Pelagic Food Chain: Summary

- The food chain concept
  - An attempt by scientists to make a simple model of the extreme complexity of biological communities
  - Illustrate simple principles
  - Goal of constructing a budget of
    - Production at each trophic level
    - Who eats what
  - Also understand how these properties change over time and location

Pelagic Food Chain: Summary

- More realistic: food web
  - Still very oversimplified
  - Can be verified by measurements
    - Observe gut contents
    - Use isotopes to track flow of organic carbon
  - Even at this level, calculations of production & efficiency get complex quickly

Pelagic Food Chain: Summary

- Example of a food web model derived from research
  - Puget Sound pelagic zone
    - Large number of organisms (but still not all)
    - Based on gut contents
  - Weight of arrow shows proportion of production following that path
    - How we derive simpler “food chain” model
    - Highlight “dominant” species & trophic pathways
Pelagic Food Chain: Summary

- The main chain:
  - 4 Birds & whales
  - 3 Baitfish
  - (2.5) Carnivorous zooplankton
    - Side branches not leading to higher levels
  - 2 Copepods & krill
  - 1 Phytoplankton

Pelagic Food Chain: Summary

- What determines which organisms are found in which environment? Evolution
  - Example:
    - Anchovy & sardine dominant baitfish off California
    - Herring & sand lance dominant baitfish off Washington
    - Why? Not entirely clear
      - Herring prefer cooler water
      - Differences in types of zooplankton & fish feeding adaptations?
  - Example:
    - Mackerel dominant feeder on baitfish off California
      - Prefer warmer water
    - Salmon off Washington
      - Prefer cooler water & need rivers

Productivity in Ocean Zones

- Comparing 3 general types of environments
  - Again a great simplification
  - Based on productivity
- Types defined in Sverdrup textbook
  - Upwelling zones
  - Coasts
  - Open ocean
- My modification
  - “Coasts” lumped with temperate & subpolar open ocean
  - “Open ocean” includes only low latitudes

Pelagic Food Chain: Summary

- 3 factors that determine food-chain productivity differences in different environments
  - Primary productivity
    - Subject of next lecture
  - Trophic efficiency
    - Argued to reflect dispersal of food supplies
    - Predators expend more energy to obtain dispersed prey
  - Number of trophic levels
    - Size of primary producers
      - Small phytoplankton: more trophic levels to grow a fish big enough to harvest
    - Size of harvestable fish
      - Small fish harvestable near shore, big fish far from shore

NOTE: Biomass used here as an indicator of productivity
Comparing Food Chains

• Upwelling vs. (low-latitude) open ocean
  - Remember Peruvian case is unique
  - More typical upwelling has harvest from 3rd trophic level
    • Also some from 4th

• In (low-lat) open ocean, phytoplankton small
  - Microflagellates & cyanobacteria
  - So herbivores small (Protozoa microzooplankton)
  - Copepod- & krill-sized zooplankton are carnivores
  - 1 extra trophic level to reach that size of ZP

Result: 2 extra trophic level in (low-lat) open ocean vs. (typical non-Peru) upwelling

• Combines with lower efficiency in open ocean
  - These two factors illustrated in these pyramids
  - For 1000 arbitrary units of PP (primary productivity)
  - But PP is 10-20 times higher in upwelling