Why is the Spring Bloom in the North Pacific “missing”?

N. Pacific--the Bering Sea blooms, but the rest of the North Pacific is low in biomass

N. Atlantic--widespread blooming of phytoplankton throughout the basin, not just near land
Fig. 3.—Average seasonal change in chlorophyll a (in mg·m$^{-2}$) at OWS P (1959–1970) from Anderson et al. (1977) and OWS I (1971–1975) from Robinson (unpubl. data).

Fig. 4.—Average seasonal change in primary productivity (0–50 m) at OWS P (1960–1966) from McAllister (1969) and OWS I (1971–1975) from Robinson (unpubl. data).
Behavior: Multiple Days

Migration by Growth Stage

Copepods produce eggs as a function of:
- Water Temperature
- Time of Year
- Availability of Prey

Egg production occurs mostly at night, when at depth

Development of early stages at depth is advantageous because:
- Fewer predators
- Can’t swim yet
- Minimizes advective losses

Figure 2.5 Copepods. (A) Typical copepod showing major anatomical features. (B) Outline of the typical life cycle of a copepod.
Figure 2.24 (A) The life cycle of *Calanus finmarchicus* in the North Atlantic Ocean. (B) The life cycle of *Neocalanus plumchrus* in the North Pacific Ocean.
What about Iron?

-The deep concentrations of iron are very similar in the North Pacific and North Atlantic (bottom panel), but the surface concentrations are very low in the North Pacific compared to the North Atlantic (top panel)

http://www-paoc.mit.edu/cmi/applications/biogeochemical.htm
Ecumenical Iron Hypothesis:

1) In the North Atlantic, Iron is not limiting, but in the North Pacific, Iron is limiting to diatoms--smaller cells are less iron limited, but are heavily grazed.

2) In the North Atlantic, there is very deep winter mixing (NADW forms); In the North Pacific, there is no deep water formation.

3) In the North Atlantic, zooplankton “bloom” after the phytoplankton, but in the North Pacific, zooplankton are present all year.

4) Iron limits diatom growth in the N. Pacific, and the macro- and micro-zooplankton control the limited diatom blooms and blooms of other organisms!
The Pacific’s Salmon Are Back — Thank Human Ingenuity

by ROBERT ZUBRIN April 22, 2014 4:00 AM

Geoengineering could turn our long-barren oceans into a bounty.
Iron Fertilisation Of The Oceans Produces Fish And Sequesters Carbon Dioxide. So Why Do Environmentalists Oppose It?


The ocean response to volcanic iron fertilisation after the eruption of Kasatochi volcano: a regional-scale biogeochemical ocean model study

A. Lindenthal¹, B. Langmann¹, J. Pätsch², I. Lorkowski², and M. Hort¹

Fig. 2. Atmospheric dispersion of the Kasatochi ash cloud from 8–11 August 2008 based on MODIS level 1b data at 11 and 12μm using brightness temperature difference (BTD) (from Langmann et al., 2010a).

Fig. 6. Comparison of observed Chl α concentrations at Papa for 2007/2008 (Hamme et al., 2010) and simulated Chl α concentrations for 2008 with and without iron fertilisation in August 2008.
Satellite chlorophyll-a image showing regions of elevated chlorophyll on 30 August 2012.
Plots showing CPR phytoplankton data (See Table I for derivation of indices).
Plots showing CPR zooplankton data.

Sonia D. Batten, and James F. R. Gower J. Plankton Res. 2014;36:925-932
In conclusion, while other factors may have had a role to play and we cannot exclude them based on the data we have available, it seems that the phytoplankton bloom induced in August 2012 could have been responsible for the high zooplankton numbers and subsequent low large phytoplankton and microzooplankton concentrations recorded by the CPR in the autumn of that year for the region considered here. Whether or not this in turn could lead to an increase in fish, or other higher trophic level, productivity in the region given the small size of the fertilized area, is outside the scope of this study, but the authors would like to see a full exploration of the data collected by the HSRC during this event.

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