RITA CASTILHO

MARINE BIOGEOGRAPHY AND EVOLUTION

OCEAN ECOSYSTEMS

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OCEAN ECOSYSTEMS

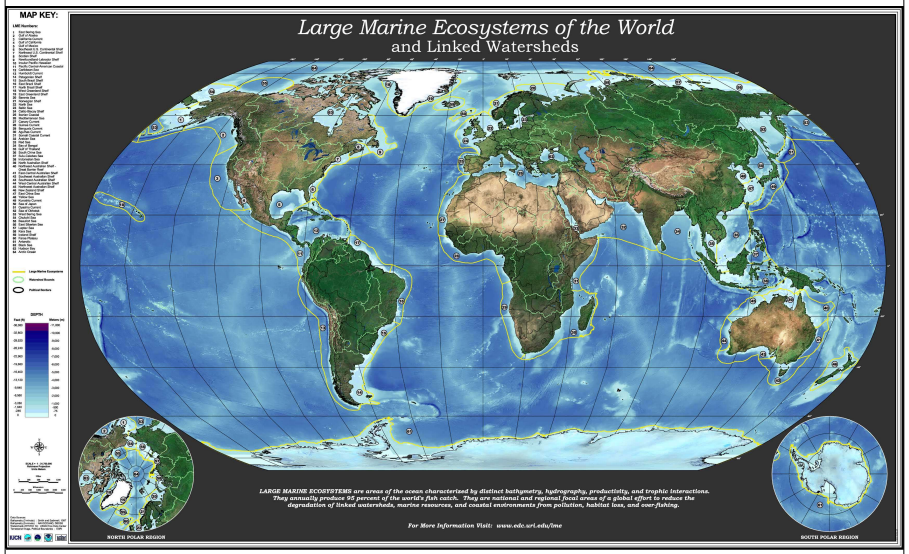
an environment that has all necessary requirements for an organism to live

Habitat

A group of interconnected elements, formed by the interaction of a community of organisms with their environment

Ecosystem

Ecosystem = many habitats



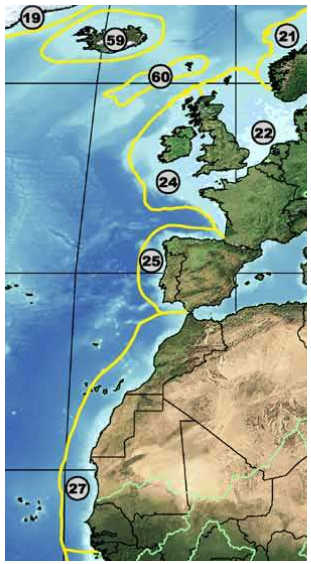
Large marine ecosystems are areas of the ocean characterized by distinct bathymetry, hydrography, productivity, and trophic interactions.

http://lme.edc.uri.edu

MAP KEY:

LME Numbers:

1 East Bering Sea
2 Gulf of Alaska
3 California Current
4 Gulf of California
5 Gulf of Mexico
6 Southeast U.S. Continental Shelf
7 Northeast U.S. Continental Shelf
8 Scotian Shelf
9 Newfoundland-Labrador Shelf
10 Insular Pacific-Hawaiian
11 Pacific Central-American Coastal
12 Caribbean Sea
13 Humboldt Current
14 Patagonian Shelf
15 South Brazil Shelf
16 East Brazil Shelf
17 North Brazil Shelf
18 West Greenland Shelf
19 East Greenland Shelf
20 Barents Sea
21 Norwegian Shelf
22 North Sea
23 Baltic Sea
24 Celtic-Biscay Shelf
25 Iberian Coastal
26 Mediterranean Sea
27 Canary Current
28 Guinea Current
29 Benguela Current
30 Agulhas Current
31 Somali Coastal Current
32 Arabian Sea
33 Red Sea
34 Bay of Bengal
35 Gulf of Thailand
36 South China Sea
37 Sulu-Celebes Sea
38 Indonesian Sea
39 North Australian Shelf
40 Northeast Australian Shelf - Great Barrier Reef
41 East-Central Australian Shelf
42 Southeast Australian Shelf
43 Southwest Australian Shelf
44 West-Central Australian Shelf
45 Northwest Australian Shelf
46 New Zealand Shelf
47 East China Sea
48 Yellow Sea
49 Kuroshio Current
50 Sea of Japan
51 Oyashio Current
52 Sea of Okhotsk
53 West Bering Sea
54 Chukchi Sea
55 Beaufort Sea
56 East Siberian Sea
57 Laptev Sea
58 Kara Sea
59 Iceland Shelf
60 Faroe Plateau
61 Antarctic
62 Black Sea
63 Hudson Bay
64 Arctic Ocean



Marine habitats

Coastal

Coral Reef

Estuaries

Deep

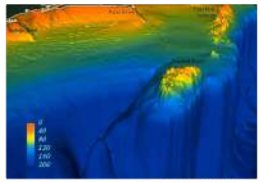
Polar

Mangroves

Marine habitats

Upwelling region

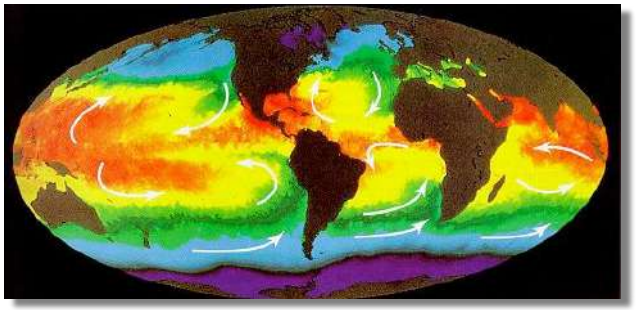
Open Ocean



Continental shelf

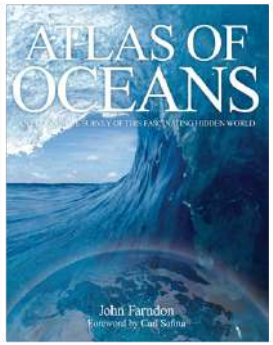
Deep

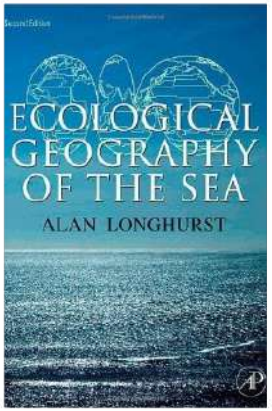
Marine habitats



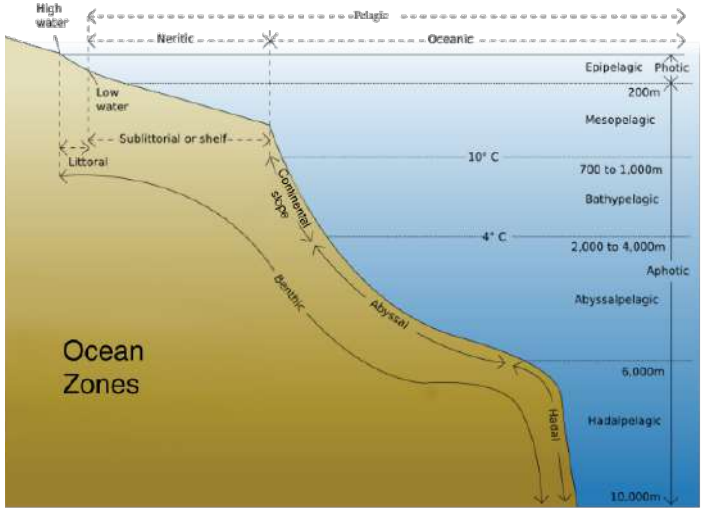
How might they be defined?

Marine habitats

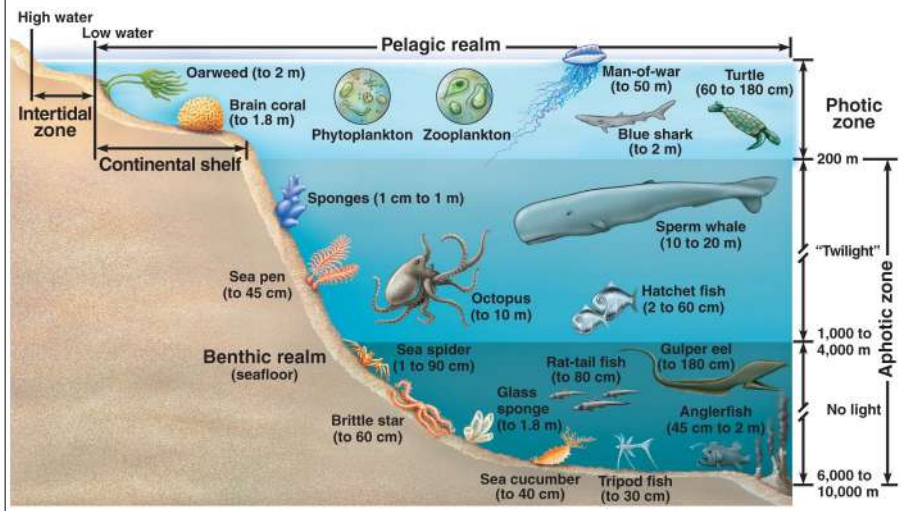




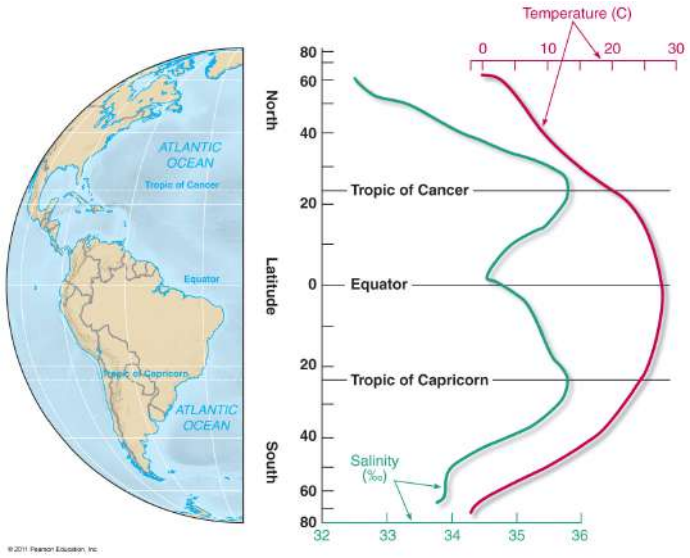
Marine habitats



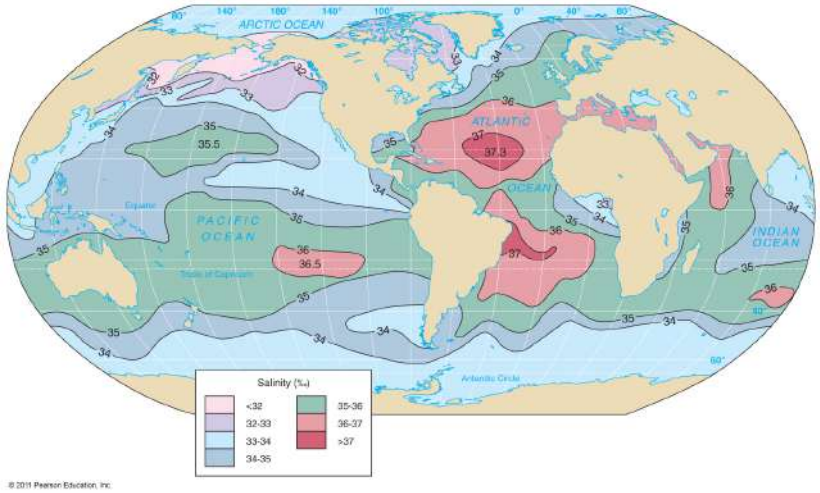
Marine habitats



Marine habitats

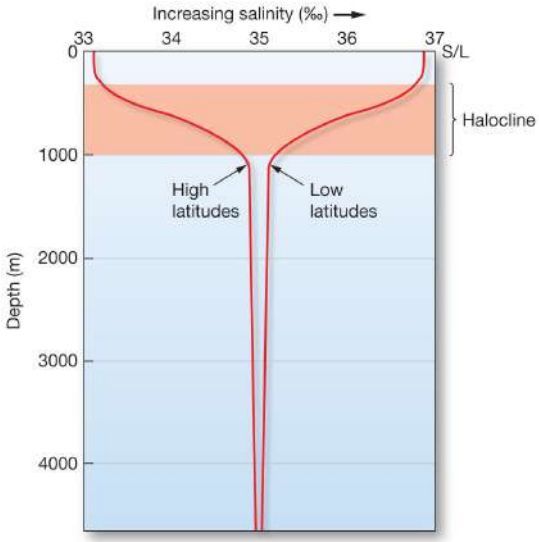


Marine habitats Salinity

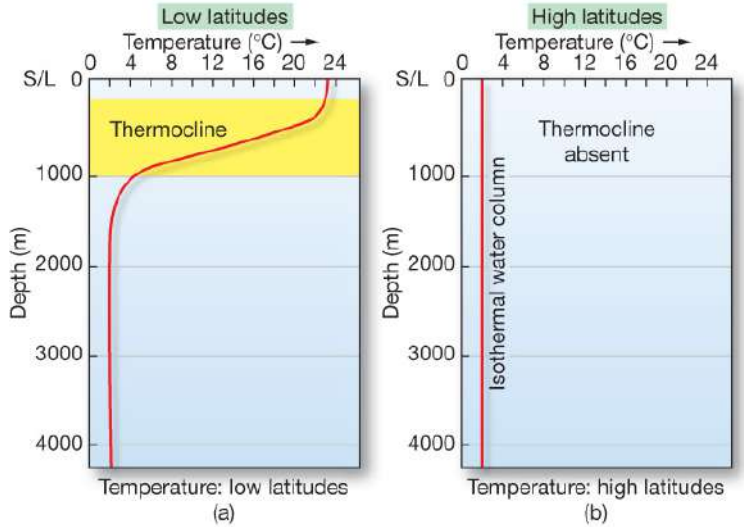


Marine habitats Salinity

Low latitudes – salinity decreases with depth
High latitudes – salinity increases with depth
Deep ocean salinity fairly consistent globally
Halocline – separates ocean layers of different salinity



Marine habitats Temperature

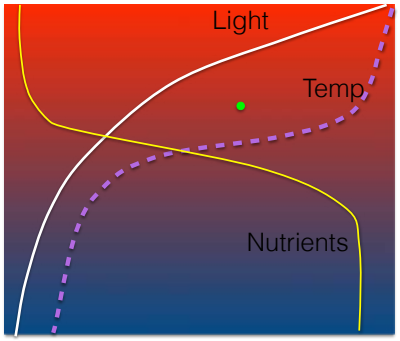


Marine habitats

What Limits Primary Productivity?

Stratified Ocean Condition

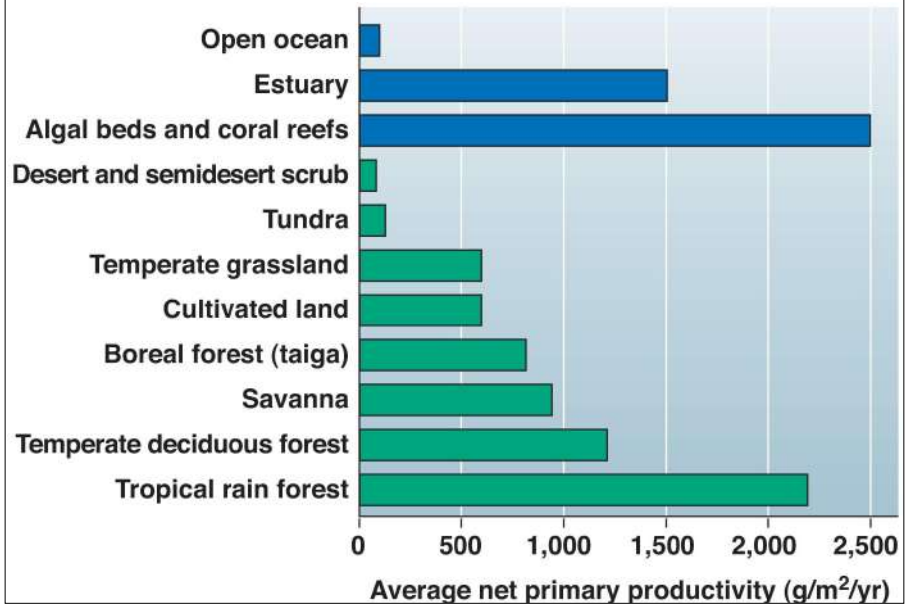
Warm, low nutrients, High light



Cold, high nutrients, low light

Depth

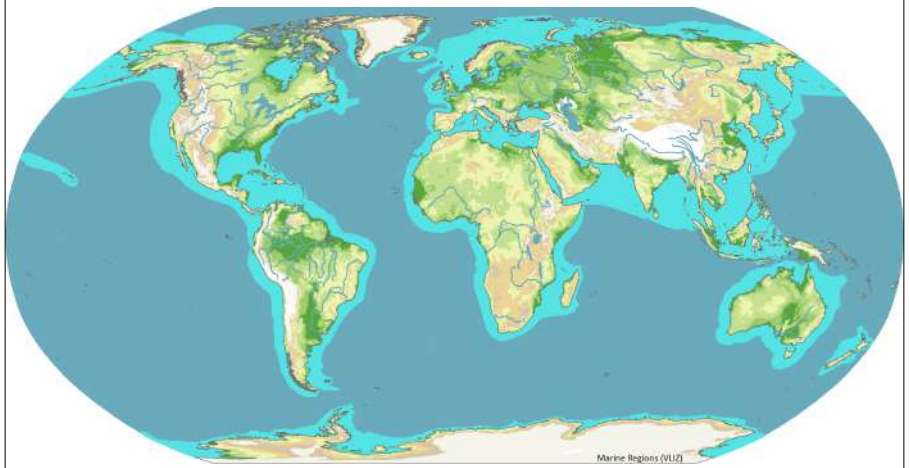
Marine habitats Productivity



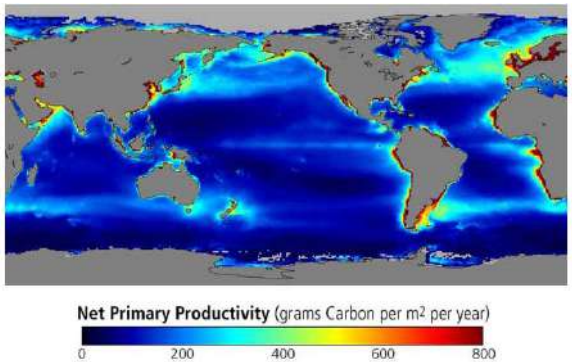
Marine habitats • Coastal

Marine habitats • Continental

Marine habitats • Continental

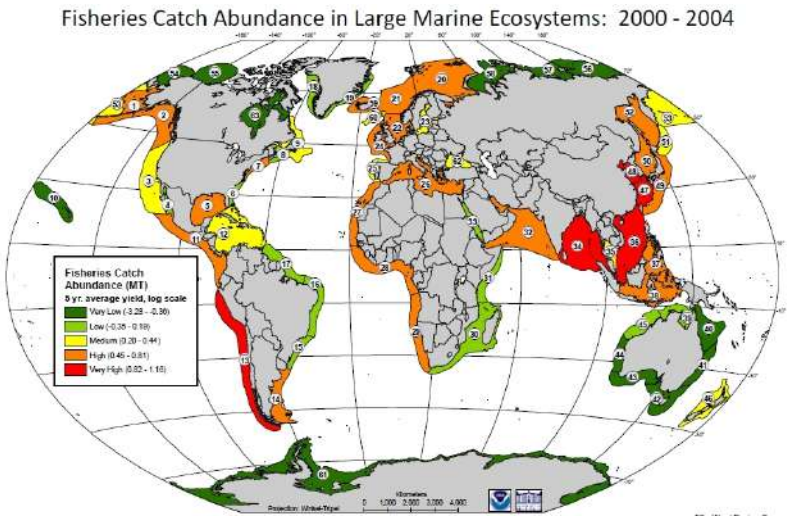


Marine habitats • Continental



WHY CONTINENTAL SHELF HAVE HIGH PRIMARY PRODUCTIVITY?

Marine habitats • Continental



Marine habitats • Continental

Continental shelves account for:

over 25% of global primary productivity

90-95% of the world's marine fish catch

80% of global carbonate production

50% of global de-nitrification

90% of global sedimentary mineralization

Marine habitats • Coral Reef

Marine habitats • Coral Reef

Structures in the shallow oceans that are built by animals called corals; serve as a habitat for many diverse organisms.
Require two things: warm temperatures and sunlight

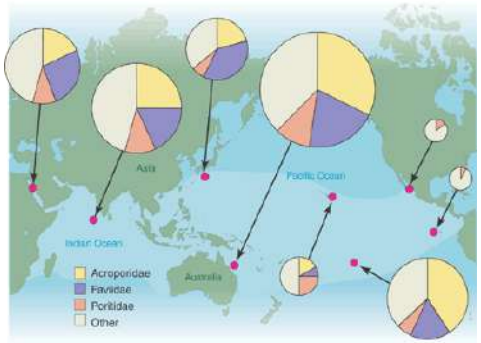
One of the most biological diverse and productive ecosystems.

Found in warm, clear and shallow tropical oceans

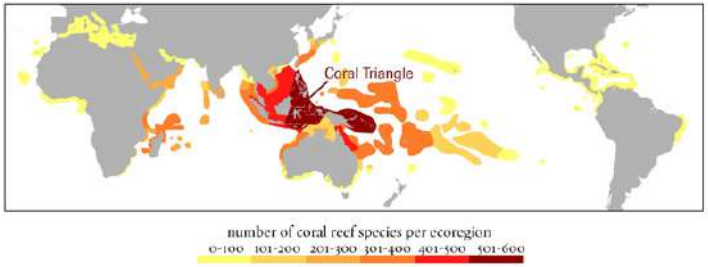
On $CaCO_3$ substrate deposited by reef building corals (50% of all Ca deposit in the sea) and other calcified organisms.

Provide shelters and food to fish

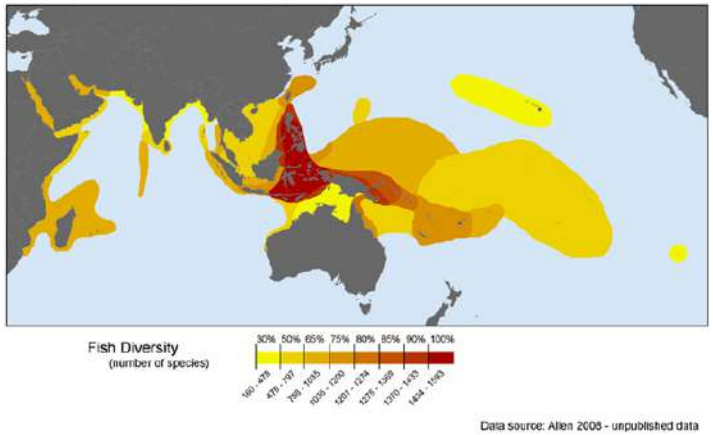
Marine habitats • Coral Reef



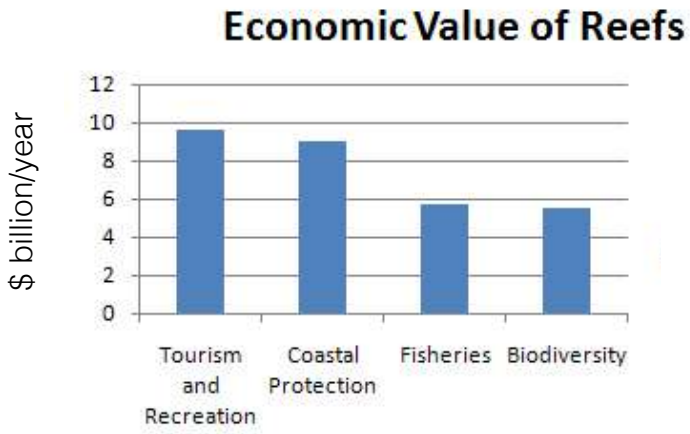
Marine habitats • Coral Reef



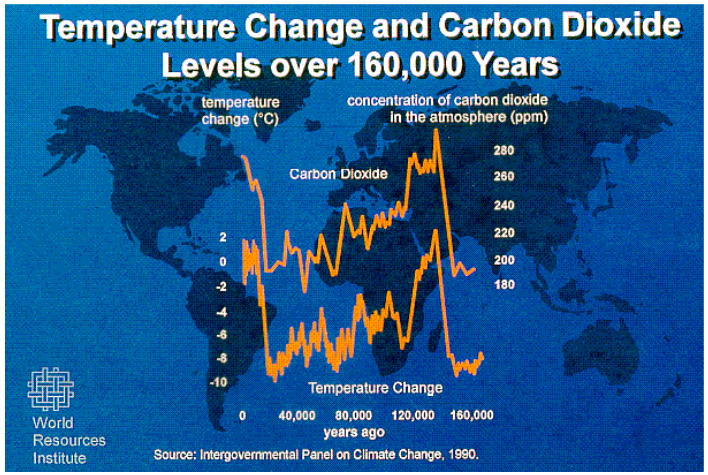
Marine habitats • Coral Reef



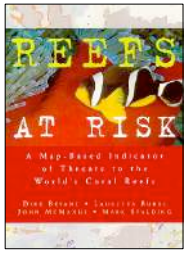
Marine habitats • Coral Reef



Marine habitats • Coral Reef



Marine habitats • Coral Reef



Global *Reefs at Risk* successful at raising awareness.
Relatively coarse-scale (4km.)

Regional Reefs at Risk series
Higher resolution analysis – valuable for management
More integration and improvement of data

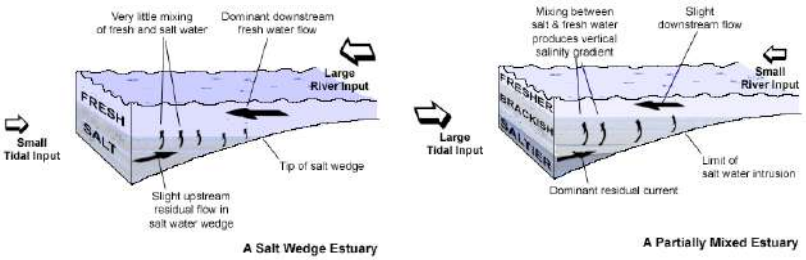
Marine habitats • Estuaries

Marine habitats • Estuaries

An area in which fresh water from a river mixes with salt water from the ocean; a transition area from the land to the ocean. Other names: bay, sound, lagoon, harbor, or bayou.

Marine habitats

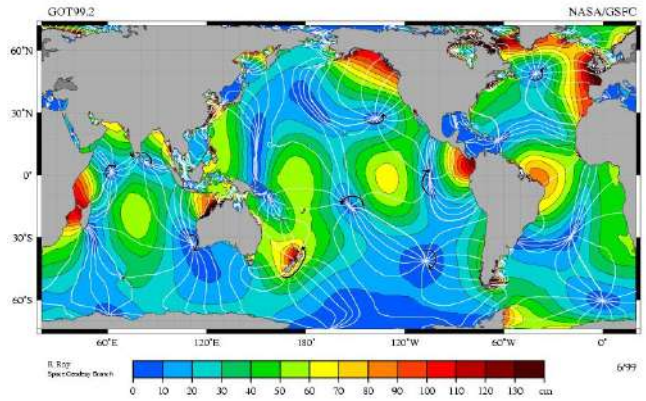
“Classic” Estuarine Circulation



river output greatly exceeds marine input and tidal effects have a minor importance

Marine habitats

Tidal Mixing on Continental Shelves



Marine habitats • Salt marshes

Salt marshes: low areas that is subject to regular, but gentle, tides, dominated by grasses

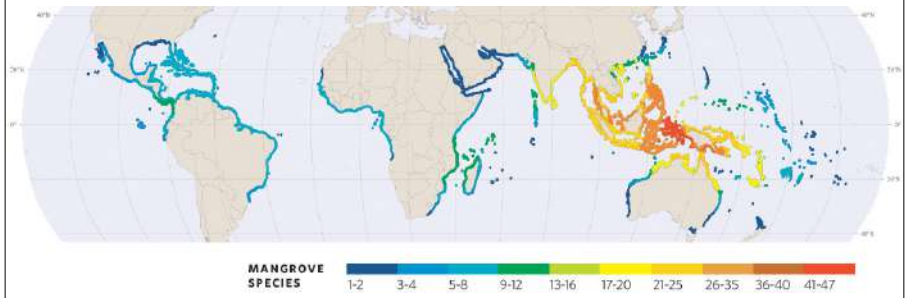
Marine habitats • Salt marshes

Salt marshes: low areas that is subject to regular, but gentle, tides, dominated by grasses

Marine habitats • Mangroves

Coastal wetlands located in tropical and subtropical zones; characterized by salt-tolerant trees and shrubs, such as mangrove trees

Marine habitats • Mangroves



75% of tropical coast lines (water temp above 24 C)

Marine habitats • Mangroves

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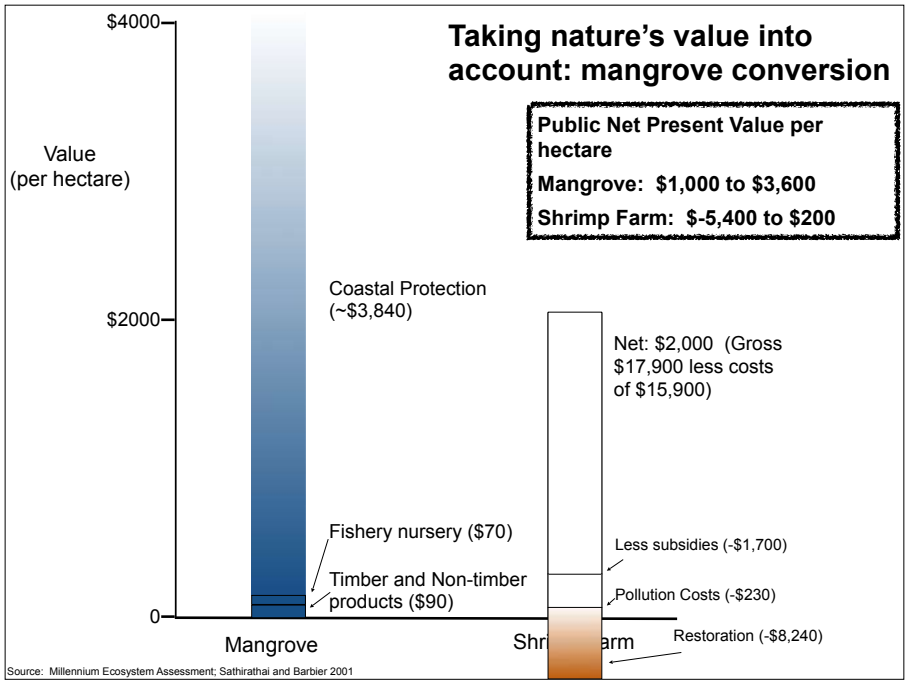
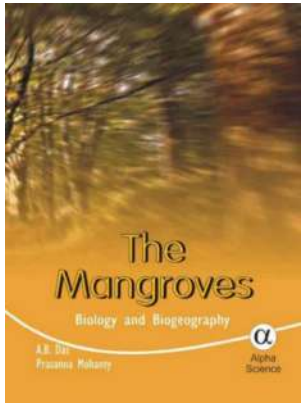
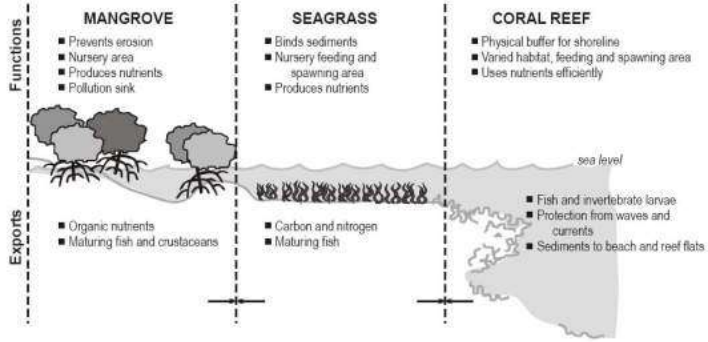


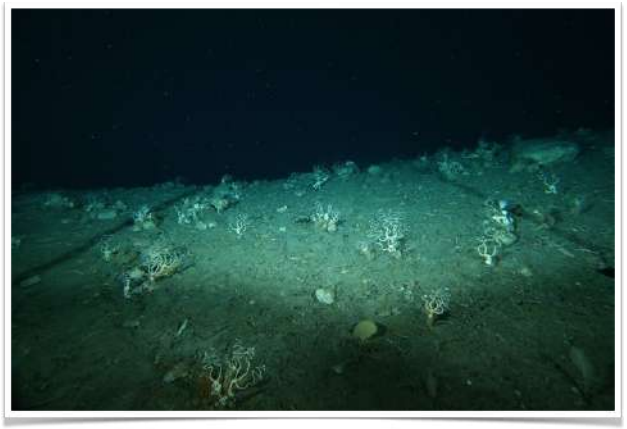
Marine habitats • Mangroves



Marine habitats • Continental



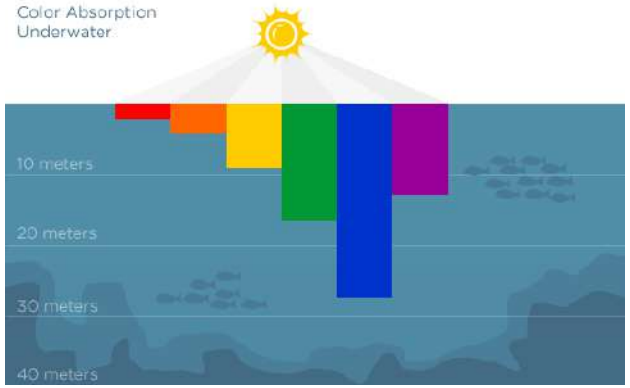
Marine habitats • Deep Sea



Marine habitats • Deep Sea

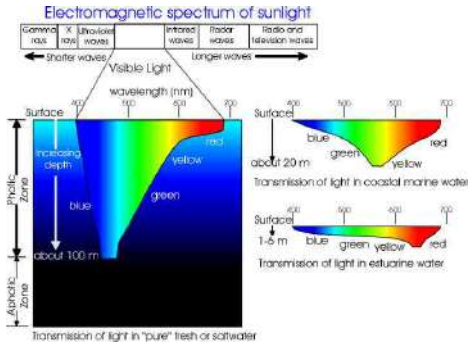
Marine habitats • Deep Sea

Light



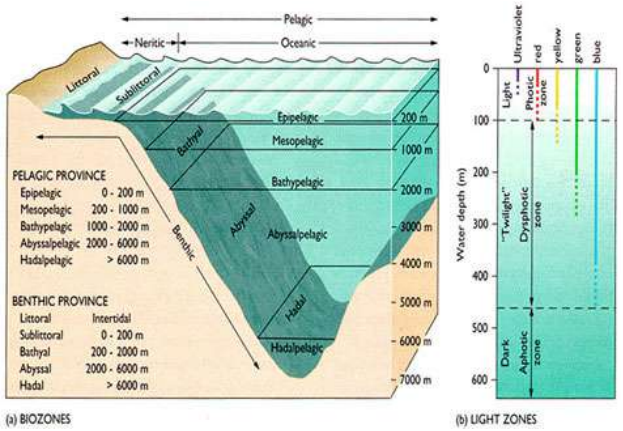
Marine habitats • Deep Sea

Light



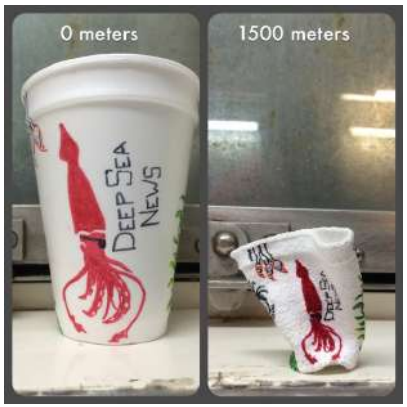
Marine habitats • Deep Sea

Light



Marine habitats • Deep Sea

Pressure



Marine habitats • Deep Sea

Pressure

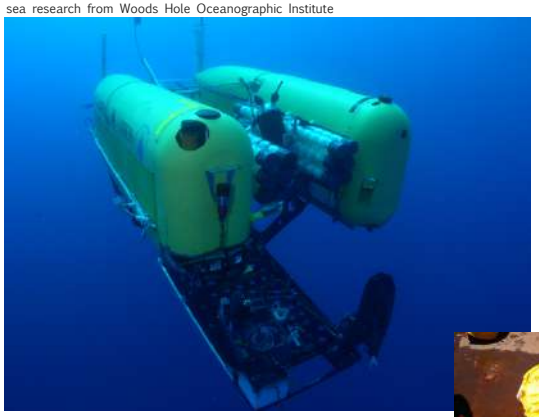
	Meters	Atmospheres	Deeposity *
Typical Scuba	30	3	meh.
Free Diver	180	18	impressive for a human.
Emperor Penguin	500	51	beats flying any day.
Deep submergence diving	701	71	whoa. just whoa.
Submarine	730	74	better than a minibus.
Sperm Whale	1200	122	kraken killer.
Elephant Seal	1500	152	king of the southern ocean.
Cuvier's Beaked Whale	2992	304	elusive ninja.
Alvin	6000	610	spherical wonder.
Abyssobrotula galatheae, the deepest fish	8370	851	lonely.
CTD	10000	1017	hardest worker in the ocean.
Nereus	10902	1108	RIP.

* A totally subjective measure of their deep sea prowess made up

Marine habitats • Deep Sea

Pressure

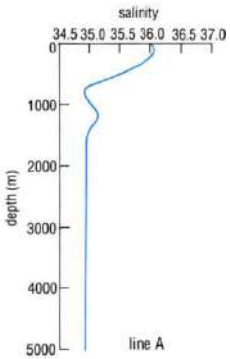
Nereus: $8 million hybrid-transformer-multipurpose-all knowing-swiss army knife of deep-sea research from Woods Hole Oceanographic Institute



May 10, 2014, catastrophic implosion of the vehicle

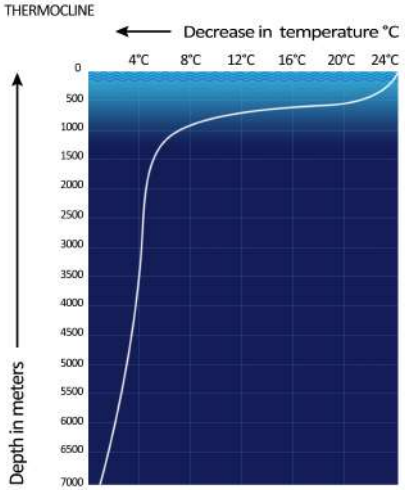
Marine habitats • Deep Sea

Salinity



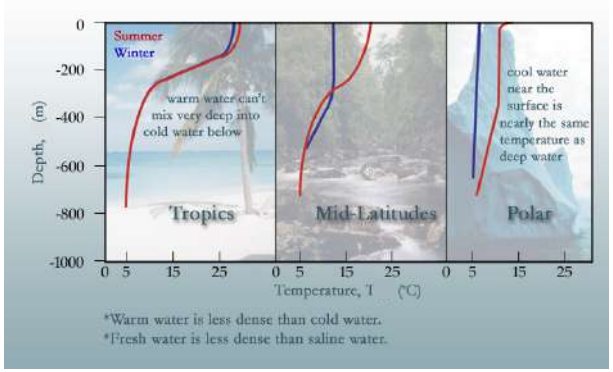
Marine habitats • Deep Sea

Temperature



Marine habitats • Deep Sea

Temperature

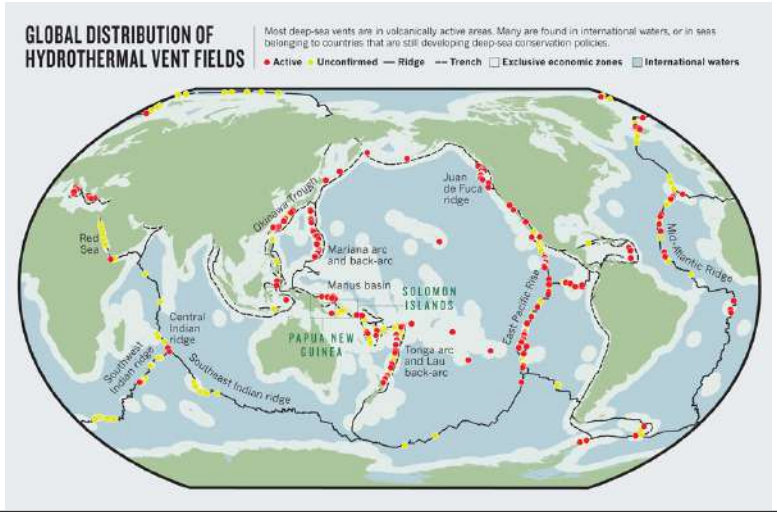


Marine habitats • Deep Sea

Temperature ??

Marine habitats • Deep Sea

Temperature



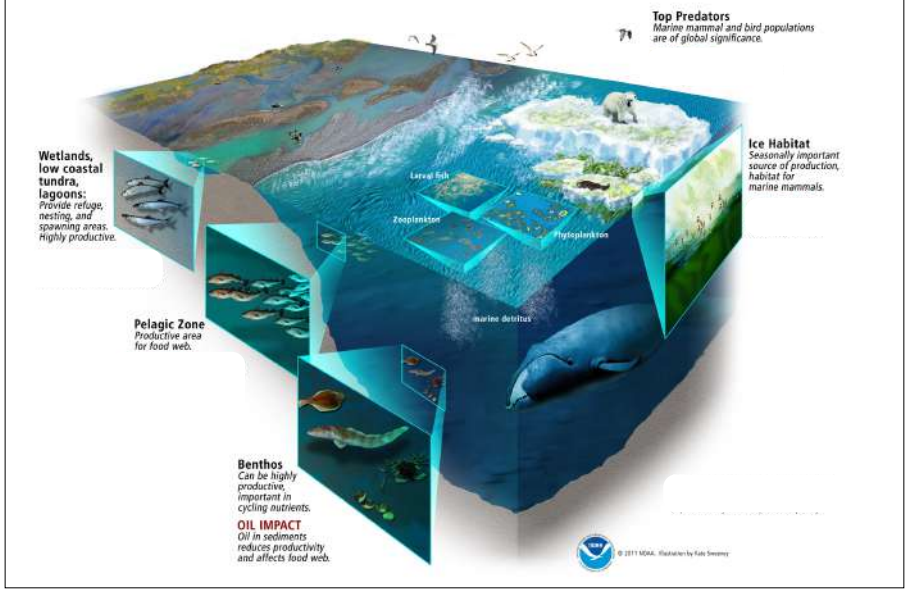
Marine habitats • Deep Sea

Environmental characteristics

Light	No light, no photosynthesis, no plants. Sources of energy?
Pressure	Pressure in the ocean increases by about 1 atmosphere for every 10 meters of depth, pressure is extreme
Salinity	Salinity is remarkably constant throughout the deep sea, at about 35 ‰
Temperature	Below 3,000 to 4,000 m, the water is isothermal between 0 to 3 °C. Exceptions: hydrothermal vents.

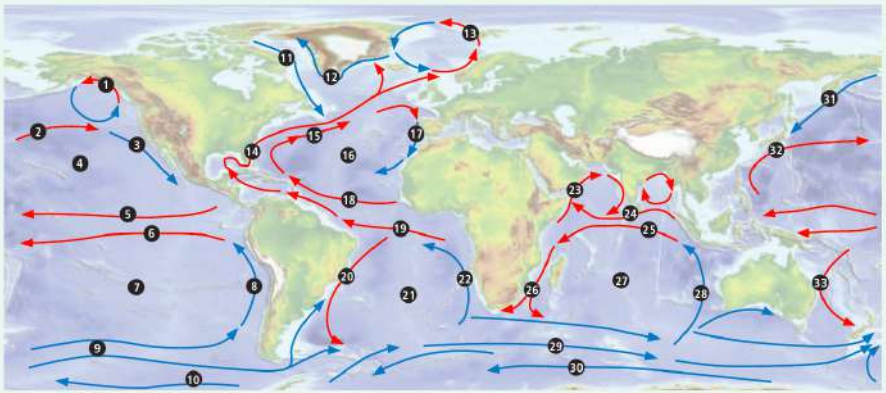
Marine habitats • Polar

Marine habitats • Polar



Marine habitats • Polar

Marine habitats



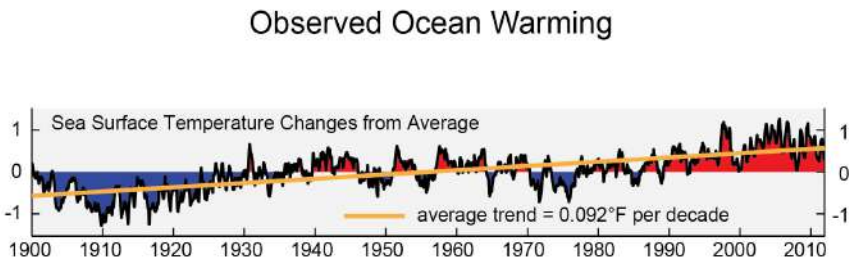
Each ocean has its own pattern of surface currents, dominated by huge gyres – circulating currents that flow clockwise in the northern hemisphere and counterclockwise in the southern. Within these, warm currents flow away from the tropics and cool currents return.

Warm current
Cold current

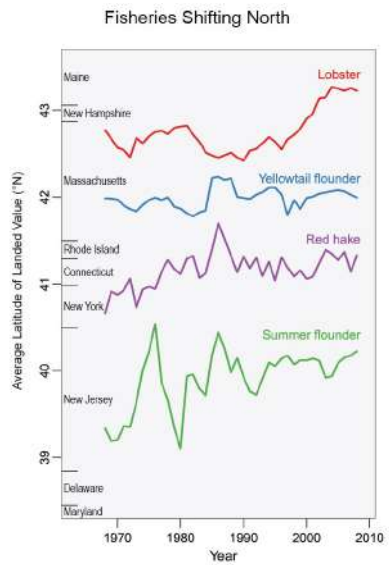
Currents and Gyres

1. Alaska
2. North Pacific
3. California
4. North Pacific Gyre
5. North Equatorial
6. South Equatorial
7. South Pacific Gyre
8. Peru
9. West Wind Drift
10. East Wind Drift
11. Labrador
12. East Greenland
13. Norwegian
14. Gulf Stream
15. North Atlantic Drift
16. North Atlantic Gyre
17. Canary
18. North Equatorial
19. South Equatorial
20. Brazil
21. South Atlantic Gyre
22. Benguela
23. Somali
24. North Equatorial
25. South Equatorial
26. Agulhas
27. Indian Ocean Gyre
28. West Australia
29. West Wind Drift
30. East Wind Drift
31. Oyashio
32. Kuroshio
33. East Australia

Marine habitats • Deep Sea



Marine habitats • Deep Sea



Pinsky, M. L., and M. Fogarty, 2012: Lagged social-ecological responses to climate and range shifts in fisheries. *Climatic Change*, 115, 883-891, doi:10.1007/s10584-012-0599-x