

Resources from the Sea

Ocean Food Resources:

Advantages:

- Seafood is a nutritionally advantageous source of animal protein.
- Seafood harvesting can release more land-grown grains for our consumption.
- Mariculture reduces the demands on land, water and energy.

Possible challenges:

- Most of oceanic biological production is planktonic (i.e., microscopic to submicroscopic) and dispersed.
- Continental shelf and estuaries cover tiny fractions of the earth's surface.
- The maximum sustainable yield of ~240 million metric tons per year is barely 10% of what is needed.
- Asia, with ~56% of world population, needs to double its energy and protein intakes to reach the world average at the comparable levels of prosperity, but already consumes ~75% of the world's seafood harvest.

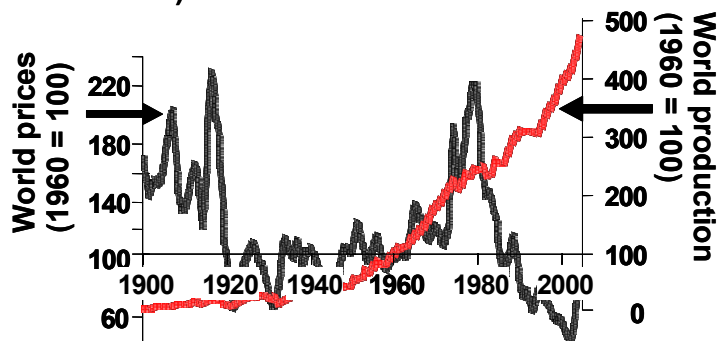
Ocean's Mineral Resources:

Ocean's already provide

- ~50% of our supply of Mg and Mg compounds, ~70% Br, ~15% Co, ~5% Mn and Ni, and ~0.5% Cu;
- ~30% of salt, ~10% of sand/gravel; and
- are an inexhaustible source of water.

- This is good. Mineral resources are crucial because they have defined the human history but are essentially exhaustible. Now, the basic rule of the market is that prices rise if demand exceeds the supplies, and fall when supplies exceed demand. If the prices stay flat, then we would assume that supplies have somehow stayed abreast of the demand. As the following graph of world price and production data for the four common nonferrous metals shows, demand

World price and production statistics for selected nonferrous metals (aluminum, copper, tin and zinc)

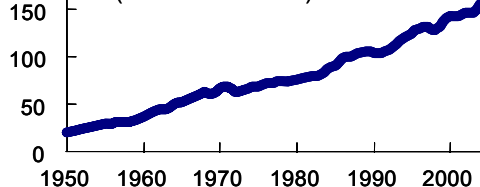


<http://minerals.usgs.gov/ds/2005/140/#data>

Marine biological productivity and harvest

Can oceans solve the world food problem? Worldwide, the 3.46 billion metric tons of total food production (2004) has been barely sufficient for the 6.46 billion population. If this population doubles to ~12 billion in another 50 years, and aquaculture becomes the source for much of the additional food that this population will require, then the world fisheries output will need to rise to ~3 billion tons. After all, seafood is not only a nutritionally advantageous source of animal protein

World Fisheries Output (million metric tons)



<http://earthtrends.wri.org/text/coastal-marine/variable-834.html>

Oceans cover >70% of earth's surface. One would therefore expect marine life to be more abundant than the life on land. But the biological productivity of oceans, at ~20 billion metric tons of carbon assimilation, is barely 80% of that on land (~25 billion metric tons of carbon assimilation). This is because, as photosynthesis is the dominant form of autotrophy on earth, biological activity in the oceans is limited to where nutrients are available in photic waters. Most of it occurs on the continental margins, where the nutrient-laden seafloor is photic as well, and in the regions of equatorial and circum-Antarctic divergence (up-welling and circulation retain nutrients in the photic surface waters here).

Ryther* used a novel approach to estimate the world's potential fish production. As is illustrated below, the total fish production world-wide is basically the product of total primary production and

	Primary productivity (g C/m ² per yr)	Total area (million km ²)	Total primary production (g C/m ² per yr)	Number of trophic levels	Net transfer efficiency	Total fish production (metric tons per year)
Oceanic	50	325	16.3x10 ⁸	15	0.0001	~1x10 ⁶
Coastal	100	36	3.6x10 ⁸	5	0.33	~120x10 ⁶
Upwelling	300	0.36	1.1x10 ⁸	1.5	1.2	~120x10 ⁶

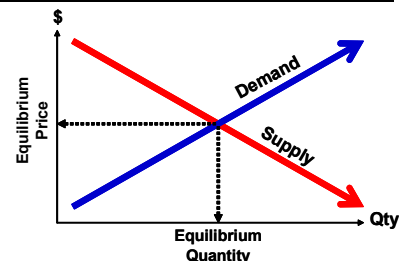
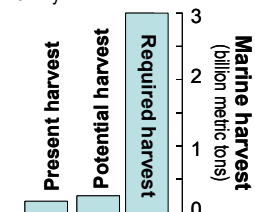
* J.H. Ryther: Science, vol. 166, pp. 72-76 (1969).

net transfer efficiency across all the trophic levels. Thus, while open ocean has most of the ocean's primary production, total fish production here is limited because the large number of trophic levels lowers the net transfer efficiency substantially. The upwelling regions cover a small fraction of the oceanic surface, and therefore have the least primary production amongst all the biologically productive parts of the ocean, but have very high net transfer efficiency because the very small number of trophic levels. Therefore, the world ocean's potential seafood harvest is barely one-tenth of what we would need if the oceans were to feed our growing numbers! Interestingly, even though our current seafood harvest is barely three-fifths of this potential level, over-fishing** is a problem that begs to be addressed.

**http://www.pewtrusts.org/pdf/env_pew_oceans_final_report.pdf

but will also free for human consumption the cereals and water now being used for the livestock.

Unfortunately, this is a far cry from the 156 million metric tons of total fisheries output worldwide in 2004 and the question is why.



for these metals has been rising steadily, but their inflation adjusted prices have remained flat. This is mainly because of the technological advances that have enabled extraction from lower-grade occurrences, so raising the quantity of reserves available. But commercial mining of manganese nodules that extensively litter the seafloor is unlikely anytime soon, because the supply of land based reserves may last for a long time.



<http://www.ngdc.noaa.gov/mgg/geology/mmdb.html>