

Biology of Marine Life

Ninth Edition

James L. Sumich | John F. Morrissey



Chapter 7 Estuaries

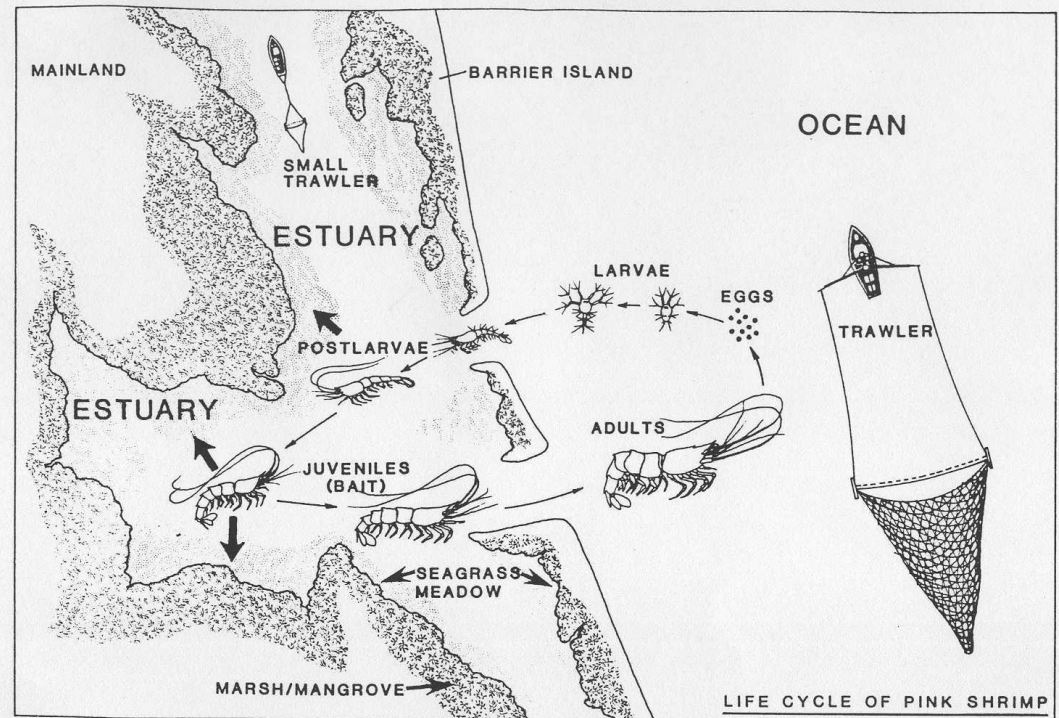
Where fresh water meets the sea



Properties of Estuaries

1. Fragile
2. Productive – rival coral reefs & rain forests!
3. Variable
4. Provide habitat – many species use estuaries as a nursery

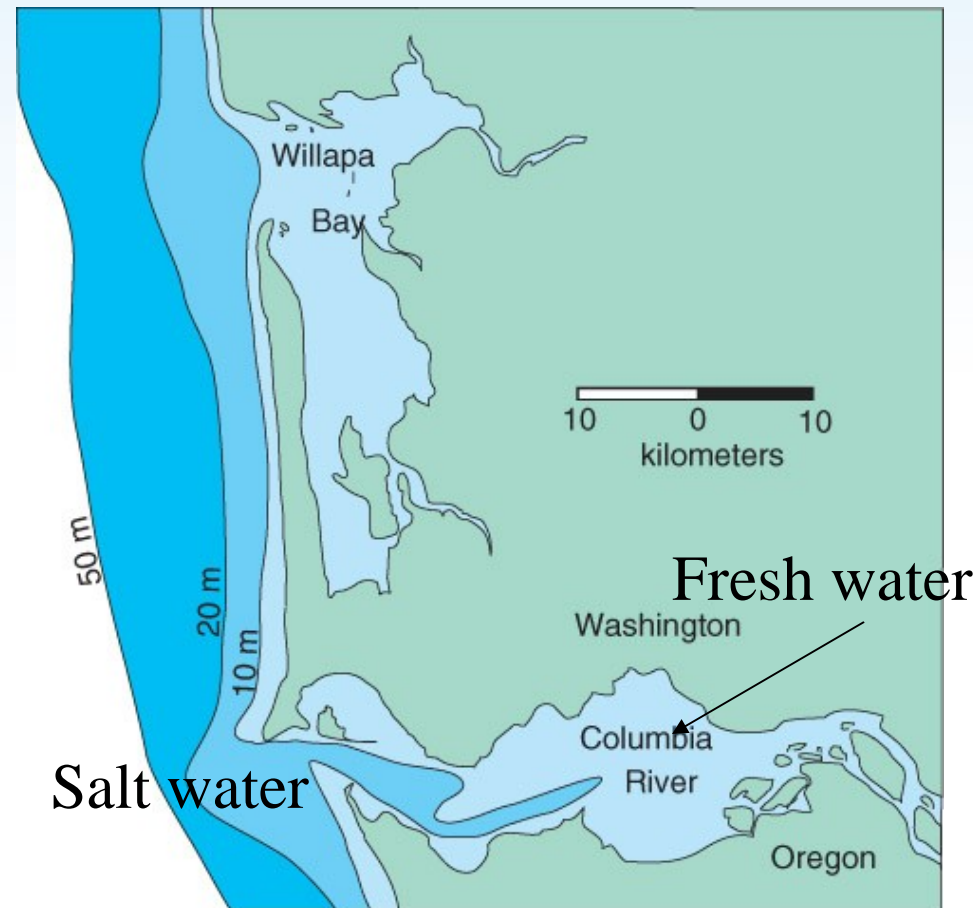
Why do you think this is?



Types of Estuaries

Estuaries are classified both by their modes of formation and by their patterns of water circulation:

- 🐟 Coastal plain estuaries
- 🐟 Bar-built estuaries
- 🐟 Deltas
- 🐟 Tectonic estuaries
- 🐟 Fjords



Types of Estuaries

Coastal Plain



Courtesy of NASA, Johnson Space Center

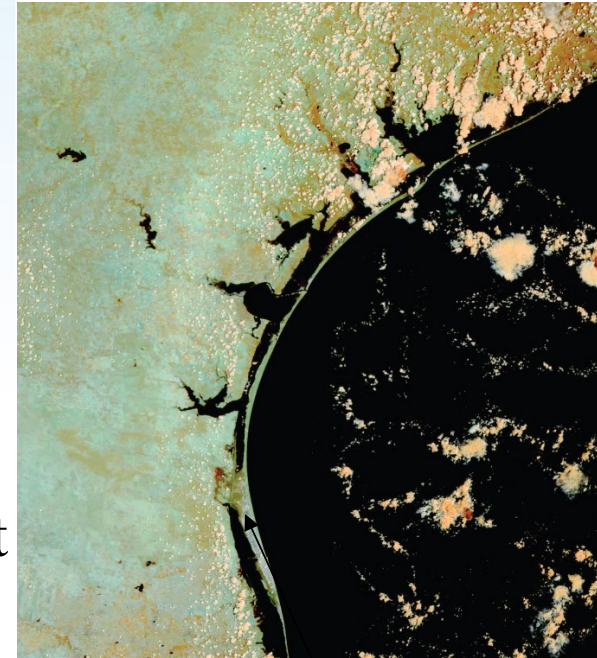
a

Drowned river valley
From rising sea levels



b Lagoon – like bar-built
with no freshwater
input, so not an
estuary, but still
cool!!!

Bar-built



Courtesy of NASA, Johnson Space Center

c

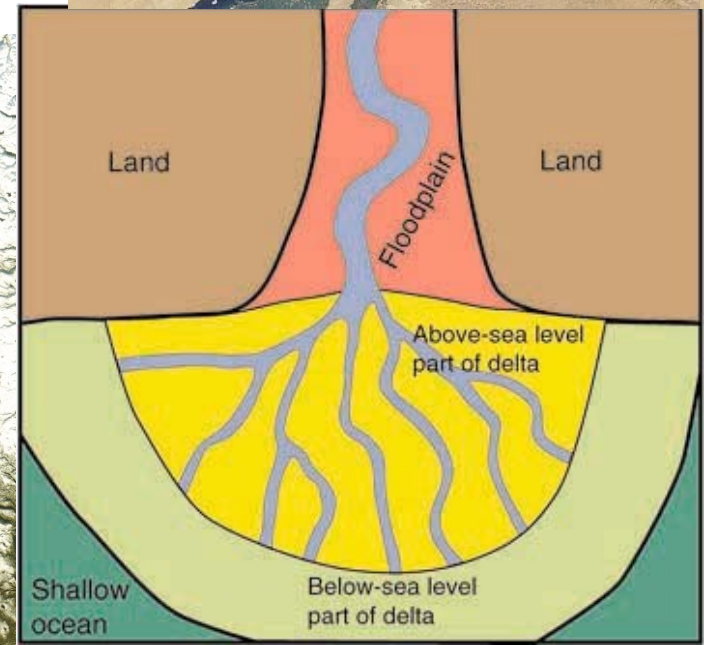
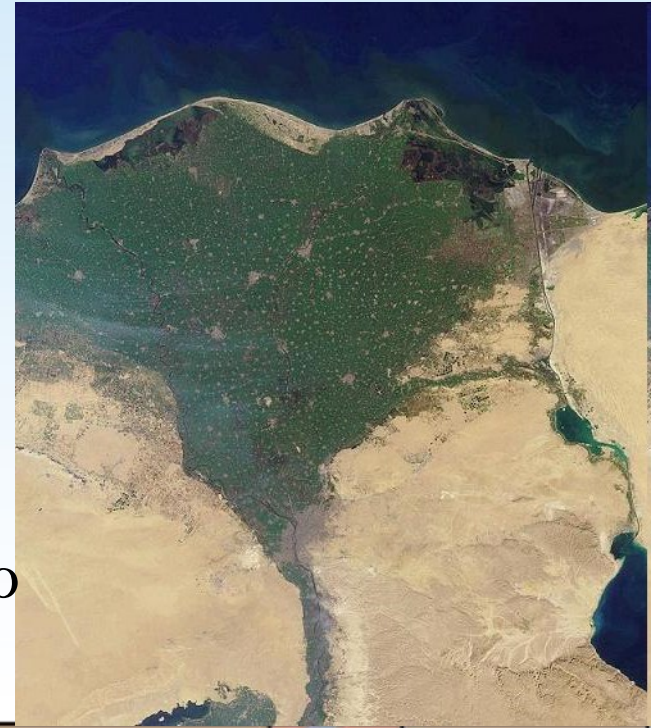
Sand makes barrier
island

Types of estuaries

Fjords - long, narrow, steep sides created in a valley carved by glacial activity



Deltas – high sediment, fan-like openings to sea



Types of estuaries

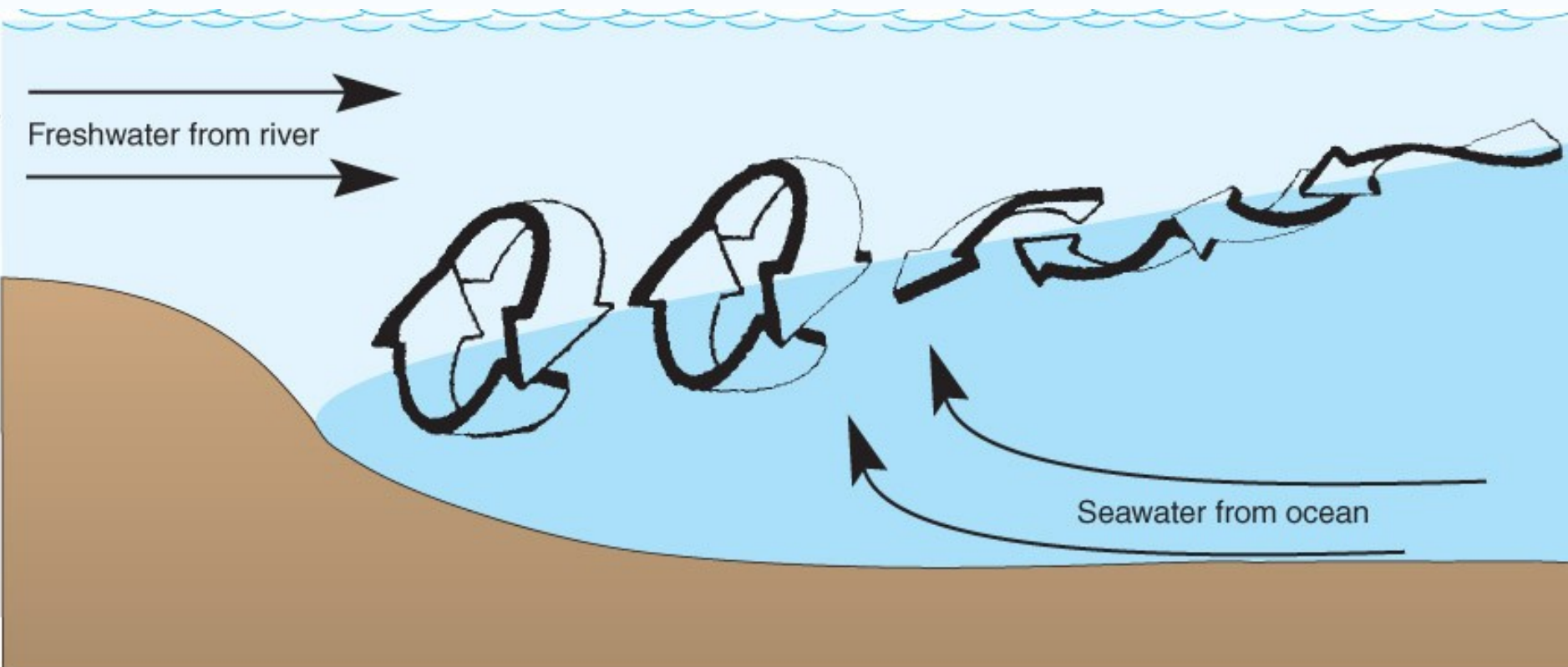
San Francisco Bay

Tectonically built estuaries:
land sinks from crustal
movements



Estuarine Circulation

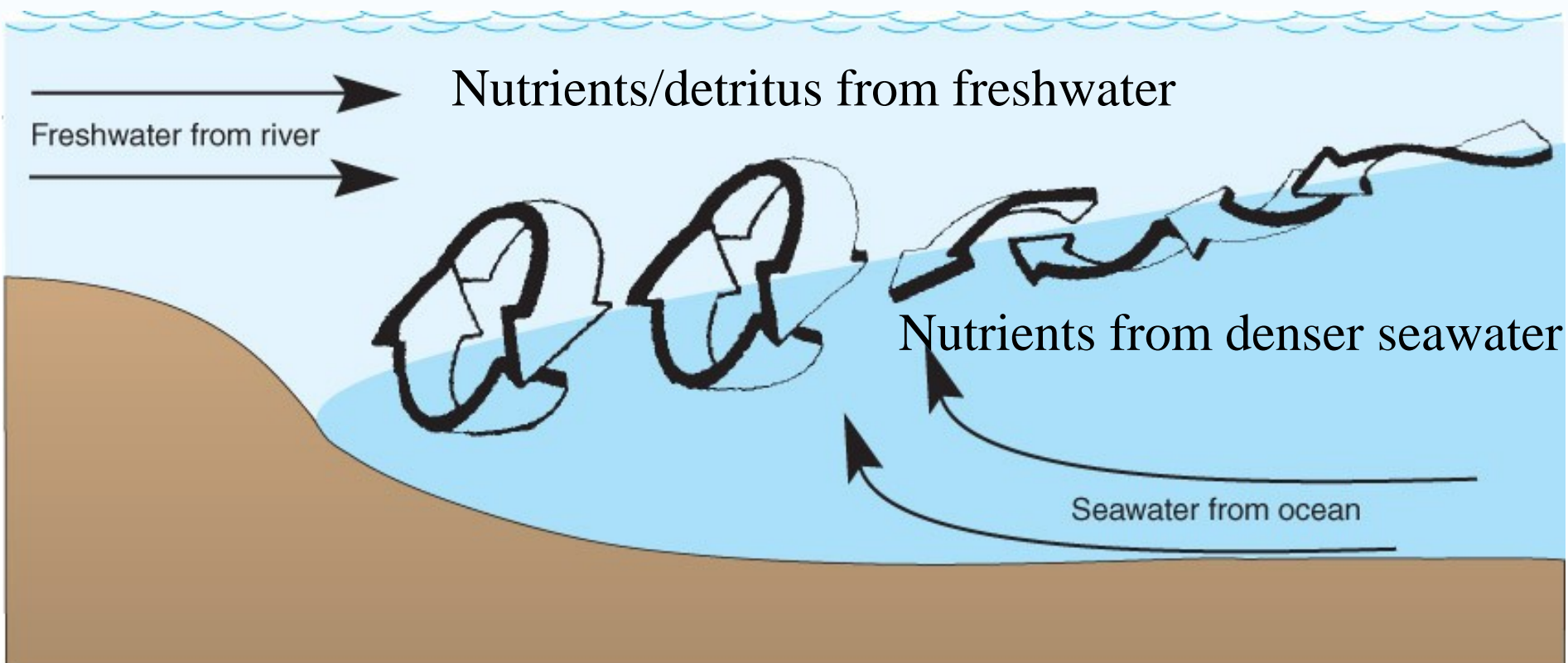
- 🐟 Salinity in estuaries typically increases from the estuary head downstream to its mouth.
- 🐟 Due to the higher density of seawater:
 - incoming tides move along the floor of the estuary
 - riverine inputs exit along its surface



Estuarine Circulation

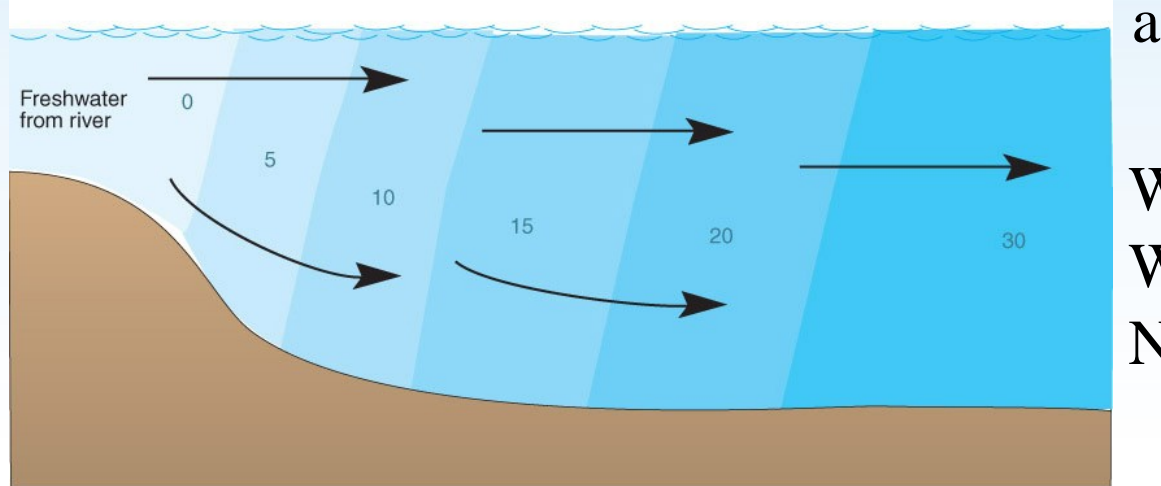
🐟 A LOT OF UPWELLING IN ESTUARIES!!!

- Detritus and other organic nutrients settle out of the river water
- High primary production!!!



Estuarine Circulation

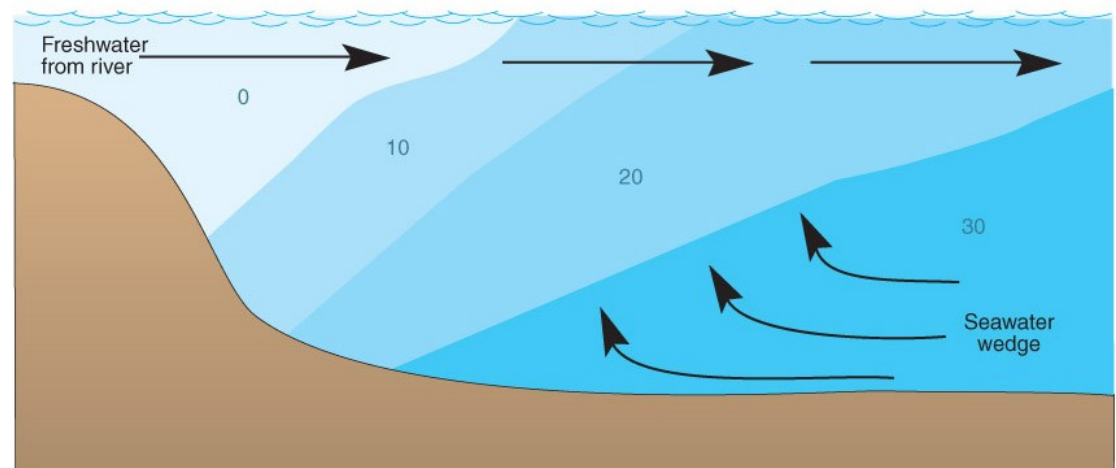
Classification based on salinities



a

Well-mixed
Wide-mouthed estuary
No haloclines

Stratified
Narrow-mouthed estuary
Distinct haloclines



b

Salinity Adaptations by Estuarine Organisms



The salinity is in the open ocean



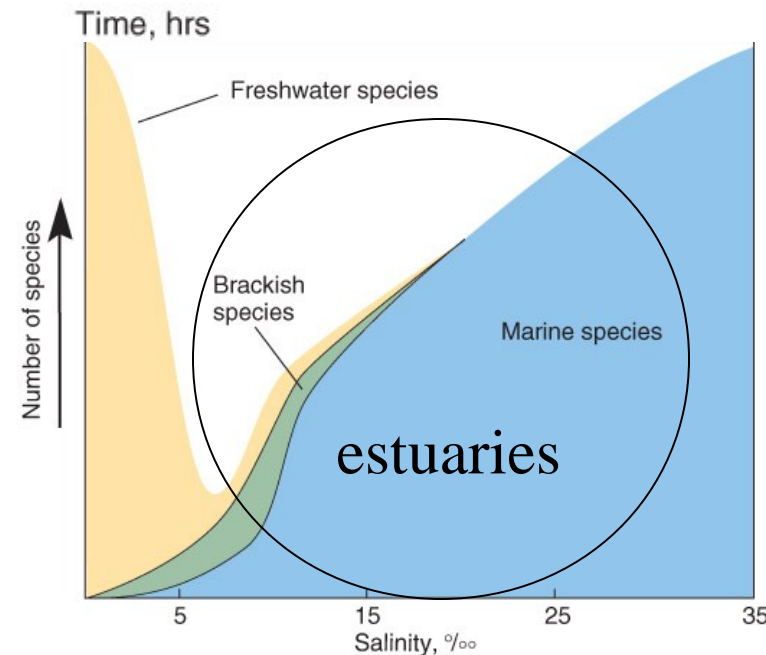
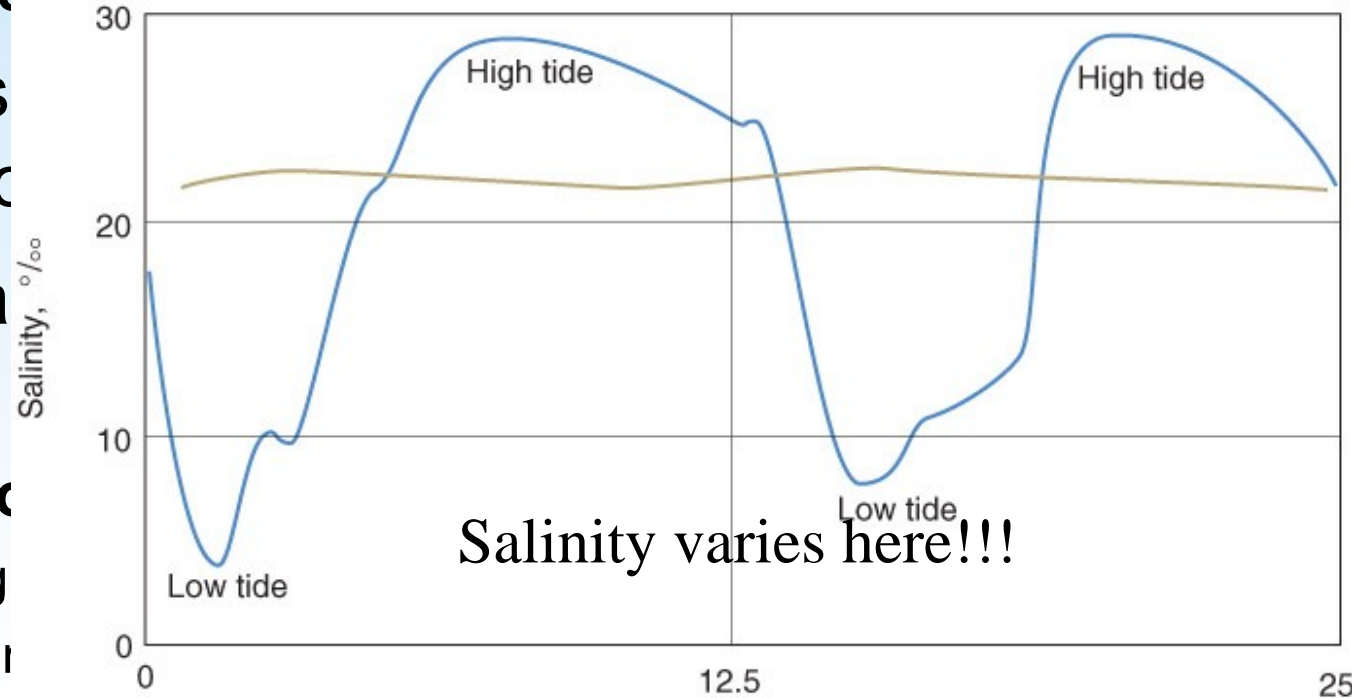
Different organisms than others

- **Osmoconformers**

- remaining
- traveling in
- Generally

- **Osmoregulators** can regulate their internal salinity

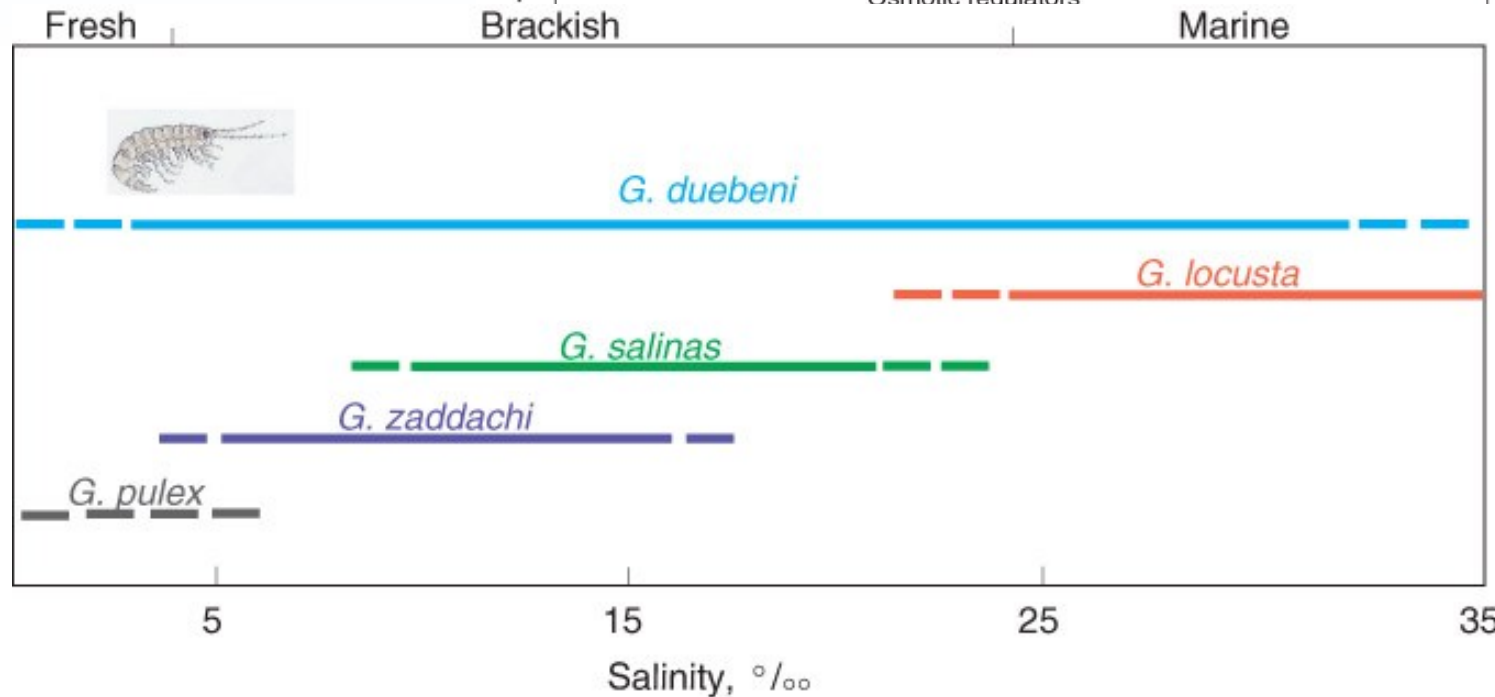
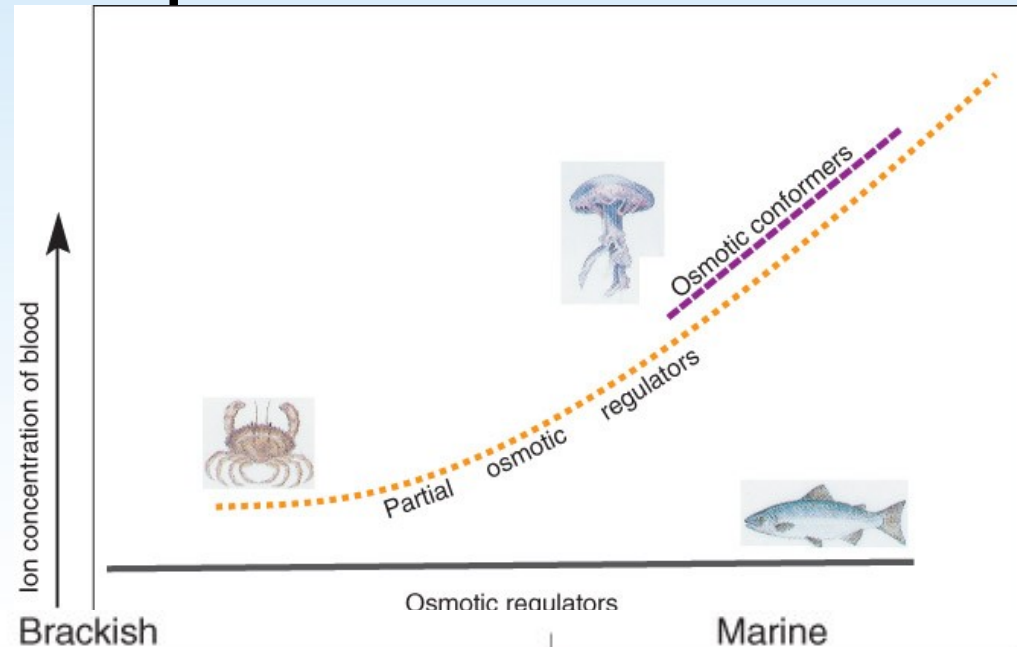
- All vertebrates and fast-swimming invertebrates



Salinity Adaptations

Osmoconformers are stenohaline (most estuarine animals)

Osmoregulators are euryhaline



Which one is a
osmoregulator?
Which one is
stenohaline?

Sediment Transport: Creating Habitats Substrates in estuaries

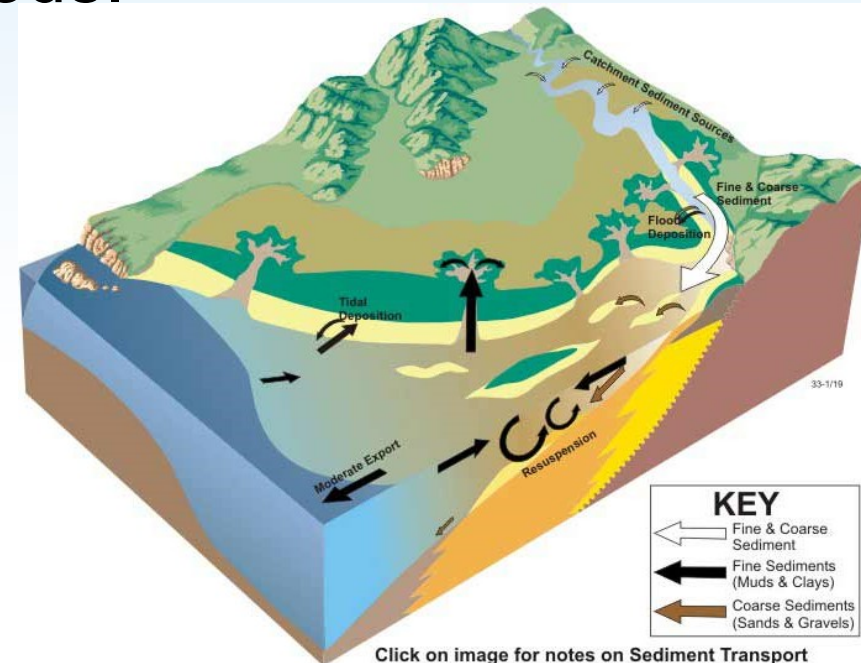
- Sediments are transported into estuaries by rivers that drain coastal watersheds.

large-grained coarse sediments at the head, finer sediments near the mouth (high water velocity)

muddy sediments predominate the floor at the mouth of estuaries

creates different habitats

- These sediments create deltas and bar-built estuaries.



Estuarine Habitats and Communities

1. Salt Marshes – highest elevation

2. Mudflats

3. Channels

🐟 **Salt marshes are intertidal grasslands (salt-tolerant) that grow along estuarine shores.**

🐟 **Covered at high tide**



Provides the food base of estuaries, mainly as detritus

Estuarine Habitats and Communities

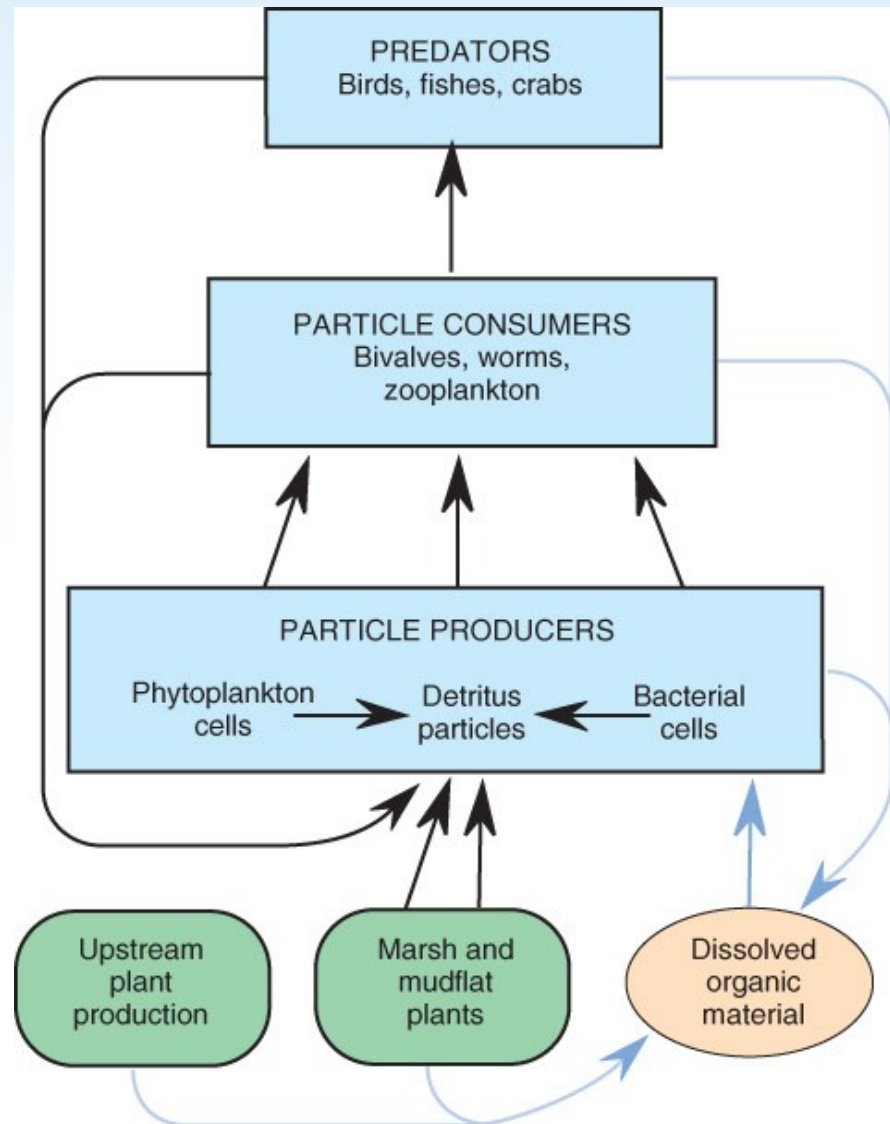


Fig. 7.11 Food particle production and utilization in a typical estuary.

Estuarine Habitats and Communities

1. Salt Marshes
- 2. Mudflats – alternately submerged and exposed by tides**
- 3. Channels – always submerged**



Estuarine Habitats and Communities

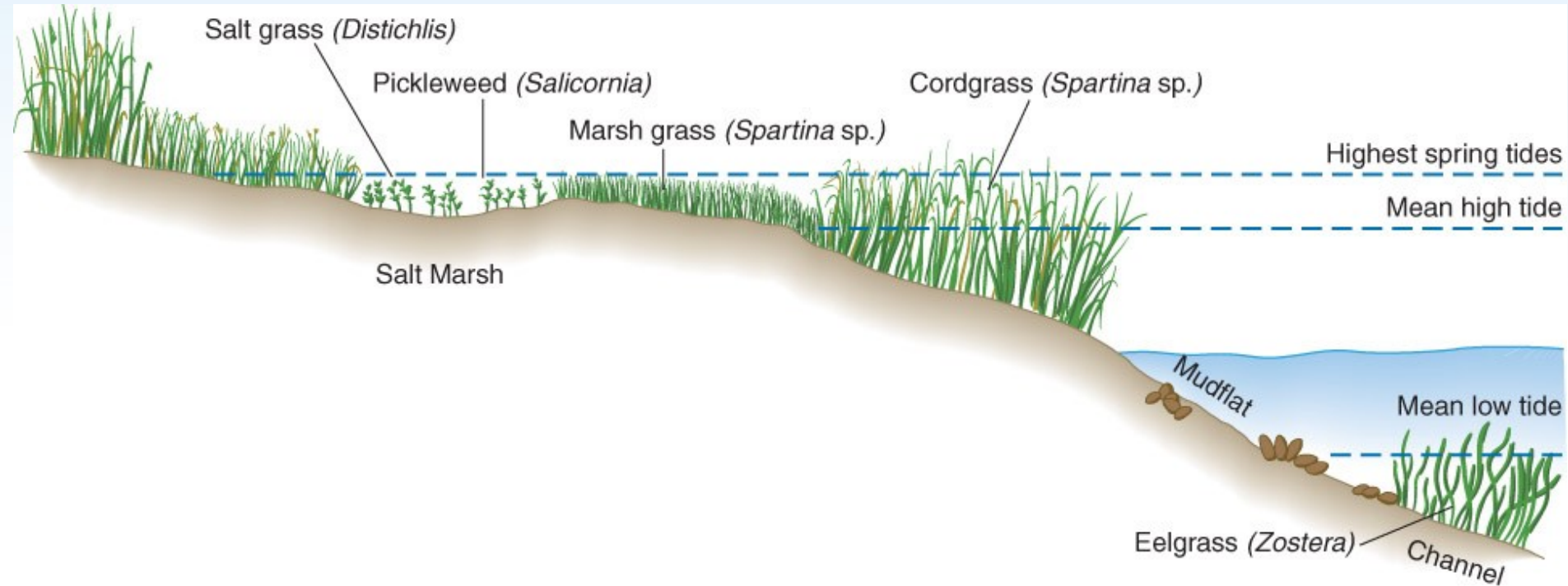


Fig. 7.9 Plant-dominated salt marsh, mudflat, and channel habitats of Chesapeake Bay and other East Coast estuaries, with their vertical position relative to high tide indicated.

Estuarine Habitats and Communities

More about salt marshes

Salt Marshes – also called wetlands, wet grasslands

halophytes



Courtesy of Louise Kane/NOAA Restoration Center
Special glands that excrete salt



Courtesy of John Bruno/NOAA
Stores excess salt in leaves

Fig. 7.10 Two types of emergent salt marsh plants: (a) A stand of cordgrass, *Spartina*, with taller mangroves behind (left); (b) Pickleweed or glasswort, *Salicornia* (right).

Estuarine Habitats and Communities

More about mudflats

- Mudflats, or tideflats, are nutrient-rich, fine-grained muds that are exposed during low tide.
- They act as both home and food source for a wide variety of **infauna** and **epifauna**.
- 3 major producers: diatoms, macroalgae, & seagrasses

Fig. 7.13 Barren surface of a mudflat, with tubes, openings, burrows, and other evidence of abundant animal life beneath the surface.

Eelgrass, a flowering plant!

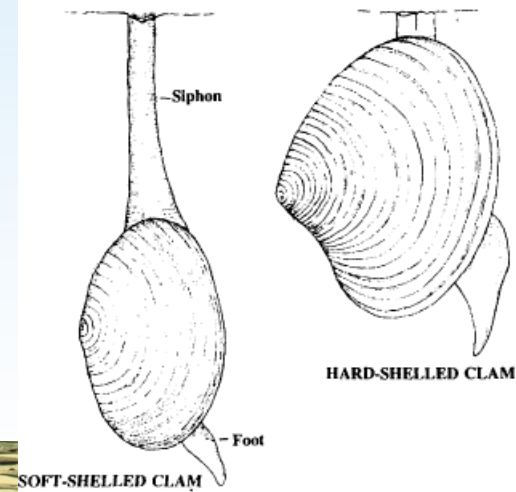
Anoxic below!!!!



Estuarine Habitats and Communities

Mudflats – the anoxic habitat below!!!

1. Bacteria and fungi-dominated
2. Organisms must deal with varying oxygen (tide) levels – none to a lot (high tide)
3. Sulfate is used in anaerobic respiration, releasing hydrogen sulfide = rotten egg smell!!!
4. Anoxic = black mud!
5. Salinity levels are more constant below



Estuarine Habitats and Communities

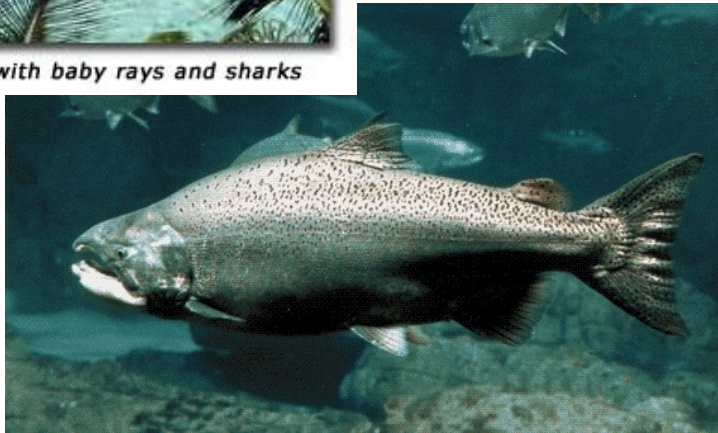
More about Channels

- 🐟 Channels are home to organisms that cannot tolerate intertidal life in wetlands or on mudflats.
- 🐟 Some live in estuarine channels full-time
- 🐟 Others simply visit the estuary to spawn

photo: Anna Collins

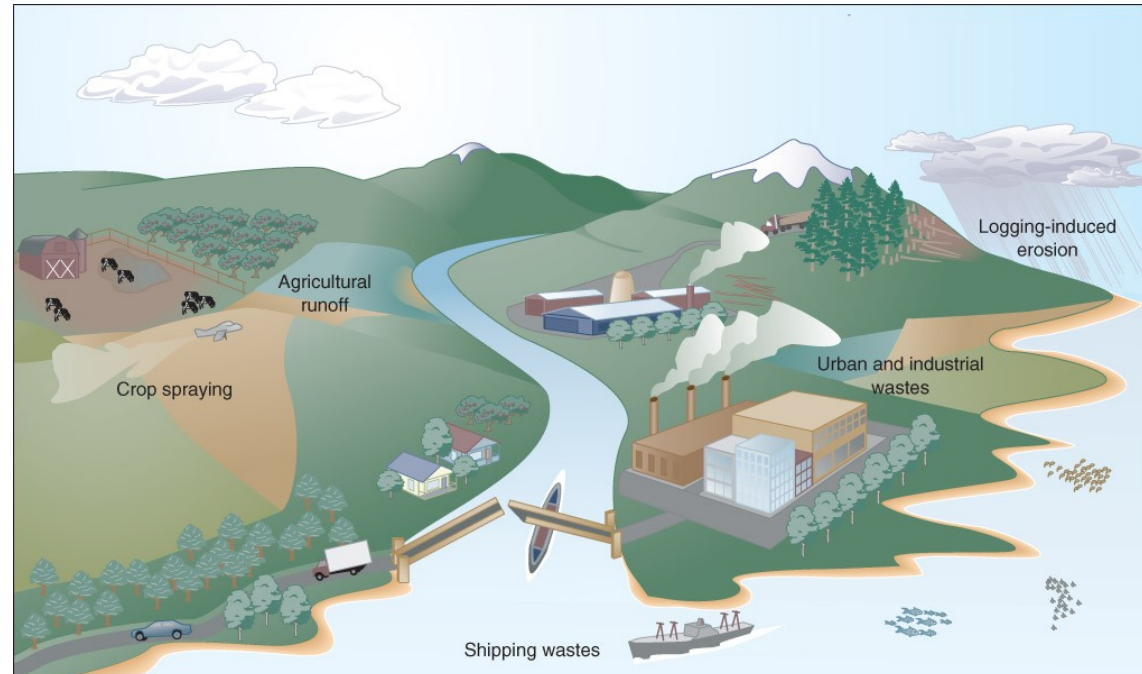


Estuary Lagoon with baby rays and sharks



Environmental Pollutants – Estuaries are more vulnerable than other habitats

- Estuaries are usually supplied with freshwater by rivers and streams that collectively drain vast watershed areas.
- Many pollutants are carried to estuaries where they are trapped and accumulate.



Environmental Pollutants

A Summary of the Sources and Effects of Some Marine Pollutants

Pollutant	Sources	Effects
Particulate material	Dredged material, sewage, erosion	Smothers benthic organisms, clogs gills and filters, reduces underwater light
Dissolved nutrients	Sewage, agricultural runoff	Increases phytoplankton blooms, decreases dissolved oxygen
Toxins	Pesticides, industrial wastes, oil spills, antifouling paint	Increases incidence of disease, contaminates seafood, suppresses immune systems, contributes to reproductive failure
Oil	Tankers, drill sites, urban and industrial wastes	Smothers organisms, clogs gills, mats fur or feathers, causes anatomical and physiological abnormalities
Marine debris	Garbage, ship wastes, fishing gear	Causes physical injuries and mutilations, increases mortality

Environmental Pollutants

Oxygen-depleting
Pollutants – can lead to
“dead zone” from
decomposition of an algal
bloom

Fig. 7.15 SeaWiFS satellite view of the U.S. Gulf Coast, with the dead zone at the mouth of the Mississippi River indicated by black.



Environmental Pollutants

Toxic Pollutants

- 🐟 The effects of several toxic pollutants are compounded by their tendency to bioaccumulate.

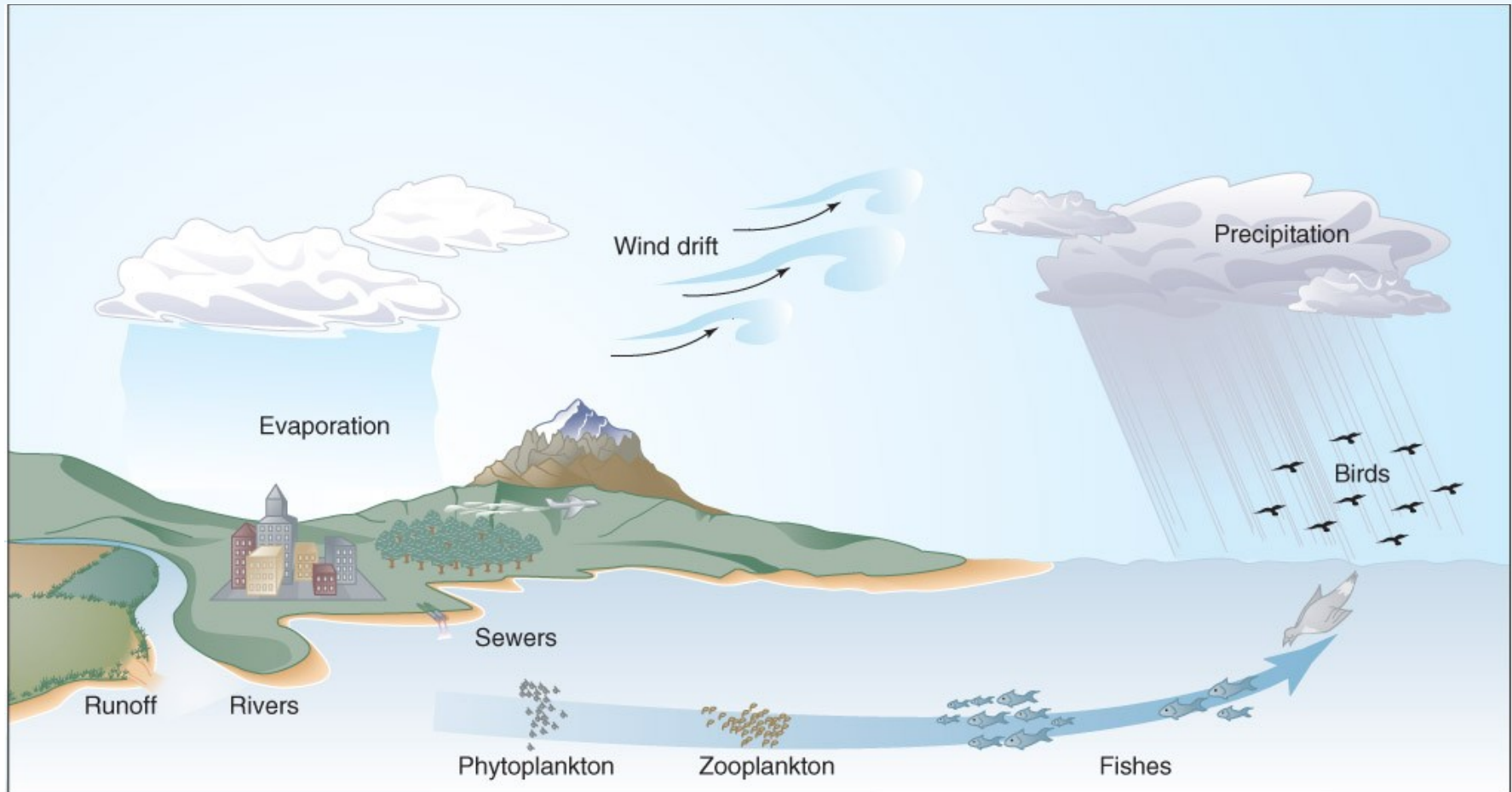


Fig. 7.16 Transfer of DDT to and within marine food webs (arrows).
DDT is absorbed by phytoplankton and then concentrated at each step in the food web.

The Chesapeake Bay System – a well known estuary

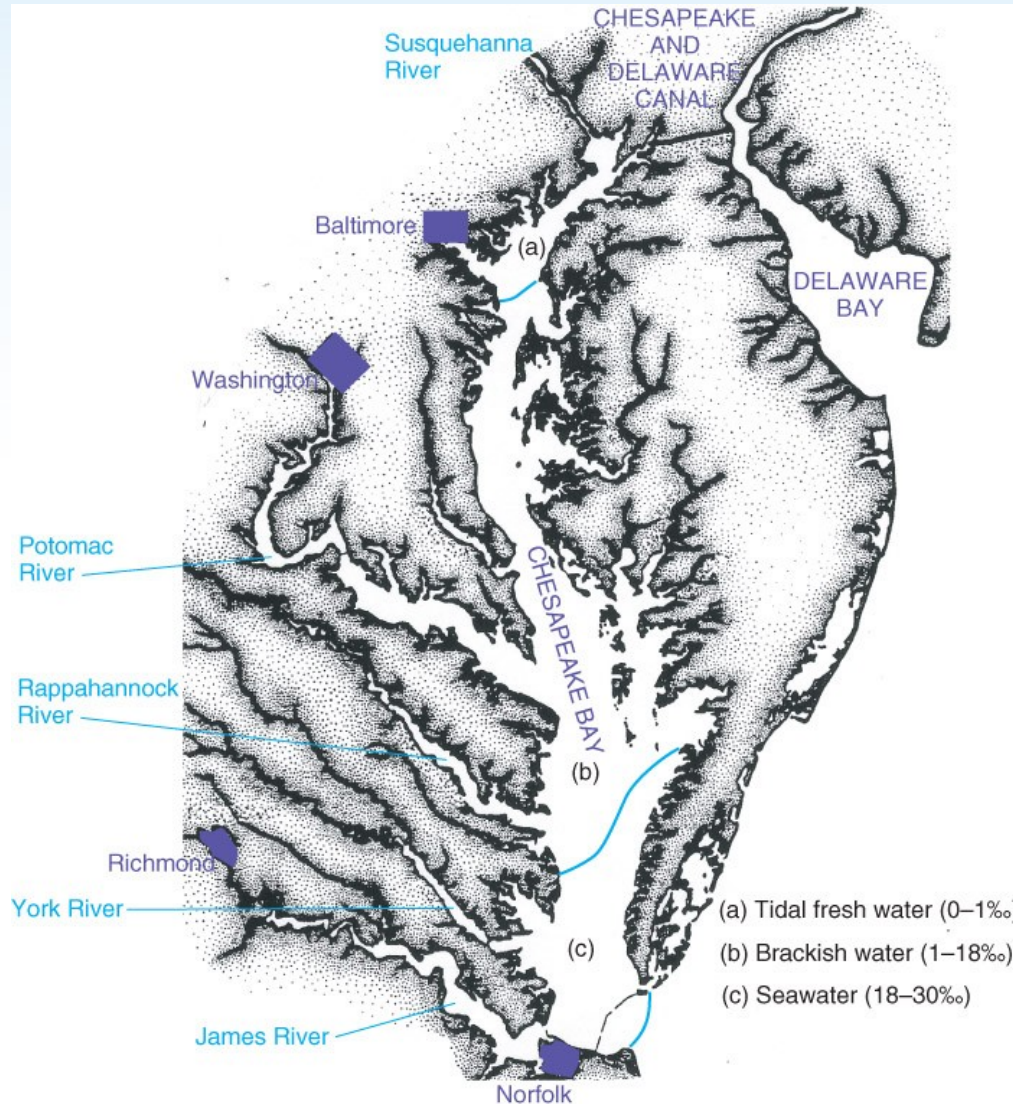


Fig. 7.17 Chesapeake Bay and its numerous smaller side estuaries, showing mean surface salinity zones.

The Chesapeake Bay System

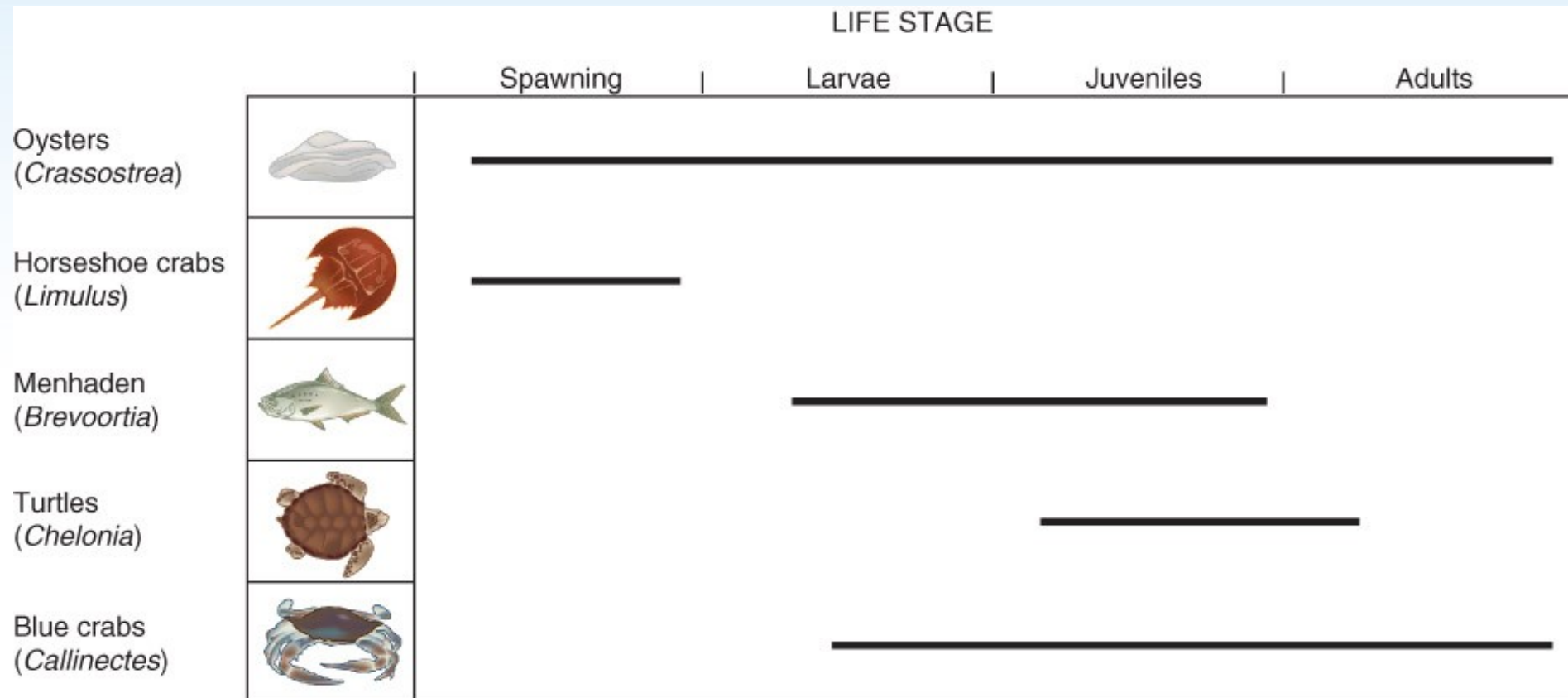


Fig. 7.18 Utilization of estuaries by different life stages of five common inhabitants of Chesapeake Bay.