

The Northwest Shipworm

Bankia setacea (Tryon, 1865)

What is *Bankia setacea*?

What environmental factors affect its presence?

How does the Snohomish River estuary function?

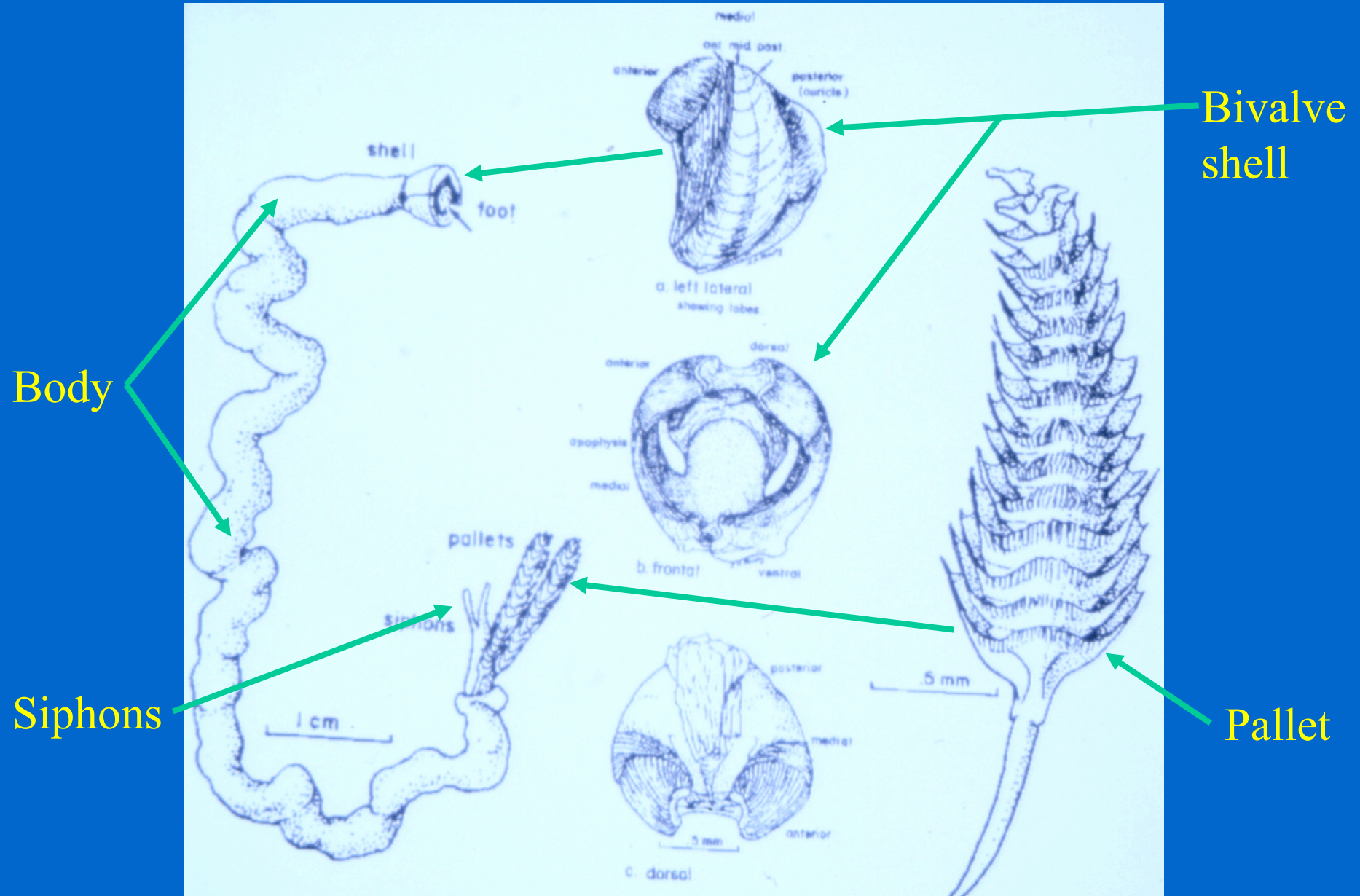
What is an “indicator species”?

Is *B. setacea* giving some indication of human impact?

1. What is *Bankia setacea*?

Northwest or Pacific Shipworm: A member of the bivalve mollusc family with a worm-like shape found boring in submerged wood in marine or only slightly brackish waters of the Pacific Coast from Alaska to San Diego. After 3-4 weeks as free swimming larvae and having reached a size of 1/100 of an inch (250 μ) they settle on submerged wood. The mature shipworm can reach a length of 3-4 feet and a maximum diameter of 1 inch within a year.

Physiology of *Bankia setacea*)

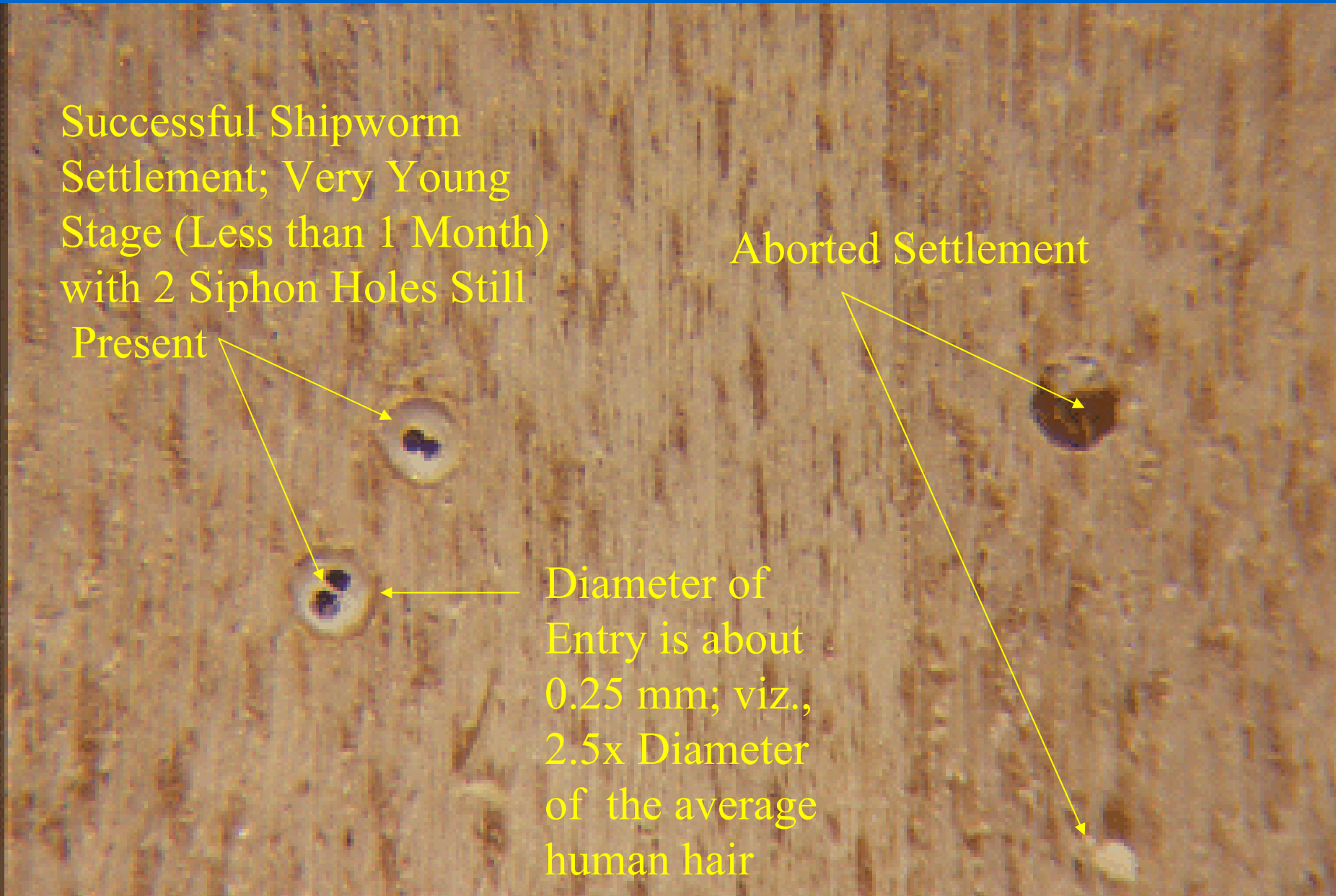


Bankia setacea Settlement

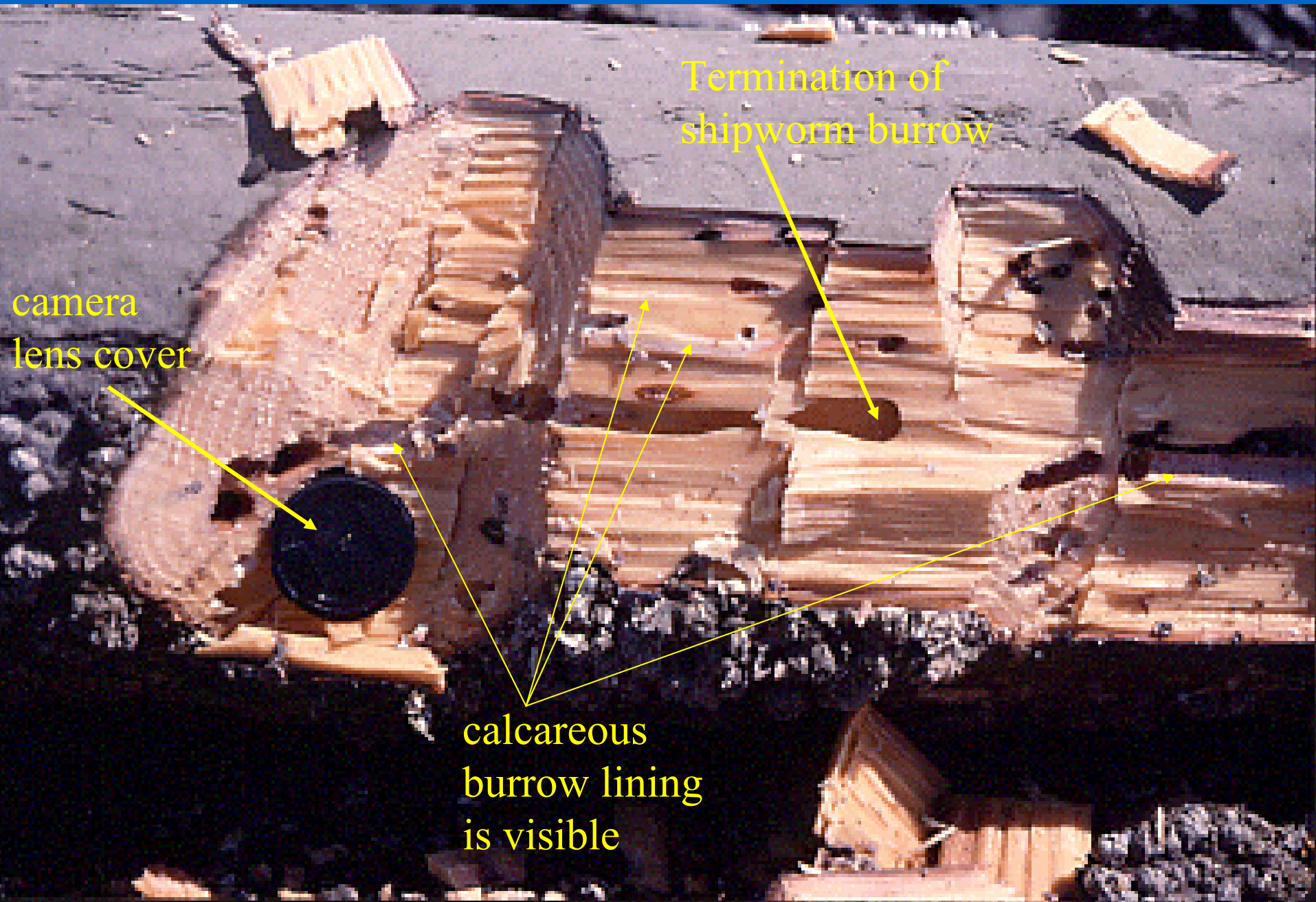
Successful Shipworm
Settlement; Very Young
Stage (Less than 1 Month)
with 2 Siphon Holes Still
Present

Aborted Settlement

Diameter of
Entry is about
0.25 mm; viz.,
2.5x Diameter
of the average
human hair



Mature Shipworm Burrows



camera
lens cover

Termination of
shipworm burrow

calcareous
burrow lining
is visible

2. What environmental factors affect its presence?

Salinity

Water Temperature

Turbidity

Veliger Density

Submerged Wood

Air Exposure of Wood

Air Temperature

Pollution

Fouling Communities

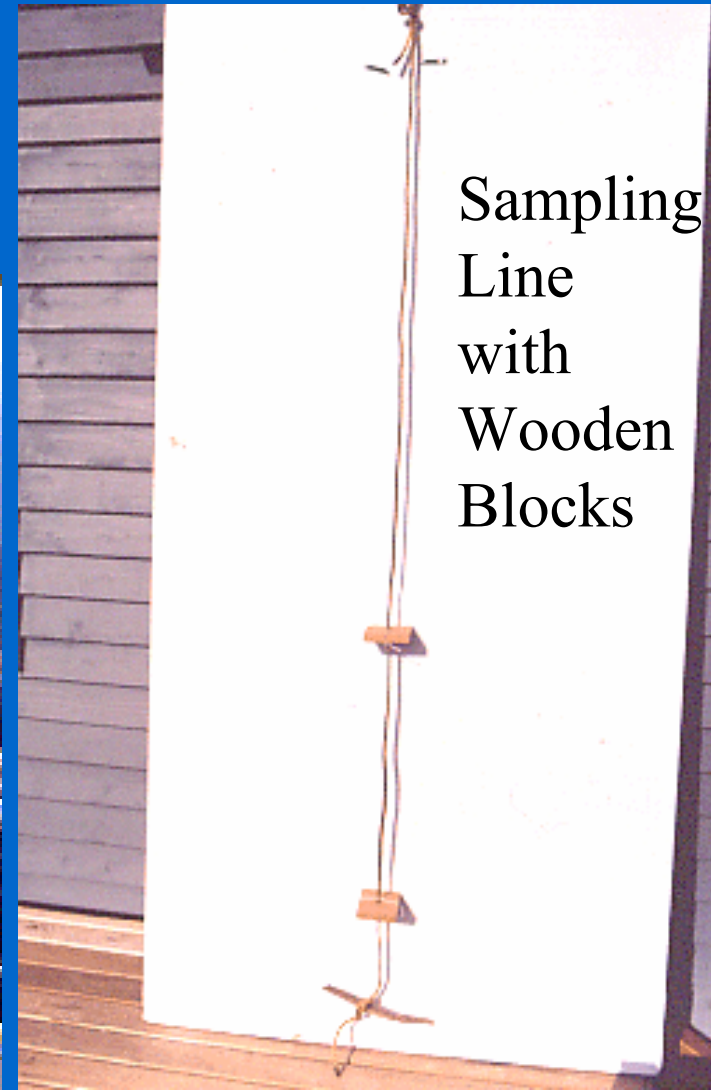
Currents

Nutrients

Halocline Formation

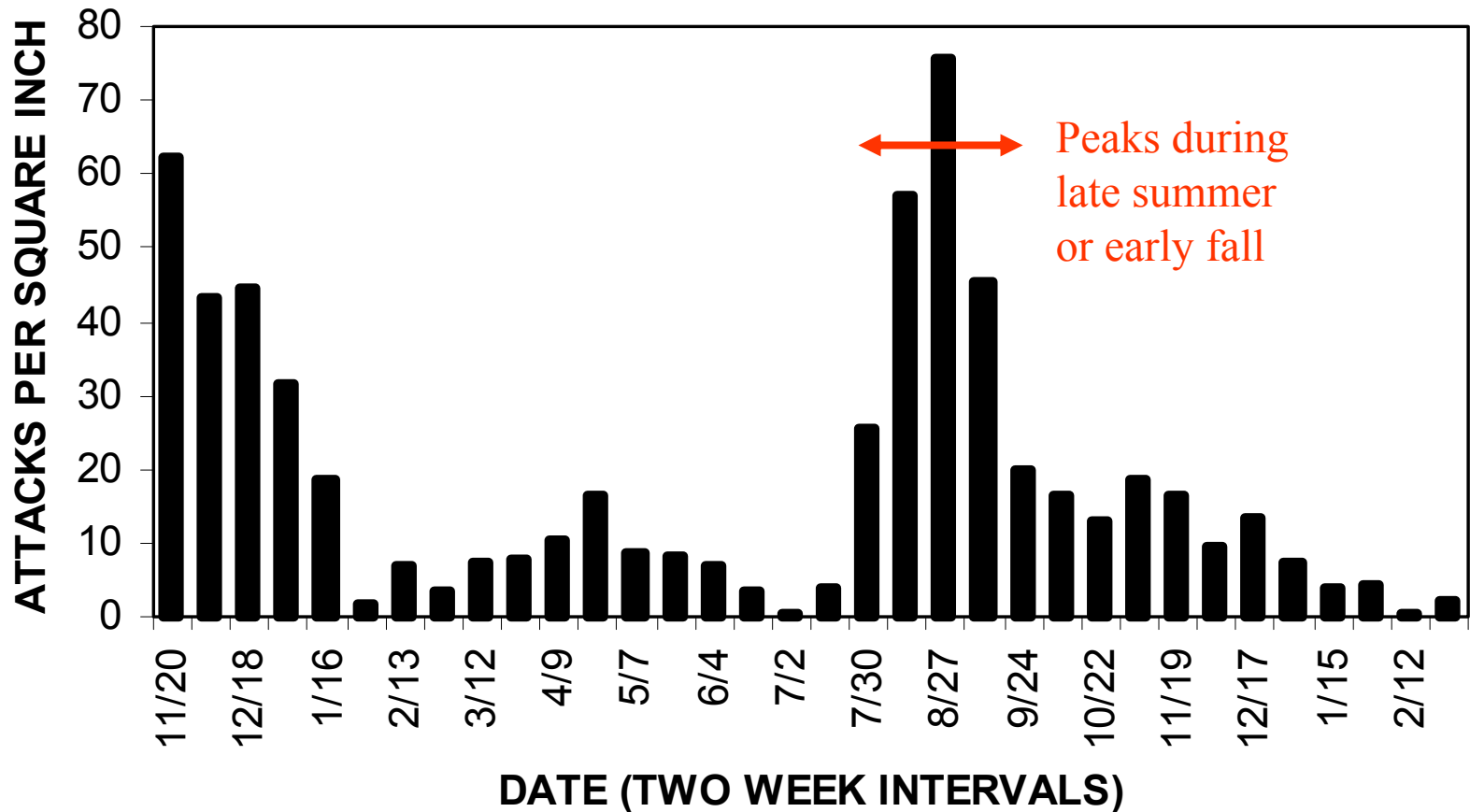
Monitoring Shipworm Settlement

Pulling the sampling lines



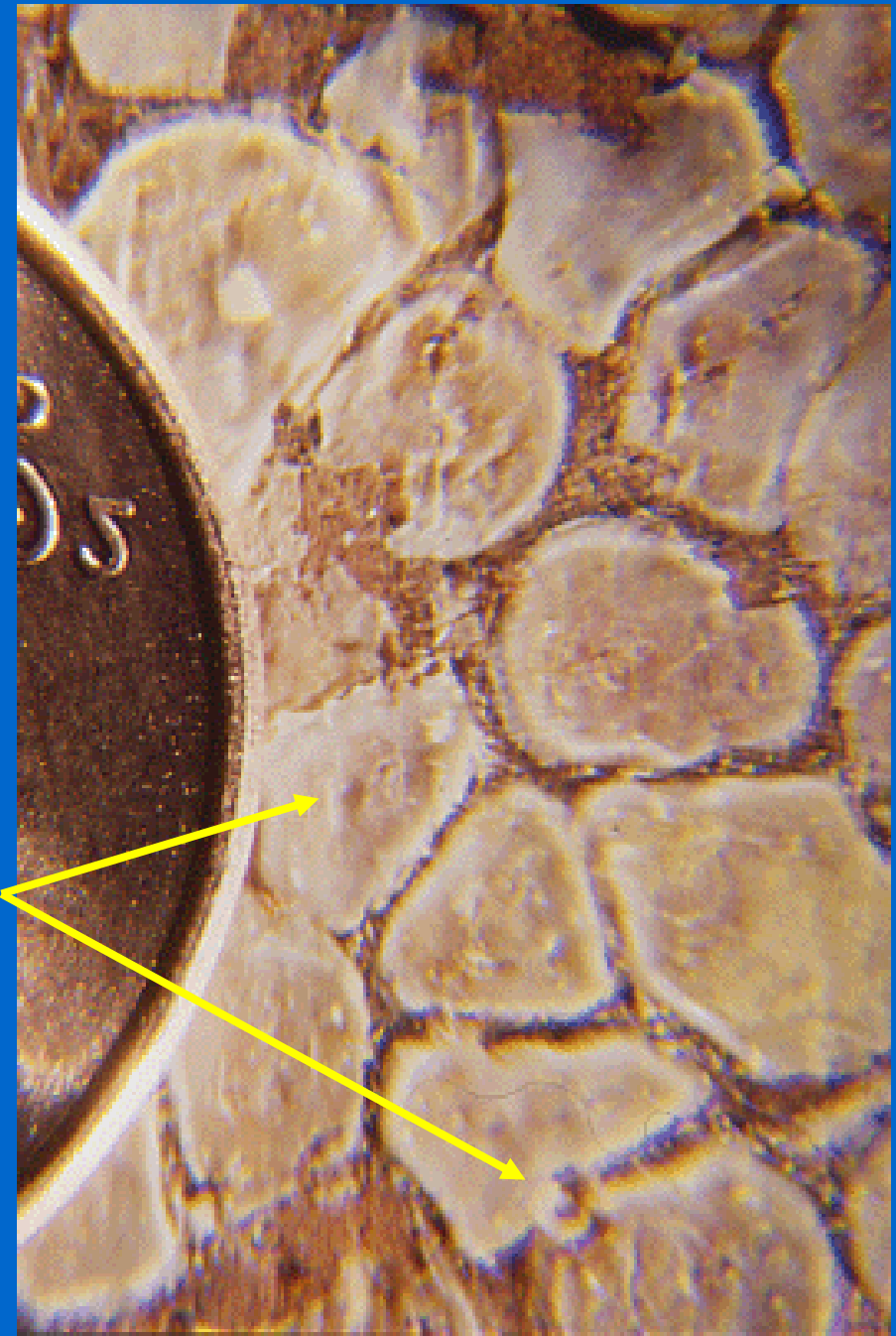
Marine Water Settlement Data

***BANKIA SETACEA* SETTLEMENT PORT GARDNER MARINE WATERS**

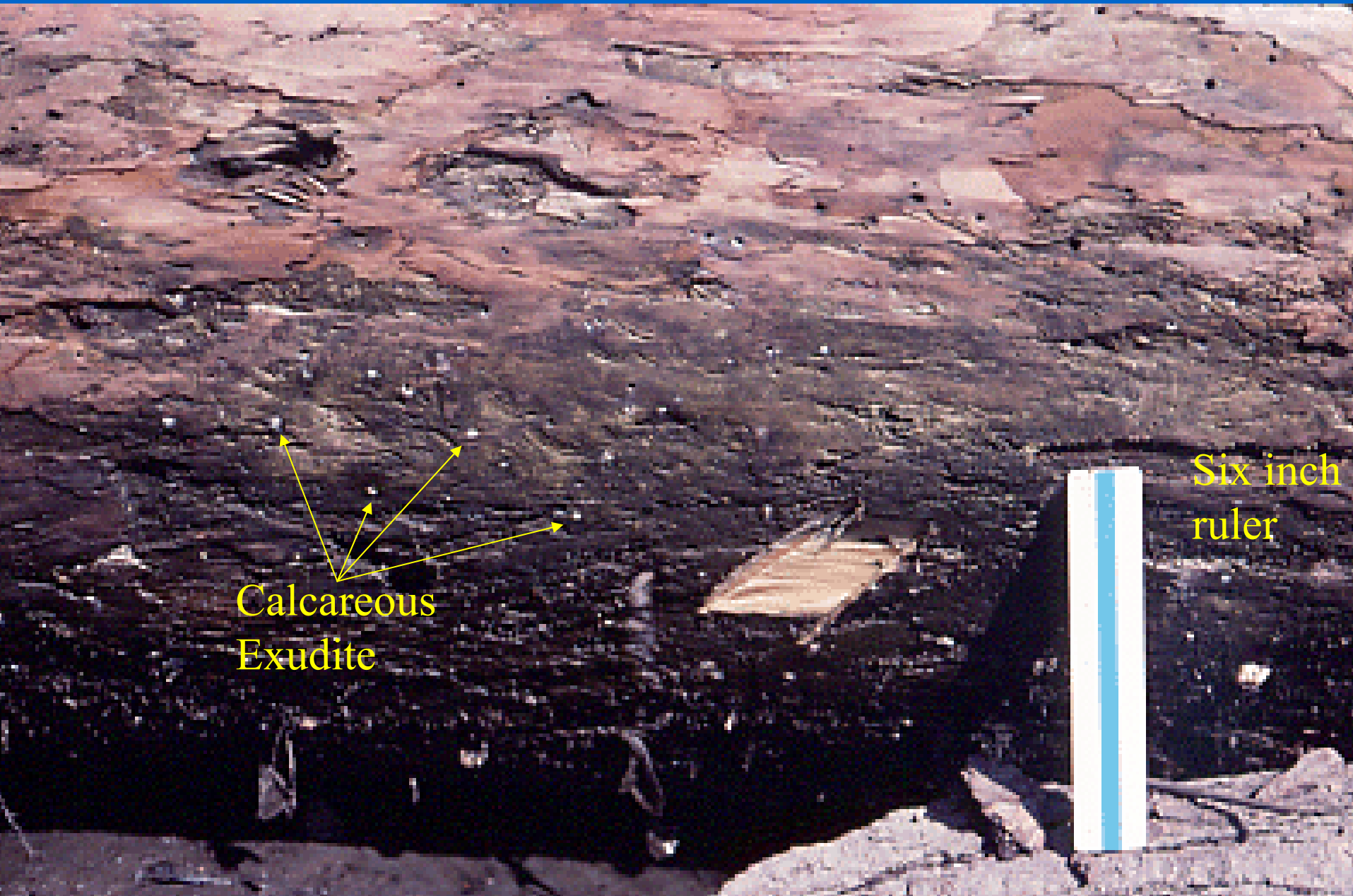


Barnacle Fouling

Calcium “footprints” of Barnacles on wood substrate. Penny indicates the scale. Arrows show shipworms that have been overlaid by barnacle settlement.



Shipworm Dying Due to Fresh Water



Calcareous
Exudite

Six inch
ruler

Log Rafts at Low Tide

Exposure to Air

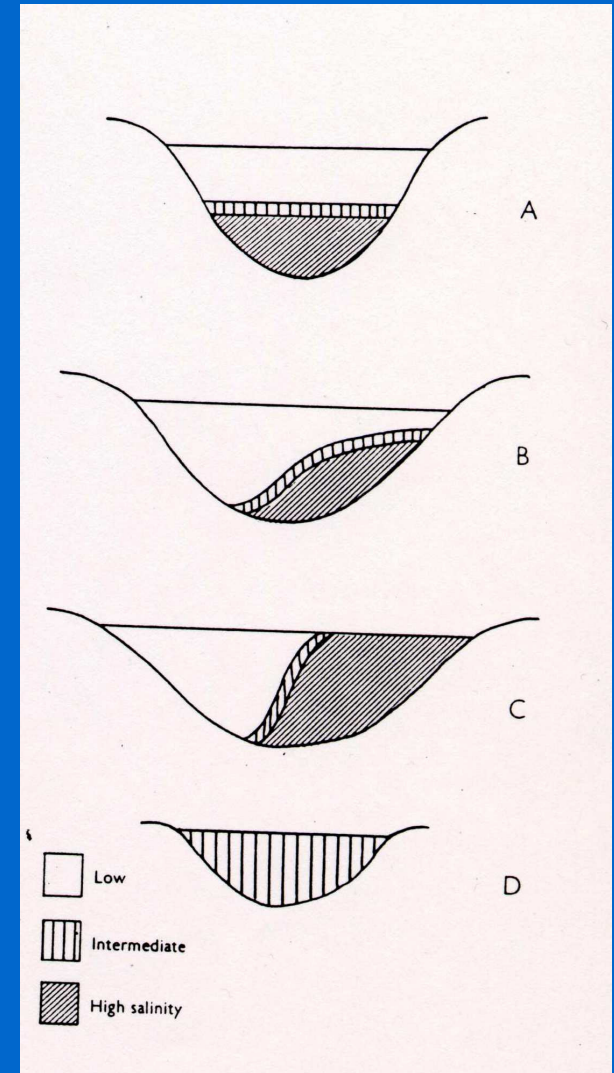


Any location above
MLLW (0.0 ft level)
is safe from *B. setacea*

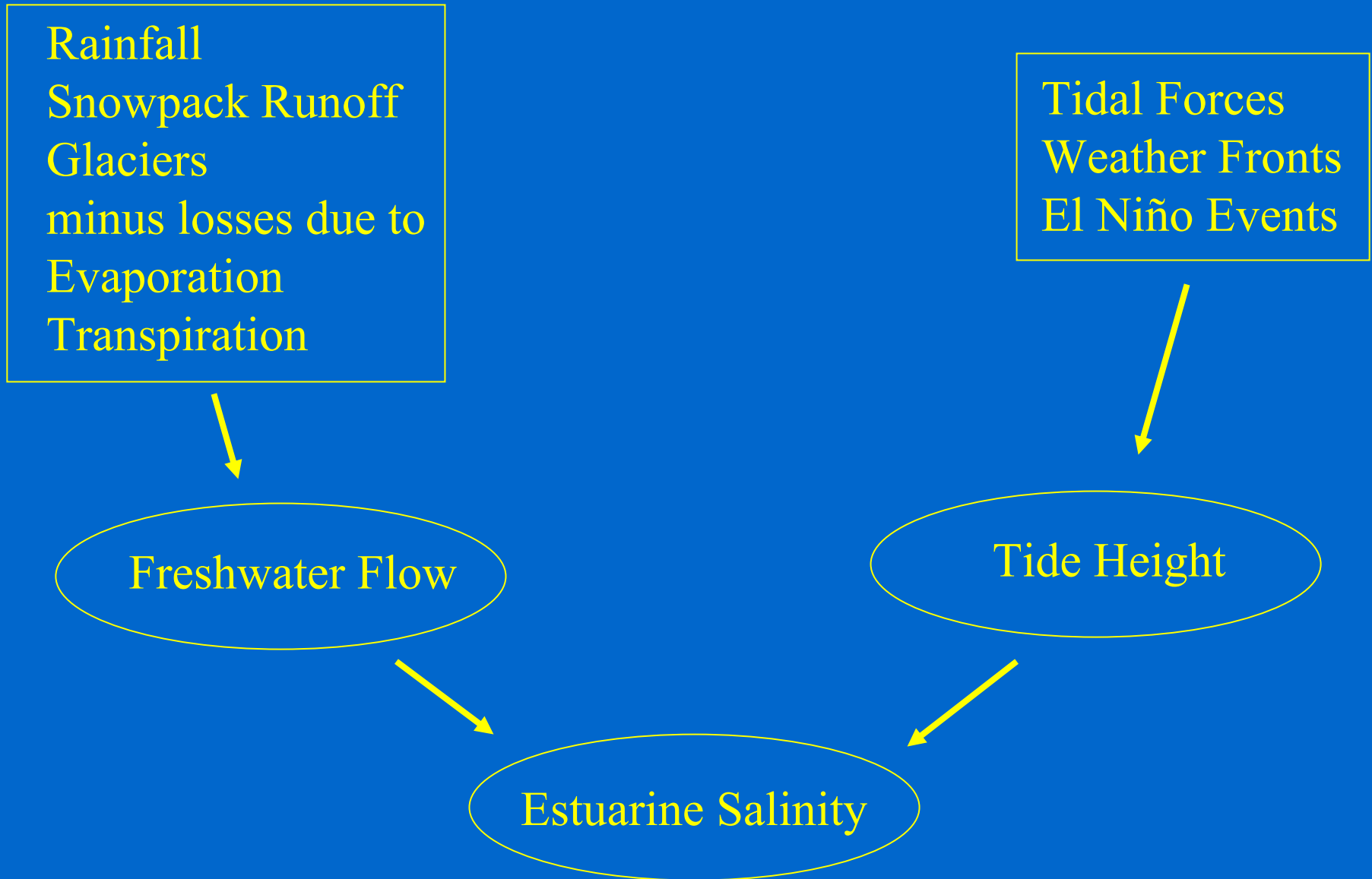
3. How does the Snohomish River estuary function?

Estuary Types

The type of estuary may change from “A” to “D” with changes in the river conditions such as: **decreasing flow**, increasing tidal velocity, increasing width, and decreasing depth. These changes may occur due to seasonal variations in river flow.



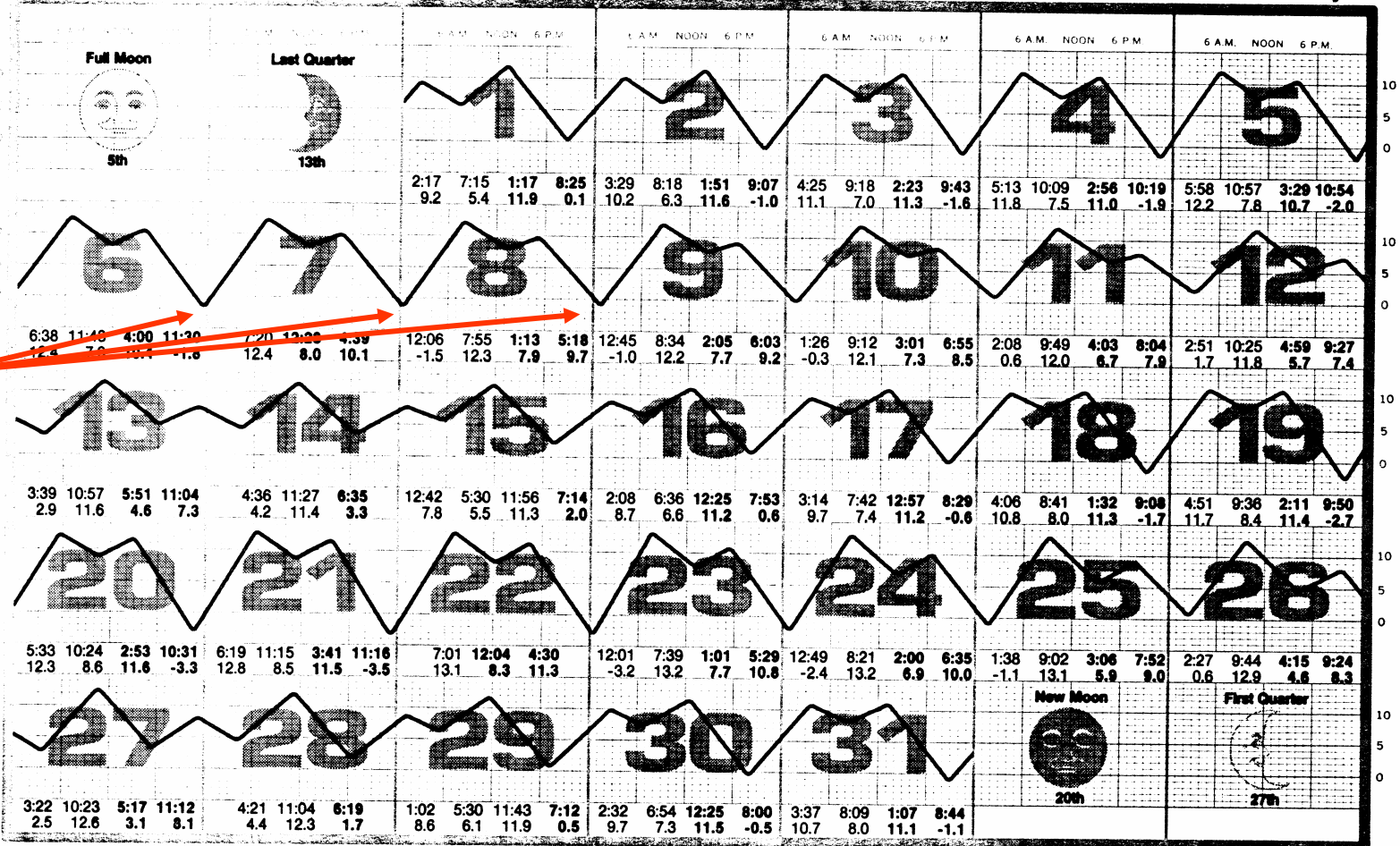
Estuarine Salinity



Predicted Tidal Levels*

december 1987

sunday monday tuesday wednesday thursday friday saturday



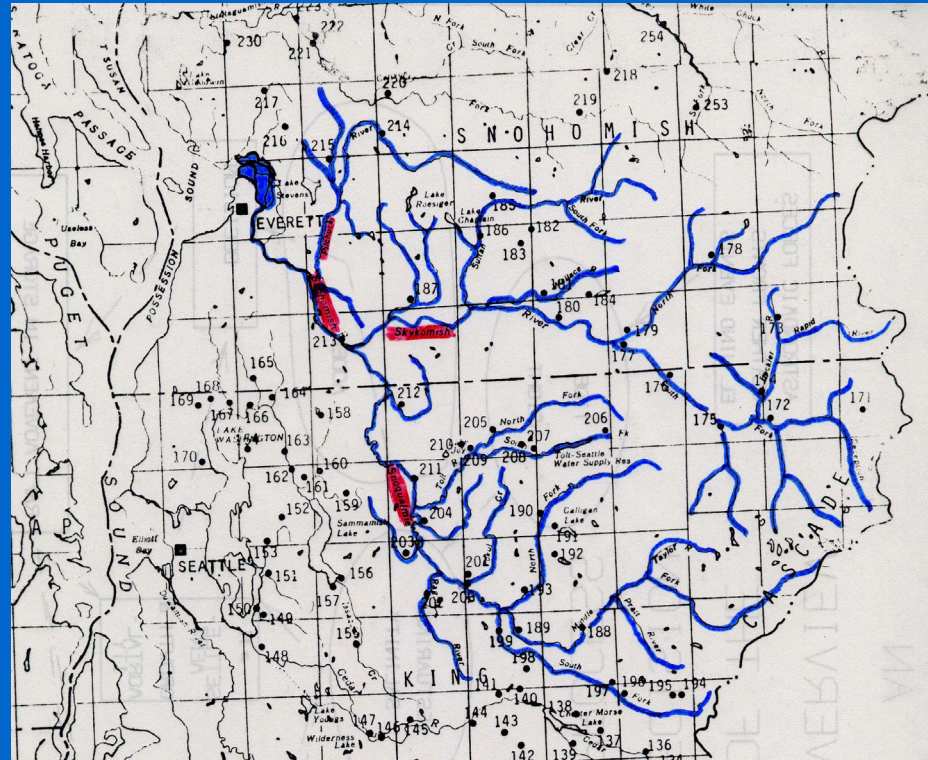
SEATTLE TIDES - CORRECTED FOR DAYLIGHT SAVING TIME

* Not the same as observed tidal levels.

Lower
Low
Water,
LLW

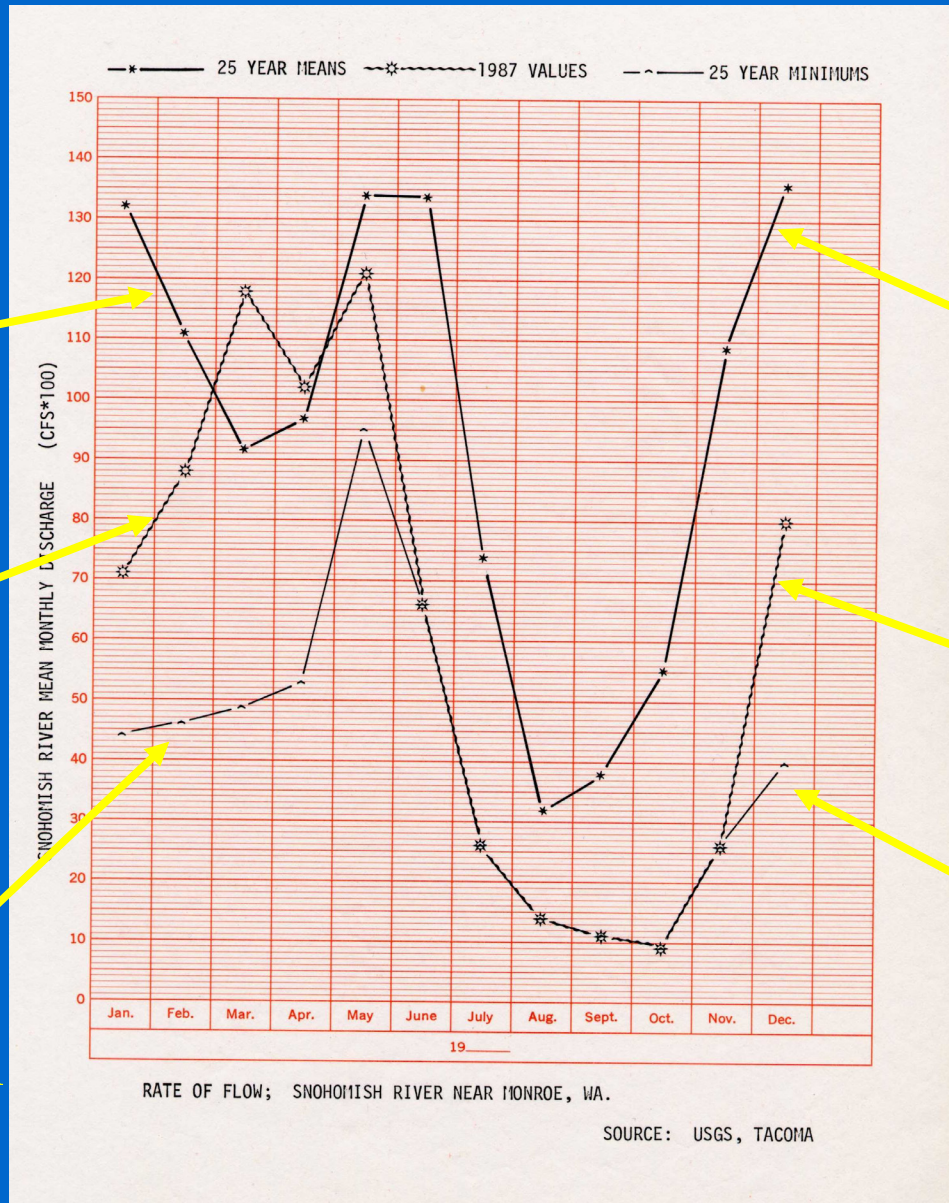
Snohomish River Basin

Runoff is an Integrator of Environmental Conditions



Drains 1500 square miles with only minor removals for city water and irrigation. Limited regulation at Spada Lake and Snoqualmie Falls. Major tributaries include the Pilchuck, Snoqualmie and Skykomish Rivers. USGS

Snohomish River Flow Record



25 year mean

1987 value

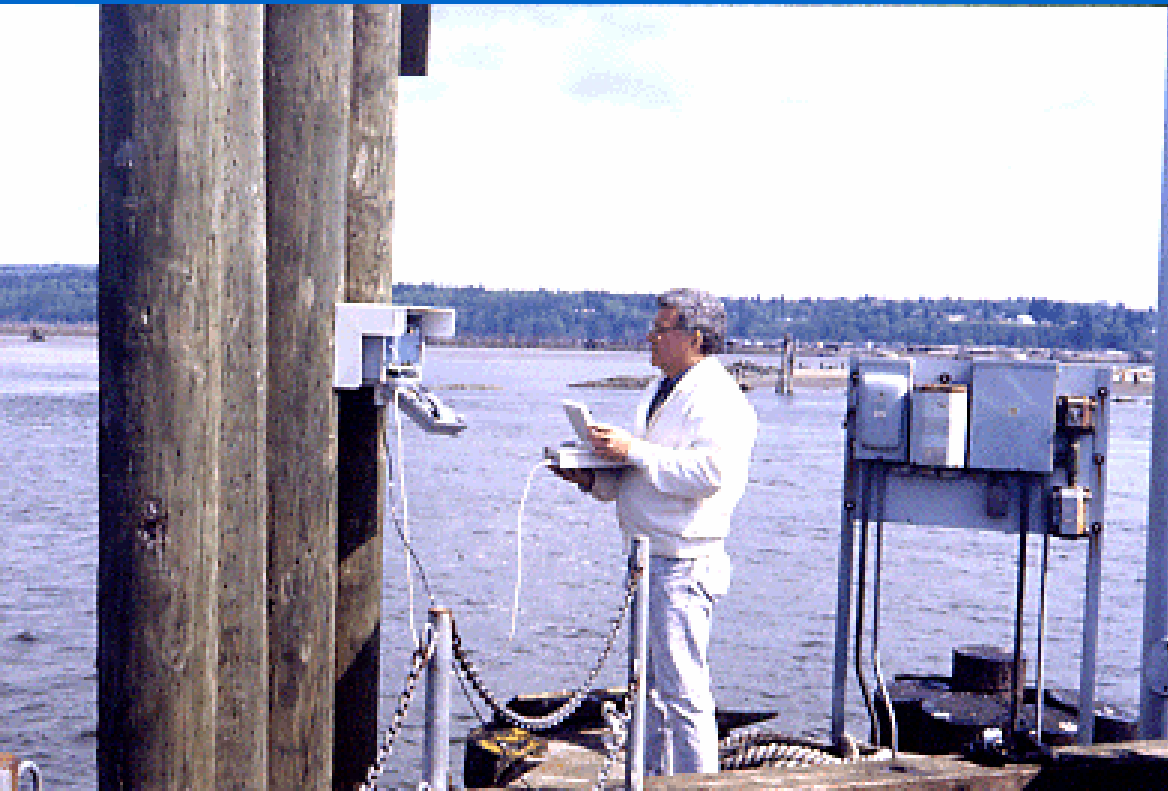
25 year minimum

25 year mean

1987 value

25 year minimum

Salt Water Intrusion Monitoring

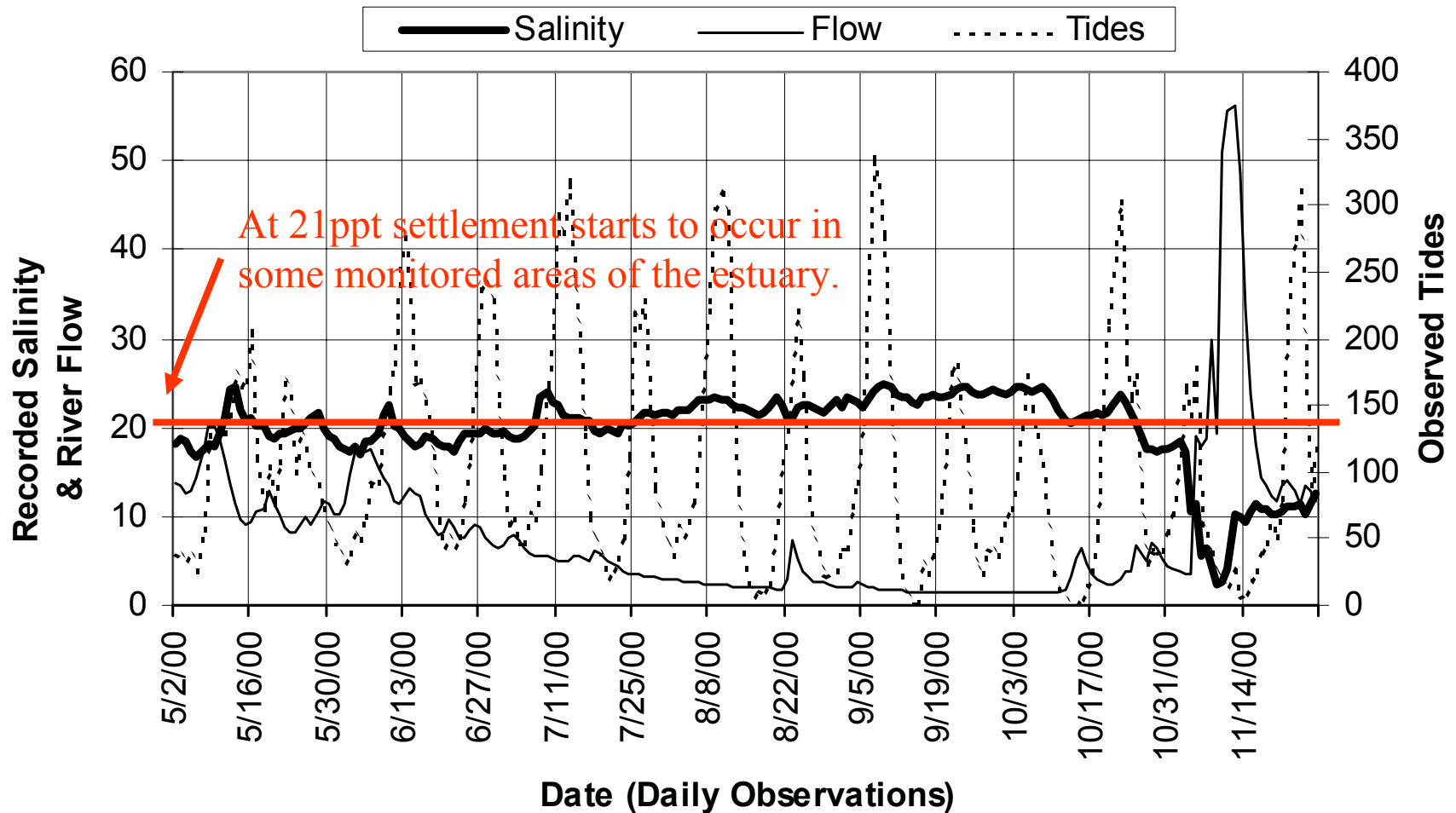


Down Loading
the Electronic
Data Logger

Estuary Salinity - Factor Interactions

1989 Estuary Data

Average Oceanic Salinity is 35 ppt
Puget Sound Salinity varies, ~ 32 ppt



Salinity Model

$$S_t = b_0 + b_1 F_{t-2} + b_2 F_{t-2}^2 + b_3 M_t^4$$

- S: (parts per thousand) average salinity for the indicated day
- F: (cubic feet per second) average flow for the indicated day
- M: product of the average high and average low tide for the day

4. What is an “indicator species”?

A quick search of the internet resulted in three definitions. There are some subtle differences but there is a common idea found in all three: **perceptible response to environmental change.**

Indicator Species

First Definition

"A species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem; **taxa that are sensitive to environmental conditions and which can therefore be used to assess environmental quality.**"

Source: FishBase; <http://www.fishbase.org/home.htm>

Indicator Species

Second Definition

"A species whose presence in a certain location or situation at a given population level indicates a particular environmental condition. Their population changes are believed to indicate effects of management activities on a number of other species or water quality."

Source: USFS, Eastern Region; <http://www.fs.fed.us/r9/>

Indicator Species

Third Definition

"An organism that indicates the presence or absence of any particular factor, e.g. fecal coliforms are used as an indicator species for the presence of disease causing organisms in drinking water."

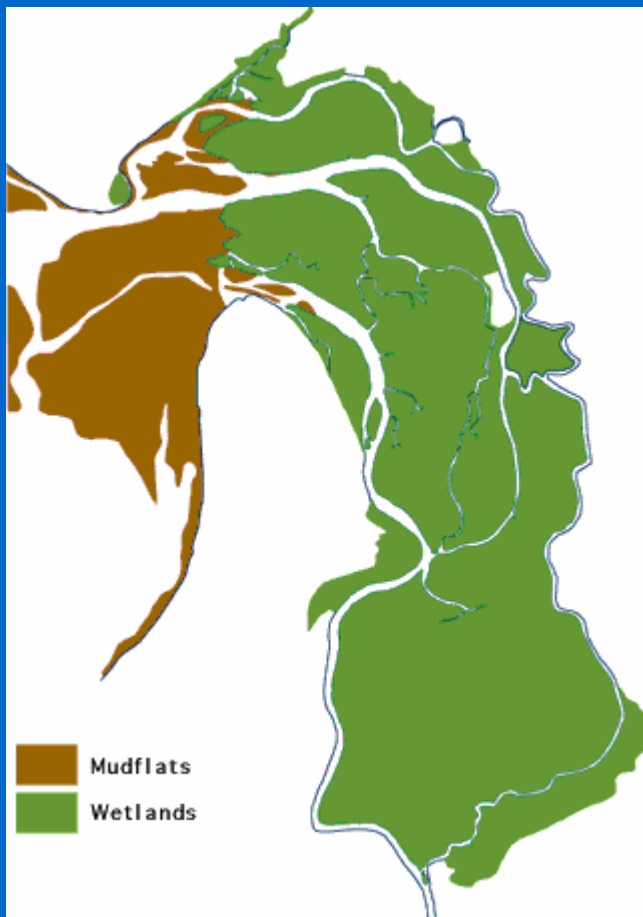
Manitoba Conservation; <http://www.gov.mb.ca/environ/>

5. Is *B. setacea* giving some indication of human impact?

There is some evidence that *B. setacea* was of limited historical occurrence in the estuary. Pollution from the pulp mills along the river seems to have further restricted its occurrence until mill effluent was cleaned up in the late 1970's. Serious shipworm infestations were noted starting in the 1980's. Why are these infestations now being observed in areas historically shipworm-free?

The Snohomish Delta: A Dramatically Changing Landscape

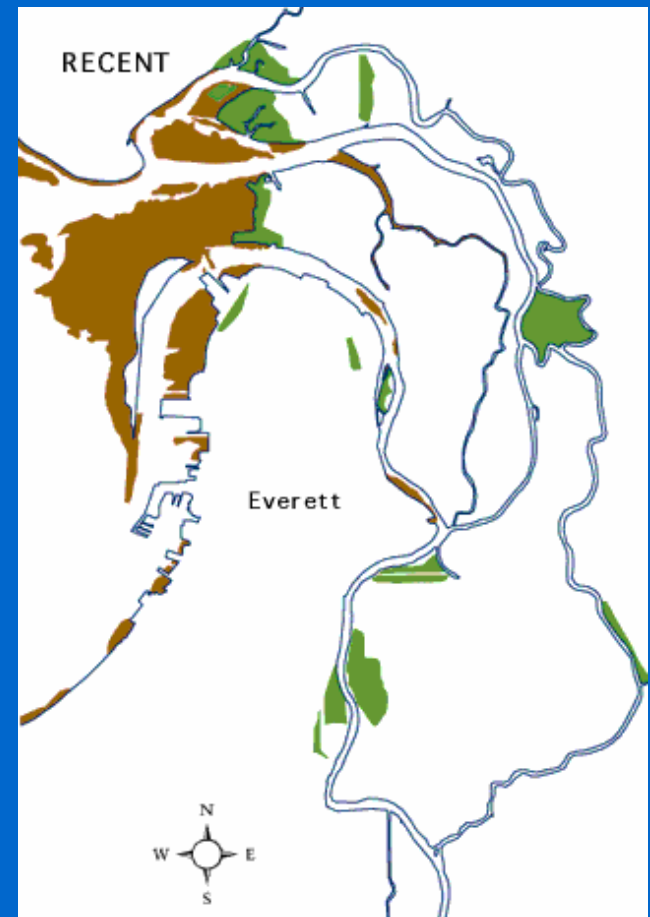
Floodplan Area



“In 1884-85, virtually the entire Snohomish delta was wetland, totaling 15 square miles.”

People For Puget Sound

Channelization & Dredging



Urbanization



Accelerated Runoff



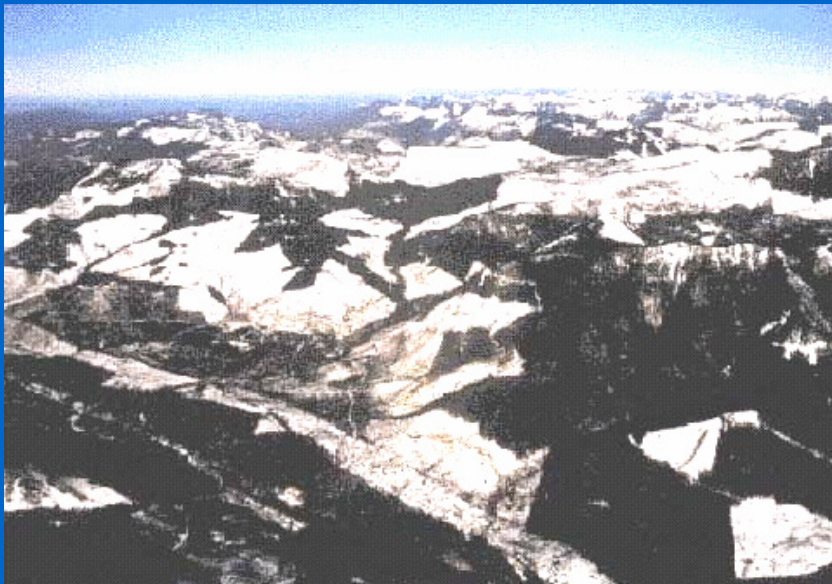
Timber Harvesting



Clearcut



Selection Cut



Forest Coverage

Changes in runoff quantity and timing

“Increases in annual water yield in small experimental watersheds in the region have ranged up to 600 mm (24 in) after entire watersheds were logged and up to 300 mm in watersheds that were 25 to 30 percent logged. Most of the increase has occurred during the fall-winter rainy season.”

Dennis Harr, “Potential for augmenting water yield through forest practices in western Washington and western Oregon, Am. Water Res. Assoc.

Global Changes

If local changes such as channelization, urbanization and forest harvesting do not appear to be implicated in late summer and early fall *B. setacea* settlement are there some global factors that might be operating?

Sea Level Variation

Superimposed on glacial rebound and tectonic subduction are interannual variations due to **oceanic temperature variation** (the 1982-83 El Niño increased local levels by up to 30 cm).

Interannual variation in atmospheric pressure and wind forcing also cause large sea level changes, particularly in the winter.

Harold Mofjeld, “Long-term trends and interannual variations of sea level in the Pacific Northwestern region of the United States” NOAA Report.

Glacial Recession

“Since 1977, **warmer, drier climatic conditions** have prevailed in the North Cascades, resulting in the retreat of 42 of the 47 glaciers examined.”

Mauri Pelto, “The annual balance of North Cascade glaciers, Washington, U.S.A., measured and predicted using an activity-index method” J.of Glaciology.

The Mountain Snowpack

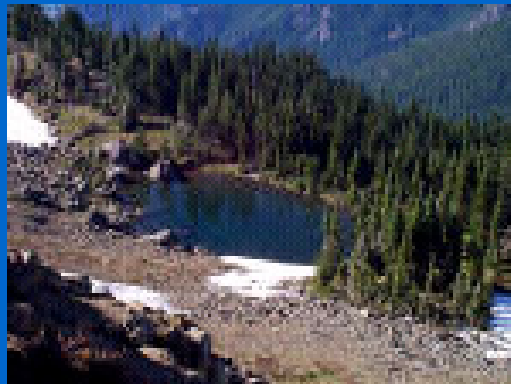


Winter



Early Spring

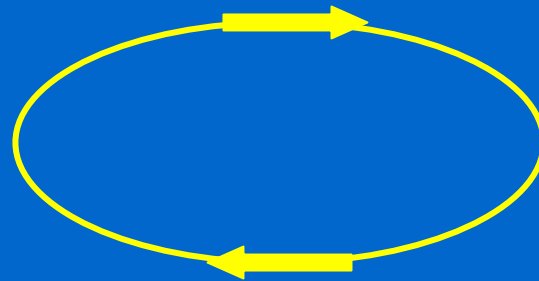
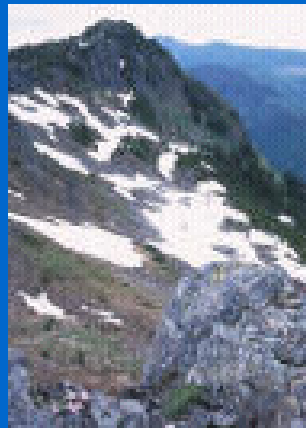
Late Summer



Spring



Early Summer



Snowmelt: Quantity & Timing



Higher average winter temperatures mean that the amount of water storage as snow in the Cascades will decrease leading to reduced late summer flow from snowmelt.

Global Warming?

B. setacea has expanded its occurrence within the estuary and thereby appears to be indicating significant habitat modification due to changing environmental factors.

The movement of *B. setacea* into previously unoccupied areas of the estuary appears to be following increases in late summer salinity in these same areas.

This increased salinity is attributed to lower freshwater flow in the late summer and some indication of higher salt-water tides.

Realistic mechanisms can be hypothesized to explain reduced summer flow in the Snohomish and the occurrence of higher tides.