# Censusing Non-Fish Nekton

Carolyn Levi, Gregory Stone and Jerry R. Schubel
New England Aquarium • Boston, Massachusetts USA

This is a brief summary of a "Non-Fish Nekton" workshop held on 10-11 December 1997 at the New England Aquarium. The overall goals were: (1) to assess the feasibility of conducting a census of life in the sea, (2) to identify the strategies and components of such a census, (3) to assess whether a periodic census would generate scientifically worthwhile results, and (4) to determine the level of interest of the scientific community in participating in the design and conduct of a census of life in the sea.

This workshop focused on "non-fish nekton," which were defined to include: marine mammals, marine reptiles, cephalopods and "other invertebrates." During the course of the workshop, it was suggested that a more appropriate phase for "other invertebrates" is invertebrate micronekton. Throughout the report we have used the latter terminology.

Birds were omitted only because of lack of time. Within the reptile group, snakes and crocodiles were underrepresented; in the marine mammal group, pinnipeds were underrepresented. However, for the purposes of the workshop these deficiencies are not fatal.

Four white papers were commissioned to provide a point of departure for discussion at the workshop. The four papers deal with (1) marine mammals, (2) cephalopods, (3) invertebrate micronekton and (4) marine reptiles.

The participants ranked the categories of animals in terms of estimated biomass (Table 1) and knowledge relative to what remains to be learned (Table 2.)

**TABLE I**

**Non-Fish Nekton Ranked in Decreasing Order by Biomass***

| |
|---|
| Invertebrate Micronekton |
| Cephalopods |
| Marine Mammals |
| Marine Reptiles |

*Biomass of invertebrate micronekton probably exceeds the biomass of the other three categories combined.

**TABLE 2**

**Non-Fish Nekton Ranked in Decreasing Order of State of Knowledge Relative to What Remains to Be Learned**

| |
|---|
| Marine Mammals |
| Marine Reptiles |
| Cephalopods |
| Invertebrate Micronekton |

## SUMMARIES OF WORKING GROUPS

### Cephalopods

New higher-level taxa are yet to be discovered, especially among coleoid cephalopods, which are undergoing rapid evolutionary radiation. There are great gaps in natural history and ecosystem functioning, with even major commercial species largely unknown. This is particularly, complex, since these short-lived, rapidly growing animals move up through trophic levels in a single season.

1. Early consolidation of existing cephalopod data is needed, including the vast literatures in Japanese and Russian. Access to and evaluation of historical survey, catch, biological and video image data sets and collections is needed. An Internet-based repository, e.g. "Cephalopod Base," similar to "Fish Base," would help in consolidation and access and help get people up to speed for new projects. Support for Russian scientists and recent Ph.D.s could help solve the lack of human resources.

2. The mesopelagic region has the greatest potential to yield most new insights. It has the largest biomass and greatest diversity, including the enormous biomass in the deep scattering layer, and it is doable with technology we already have or could develop in a couple of years. Sampling techniques need to be cross correlated and improved. We suggest a multiple gear approach, combining manned submersible and ROV images, optical scanning technologies, net sampling, and multiple acoustic technologies. Include marine mammal tagging and tracking and intense sampling in areas where whale studies are ongoing or possible.

3. The paralarvae of mesopelagics are currently unidentifiable. DNA techniques could link life history stages and lay groundwork for studies of cryptic speciation.

4. Archival radio pop up tags could work for learning about larger species of ammoniacal squids – *Histioteuthis and Moroteuthis* – in the mesopelagic region.

5. Participate in four location intensive and four transect mesopelagic censuses with the Invertebrate Micronekton group. With the Invertebrate Micronekton group, we identified the location-intensive sites as:
   (a) The canyons of the south side of Georges Bank and the "Gully," off Sable Island, Nova Scotia (the Gully is rich in *Histioteuthis* and sperm whales).
   (b) Bahamas/Caribbean
   (c) Monterey Bay
   (d) Sagami Bay, Japan

These surveys would also benefit a census of micronektonic fishes. Include collaboration with "cetacean samples" and a day/night regime.

## Marine Mammals

A review of marine mammal distribution and abundance led us to conclude the largest gaps in our knowledge centered around interactions and functions within habitats. In many cases, we don't know where appropriate surveys should begin and end (i.e. the ranges and seasonal movements of animals are poorly defined or unknown). Greatest value will come from counting populations that are rapidly increasing or decreasing or that are moving around over a lot of ocean. To make a quantum leap forward in understanding the worldwide distribution, behavior, abundance, diversity, and ecological roles of marine mammals, we outlined the following prioritized strategy, which is dependent upon three or four large bags of money.

*Greatest value will come from counting populations that are rapidly increasing or decreasing or that are moving around over a lot of ocean.*

**Bag 1. New Devices** (e.g. satellite telemetry, miniaturized sensors, bells and whistles; 50,000 tags are needed, a 1000-fold increase in tagging)

1. What can we measure or obtain:
   (a) light, color, temperature, salinity, orientation, position, sound, chemical and olfactory cues, bioluminescence, visual imagery, physiology.

2. What will it teach us?
   (a) oceanographic and sea-truth sampling stations.
   (b) the definition of home ranges, seasonal movements, and habitat use patterns, which will help define subsequent survey requirements.
   (c) G(0) corrections – dive time data to allow corrections to survey data on the amount of time an animal is present at the surface.
   (d) information about physiology, prey, feeding behavior, habitat use and oceanography correlated in 3D, with emphasis on the scattering layer.

**Bag 2. Worldwide inventories**

1. Space imagery
   (a) aggressively pursue this option to test its limits and applicability.
   (b) turtle beach assessments, pinniped haulouts, polynyas, breeding lagoons, and the feasibility of counting some whale species (belugas, grays, rights).
   (c) investigate high resolution infrared for night time and Arctic assessments.

2. Surveys of regions
   (a) integrate survey planning with other ongoing data collection and archival organizations.
   (b) aerial (standard transect methods).
   (c) shipboard (transects, plus oceanography, molecular biology, and acoustics).
   (d) quadrant sampling (predetermined stations, with observing and sampling of oceanography, biology at all trophic levels, acoustics, benthic ecology, and molecular biology).
   (e) nuclear submarines as research platforms.
   (f) acoustic tomography assessment of biomass.
   (g) needs are in developing countries, feasibility studies may be more cost effective in areas where more baseline information is available.
   (h) base surveys on earlier telemetry work.
   (i) include and assess human activities within every survey protocol.

**Bag 3. Modeling**

1. Use the data collected from the first two bags to develop system models that will provide predictive power for trends in distribution and abundance vs. changes in habitat, global climate, human activities, and the price of pork bellies.

**Bag 4.** Repeat in x years, where x is something less than 100.

Additionally, we predict that new species will come primarily from "splitting" rather than new discoveries.

## Invertebrate Micronekton

We want to assess the diversity and abundance of mesopelagic animals. This is the largest habitat on earth and it contains the least known major faunal groups.

1. The recommended approach is ecological and functional rather than strictly taxonomic: Identifying animals in the context of their ecological roles or niches, and using this framework as a means of

categorizing and organizing the data on their diversity and abundance.

2. This approach would be best initiated by working first in an area or areas where a basic data set exists (coastal), using this information to create the ecological framework, then expanding the scale of operations to include boundary current and central gyral regions.
3. The recommended technological and methodological approach involves both remotely operated vehicles and manned submersibles to conduct *in situ* surveys and sampling in the upper 1000m of the water column.
4. These platform technologies would be supplemented by acoustic and optical instrumentation which themselves would be integrated to maximize their survey effectiveness.
5. Traditional acoustic and trawl sampling would also be integrated into the program.
6. This effort would include cephalopods and midwater fishes as well as the invertebrate micronekton. Additional added value would accrue from integration with surveys of other nekton (e.g. fishes, whales, turtles).
7. The effort is based on existing technologies, albeit with some in novel applications and combinations.
8. We believe that this approach is feasible and would be cost-effective for closing the largest gaps in our understanding of marine biodiversity.

## Marine Reptiles (Sea Turtles)

While sea turtle ranges have been delimited to some extent – through data collected in targeted fisheries, incidental takes and strandings – most studies are concentrated on nesting beaches. These include the more accessible, identifiable beaches and leave all but nesting females and hatchlings largely unaccounted for. Gaps in assessment, understanding turtle functions within their habitats, and understanding life history include not knowing where pelagic juveniles go after reaching a certain size; how many turtles are nesting on a worldwide basis; and many reproductive parameters, including the size of reproductive units and whether or not nesting populations are unique stocks.

We have identified the following major gaps/research needs (with the caveat that our "group" consisted of two persons):

1. Study nesting assemblages as population/reproductive units.
2. Apply sampling techniques on a worldwide basis to ascertain global status of seven species.
3. To develop and fully utilize remote sensing-derived information to provide or improve precision of census information for nesting females, pelagic, and benthic life history stages.
4. To develop and deploy a permanent tag that will provide information on migratory routes, age, mortality, and other information, and to build and maintain an accessible database.
5. To develop and utilize remote sensing technologies to map habitat types, and together with satellite tags (of some type), to determine migratory routes and pelagic habitat preferences.
6. Predicting where turtles are, based on habitat preferences will allow census sampling to be more efficient and more meaningful.
7. For some life history stages, catch per unit effort may be estimated rather than absolute abundance; however, sampling must be conducted globally.
8. Aerial or remote survey techniques will be developed that will allow census for all species in all areas of the globe, particularly those that currently lack coverage.
9. For long-lived species (sea turtles and the like) research commitments must be long-term in order to develop meaningful time series.
10. This information, once gathered, can be utilized to develop predictive population models to track/evaluate recovery of depleted populations worldwide.
11. On priority basis, we need to target world oceans where we have the least information on sea turtle populations.

Do we need a census? Yes. Are we interested in participating? Yes. Do we want collaborators? Yes, especially from the marine mammal group, with which we share tagging technology needs.

## CONCLUSIONS AND RECOMMENDATIONS FOR WHICH THERE WAS UNANIMITY OR NEAR UNANIMITY

1. There was unanimity that "it" is worthwhile, that the group wants "it" They want "it" as soon as they can get "it," as much of "it" as they can get, and for as long as they can get "it."

2. We seek a fundamental understanding of the way things live and die in the sea.

3. There is more than one metric of abundance; in some cases biomass (e.g. cephalopods) may have more meaning than numbers of individuals. We would like to quantify biomass at least in the top trophic levels, and across the age spectrum of species. We may be able to predict productivity from biomass and energetics.

4. Collaborations will add value to any efforts to take a census of life in the sea: collaborations between technologists and marine biologists; collaborations between physical oceanographers and biological oceanographers; and collaborations among scientists interested in different animal groups.

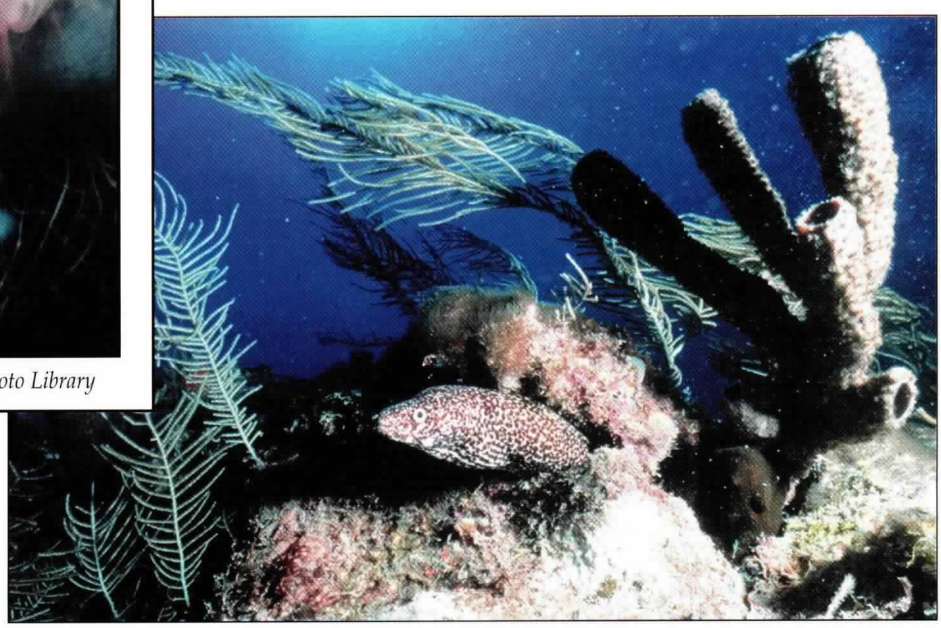
5. Technology was a recurrent theme throughout the discussions. There was a strong consensus that existing technologies had not been fully exploited, particularly the opportunities for marrying different kinds of technologies such as acoustic and optical sensors, and for exploiting advances in computer technology, sensors, and submersibles. Other technologies that offer particular promise are "critter cams" and tags. By ground-truthing remote technologies against sampling, we would like to remotely identify taxa, to the species level, where possible.

6. Animals have great underutilized potential as "platforms" for research. The application need not be restricted to large mammals and reptiles. Animals equipped with sensors could provide invaluable information about diversity, abundance, distribution, behaviors, and oceanographic parameters. Breakthroughs will depend upon advances in the tag industry. These advances must include not only making tags smaller and of lower power requirements and longer battery life, but also a maturation of the tag manufacturing industry to meet the anticipated demands for far greater numbers of tags. At present, tags are manufactured one at a time by several small firms in a very small cottage industry.

6. The value of simply having more ship and submersible time should not be underestimated. Every new expedition leads to greater understanding, and often to entirely new discoveries, particularly when there are trained observers on board. We have not fully utilized the technologies we already have.

7. Of looming concern, especially in the cephalopod and micronekton groups, is that a census will be constrained by the small population size and poor funding of systematists. There are few people qualified to identify the animals we want to census, and career paths for new systematists are limited.

*Credit: NOAA Photo Library*



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