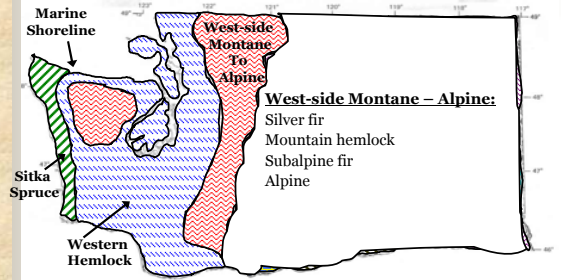


### West-side Ecosystems

January 16, 2008

### Washington State Ecoregions: West-side



**West-side Montane - Alpine:**  
 Silver fir  
 Mountain hemlock  
 Subalpine fir  
 Alpine

### Ecosystems of the Marine Shoreline Ecoregion

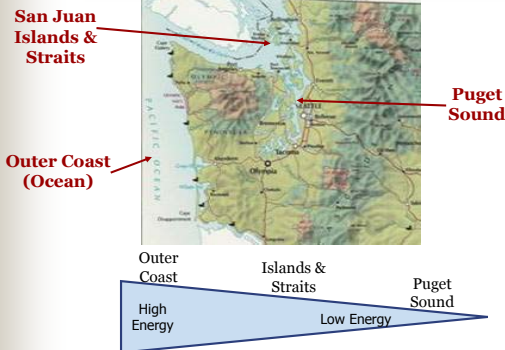


### Marine Shoreline Ecosystems



I. Marine Shoreline Regions  
 II. Ecosystems & Human Impacts

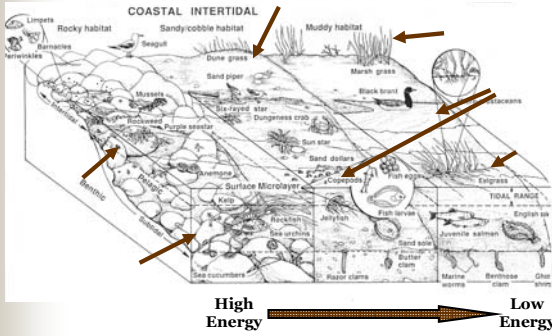
### I. Marine Shoreline Regions of WA



### I. Marine Shoreline Regions of WA



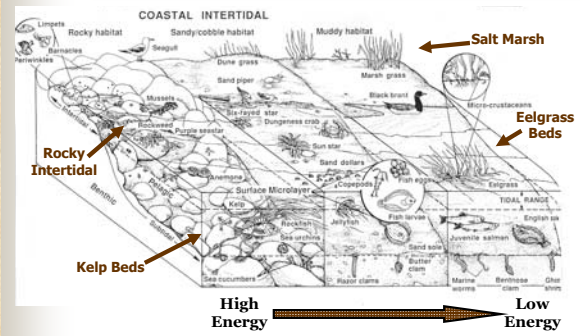
## II. Marine Shoreline Ecosystems



Kruckeberg 1991

## II. Marine Shoreline Ecosystems

### Ecosystems of focus



## Kelp Beds (Kelp Forests)



Dominated by 3 large brown algal species (kelp):

*Nereocystis luetkeana* (bull kelp)

- Up to 20 m tall
- Annual
- Puget Sound, straits, protected outer coast

*Macrocystis integrifolia* (giant kelp)

- Up to 10 m tall; perennial
- Outer coast nearshore & western straits

*Macrocystis pyrifera*

- Up to 40 m tall; perennial
- Outer coast further away from shore
- In water up to 80 m deep

Kruckeberg (1991)

Dr. Macrocystis luetkeana, the Bull Kelp

## Kelp Beds: Other organisms

### Primary Producers

Dominated by large brown algae – kelps (surprise ☺)

Other algae in kelp beds vary greatly with:

- dominant overstory species
- energetics of water at the site
- region (PS, straits, outer coast)
- season

### Consumers

Invertebrates feeding on kelp: *urchins, snails, etc.*

Filter feeders using kelp as a place to live (*sponges, bryozoans, tunicates, marine worms, etc.*)

Invertebrates: *crabs, shrimp, etc.*

Pinnipeds: *sea otters*

Fish: *bass, lingcod, perch, sculpins, etc.*

There is a rich variety of consumers that vary through time & space – we cannot do them justice here

## Ecosystem Net Primary Productivity

### Annual Net Primary Productivity of Ecosystems



NPP =

Ecosystem Type	Mean NPP g C / m <sup>2</sup> / yr	Range of NPP g C / m <sup>2</sup> / yr
<b>Terrestrial Uplands</b>		
Tropical rain forest	2,200	1,000 - 3,500
Temperate evergreen forest	1,320	600 - 2,500
Temperate deciduous forest	1,200	600 - 2,500
Boreal forest	800	400 - 2,000
Woodland & shrubland	700	250 - 1,200
Temperate grassland	600	200 - 1,500
Tundra and alpine	140	10 - 400
Desert & semidesert scrub	90	10 - 250
<b>Freshwater Wetlands</b>		
Swamp & marsh	2,000	800 - 6,000
Lake and stream	250	100 - 1,500
<b>Marine</b>		
Algal beds and reefs	2,500	500 - 4,000
Estuaries	1,800	500 - 4,000
Open Ocean	125	2 - 400

## Kelp Beds are highly productive ecosystems

### Annual Net Primary Productivity of Ecosystems

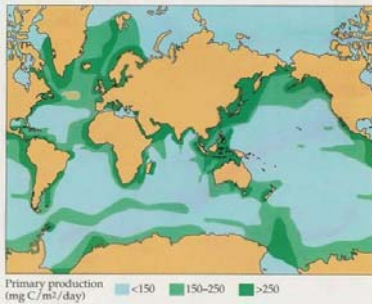
Kelp beds are as productive as tropical rainforests

Ecosystem Type	Mean NPP g C / m <sup>2</sup> / yr	Range of NPP g C / m <sup>2</sup> / yr
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## Kelp Beds

Why are kelp beds so highly productive ?

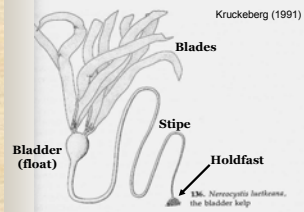
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## Kelp Beds

Why are kelp beds so highly productive ?

- 1.
- 2.
- 3.
- 4.

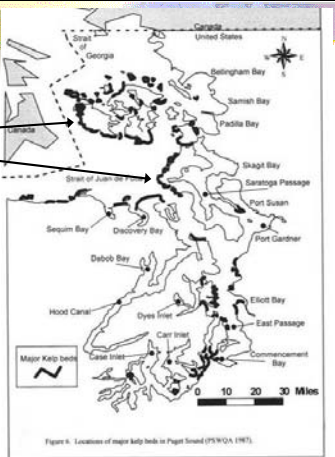


Bladder takes advantage of water's buoyancy to position blades in light



## Kelp Bed Distribution in Puget Sound & San Juan Islands

Note the greater abundance on more exposed, high-energy shorelines



## Kelp Beds (Kelp Forests)

### Bottom Line

- Kelp beds are HIGHLY productive ecosystems
- Kelp beds associated with higher energy shorelines
- Kelp beds vary in species composition and seasonal dynamics



## Eelgrass Beds

Padilla Bay

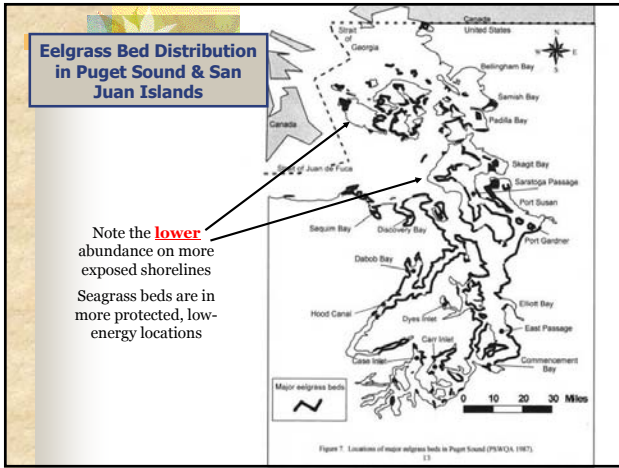


## Eelgrass Beds

Environment







### Eelgrass Beds

Eelgrass beds are also **VERY** Productive

**A) Who does the productivity?**

- Eelgrass (*Zostera marina*)  
Flowering, vascular plant  
An ecological engineer
- \_\_\_\_\_

WA Sea Grant

**B) Why are eelgrass beds so productive?**

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

### Salt Marsh

Salt marshes commonly occur in **ESTUARIES**

Quilceda Salt Marsh

Salt water ← Freshwater

Estuary: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



### Salt Marsh Ecosystem Productivity

Salt Marshes are also highly productive

#### Annual Net Primary Productivity of Ecosystems

Ecosystem Type	Mean NPP g C / m <sup>2</sup> / yr	Range of NPP g C / m <sup>2</sup> / yr
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### Salt Marshes

Salt marsh plants are unique and highly adapted to salty conditions – they are often not found outside of salt marshes

*Jaumea carnosa*

*Scirpus acutus*

*Salicornia virginica*

*Carex lyngbyei*

## Salt Marshes

High seasonal productivity supports migratory waterfowl



Snow geese  
Skagit Delta

## Salt Marshes

Salt Marsh Ecosystems are tightly coupled to the health & function of surrounding ecosystems

*Some Examples*

- 1. Sediment brought down from inland ecosystems by rivers**
  - Nutrient input
  - Determines tidal height
- 2. Detritus washed up by tides**
  - Organic matter / Nutrient input
- 3. Logs brought downstream**
  - Sites of ecosystem diversity



## Salt Marshes: Human Impacts

Severe decline in salt marsh habitat area with Euro-American colonization

1800 – 1979: 70% loss in area  
Particularly high in urban locations



WA Dept of Natural Resources (1998)

## Salt Marshes: Human Impacts

Historical loss of salt marshes through agricultural conversion



Pristine Salt Marsh in Puget Sound

Pre European Settlement:

2000:



## Salt Marshes: Human Impacts

More recent loss of salt marshes through urbanization



Ocean Shores, Grays Harbor County

WA DNR 1998

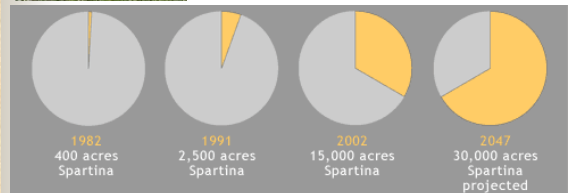
## Salt Marshes: Human Impacts

The specter of invasive species: Cordgrass as an example



*Spartina*

*Spartina alterniflora* invasion of Willapa Bay



Photos & graphics: WA Dept. of Ecology



## Salt Marshes: Human Impacts

### *Spartina* invasion of Willapa Bay



*Spartina* invasion colonizing tidal mudflats in Willapa Bay



*Spartina* invasion altering sediment transport at the mouth of a stream

Photos: WA Dept. of Ecology

## Rocky Intertidal

### Primary Productivity by a great diversity of Algae

#### Some Examples

#### Brown Algae



Fucoxanthin



#### Red Algae



#### Green Algae



Drawings from Kozloff (1993) and Sheldon (1998)

## Rocky Intertidal

### Algae (and other material) eaten by a variety of marine invertebrates

*Strongylocentrotus purpuratus*



*Notoacmea scutum*



*Balanus glandula*



*Halichondria* sp. (sponge)



*Katharina tunicata*

*Anisodoris nobilis*



*Pugettia producta*



Polychaete worm tubes



*Mytilus californicus*

LIGIA PALLASII

Drawings from Sheldon (1998)

## Rocky Intertidal

### A variety of carnivores consume the herbivores



*Anthopleura xanthogrammica*

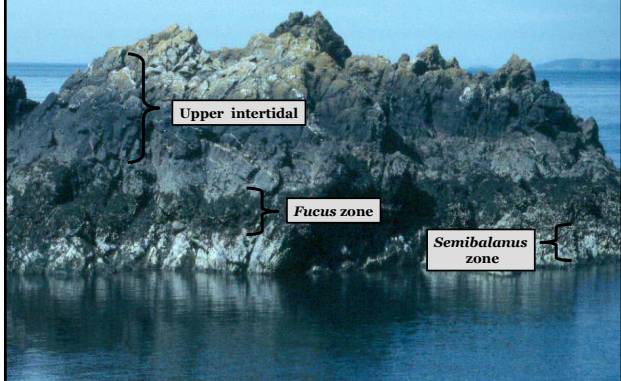


*Pisaster ochraceus*



## Rocky Intertidal

### Rocky Intertidal communities are often highly organized



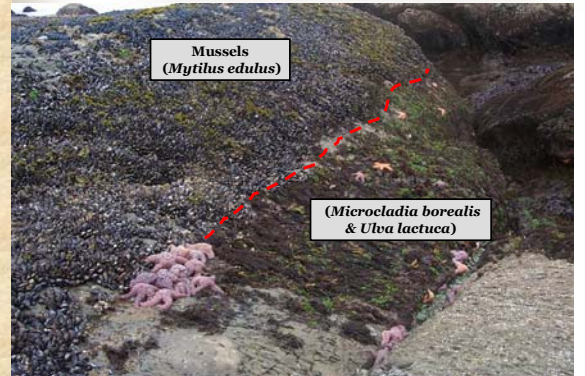
Upper intertidal

*Fucus* zone

*Semibalanus* zone

## Rocky Intertidal

## Rialto Beach



Mussels (*Mytilus edulis*)

(*Microcladia borealis* & *Ulva lactuca*)





## Coastal Bog Ecosystems



Trapped water in old coastal dune features

- 
- 
- 

## Coastal Bog Ecosystems

Sphagnum moss Bogs



Lodgepole pine (*Pinus contorta*) growing on floating mat of *Sphagnum* moss

## Coastal Bog Ecosystems

Specialized plant species found nowhere else in our region  
Evergreen leaves conserve nutrients in nutrient-poor environment



*Ledum groenlandicum*  
Labrador tea



*Kalmia potifolia*  
Bog laurel



## Coastal Bog Ecosystems

Specialized plant species found nowhere else in our region  
Carnivorous plants acquire nutrients in nutrient-poor environment

Sundew



*Drosera rotundifolia*



*Drosera intermedia*

## Coastal Bog Ecosystems: Human Impacts

Conversion to cranberry farms



## Coastal Bogs: Human Impacts

In addition to salt marshes, coastal bogs are being lost to urbanization



1967




1997

Ocean Shores, Grays Harbor County



## Sitka Spruce Forest Ecosystems

"Coastal Temperate Rain Forest"



## Sitka Spruce Forest Ecosystems

Sitka spruce (*Picea sitchensis*) Dominant coastal tree: Oregon to Alaska

**Among the 3 largest trees in WA**

- 175 – 200+ feet tall
- 8 – 16 feet in diameter

**Rapid growth: 175 ft in 100 years**

**Life span ~ 700 + years**




## Sitka Spruce Forest Ecosystems

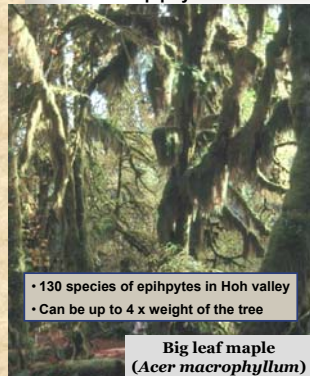
Washington's largest Sitka Spruce



WORLD'S LARGEST  
SPRUCE  
TREE  
191' TALL  
96' SPREAD  
58' AROUND  
ABOUT 1000  
YEARS OLD

## Sitka Spruce Forest Ecosystems


**Epiphytes**



- 130 species of epiphytes in Hoh valley
- Can be up to 4 x weight of the tree

**Big leaf maple**  
(*Acer macrophyllum*)

**Towering trees**



## Sitka Spruce Forest Ecosystems


### Animal Species

**Greatest vertebrate species diversity in the US except subtropical coastal areas (S California & Florida)**

~ 225 native vertebrates

But only 11% restricted to coastal rain forest ("endemic")


- 2% bird species mostly endemic
- 14% mammals endemic
- 72% amphibians endemic



Canopy complexity → species diversity

**Many vertebrate species are strongly tied to mature forest conditions** (exploiting managed forests as remnant populations)

- 56 vertebrate species use cavities of large trees
- 42 vertebrate species use woody debris



## Sitka Spruce Forest Ecosystems

### Some Representative Animal Species

Northern flying squirrel



Northern spotted owl



Black-tailed deer



Marbled Murrelet



Roosevelt Elk



