survey 2016	PMEP Survey 2016; Boyer and Wyllie-Echeverria 2010	PMEP Survey 2016; Bernstein et al. 2011; Melrose et al. 2015
Propeller wash/boat wake	Thom et al. 2011; WA DNR 2015		Boyer and Wyllie-Echeverria 2010	Bernstein et al. 2011
Boat grounding/anchor	Thom et al. 2011; WA DNR 2015		Boyer and Wyllie-Echeverria 2010	
Climate and Geologic Events				
Sea level rise	Thom et al. 2011; WA DNR 2015; Shaughnessy et al. 2012	Shaughnessy et al. 2012; PMEP Survey 2016	Boyer and Wyllie-Echeverria 2010; Shaughnessy et al. 2012; PMEP Survey 2016	Shaughnessy et al. 2012; Melrose et al. 2015; PMEP Survey 2016
Sea temperature changes	Thom et al. 2011; WA DNR 2015; PMEP Survey 2016	PMEP Survey, 2016	Boyer and Wyllie-Echeverria 2010; PMEP Survey 2016	Johnson et al. 2016; Melrose et al. 2015; PMEP Survey 2016
Storm events	Thom et al. 2011; WA DNR 2015			
Tectonic changes			Shaughnessy et al. 2012	
Other human impacts				
Lack of awareness		PMEP Survey 2016		

West Coast Eelgrass:

Data & Knowledge Gaps

Spatial extent of eelgrass

- Grays Harbor
- 19 estuaries in Oregon & Washington (estuaries with literature / Shorezone presence, no extent data)
- No California Shorezone data
- 13 estuaries with eelgrass data over 10 years old
- Zostera japonica extent (and documented spread of occurrence)
- Changes in extent over time (current vs. historic)
- Dynamic nature of eelgrass

Ecosystem services and threats

- Lack of quantification of services on West Coast
  - Shoreline stabilization, filter and improve water quality, mitigate ocean acidification, sequester carbon, uptake toxic chemicals, nursery habitat provision.
- Impact of spread of Z. japonica on native eelgrass (Z. marina)
- Impact of sea level rise on eelgrass distribution

Report Recommendations:

Data Collection

More standardized approaches to data collection

- For both eelgrass and fish/invertebrate use of eelgrass
- Each ecoregion uses different methodologies
  - Salish Sea: underwater videography with depth (presence/absence points)
  - WA/OR/NoCal Coast: Aerial imagery;
  - Central California: Aerial imagery; side-scan sonar;
  - Southern California: Side-scan sonar
- Use area of eelgrass as opposed to “presence” of eelgrass
- Across habitat types – certain methods found reduced efficiency in eelgrass beds.

Distinguish between species in future extent data collection efforts

- Specifically Z. marina and Z. japonica
- Z. japonica managed differently in each state, even though they provide similar ecosystem services (and in certain cases, unique services)

Report Recommendations:

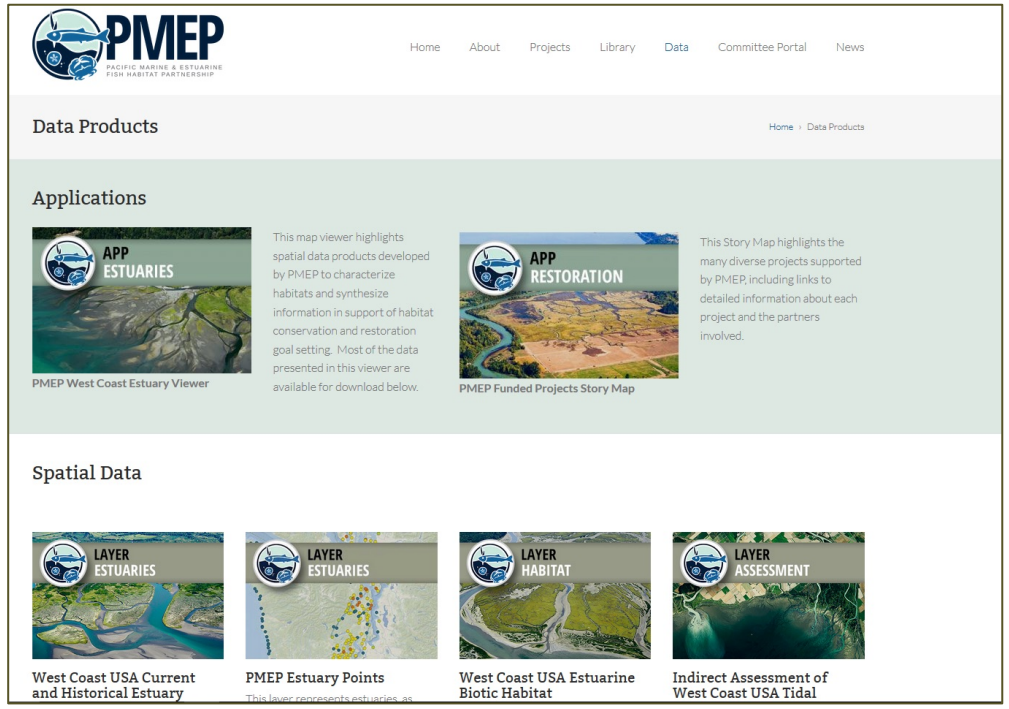
Restoration & Management

- Landscape scale management – mitigate local threats and build resilience.
- Outreach to the public about value of eelgrass – help reduce local threats.
- Considerations for both habitat requirements (depth range, etc.) and local threats to eelgrass habitat should be taken into consideration before selecting eelgrass restoration sites.
- Structure, as opposed to specific habitat types may play a more important role in for habitat provision; paired habitat restoration (eelgrass and shellfish) may increase species richness of restored areas.

Dayv Lowry, WDFW

Andrew Weltz, CDFW

Next Steps



www.pacificfishhabitat.org

- Report and data due for release by March
- Coming soon:
  1. View and download report
  2. Explore estuaries app
  3. Download data

Acknowledgements

- Data contributors
  - WA DNR, SVMP data (Lisa Ferrier)
  - SoundIQ (Suzanne Schull)
  - Oregon EPA (Pat Clinton)
  - ODFW SEACOR dataset (Tony D'Andrea)
  - CDFW N. California dataset, California data compilation (Andrew Weltz, Paulo Serpa)
  - Ocean Imaging N. California dataset
  - Estuary Research Reserves, National Estuary Program (Jenni Schmitt, South Slough; Ann Kitajima, Morro Bay ; Charlie Endris, Elkhorn Slough)
  - NOAA / Merkel & Associates California (Bryant Chesney, NOAA)
  - ERMA / S. California Bight data compilation
  - USGS (Eric Grossman)
  - Shorezone (WA DNR, OR ODFW)
- PMEP Science & Data Committee and Steering Committee
- OR Coastal Management Program
- NOAA – Bryan Pestone
- Webinar attendees, survey respondents, literature contributors

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Questions?

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