Collaborative Approach to Light Availability & Attenuation:
Illuminating Data Needs in Puget Sound Nearshore

John Vavrinec
Sr. Research Scientist / Dive Officer
PNNL Marine Sciences Laboratory

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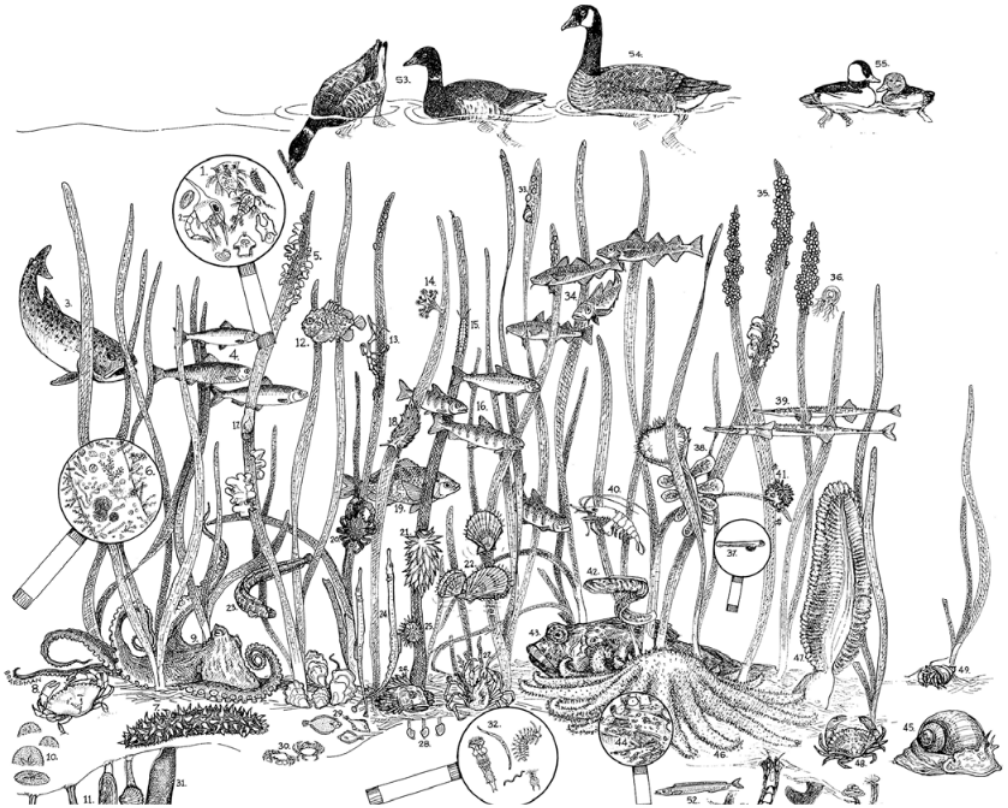
The Eelgrass Meadow — A World of Microhabitats



1. Zooplankton
2. Larval crab
3. Salmon
4. Herring
5. Epiphytic macroalgae
6. Epiphytic microalgae, Hydozoa, and bryozoa
7. Sea cucumber
8. Dungeness crab
9. Octopus
10. Sand dollars
11. Clams and cockles
12. Pacific spiny Lumpsucker
13. Caprellid amphipod
14. Stalked jellyfish
15. Eelgrass isopod
16. Juvenile salmon
17. Bubble shell
18. Opalescent nudibranch
19. Perch
20. Juvenile kelp crab
21. Alabaster nudibranch
22. Scallop
23. Gunnel
24. Bay pipefish
25. Sea urchin
26. Juvenile sculpin
27. Decorator crab
28. Juvenile clams
29. Juvenile flounder And sole
30. Juvenile crab
31. Geoduck
32. Sediment microfauna
33. Snail and snail eggs
34. Juvenile cod, tomcod And wall-eyed pollock
35. Herring eggs
36. Jellyfish
37. Larval fish
38. Melibae-hooded nudibranch
39. Tubesnout
40. Shrimp
41. Brooding anemone
42. Prickleback
43. Sculpin
44. Bacteria on detritus
45. Moonsnail
46. Sunflower seastar
47. Sea pen
48. Red rock crab
49. Hermit crab
50. Worms
51. Ghost shrimp
52. Sand lance
53. Black Brant
54. Canada Goose
55. Bufflehead

Figure 2. The eelgrass meadow: A world of microhabitats (© permission Port Townsend Marine Science Center, Port Townsend, WA).

Mumford 2007

Eelgrass

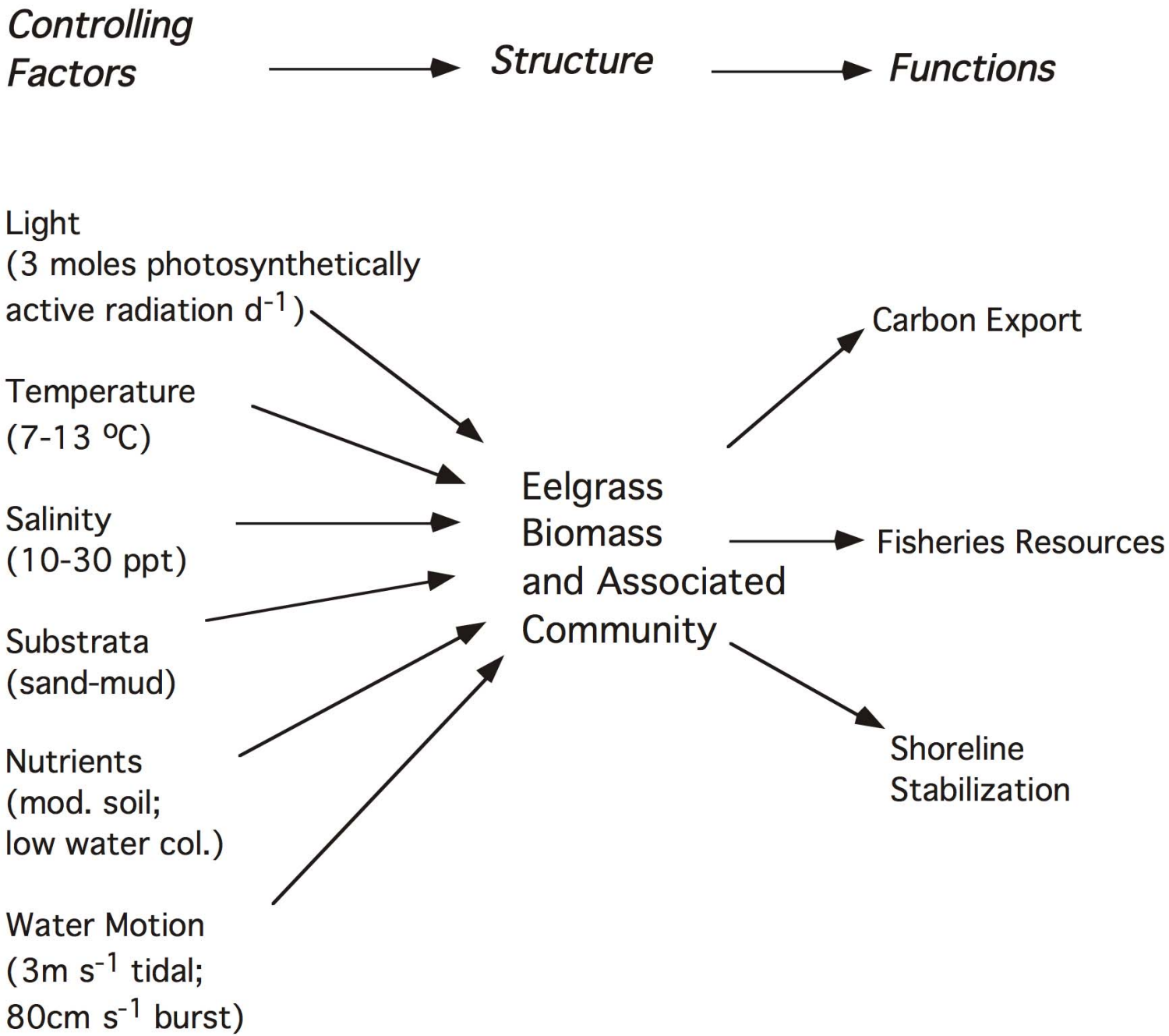
In Puget Sound, eelgrass is considered a critical habitat for fisheries support and is protected at the federal, state, and local levels.

In the early 1990's, Washington State established a "no net loss" policy for eelgrass

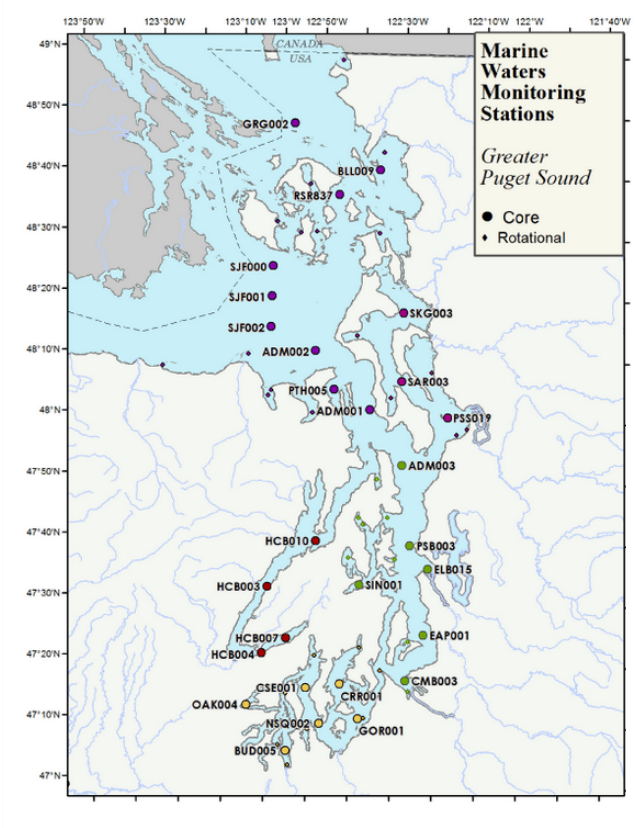
In 2010, DNR and the Puget Sound Partnership set action item to increase eelgrass 20% by 2020 (~4,000 ha)

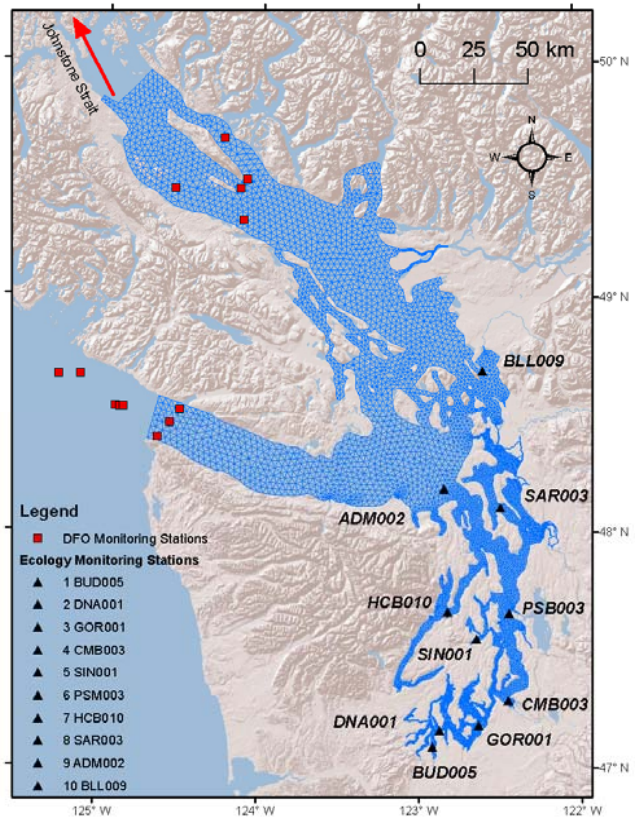
Approach to Restoration

- Modeling shorelines
- Identification of potential areas
- Field surveys
- Test plots / evaluation
- Full restoration planting

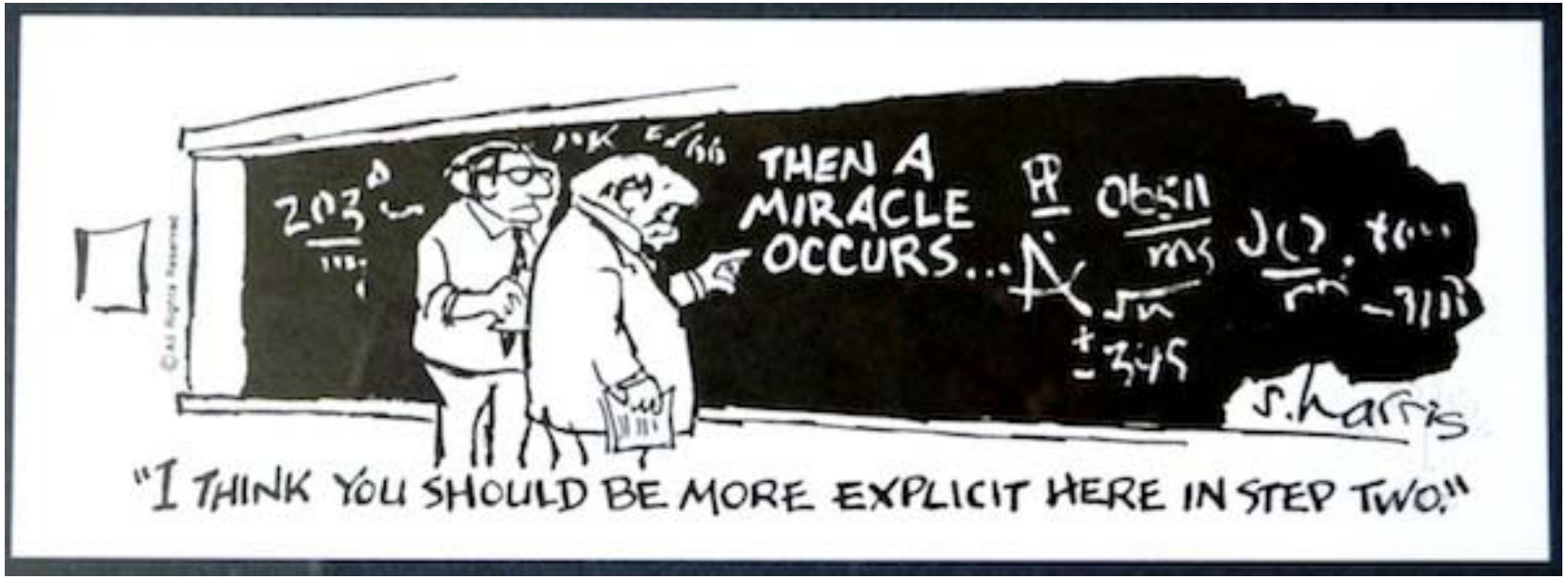

Controlling Factors
Structure
Functions
Light (3 moles photosynthetically active radiation d-1)
Temperature (7-13 ºC)
Salinity (10-30 ppt)
Substrata (sand-mud)
Nutrients (mod. soil; low water col.)
Water Motion (3m s-1 tidal; 80cm s-1 burst)
Eelgrass Biomass and Associated Community
Carbon Export
Fisheries Resources
Shoreline Stabilization

Data Sources



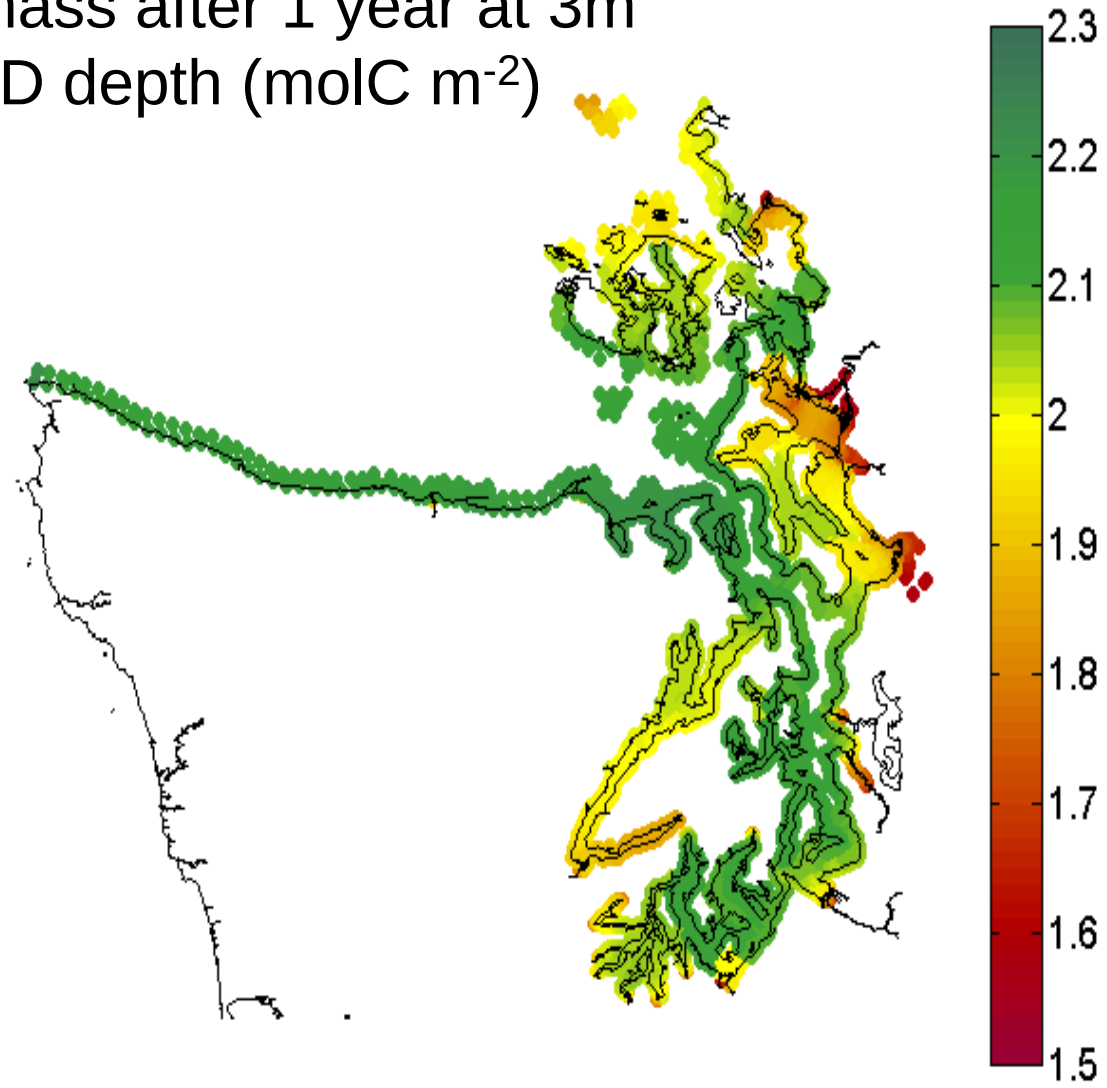


Model



Eelgrass Biomass Growth Model

Biomass after 1 year at 3m NAVD depth (molC m^{-2})

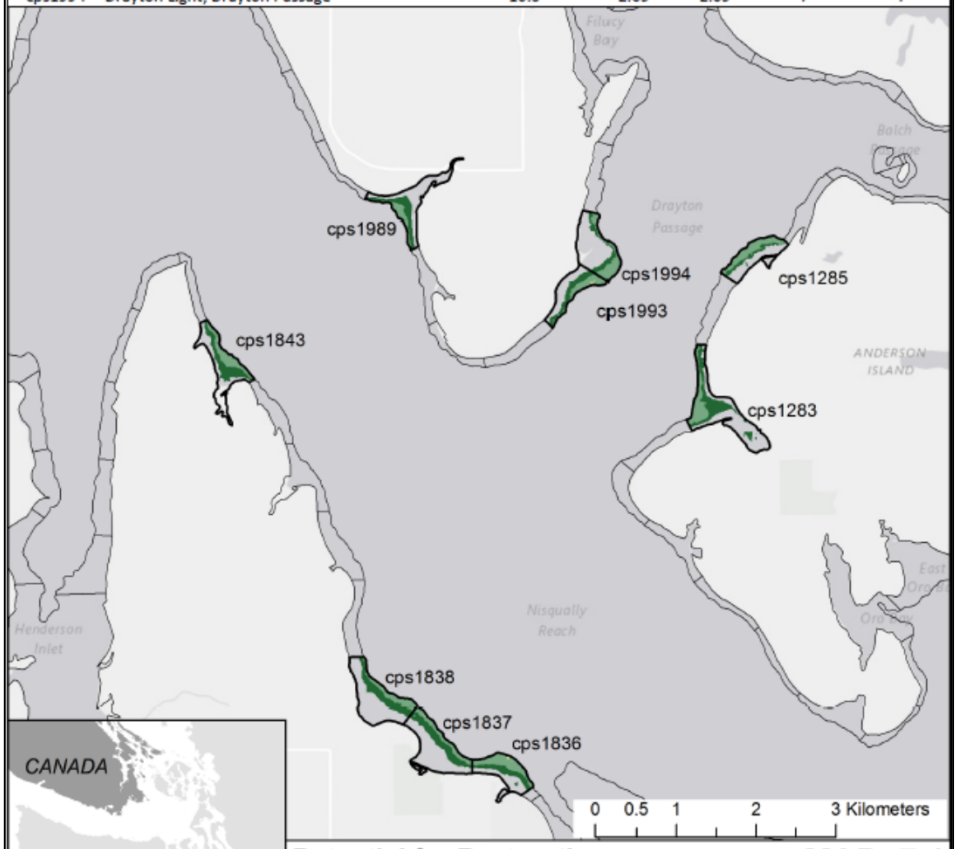


Includes:
-Light
-Temperature
-Salinity
-Density dependence
-Photosynthesis and respiration

One component of larger eelgrass habitat suitability model

(Initial biomass = 2.0 molC m^{-2})

Site Code	Site Name	Potential Restoration Area (ha)	EBM	ECI	ERP Category	Map Region
cps1283	Carlson Bay, Anderson Island	19.1	2.09	2.09	7	7
cps1285	NW Anderson Island	10.8	2.08	2.06	7	7
cps1836	Butterball Cove, Nisqually	13.7	2.09	2.09	7	7
cps1837	Sandy Point, Olympia	14.2	2.10	2.10	3	7
cps1838	Dogfish Bight, Olympia	14.1	2.10	2.10	3	7
cps1843	Poncin and Baird Cove, Olympia	14.4	2.10	2.10	3	7
cps1989	Taylor Bay, Longbranch	10.2	2.11	2.11	3	7
cps1993	S of Drayton Light, Drayton Passage	10.8	2.09	2.10	3	7
cps1994	Drayton Light, Drayton Passage	10.3	2.09	2.09	7	7



Potential for Restoration **MAP: 7.1**

Lowest | Highest

Intermediate | DNR SVMP Site Boundary

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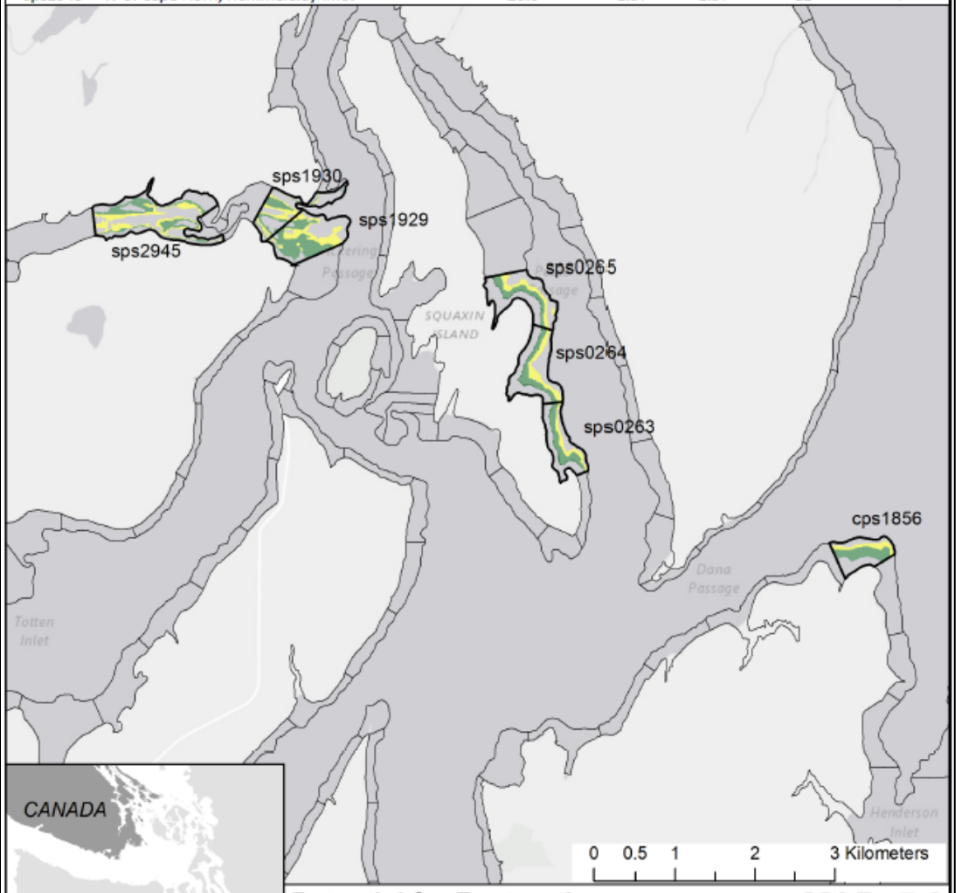
Contact: Amy Borde or Kate Buenau, Marine Sciences Lab (360) 681-4565

Site Code	Site Name	Potential Restoration Area (ha)	EBM	ECI	ERP Category	Map Region
cps1856	Dickenson Point East	13.2	1.98	1.98	12	7
sps0263	Squaxin Island State Park	12.0	1.97	1.97	12	7
sps0264	S of Seafarm Cove, Squaxin Island	14.5	1.96	1.96	12	7
sps0265	Seafarm Cove, Squaxin Island	13.1	1.96	1.96	12	7
sps1929	Cape Cod S, Hammersley Inlet	26.3	1.99	1.99	12	7
sps1930	Cape Cod N, Hammersley Inlet	11.2	1.96	1.96	12	7
sps2945	W of Cape Horn, Hammersley Inlet	26.0	1.97	1.97	12	7



Potential for Restoration **MAP: 7.2**

Lowest | Highest

Intermediate | DNR SVMP Site Boundary

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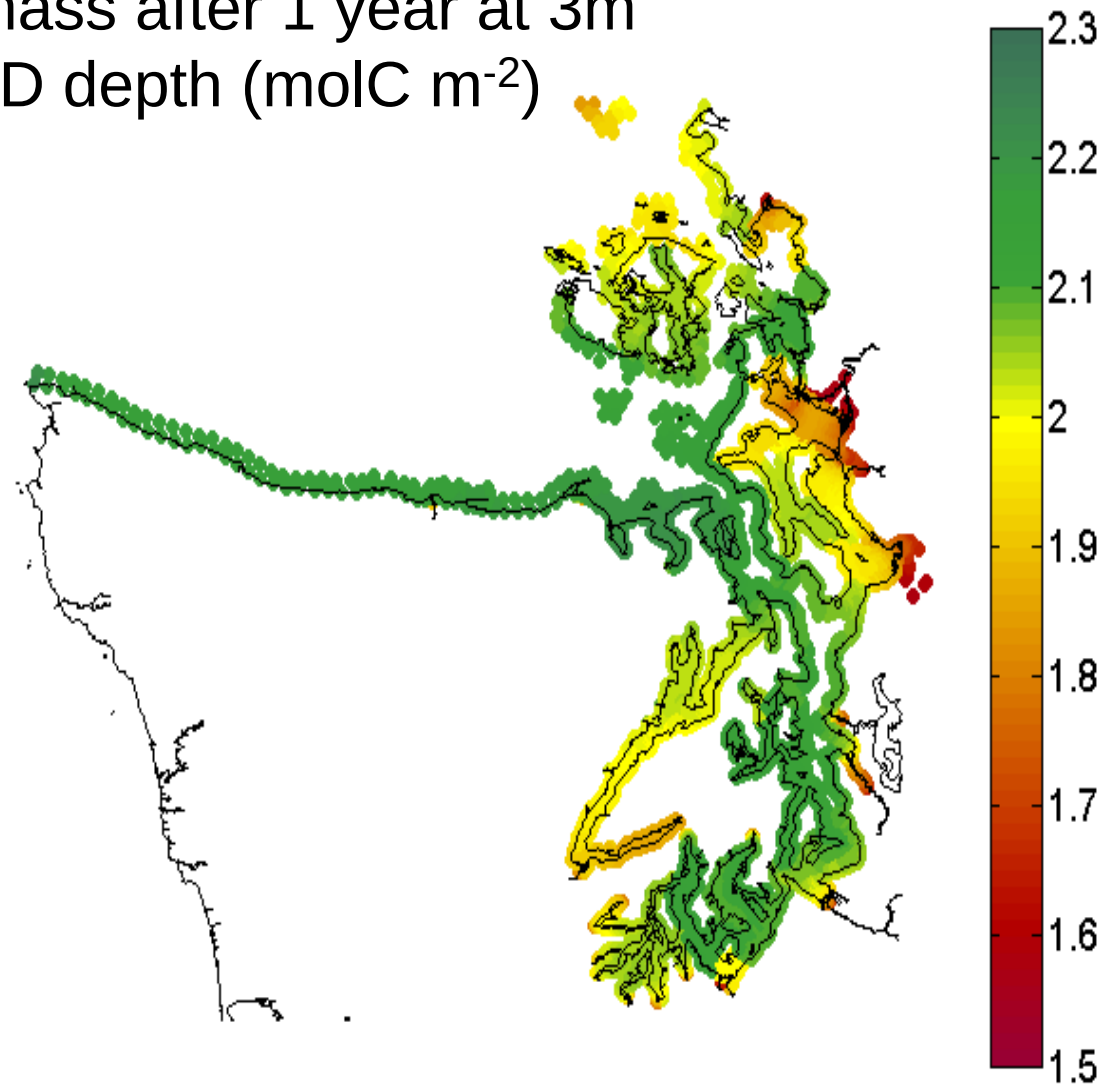
Eelgrass Biomass Growth Model

Biomass after 1 year at 3m
NAVD depth (molC m^{-2})



Includes:
-Light
-Temperature
-Salinity
-Density dependence
-Photosynthesis and respiration

(Initial biomass = 2.0 molC m^{-2})

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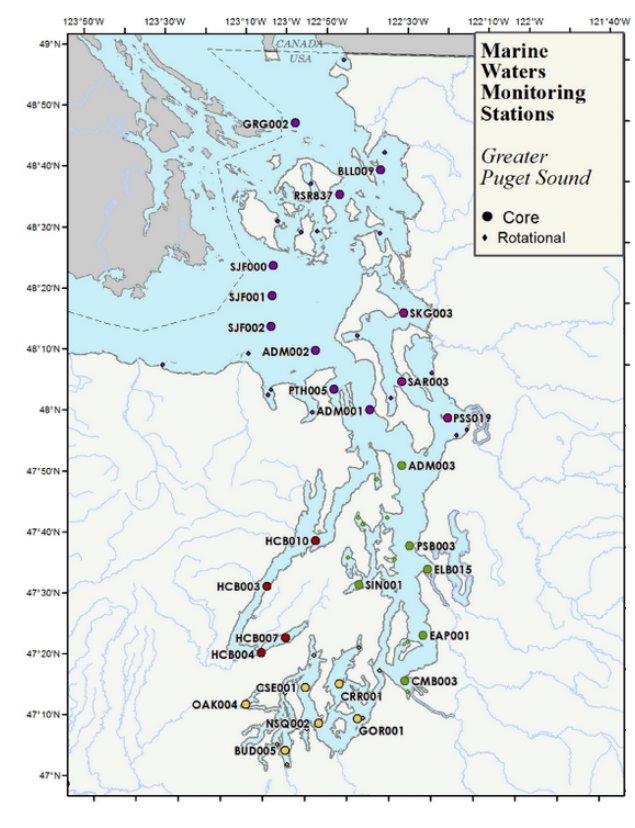
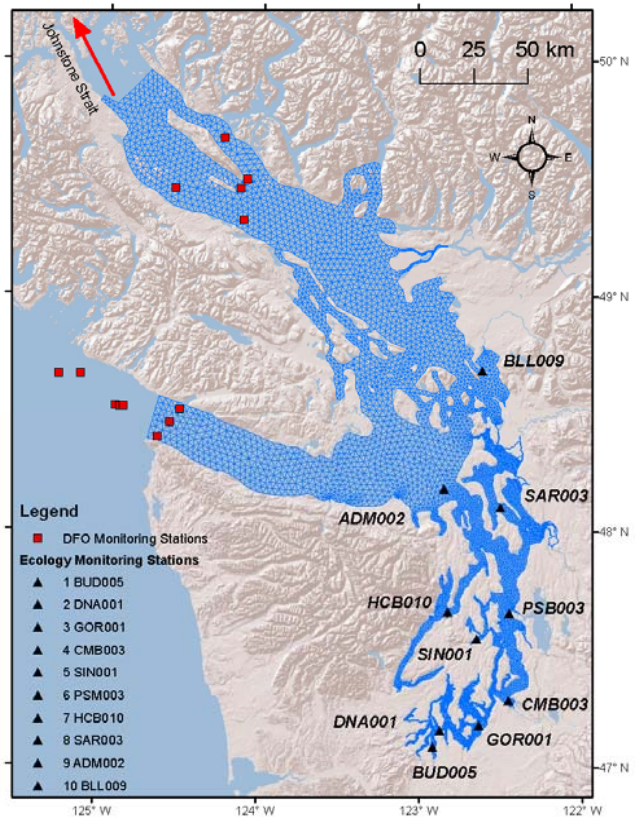
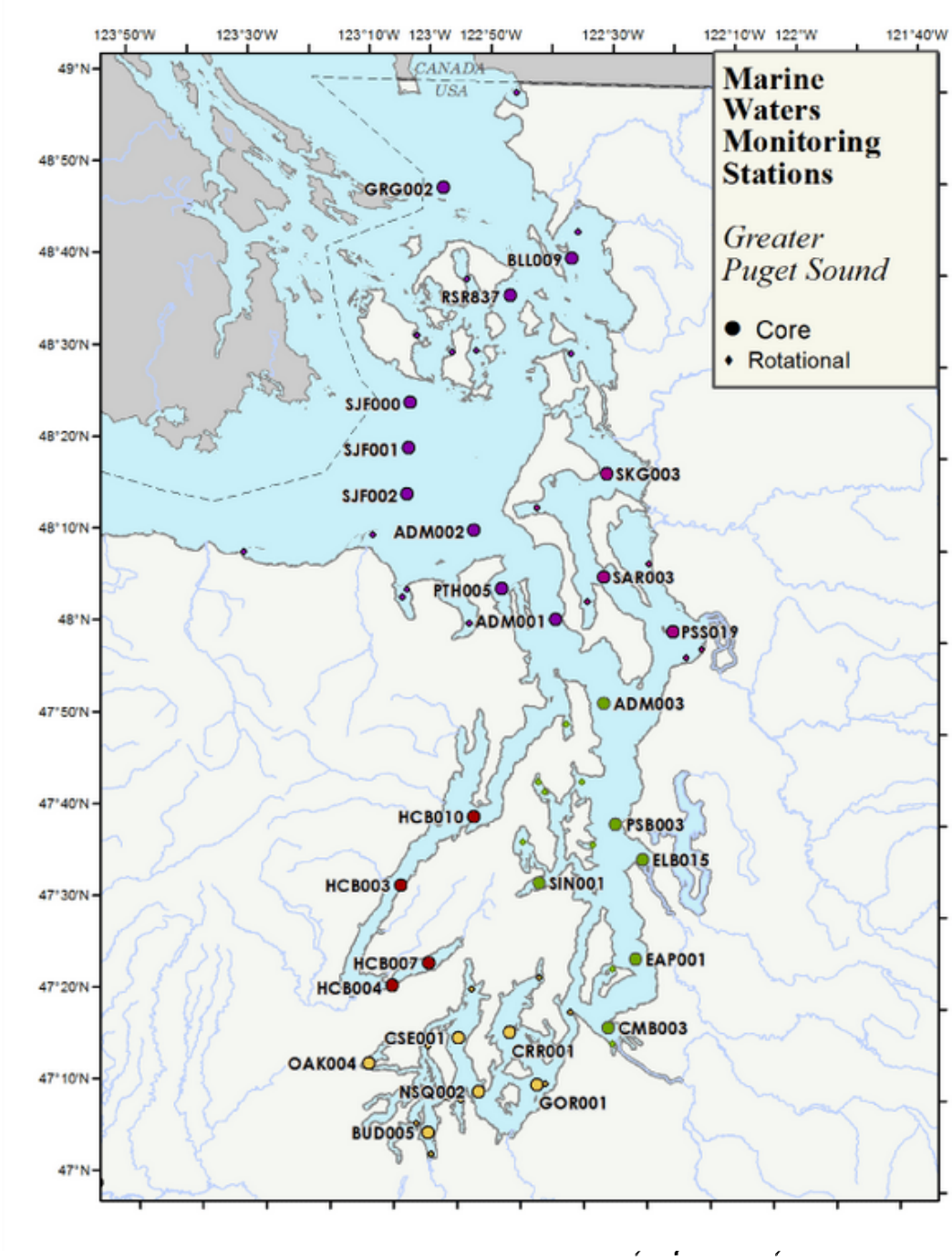
Data Sources



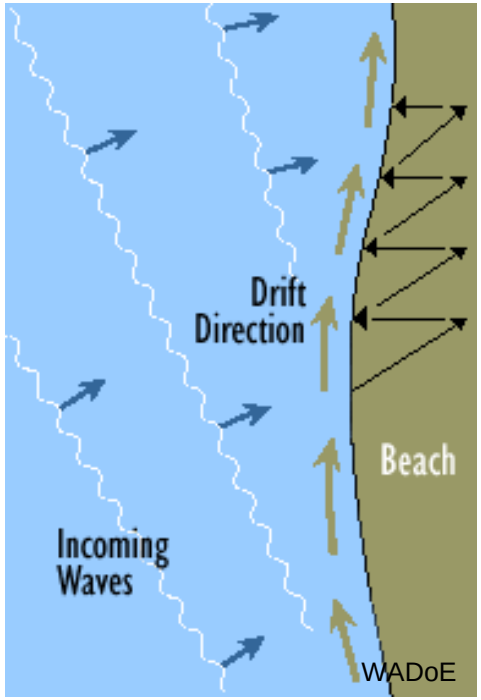


Data Sources

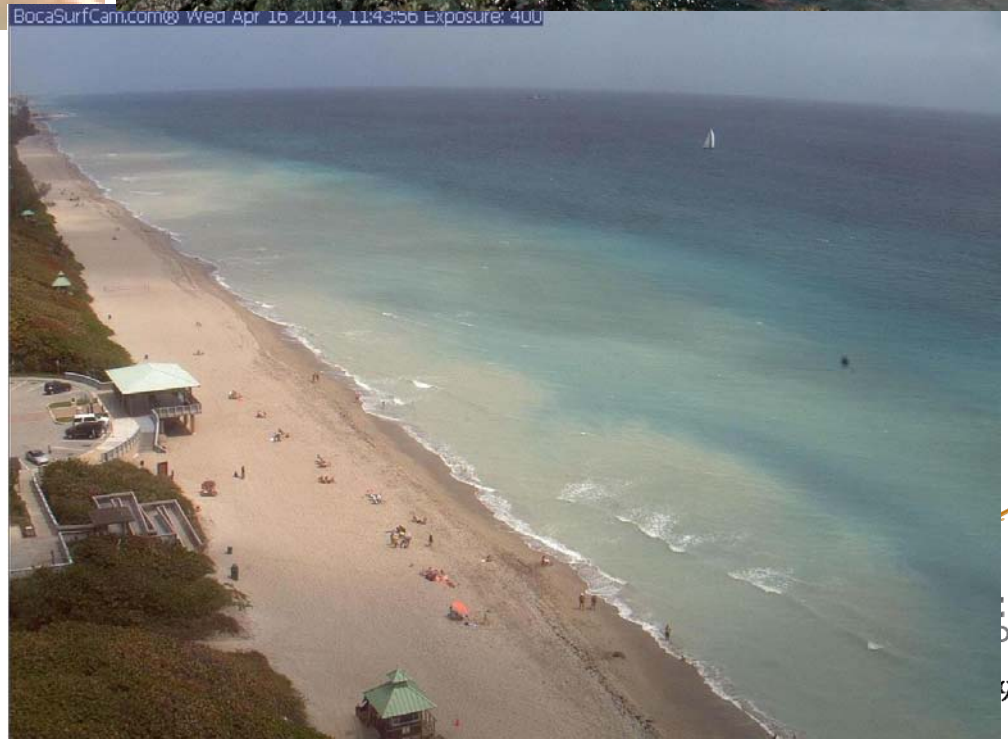


https://profile.usgs.gov/jwarrick

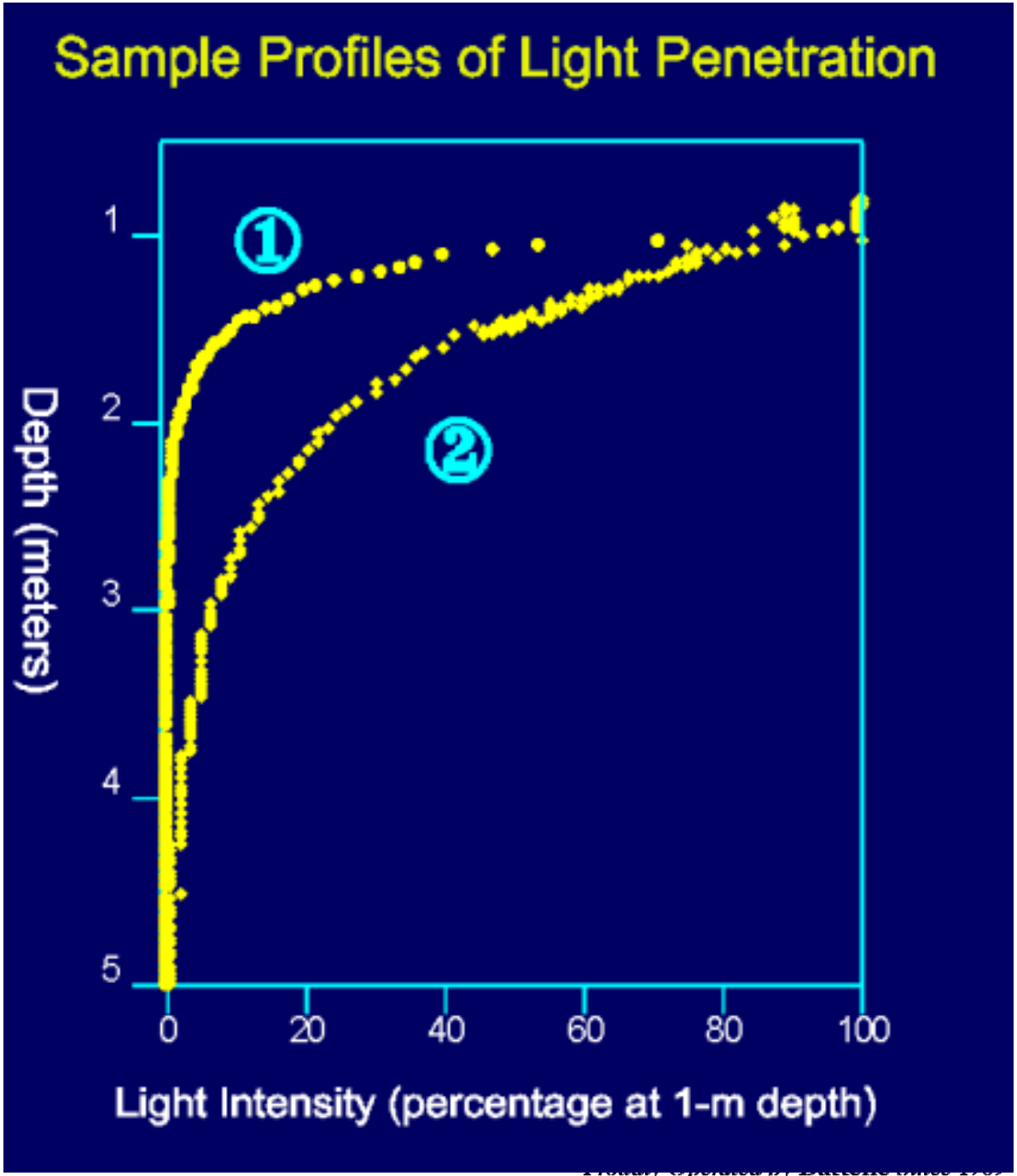
Andrew Cohen



WADoE



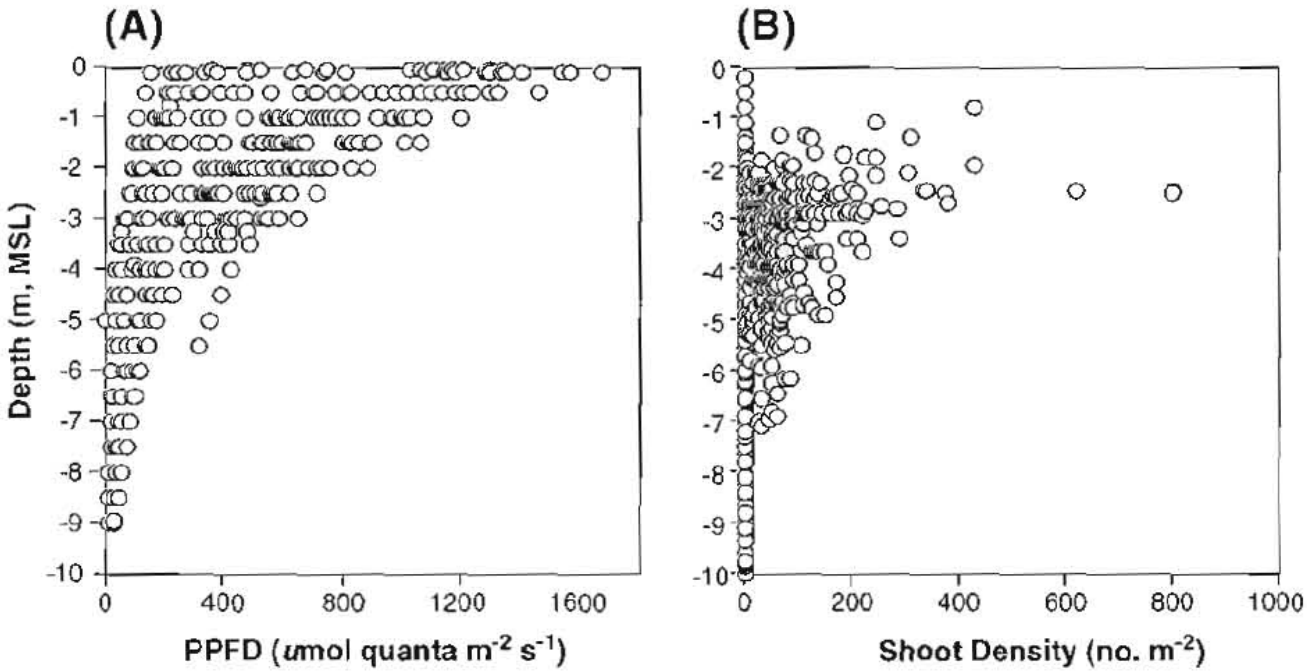
Attenuation



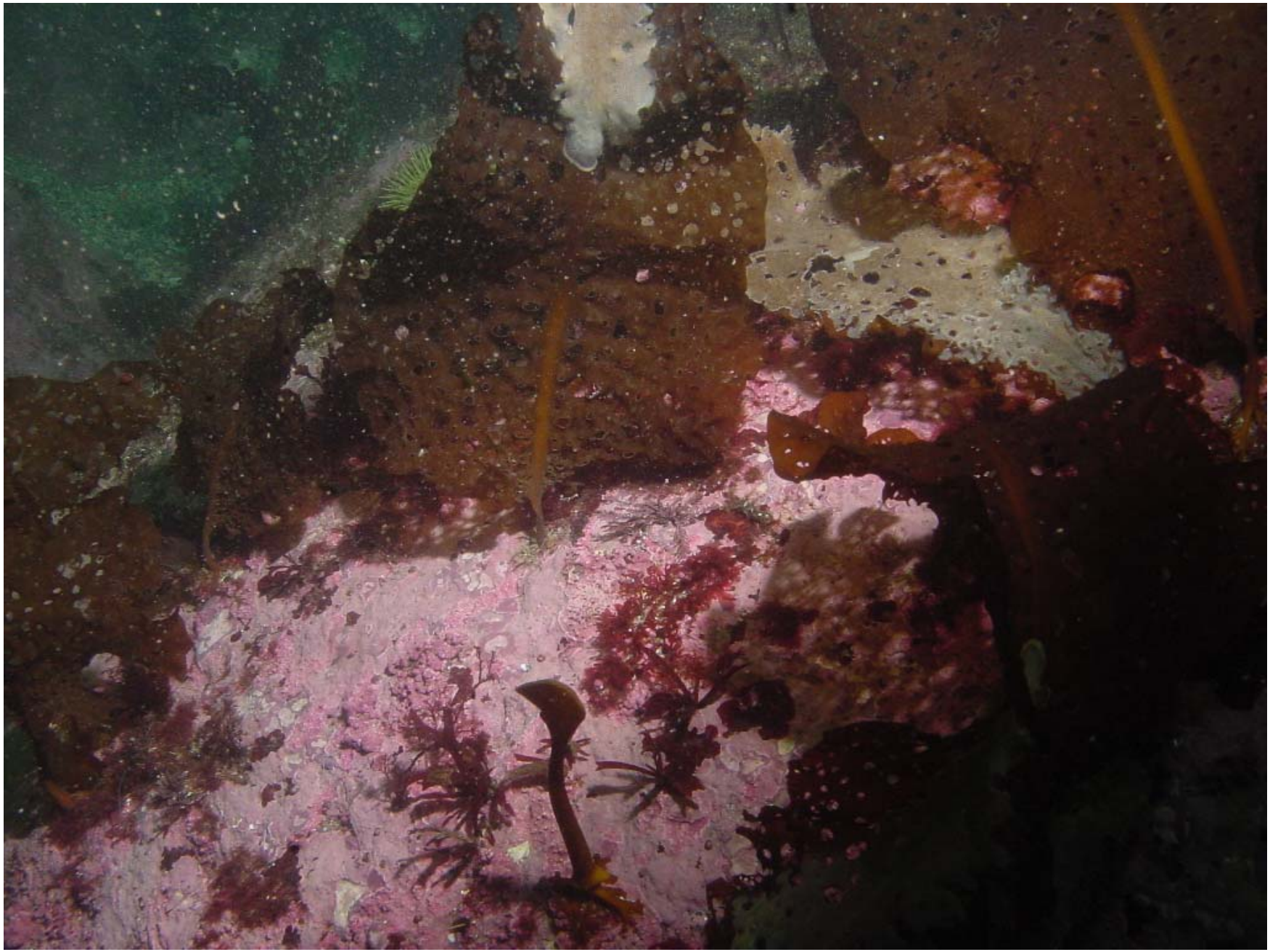
sfbay.wr.usgs.gov/.../profiles/lite_prof.html

Light vs distribution

Fig. 9 PPFD (a) and shoot density (b) vs depth relative to mean sea level at eight sites in Puget Sound

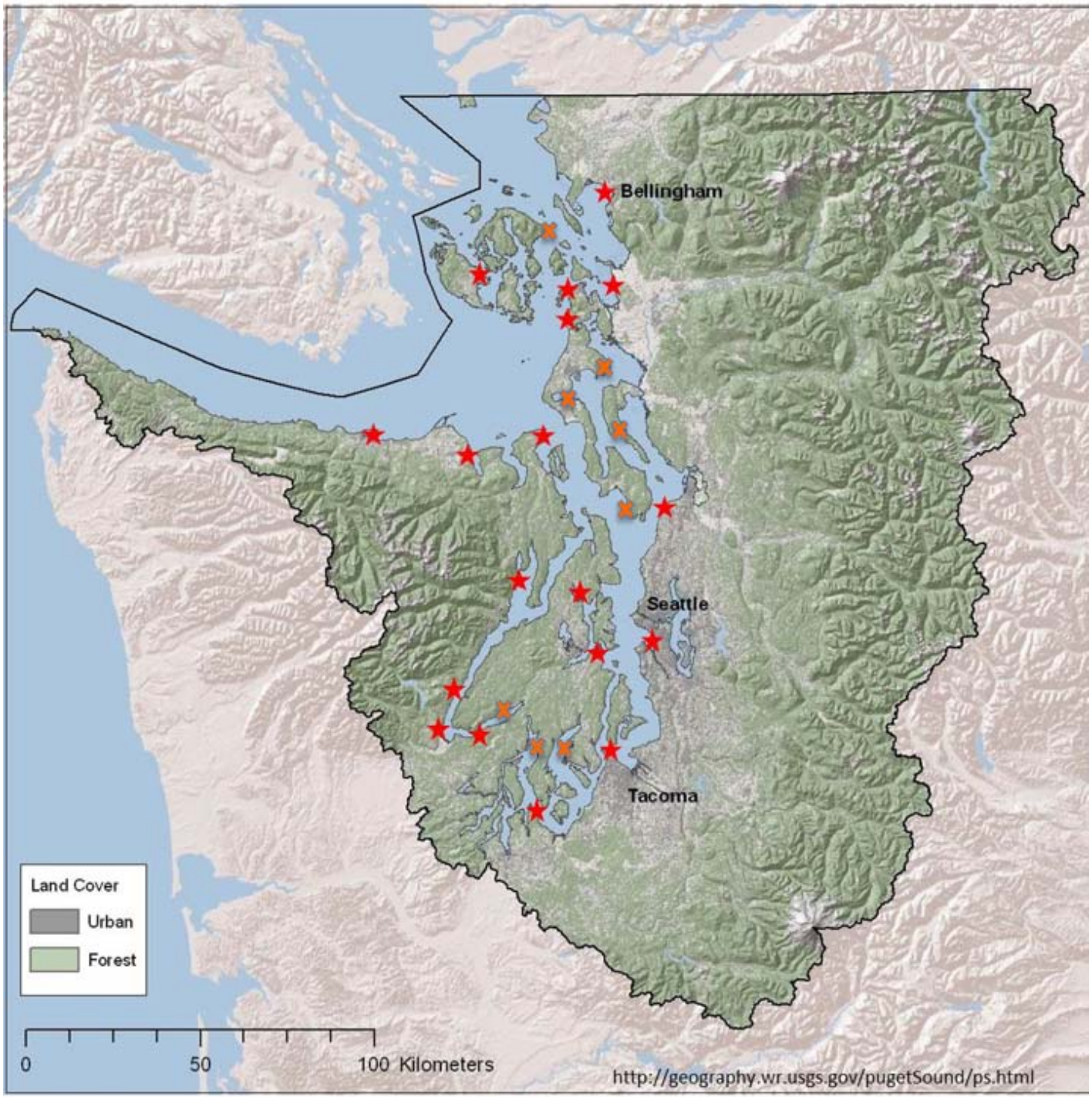


Thom et al 2008



Collaborative Collection Study

- Deploy arrays of sensors
  - PAR
  - Temperature
  - Others (water level, pH, etc.)
- Multiple stewards of sensors
  - Labs / field stations
  - Aquariums
  - State Parks
  - Interpretive Centers
  - Citizen scientists
- Shared, standardized data

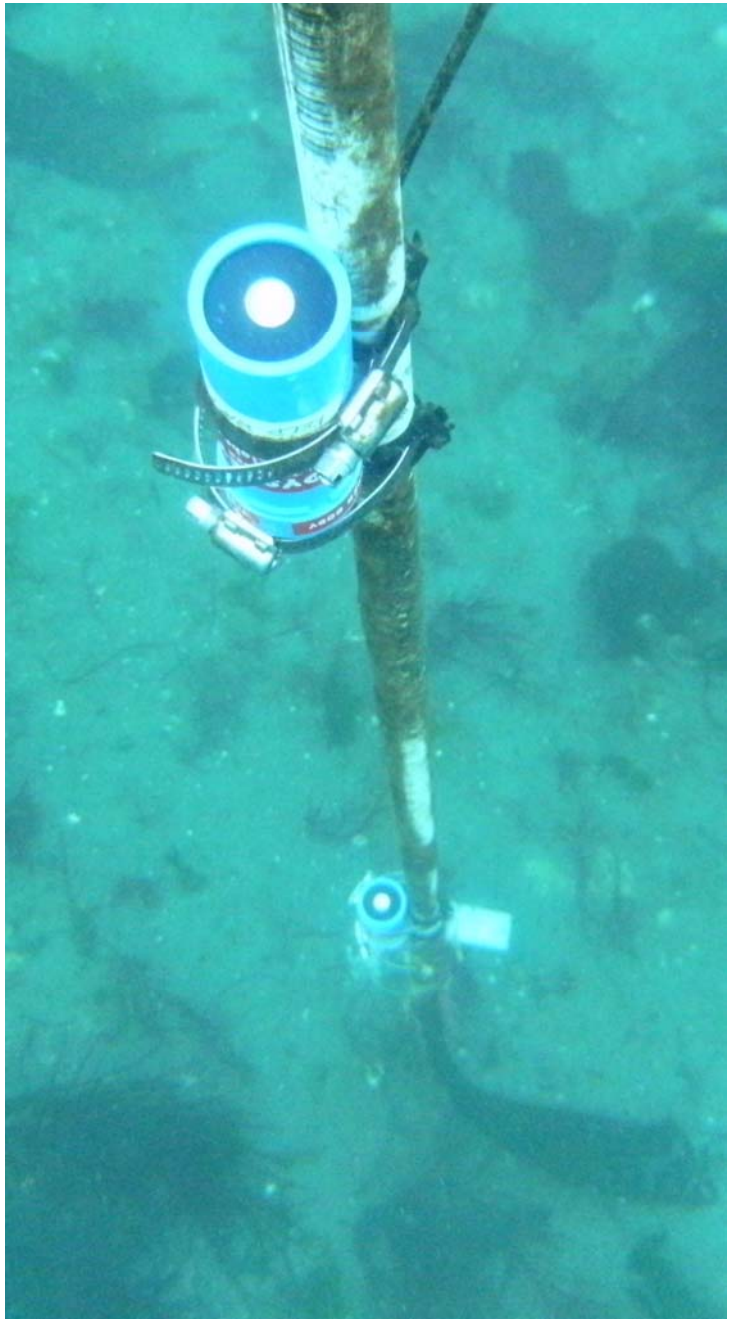

Bellingham
Seattle
Tacoma
Land Cover
Urban
Forest
0
50
100 Kilometers
http://geography.wr.usgs.gov/pugetSound/ps.html

Odyssey

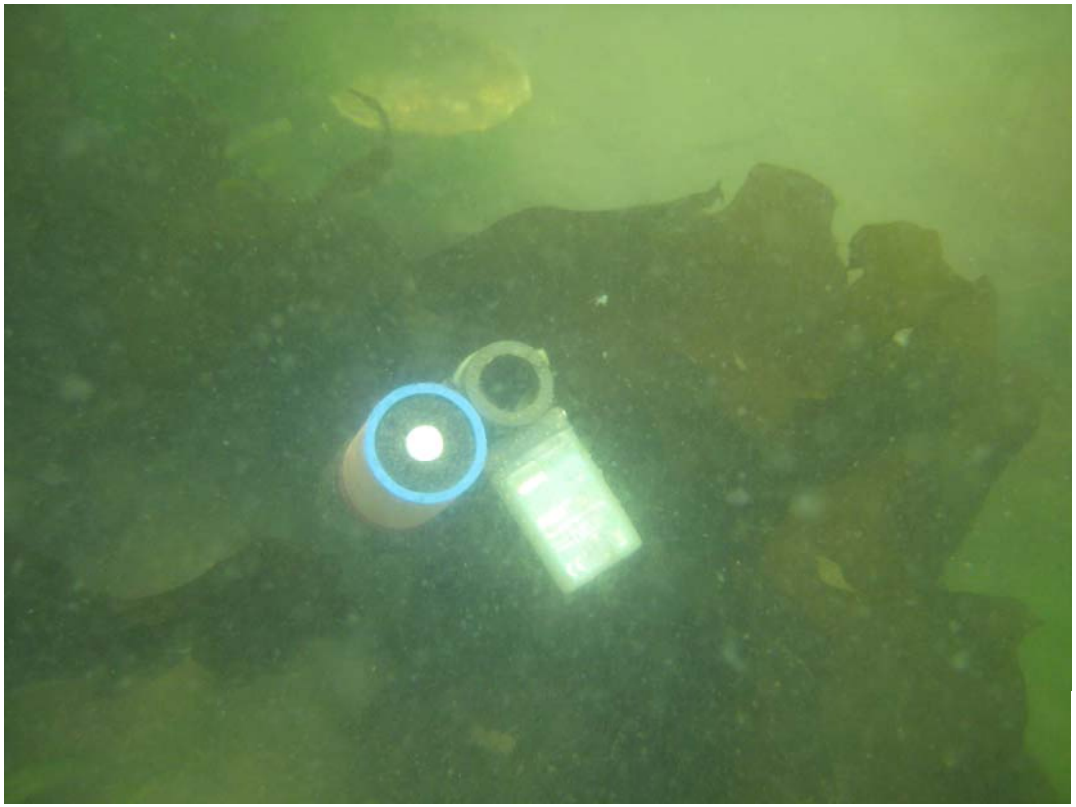
- Integrating PAR sensor
- Submersible
- Independent

Deployment

- Attached on a rail system
  - Probably needs divers to install initially
  - Ease of subsequent servicing
- Two PAR sensors for attenuation
- Standardized protocol
- Additional sensors as needed (e.g., temp, water level pH)



Servicing



- Remove biofoul
- Check for damage
- Download data
- Replace batteries
- Upload data to central source

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Data

- Downloaded by steward
- Kept in centralized location
- Compiled for sharing
- Provides full coverage of light variation
- Can be applied to models, research, etc.
  - Quantify trends in environmental parameters
  - Explaining observed patterns of distribution
  - Descriptive models
  - Predictive models (climate change, use changes)
- Encourages collaboration

Questions?

John Vavrinec
PNNL Marine Sciences Lab
1529 W. Sequim Bay Rd
Sequim, WA 98382

360-681-3665
john.vavrinec@pnnl.gov

Equipment costs

Odyssey PAR sensor	~$215
Odyssey interface cable	~$30
Onset water level / temp sensor	$299
Onset software & cable	$99
	~$650

plus mounting hardware, extra sensors, etc.

Habitat suitability model

- Biomass model results
- Presence or absence of eelgrass
- Bathymetry / potential area
- Landscape conditions
- Stressors
  - Overwater structures
  - Shoreline armoring