

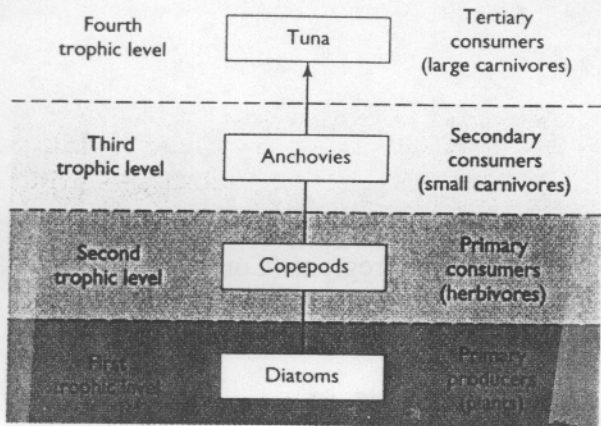
1. Review: Biologically productive regions are Ekman upwelling regions (Coriolis + friction). Critical ingredients for photosynthesis: light and nutrients. Light penetrates <100 m in water; nutrients available only in coastal and open ocean upwelling areas.
2. Biodiversity is greater on land than in the oceans because of the range in climate. The marine environment. small range of temperature: geographically: -2C to 32C, (compared to continental temperatures of -88C to 58C); diurnally: <0.5C in open ocean, <3C coastal; annually: <10C at 45N (>100C in Siberia). Salinity ranges between 20—40 permil.
3. One classification of marine biota is based on lifestyle: plankton (floaters), nektons (swimmers), benthos (bottom dwellers).
4. Microscopic algae (phytoplankton) produce >99% of food supply. Most important are the golden algae (diatoms with silica shells and coccolithophores with calcium carbonate shells) and dinoflagellate algae (e.g. red tide).
5. Nektons swim to gather food and escape predators. Body and fin shapes reduce drag. A fish classification scheme: cruising, acceleration, and maneuvering
6. Benthic communities can be found along shorelines and intertidal zones. They are banded in the vertical, reflecting degrees of tolerance to exposure to air, competition and predation pressure.
7. Migrants – Some large fish travel vast distances between their feeding and breeding grounds. Eels live in freshwater streams but breed in saltwater; salmon live in saltwater but spawn in freshwater streams.
8. NPP of oceans ~ NPP of land. NPP of open ocean ~ 75% of ocean total, but per unit area, open ocean ~ deserts. New production (upwelled NO<sub>3</sub>-) and regenerated production (NH<sub>3</sub>+ from decomposition).
9. The wood web: plants as primary producers, animals as consumers (grazers), bacteria as decomposers. Transfer of energy between trophic levels: 2% of solar energy is synthesized into organic matter. Overall 5—15% energy transfer efficiency → fewer number of individuals and total biomass of populations higher in the food chain.
10. Food from sea ~5% of protein consumed, ~ 10% of global NPP. 25—35% of coastal NPP.
11. About 240 million tons of fish are produced annually in the world's oceans (to be consumed by all predators). To maintain fish stock, < 110 million tons of fish should be harvested. Current fish harvest – about 90 millions tons.
12. Maximum sustainable yield requires harvest rate < recruitment rate. Larval and juvenile survival, recruitment (addition of young fish) very sensitive to the ocean environment – climate.

TABLE 10-2

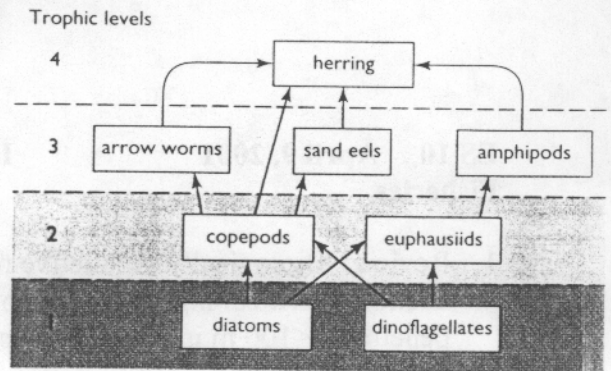
Global fish production.

Area	Primary Production (gC/m <sup>2</sup> /yr)	Ocean Area (km <sup>2</sup> )	(%)	Total Primary Production (tons C/yr)	(%)	Average Number of Trophic Steps	Material Transfer Efficiency per Trophic Level (%)	Fish Production (tons/yr)	(%)
Oceanic	50	325 × 10 <sup>6</sup>	90.0	16.3 × 10 <sup>9</sup>	81.5	5	10	1.6 × 10 <sup>6</sup>	<1
Coastal	100	36 × 10 <sup>6</sup>	9.9	3.6 × 10 <sup>9</sup>	18.0	3	15	120 × 10 <sup>6</sup>	50
Upwelling	300	0.36 × 10 <sup>6</sup>	0.1	0.1 × 10 <sup>9</sup>	0.5	1.5	20	120 × 10 <sup>6</sup>	50

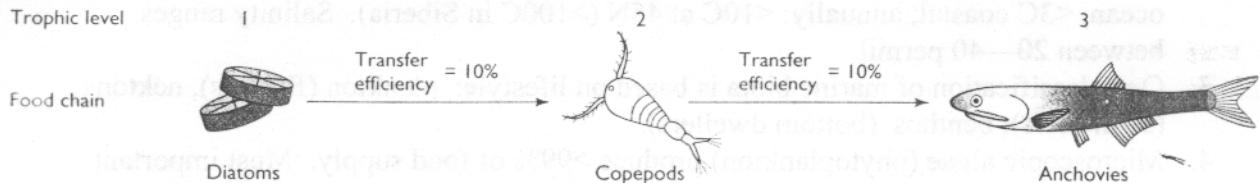
Source: Adapted from J. H. Richey, Science 166 (1969): 72-77.



(a) SIMPLE FOOD CHAIN



(b) FOOD WEB



Primary production 100 g C/m <sup>2</sup> /yr	X	Area 10 <sup>8</sup> m <sup>2</sup>	X	Transfer efficiency (across two trophic levels) 0.1 X 0.1 = 0.01	=	Anchovy production 10 <sup>8</sup> g C/yr or 10 <sup>2</sup> mt C/yr
--	---	--	---	--	---	---

