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Mapping 20 years of Global Ocean Ecosystem Research

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Expert opinion

Mapping 20 years of Global Ocean Ecosystem Research

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Global Ocean Ecosystem Dynamics (GLOBEC) is a research program initiated in 1990. Its aim is: "To advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change." For GLOBEC this means focusing on shorter-term effects, such as over-fishing and the changing ways we use the seas, in addition to their overall efforts to investigate global change in the broadest sense.

To celebrate GLOBEC's 20 years of research, a bibliometric study has been conducted to identify the most important topics among GLOBEC's publications, as well as the most productive and highly cited authors and institutes. The best 35 articles of GLOBEC's 2,900 peer-reviewed papers over the past two decades have been collected together in a Compendium to be published as a standalone publication, under the journal Progress in Oceanography banner.

What determined the "best"?

First, we constructed a keyword co-occurrence map (see Figure 1) based on the co-occurrences of terms in the titles and abstracts of 2,134 of GLOBEC's publications. This map shows relations among 800 keywords. We can then see how often a term occurred by assessing the size of the font and the bubble. The closer keywords are to each other indicates how frequently they occurred together. This means we can see the most common areas of research, and how they relate to each other. Maps like these can be visualized at an overall level (as shown in Figure 1), but it is also possible to zoom in on keywords and topics to see more detail.

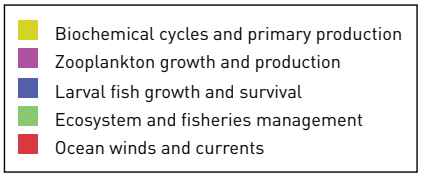
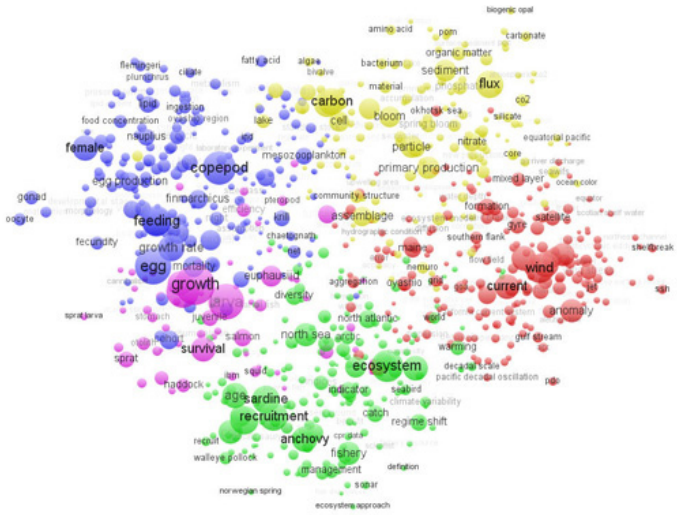


Figure 1 – Co-occurrence key word map for GLOBEC publications (screenshot from the original interactive map). Credit: With special thanks to CWTS.

Analyzing the map

This keyword co-occurrence map helps us characterize the structure and functioning of oceanic ecosystems.
In the top right section, the "primary production" compartment is represented in yellow. This includes phytoplankton, bloom, carbon and algae, together with nutrients (nitrate, silicate) and organic matter fluxes. This group of keywords can be characterized as "Biochemical cycles and primary production". As these phenomena are governed by the physical environment, they naturally neighbor the bottom right section in red, which represents physical conditions, such as current, wind and gyre, and characterized as "Ocean winds and currents".

Moving anticlockwise to the top left corner of the map, we see the "secondary producers" identified in violet. In this area, GLOBEC concentrates on copepods and their lifecycle. *Calanus finmarchicus*, the most abundant species in the North Sea and the principal food source for herring, is a preeminent subject. This is obvious considering that GLOBEC's key oceanographic sampling efforts were conducted in the North Atlantic, where *Calanus finmarchicus* is also abundant. This section can be classified as "Zooplankton growth and production".
The transition to the lifecycle of secondary producers, characterized as "Larval fish growth and survival", is depicted in mauve. This cloud merges into the green cloud representing "Ecosystem and fisheries management".



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Finally, the circle connects back to climate change (warming, decadal scale), thus closing the circle at physical environment studies into the red section, "Ocean winds and currents".

Because of GLOBEC's "whole ecosystem" approach and special emphasis on economically valuable fish species, certain keywords are found more towards the centre of the map. For instance, mesozooplankton (krill) and other planktonic components like euphasids are located more to the center, where community-level studies come together. Diversity studies, as well as some of the most widely sampled environments, also group towards the center of the map, indicating their value to all the areas of study.

Causing a splash

After identifying GLOBEC's five key subjects using the keyword co-occurrence map, we analyzed citation patterns for each of these areas (see Figure 2).

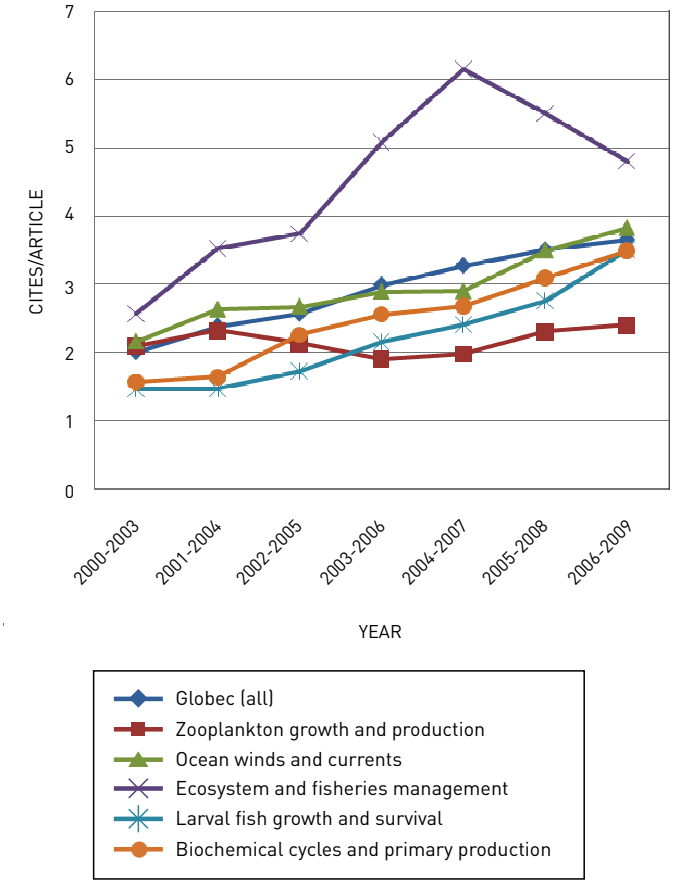

Figure 2 – Citations per article (three-year rolling window) for each of the five subject areas identified in the co-concurrence map, as well as for GLOBEC as a whole. Time periods have been represented in four-year blocks, with both publications and citations to those publications occurring in the same time period. Source: Scopus.

From this analysis, we can see that articles on ecosystem and fisheries management are by far the most highly cited. However, there has been a marked decline in citations since the peak in 2004–2007. All other subjects show steady growth in citations except for zooplankton research, which has remained relatively stable.

Combining output and citations between 2006 and 2009 shows us that ecosystems and fisheries is GLOBEC's most prolific and its most cited area of research (see Figure 3). This Figure also indicates that while zooplankton is definitely a prolific research field, it receives less citation attention than GLOBEC's other areas of expertise.

A picture of success

These analyses confirm that GLOBEC has met its original mandate "to advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems and its response to physical forcing." The map shows that it has covered all its stated areas of research and citation analyses confirmed that it has produced numerous and important studies that inform our "capability [...] to forecast the responses of the marine ecosystem to global change." Such studies are invaluable in assessing ongoing research programs.

At the same time, bibliometric analysis can overturn assumptions. In the GLOBEC study, we discovered that certain keywords, such as "modeling" or "benthos", were actually used less than we had expected.

Yet, perhaps the best outcome of such maps is that they help us clearly visualize an ambitious range of topics covered in a remarkable research program spanning 20 years

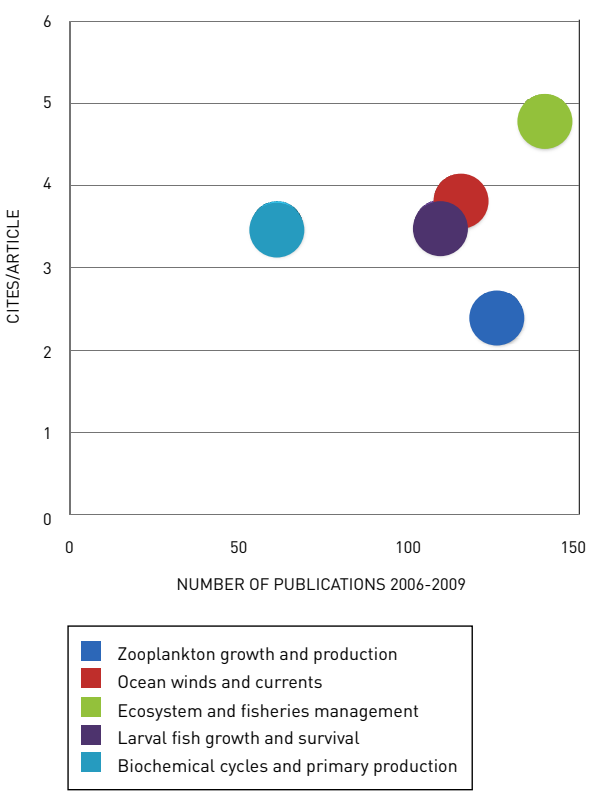

Figure 3. Comparing output with citations, ecosystems and fisheries management is clearly GLOBEC's most prolific and most cited subject area.