SAMPLING

Pelagic - “open sea”, or the water column
Benthic - “bottom”
Oceanic - refers to the open ocean environment
Neritic - the inshore, often defined as shelf depths (200 metres or less)

Nekton = organisms capable of making significant headway against currents

Plankton = organisms NOT capable of making headway against currents
Biological Sampling

**Issues**

- **Size of target organisms**
  (too small or big for sampler)

- **Number of target organisms**
  (rare, common, clogging)

- **Behaviour of organisms**
  (avoidance, attraction)

- **Patchiness of organisms in space & time**
  (evenly distributed, patchy)

- **Structure of environment**
  (cryptic species, logistic issues)

- **Ethics**
  (whales, habitat destruction)

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**Plankton**

- ![Plankton Image]

**Nekton**

- ![Nekton Image]

**Benthos**

- ![Benthos Image]
Traditionally, we have sampled the oceans in two ways.

1. Dedicated **oceanographic cruises** (typically weeks in duration) drawbacks….
   - other times?
   - storms, under ice etc.?

2. Deploy oceanographic sensors on **fixed moorings** drawbacks…
   - limited duration/sampling intensity (battery power)
   - data available after mooring recovered
   - mooring may be lost
   - require ship for deployment & recovery
   - poor spatial resolution
NEPTUNE – Deep-sea observatory now in development

A marine observatory has two key attributes:
1. Power to instruments (duration & sample frequency not battery limited).
2. Data transmission to shore in real time.

Key drawback: Spatially fixed and limited.
Protista - small unicellular organisms, some of which have photosynthetic capability and others of which do not.

Radiolarian

Tintinnid
Phytoplankton: Sampling

• net sampling
  - small size of phytoplankton necessitates very fine mesh
  - very poorly quantitative (clogging)
  - stress on cells (some burst)
  - miss smallest cells

• transmissometer - shine a beam of light across a path of water and measure how much light reaches the other side
  - not just phytoplankton blocking light, particularly in coastal waters

• fluorometer - generates light at a given wavelength, which will cause pigments to fluoresce. Measure chlorophyll fluorescence to estimate phytoplankton conc.
  - fluorescence varies with different species & conditions
  - can be made in-situ
  - can be related to carbon, but
    Fluor:Chl pigment and
    Carbon:Chl not constant
Phytoplankton: Sampling

- bottle sampling (Nansen (old), Niskin, or Go-Flo)
  - samples most abundant phytoplankton (smallest)
  - need to concentrate sample for larger cells

-bacteria, protista, phytoplankton
Rosette of Niskin Samplers
Multispectral Fluorometer

-fluorescence ~ phytoplankton
Flow cytometry uses pigments

In situ flow cytometer
SeaWifs - Sea-viewing Wide Field-of-view Sensor

- subtle changes in ocean color can signify various types and quantities of marine phytoplankton

**Problems**
- Nearshore (other particles
- Cloud, fog
- Surface veneer only
**Holoplankton:**
Zooplankton that complete their entire life cycle in the water column.

**Meroplankton:**
Organisms that spend time in the water column but also as part of the benthos. Primary example is planktonic larval stage of benthic adults.

**Zooplankton:**
Animals that live in the water column but are incapable of making substantial headway against currents.

**Nekton:**
Pelagic animals capable of making headway against a current.
**Zooplankton: Sampling**

**Net** collection - catch organisms retained on the mesh
- various net sizes, shapes, mesh sizes
- wide mouth opening on a metal ring, collecting jar on narrow cod end
- towed horizontally, vertically, or obliquely
- opening and closing nets available - sample selected depth intervals
- flow meter allows estimate of water volume sampled
- some zooplankton detect nets (visually or from turbulence) and avoid them
- some gelatinous zooplankton are destroyed

- 100-200 µm mesh used to collect large micro- & macro- zooplankton (200+)
  - clogs quickly
  - must be towed slowly (to avoid tearing)
  - fast-swimmers avoid it

- nano- and microzooplankton (< 200 µm) not quantitatively sampled in nets
  - collect water in bottles or by pumps instead and concentrate water sample (centrifugation, filtration, settling)
- oblique or vertical tows

- paired samples for various analyses

- different mesh, net size for different applications
  (e.g., ichthyoplankton 333mm, bivalve larvae 100mm)
Hardy-Longhurst Plankton Recorder

towed behind ships of opportunity

collects multiple zooplankton samples for wide spatial coverage

Moored version (with pump, computer)
Opening-closing nets
-allow sampling at a discrete (single) depth

MOCNESS
-Multiple Opening / Closing Net & Environmental Sensor System
-allows collection of multiple discrete samples
-expensive and difficult to handle
Video Plankton Recorder

- very fine resolution
- animals in context
- limited taxonomy, no good for low densities
Acoustic towed body
- fine scale resolution
- broad coverage
- poor taxonomic resolution
<table>
<thead>
<tr>
<th>Gear</th>
<th>Deployment</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
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<tbody>
<tr>
<td>Plankton nets (fine)</td>
<td>Small boat</td>
<td>Cheap, any platform</td>
<td>poorly quantitative for some taxa (net avoidance, bow wave), integrates depth</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Plankton nets (coarse)</td>
<td>Small boat</td>
<td>Cheap, any platform, large volume sample for some taxa, misses smaller taxa, integrates depth</td>
<td></td>
</tr>
<tr>
<td>Opening/Closing nets</td>
<td>Larger boat</td>
<td>Quantitative, any depth</td>
<td>Need big ship, cumbersome, expensive</td>
</tr>
<tr>
<td>Pumps</td>
<td>Medium boat</td>
<td>Quantitative, no hydrodynamic bias</td>
<td>Can be expensive, small volume</td>
</tr>
<tr>
<td>Towed Video/acoustic</td>
<td>Medium boat</td>
<td>Quantitative, broad coverage</td>
<td>Expensive, poor taxonomic resolution</td>
</tr>
</tbody>
</table>
Fisheries Scientists Participate in Harvesting

**Eggs and Larvae**
- Midwater Trawls (e.g., Tucker)
- Pumps
- Nest Surveys

**Juveniles**
- IGYPT Trawl
- Beach seine
- SCUBA
- Traps
- Tagging
- Submersibles

**Adults**
- Nets (e.g. Campelan Trawl)
- Acoustics
- Ladders
- Tagging
- Fisheries Data
- Submersibles
- Scuba
- Aerial surveys
Passive versus Active Entrapment Gear

**Active Entrapment Gear** is towed or pulled through the water

**Passive Entrapment Gear** is fixed gear
- attraction to bait
- predictable paths of movement
Bottom dredges
Trap

Gill net

Pelagic trawl

Purse seine
Species Selectivity

Longlining
- bait, hook shape and size very important

Trawling
- mesh size and selectivity
- bycatch
- behavior of fish
- habitat structure

Nets
- square versus diamond mesh
- length of cod end and net
- mesh size
SMOLOWITZ
FIGURE 5
(page 51)
Lobster traps.
Drawing by
Robin Amaral.
Fisheries acoustics...

- Samples whole water column
- Non-invasive/destructive, so natural behaviour relatively undisturbed
- School behaviour (schooling)
- Gear-avoidance issues reduced
Meiofauna

copepods

crustacea

Macrofauna

> 44 or 63 μm

Molluscs

Echinoderms

Decapods

Polychaetes

Foraminifera

Nematodes

Megafauna visible in photos

> 300 μm
Grab sampler
- semi-quantitative
- bow wave
- shape of sample
- shallow only
Epibenthic sled

- semi-quantitative
- deep and shallow
- Hyperbenthos and epibenthos
Box / Spade corer

- quantitative
- deep and shallow
Multi corer

• Quantitative for macro and meiofauna

• Deep and shallow
Submersibles

- allow collection of samples at precise scales and locations
- very expensive, difficult to get

ALVIN
SCUBA divers
-can access only a very restricted subset of habitats
-time consuming and difficult to access broad areas
-tropical diving not the norm!