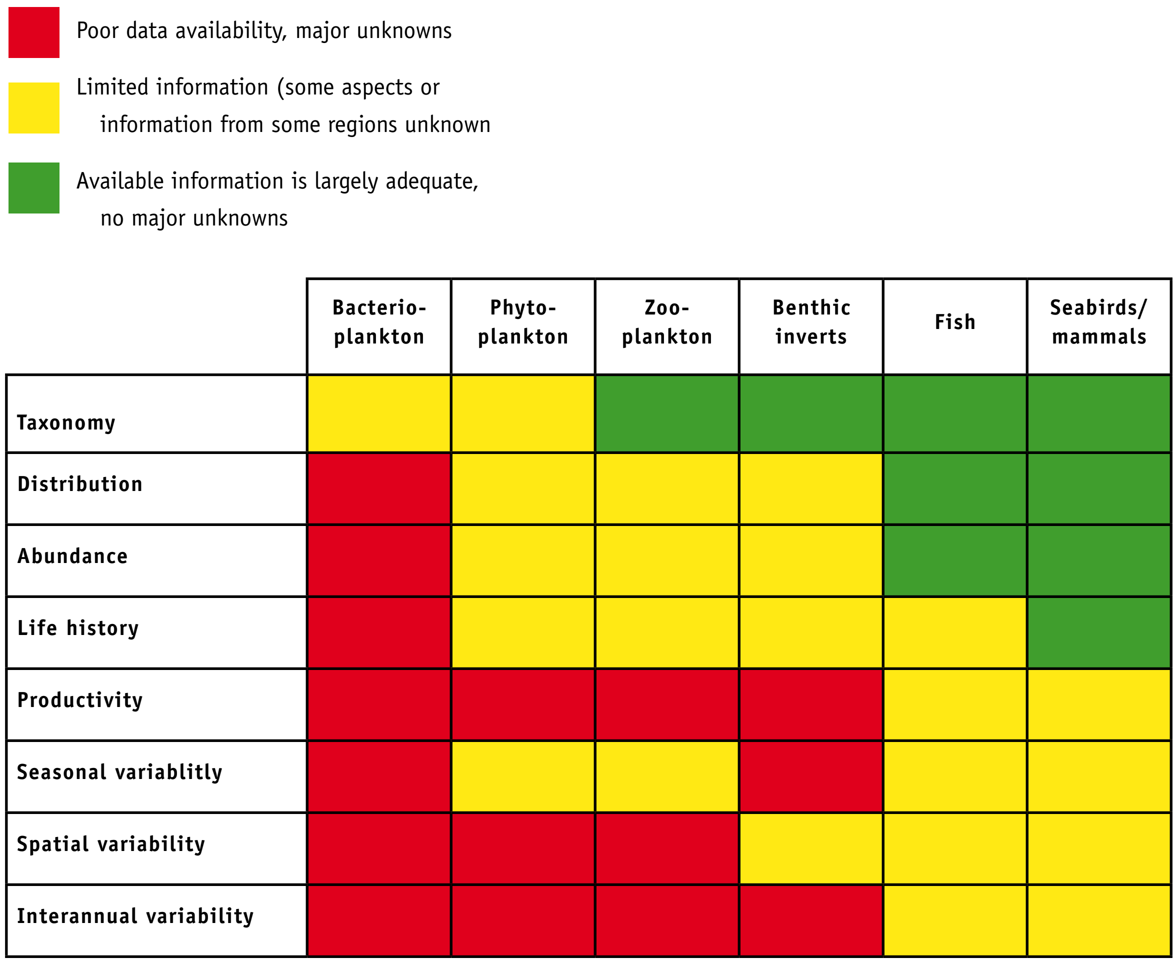
Much is known about marine life in the North Pacific Ocean. However, much remains unknown, but could be known if appropriate research were conducted. In addition to items identified as poorly known in the previous section, major questions include:

- what data are available but have not been “converted” to knowledge yet?
- is the particular knowledge relevant and worth knowing?
- why do we need it?
- what / where / when should we monitor?

the unknown



[Figure 11] Summary of unknowns in the North Pacific Ocean.

Figure 11 identifies many of the key unknowns about marine life in the North Pacific Ocean. This graphic provides a snapshot of taxonomic groups for which we have relatively good information (green squares), and those for which we have "relatively" poor information (red squares). Groups for which we have better information are represented by larger-sized taxa where information on individuals (some of the larger zooplankton, fishes, mammals, and seabirds) can be obtained. Taxa with less information tend to be the smaller organisms, and the missing information relates mostly to their ecological roles. By taxonomic group, the major unknowns are listed below.

Bacterioplankton

roles and importance are poorly understood because:

- of limitations of available technologies for identification and sample processing;
- many unknown taxa with the definition of "taxa" often relying on biochemical and genetic methods;
- of basic lack of information on distribution, abundance, and life history;
- estimates of productivity under oceanic conditions are not available;
- there is little or no information on seasonal, spatial, and interannual variability.

Phytoplankton

are somewhat better known, especially the larger forms (larger than 2 µm). However, understanding is lacking for:

- smaller organisms (smaller than 2 µm) in terms of species composition;
- productivity, where estimates are few and/or of poor quality;
- seasonal, spatial, and interannual variability, except in selected regions;
- what controls species composition within phytoplankton blooms (especially harmful algal blooms);
- which species can reach very high abundance while others remain at barely detectable levels;
- species composition of blooms that are detected by remote sensing.

Zooplankton

are generally better known than phytoplankton because of their larger size and longer generation times, but a number of critical unknowns remain:

- distribution and abundance of rare species/taxa;
- few estimates of productivity;
- very limited information on seasonal, spatial, and interannual variability, except in selected regions;
- a need for new sampling devices, *e.g.*, gelatinous zooplankton is difficult to capture and observe;
- limited knowledge of mid-water oceanic shrimps which are likely important components of open ocean food webs;
- limited understanding of very deep oceanic zooplankton.

Benthic invertebrate

taxonomy is reasonably well-known, at least for the macrofauna of the continental shelves. In general, however, many unknowns remain:

- deep-sea benthic invertebrates poorly described, with much of their ecologies and physiologies unknown;
- distribution, abundance, and life histories of many non-commercial groups;
- few estimates of benthic productivity;
- little available information on seasonal, spatial, and interannual variability, except in selected regions.

Fish

taxonomy, distribution, and abundance is reasonably well-described, in particular for those species of commercial interest. However, the roles of these organisms in multi-species assemblages, and in the ecosystem, and for many species, their life history characteristics, are less well-known. Information on non-commercial species is much poorer, to the extent that it is unknown whether or not most species are critical for the functioning of healthy ecosystems. Unknowns include:

- life histories of many species unknown (both commercial and non-commercial species);
- few productivity estimates for non-commercial species;
- limited information on seasonal, spatial, and interannual variability of many groups.

Seabirds and marine mammals

are perhaps best known because individuals can be observed and tracked, and because they must come to the ocean surface at some time to breathe. However, critical unknowns remain:

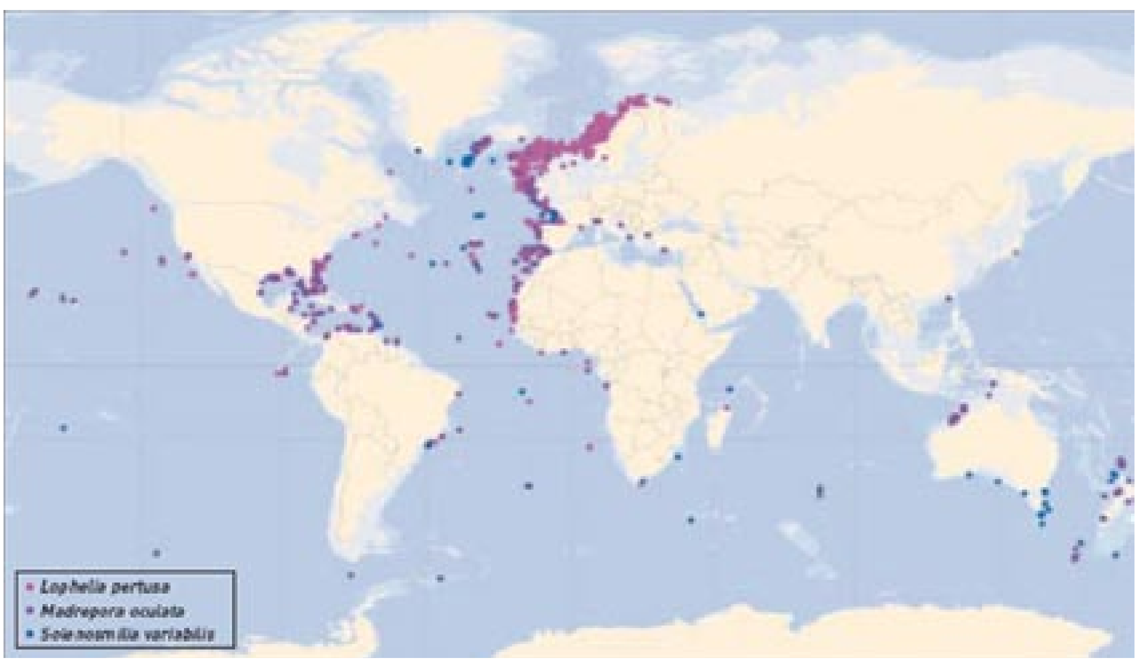
- productivities of many species in most regions;
- on seasonal, spatial, and interannual variability of many groups.

Aurelia aurita

Exciting discoveries

Two of the most exciting and surprising events concerning life in the oceans that have occurred during the past 20 years have been the discovery of deep-vent ecosystems, which derive their energy from chemosynthetic rather than photosynthetic processes, and the discovery of a new Kingdom of bacterioplankton (the Archaea). Such discoveries were unexpected, especially the deep-vent ecosystems. By the very nature of "surprise", it is unknown whether other ecosystems that exist on non-photosynthetic forms of energy might occur in the ocean. Deep benthic communities are generally poorly known, and it is certain that new species will be found among these communities. The past few years have seen an increase in awareness of deep cold-water corals (Figure 12), and a growing recognition that many of these coral species are undescribed, or have never been seen before. It is likely that are new species of invertebrates to be discovered, living in association with these deep corals – but discovering them is likely to require specialised sampling equipment. Many more deepwater coral aggregations have been found in the North Atlantic than in the North Pacific Ocean, however, this likely reflects a greater effort to sample in the Atlantic Ocean. For example, most deepwater coral reefs in the North Pacific Ocean were discovered from fragments of coral brought to the surface as bycatch in bottom trawling fish boats. There is an obvious need for more study of these ecosystems in the North Pacific Ocean, yet these deep, cold-water corals are increasingly being damaged and destroyed by deepwater trawling for finfishes.

During the past 20 years, there has also been increasing awareness of the importance of very small organisms and the microbial food web – both as a cycle itself, and its relationship to higher trophic levels. Some reports have suggested that a well-developed microbial food web may shunt energy and materials away from the "traditional" food web that leads to higher organisms, thereby decreasing the total productivity of higher trophic levels. Some studies have suggested that gelatinous zooplankton are particularly adapted to feeding on the organisms of microbial food webs, and that there is a dichotomy between diatom and dinoflagellate-based food webs which



[Figure 12] Global distribution of cold-water coral reefs: points on the map indicate observed reefs of varying size and stages of development, but not the actual area covered. The high density of reefs shown in the North Atlantic most probably reflects the intensity of research in this region. Further discoveries are expected worldwide, particularly in the deeper waters of subtropical and tropical regions.[11]

[11] Source: From Freiwald, A., Fosså, J.H., Grehan, A., Koslow, T., Roberts, J.M. 2004. Cold-water Coral Reefs. UNEP-WCMC, Cambridge, UK.

Pacific white sided dolphin

leads to fish production versus microbial-based food webs that produce jellyfish. Since gelatinous zooplankton are particularly difficult to sample quantitatively, and to capture live for physiological studies, the potentially contrasting importance of finfish versus gelatinous zooplankton food webs remains an important unknown. Resolution of this problem is likely to require new non-destructive, but rapid sampling methods.

An invaluable service that a program like the Census of Marine Life could offer would be to set standards and provide justifications for the development of new sampling systems for marine organisms. The experience of the discovery of the Archaea proves that new sampling systems will lead to new findings. Another activity which would benefit from Census of Marine Life leadership is encouragement to train new taxonomists, for invertebrate plankton and benthos in particular. This should include the use of genomic technologies to "rapidly" distinguish species. Building computer simulation models of food webs and ecosystem structure is also a valuable exercise to synthesise information, and to identify critical information gaps, *e.g.*, in species composition and their roles in ecosystem functioning and stability.