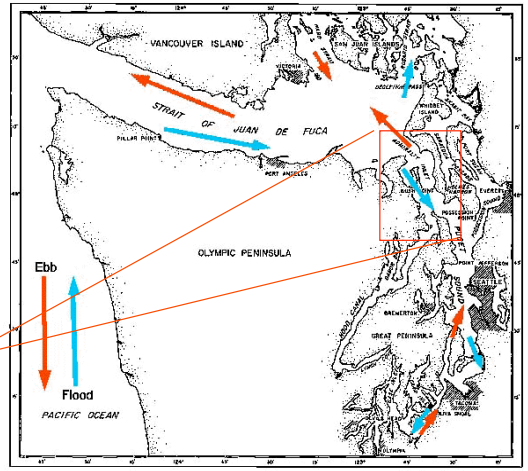
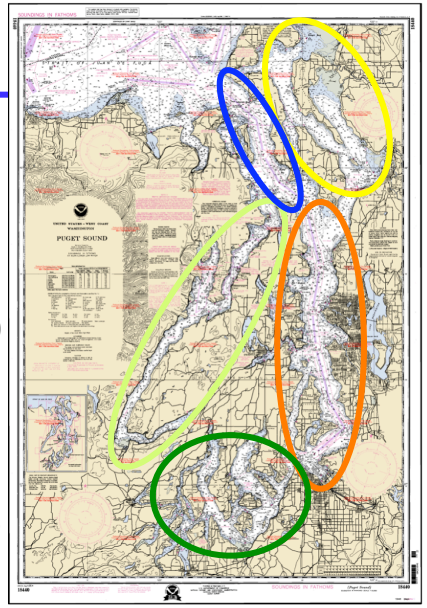
Tidal Currents in Puget Sound

- Flood from Pacific and hugs S shore of Juan de Fuca Strait
  - Coriolis effect
    - Ebb hugs N shore
- Zoom in on Admiralty Inlet below



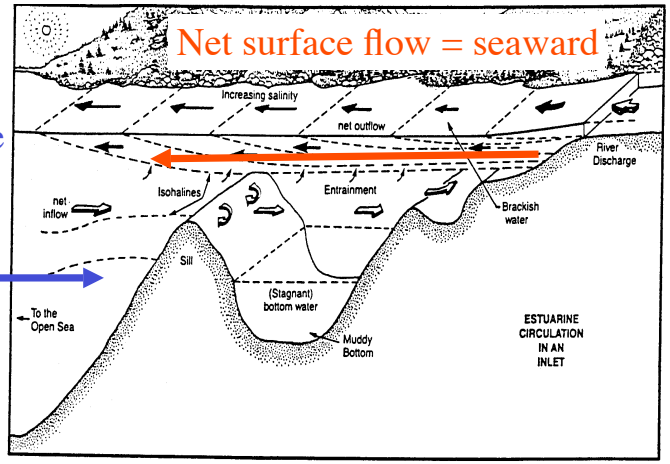
Puget Sound

- One big estuary
  - Surface salinity away from rivers 26-29 g/kg
    - Near rivers brackish, salinity <10 g/kg
  - Subsurface salinity 30 -31 g/kg depending on season
    - Inflowing ocean water salinity ~32
- Many small estuaries

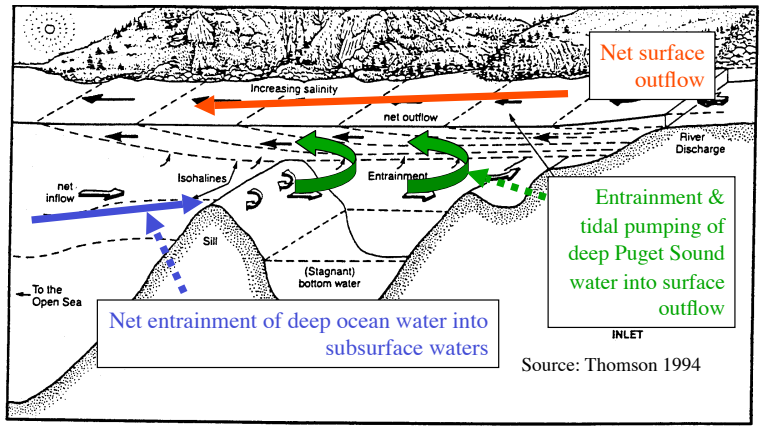


Net Puget Sound Circulation

Net subsurface flow = landward



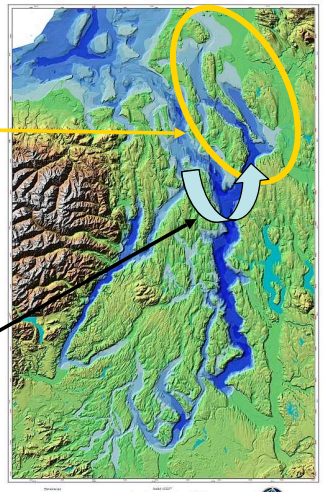
Net Puget Sound Circulation



Source: Thomson 1994

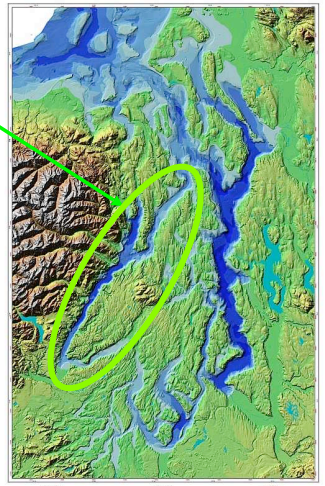
Puget Sound Sub-Basins

- Whidbey Basin
  - No sill
  - 2/3 of all the fresh water that enters the Sound
    - Skagit, Stillaguamish, Snohomish Rivers
  - Strong stratification
  - Weak tidal mixing
    - Tides must make hairpin turn at south end of Whidbey Island
  - Salt Wedge



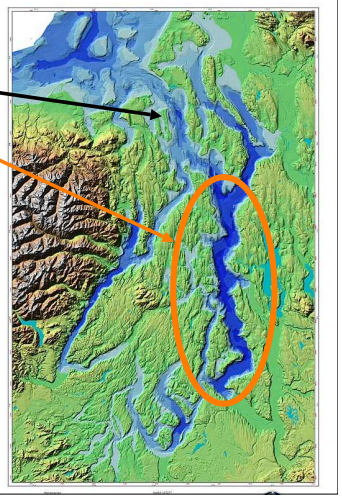
Puget Sound Sub-Basins

- Hood Canal
  - Sill under floating bridge
  - Long, narrow, deep
  - Thin layer of low-salinity water at surface
  - Strong stratifcation
  - Weak mixing
  - Fjord



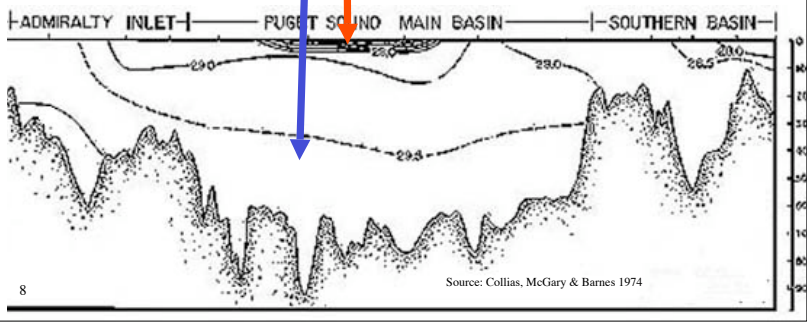
Puget Sound Sub-Basins

- Main Basin
  - Sill at Admiralty Inlet
  - Long, deep
  - Not so narrow
  - Moderate tidal mixing
  - Moderate stratification
  - Broad halocline
  - Partially mixed



Main Basin Stratification

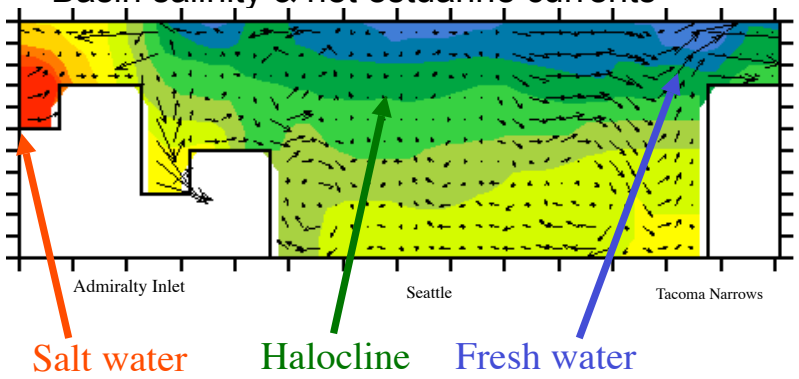
- Low-salinity (<26 g/kg) water in surface layer
  - Upper 50 meters
- Higher-salinity (<29 g/kg) water in subsurface layer



Source: Collias, McGary & Barnes 1974

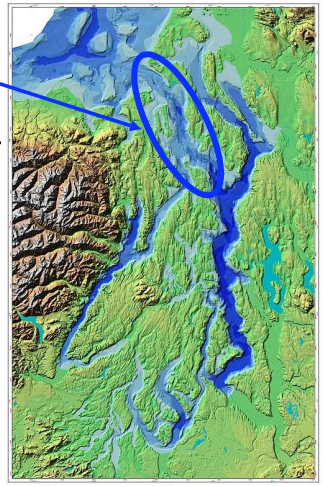
Main Basin Stratification

- Schematic time series animation of Main Basin salinity & net estuarine currents



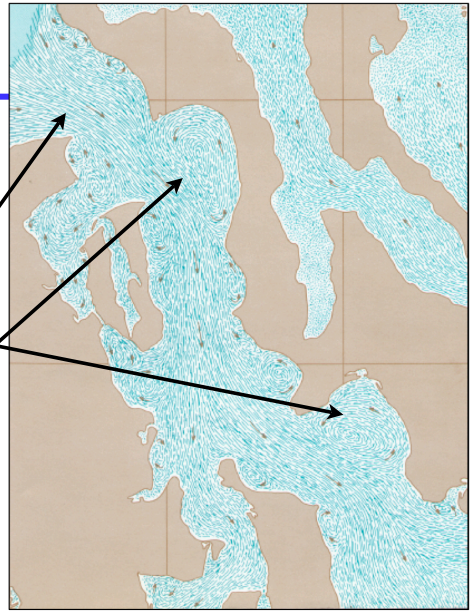
Puget Sound Sub-Basins

- Admiralty Inlet
  - (also Tacoma Narrows, etc.)
- Sill zone
  - Shallow, rough bottom topogr
  - Fast currents, strong vertical
  - Weak stratification
  - Well mixed



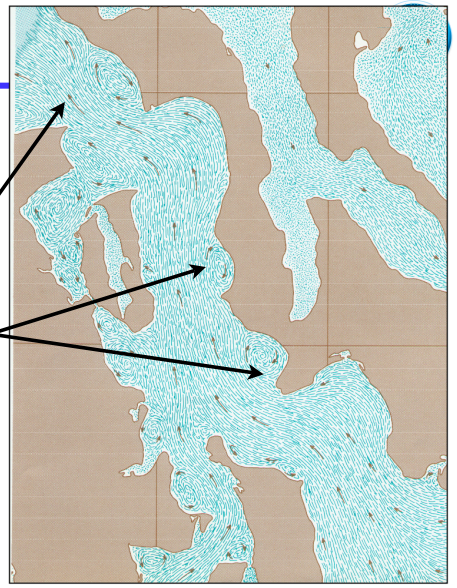
Admiralty Inlet

- Entrance to Puget Sound from Juan de Fuca Strait
  - Flood reaches 4+ knots
  - Eddies form along irregular shoreline
  - From “Tide Prints” by McGary & Lincoln 1977



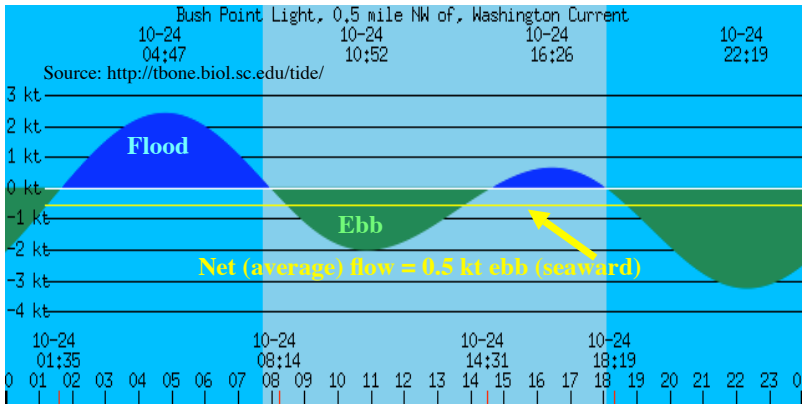
Admiralty Inlet

- Entrance to Puget Sound from Juan de Fuca Strait
  - Ebb reaches 4+ knots
  - Eddies form along irregular shoreline
  - Drawn from Puget Sound model
    - Ocean lab
    - Pacific Science Center



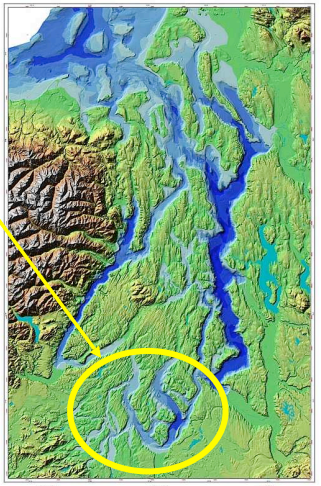
Admiralty Inlet Currents

- Well-mixed = net seaward (ebb) flow



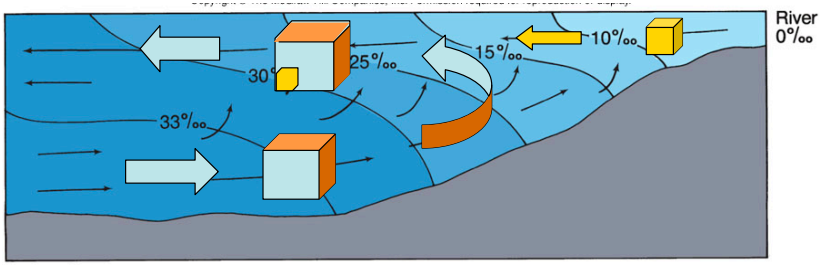
Puget Sound Sub-Basins

- South Sound
  - Sill at Tacoma Narrows
  - Nisqually River
  - Numerous inlets, channels & small streams
  - Generally weak tidal mixing
  - Difficult to categorize as a whole
    - Areas of salt wedge, well-mixed, partially mixed



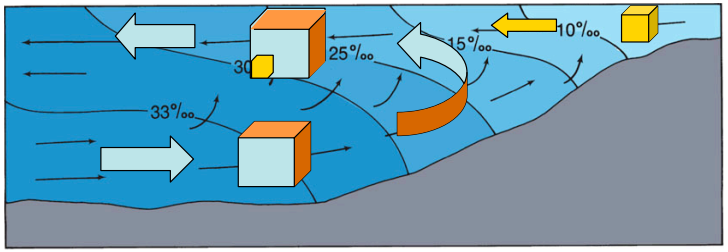
Flushing in Estuaries

- Gradual replacement of water in estuary
  - Inflowing river & ocean waters flushed to sea
  - Removes pollutants, replaces nutrients & O_2



Flushing in Estuaries

- Flushing rate = time to 100% replace volume
  - (Inter)tidal prism P = average volume entering & leaving over tidal cycle
  - Average volume of estuary V ÷ tidal prism P = # tidal cycles to flush total volume of estuary



Flushing in Estuaries

- Why care about flushing rate?
  - Removes pollutants from estuary to ocean
  - Replenishes oxygen in deep water
- Poor flushing
  - Buildup of pollutants
  - Fish die of low oxygen

Wednesday, September 20, 2006

Hood Canal fish suffocate

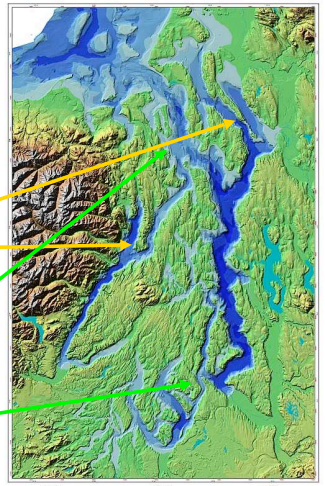
Humans could play part in low oxygen levels

By ROBERT McCLURE
P-I REPORTER

Scientists are scrambling to document what appears to be the most widespread fish kill to date in Hood Canal, the deep and poorly flushed waterway that researchers say suffers from oxygen levels at their lowest ebb in at least five decades.

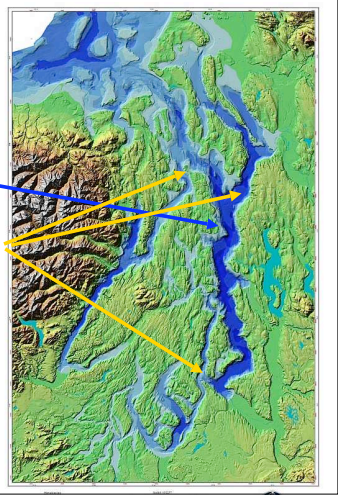
Puget Sound Basin Flushing

- Estuary type is related to flushing
  - Strong stratification, weak mixing
    - = Poor flushing
    - Salt Wedge (Whidbey Basin)
    - Fjord (Hood Canal)
  - Weak stratification, strong mixing
    - Well mixed = Good flushing
    - Tacoma Narrows
    - Admiralty Inlet



Puget Sound Basin Flushing

- Moderately stratification. moderate mixing
  - = Very well flushed
  - Main Basin
- Basins are connected
  - Whidbey, Hood Canal, South Sound connect to ocean via Main Basin & Juan de Fuca
  - Longer flushing time than one large basin
    - Must flush through Main Basin to reach ocean



Puget Sound Basin Flushing

- Hood Canal dead zone
  - Caused in part by human sewage disposal
  - Malfunctioning septic tanks
  - Very slow flushing time = 1 year or longer
- Main Basin: so far, so good
  - Receives (treated) sewage of 2.5 million people
  - Fast flushing time = 1–3 months
- New sewage discharge planned for Edmonds
  - Keep it out of the Whidbey Basin
    - Potential for another Hood Canal
    - Strong stratification, poor flushing

Puget Sound Basin Flushing

- Keep sewage discharge out of Whidbey Basin
  - Well-mixed Admiralty Inlet likely path of discharge from Edmonds site
    - Weak tidal flushing in Whidbey Basin