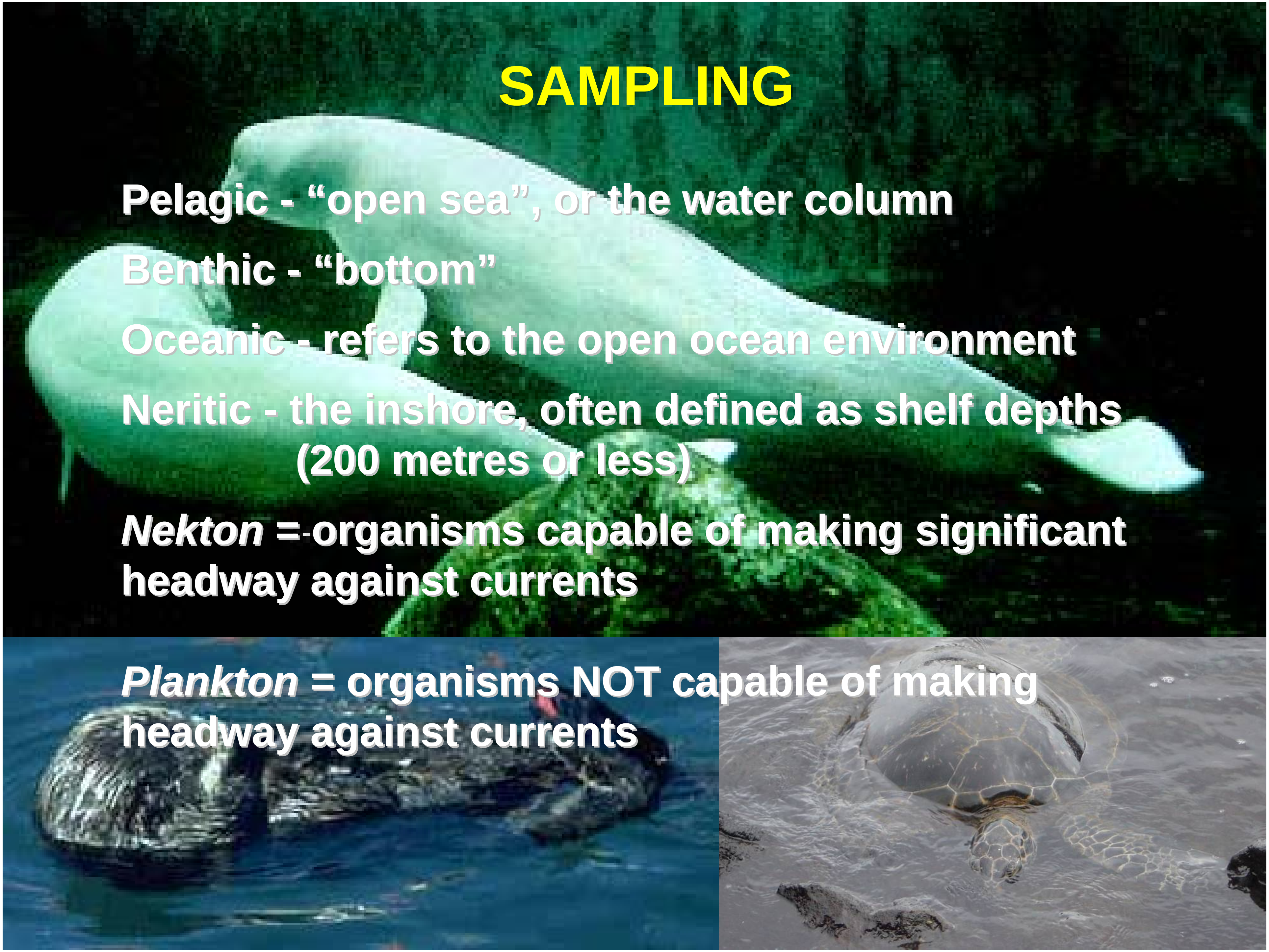
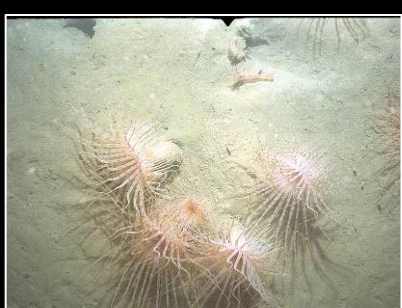

SAMPLING
Pelagic - “open sea”, or the water column
Benthic - “bottom”
Oceanic - refers to the open ocean environment
Neritic - the inshore, often defined as shelf depths (200 metres or less)
Nekton = organisms capable of making significant headway against currents
Plankton = organisms NOT capable of making headway against currents

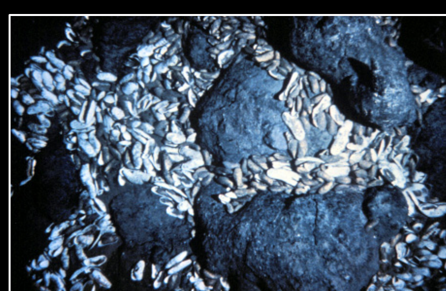
Biological Sampling

Plankton

Nekton

Benthos





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)

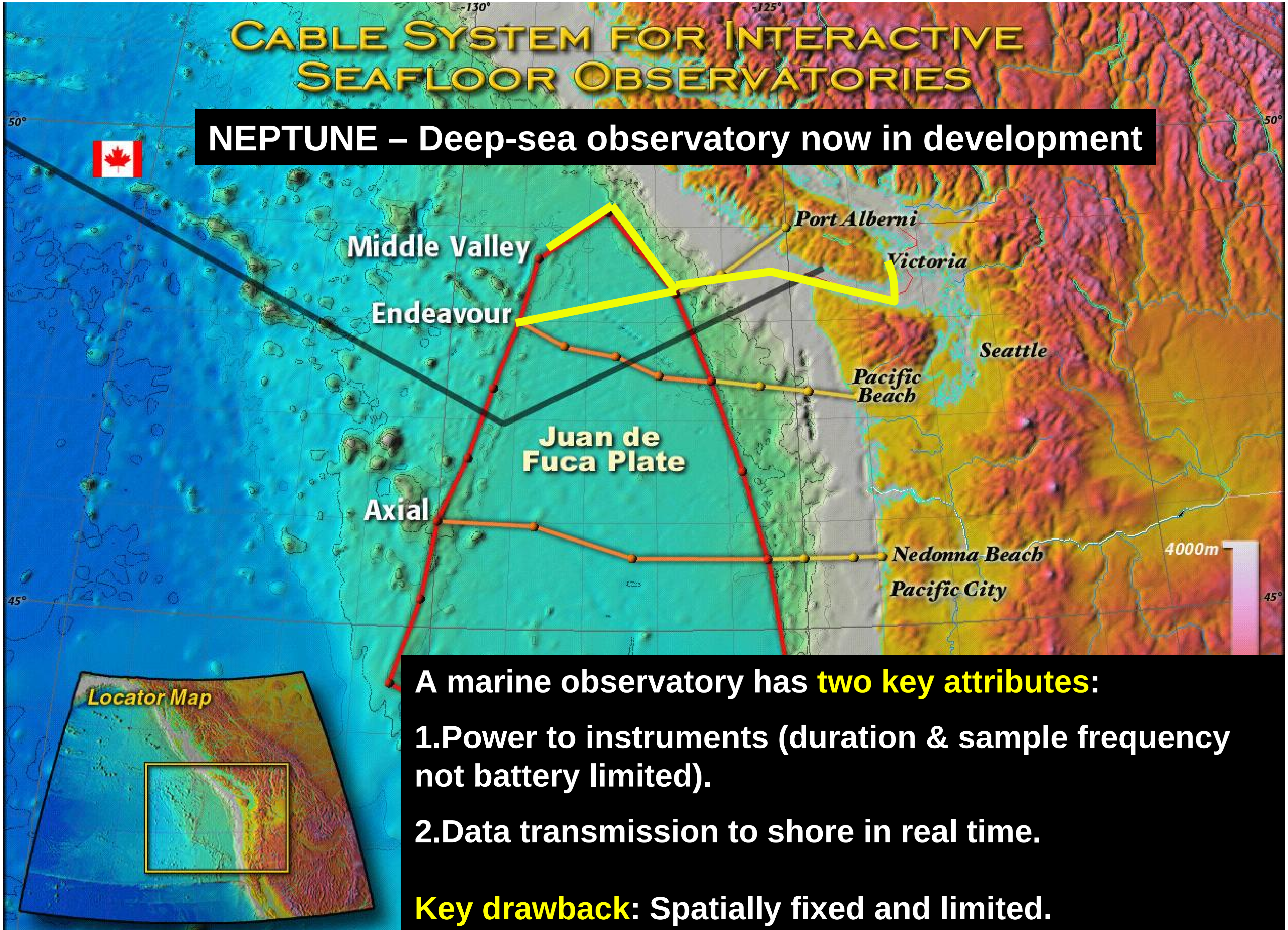
- **Ethics**
  (whales, habitat destruction)

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**:

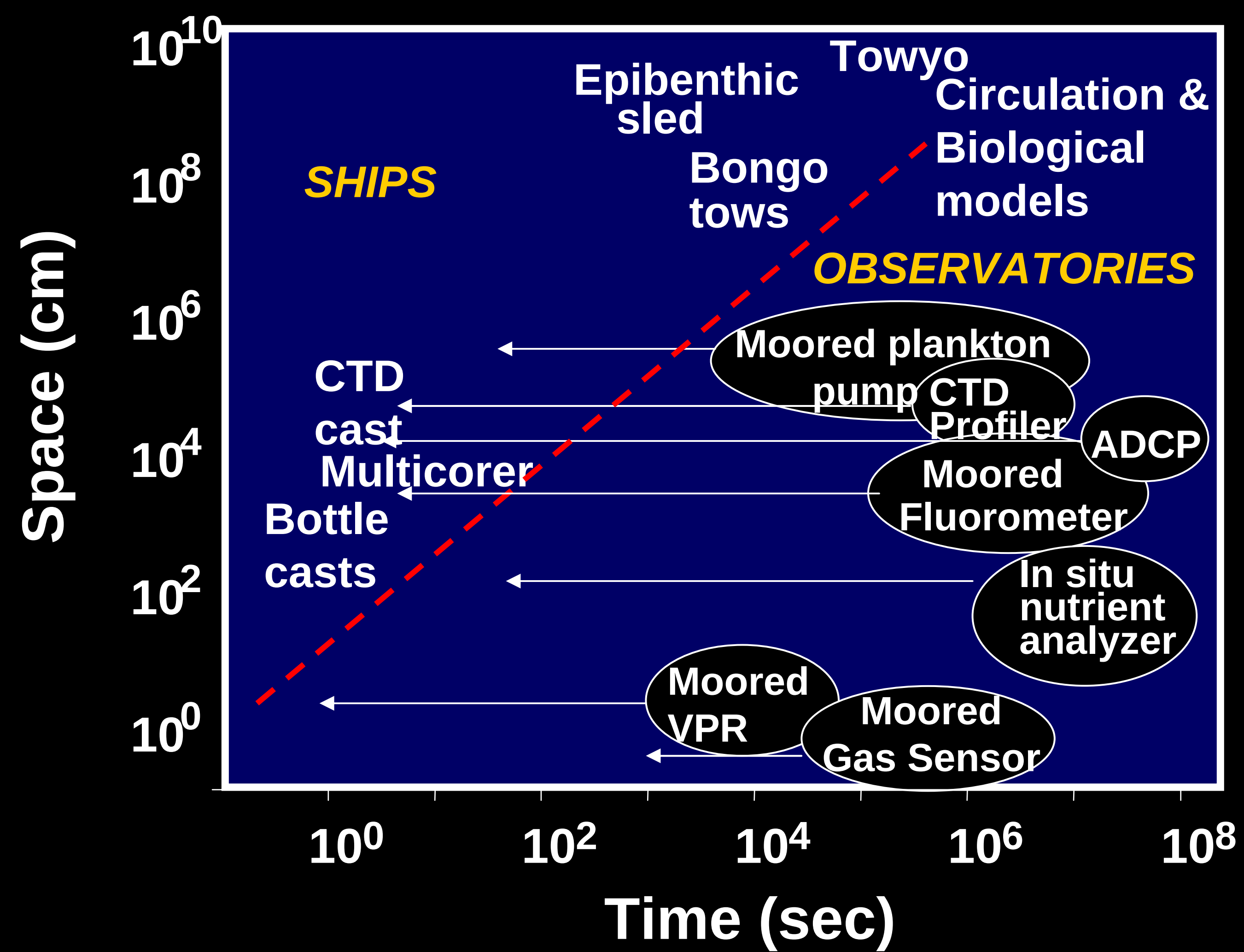
1. Power to instruments (duration & sample frequency not battery limited).

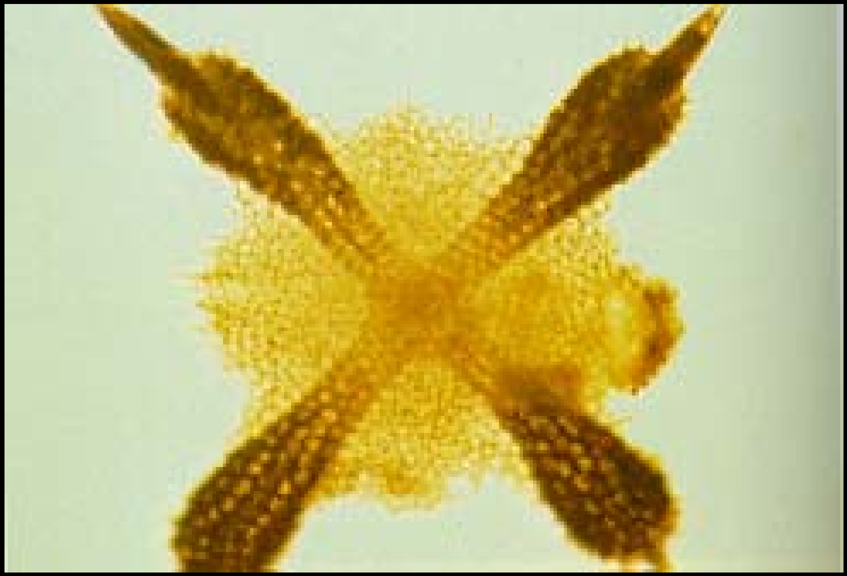
2. Data transmission to shore in real time.

Key drawback: Spatially fixed and limited.

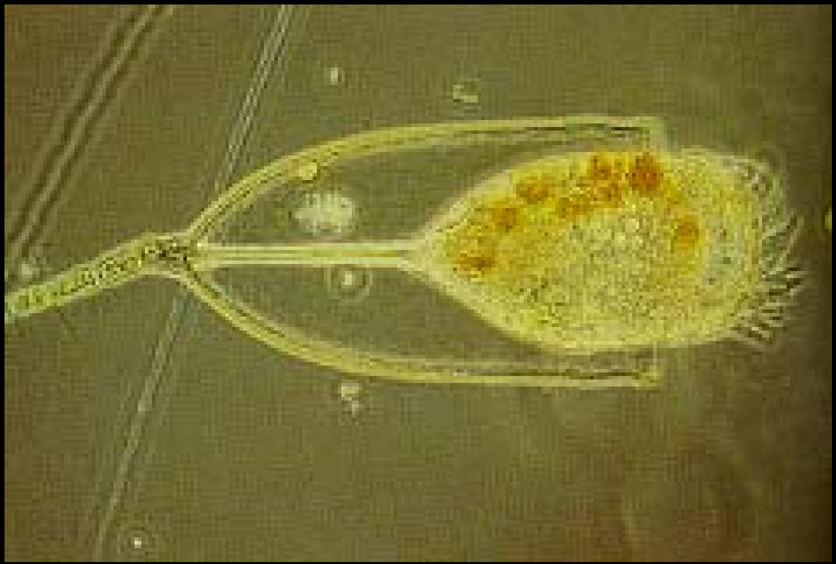
data source: Smith, W. H. F. and D. T. Sandwell, Global Seafloor Topography from Satellite Altimetry and Ship Depth Soundings combined with GTOPO30

Time-Space Plot for Instrumentation





Radiolarian



Tintinnid

Protista - small unicellular organisms, some of which have photosynthetic capability and others of which do not

Phytoplankton: Sampling

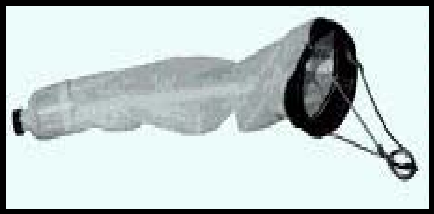
•net sampling

-small size of phytoplankton necessitates very fine mesh

-very poorly quantitative (clogging)

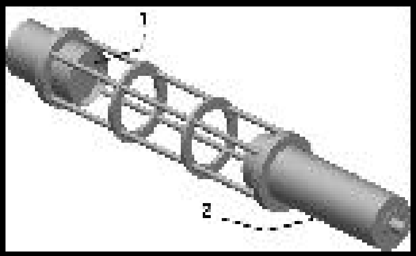
-stress on cells (some burst)

-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

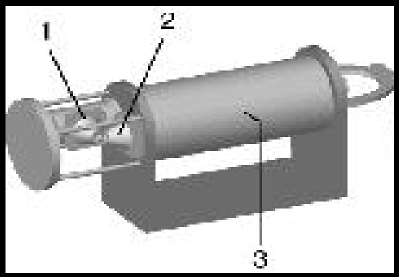


•fluorometer - generates light at a given wavelength, which will cause pigments to fluoresce. Measure chlorophyll fluorescence to estimate phyoplankton conc.

-fluorescence varies with different species & conditions

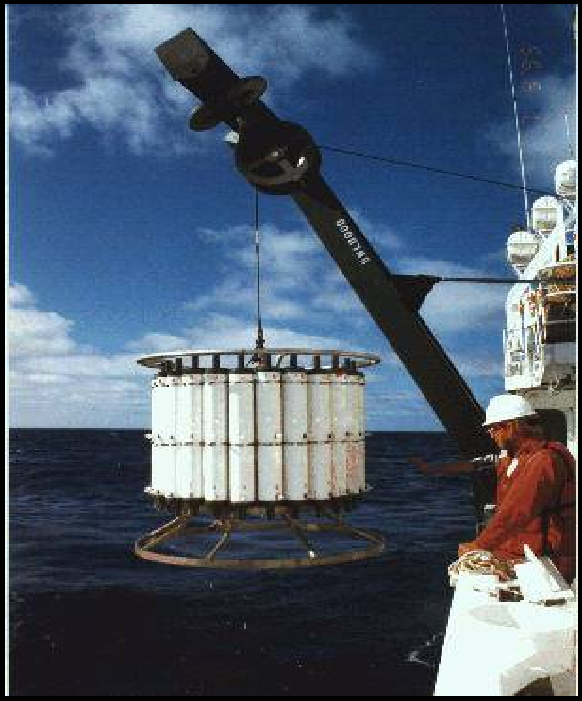
-can be made *in-situ*

-can be related to carbon, but Fluor:Chl pigment and Carbon:Chl not constant



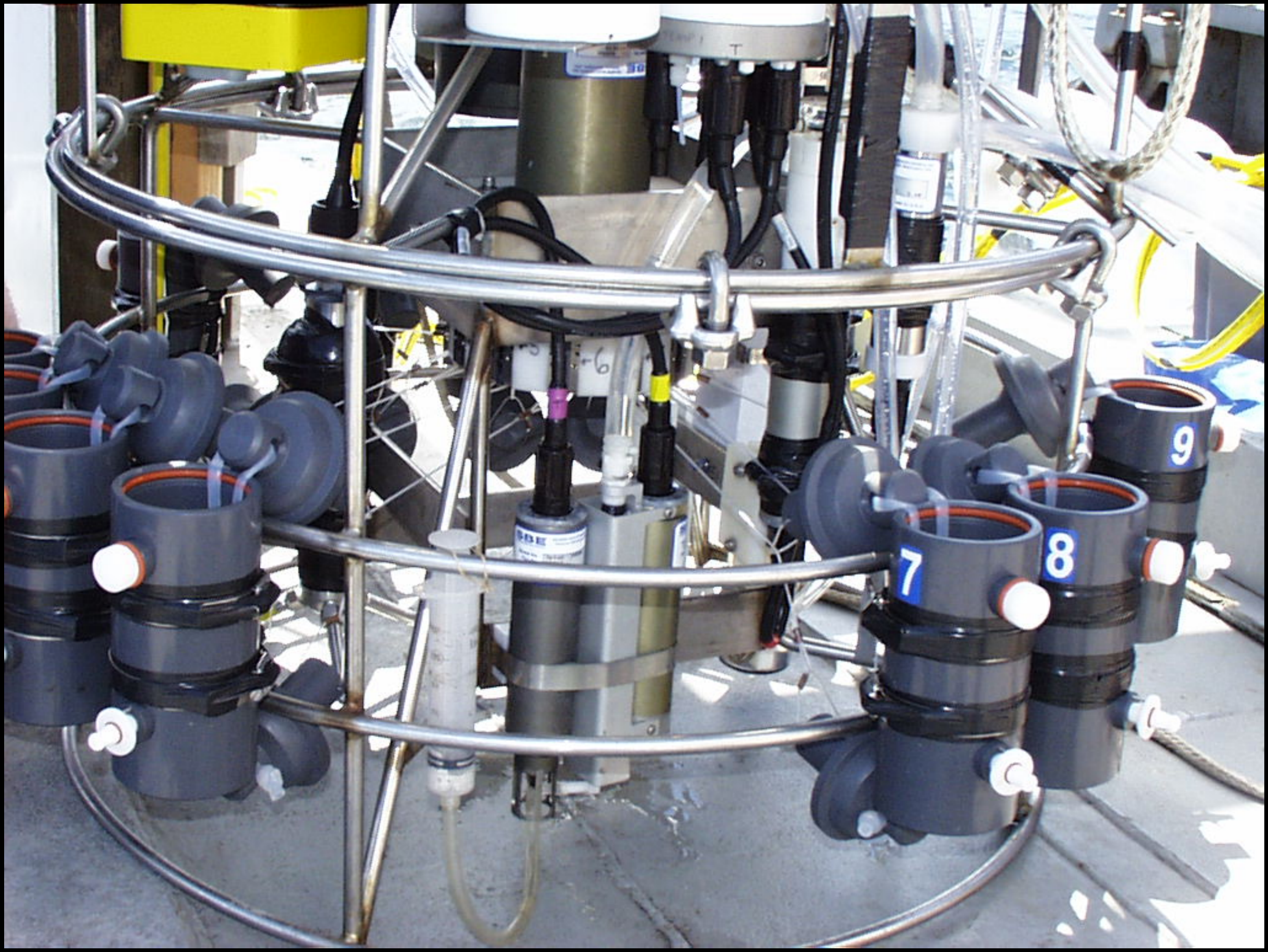
Phytoplankton: Sampling

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



-bacteria, protista, phytoplankton

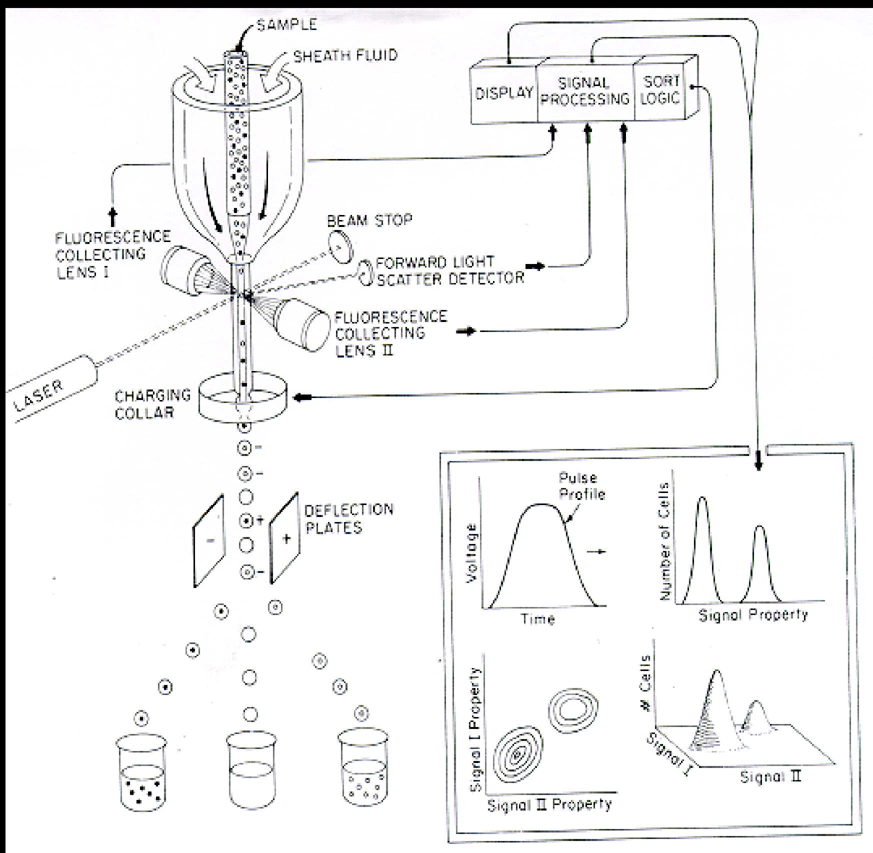
Rosette of Niskin Samplers

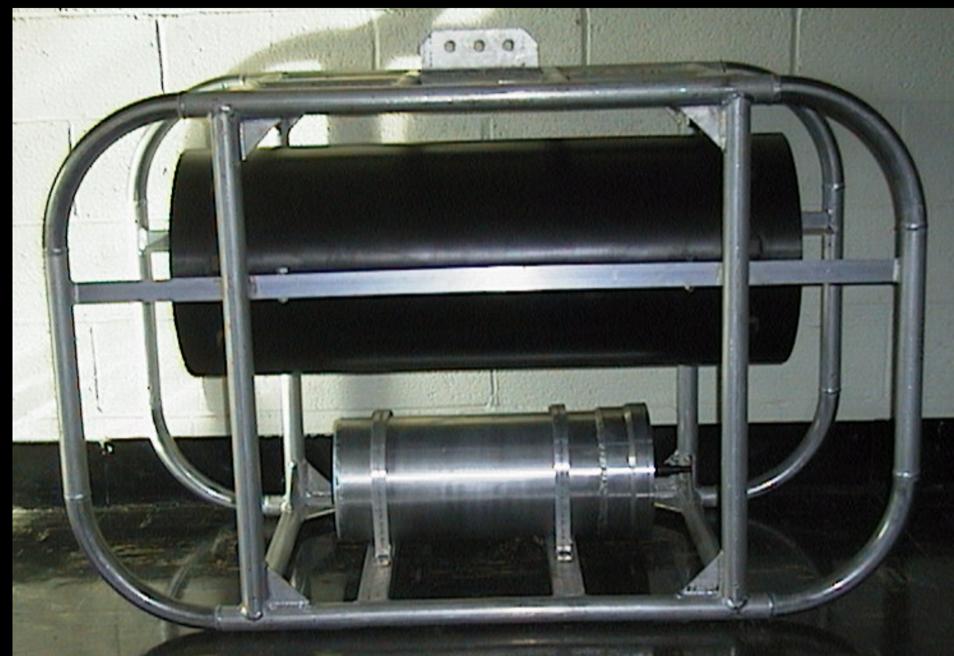


Multispectral Fluorometer

-fluorescence ~ phytoplankton

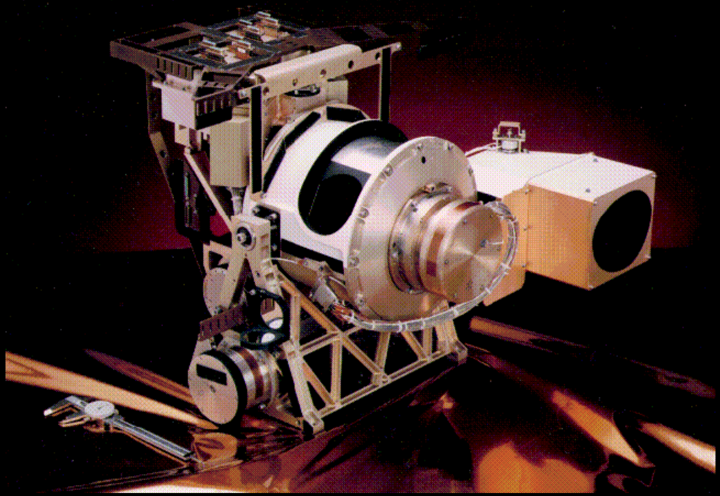
Flow cytometry uses pigments

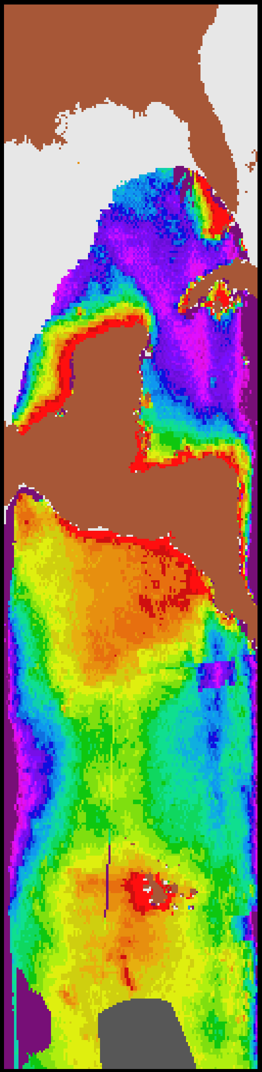




In situ flow cytometer

Satellites



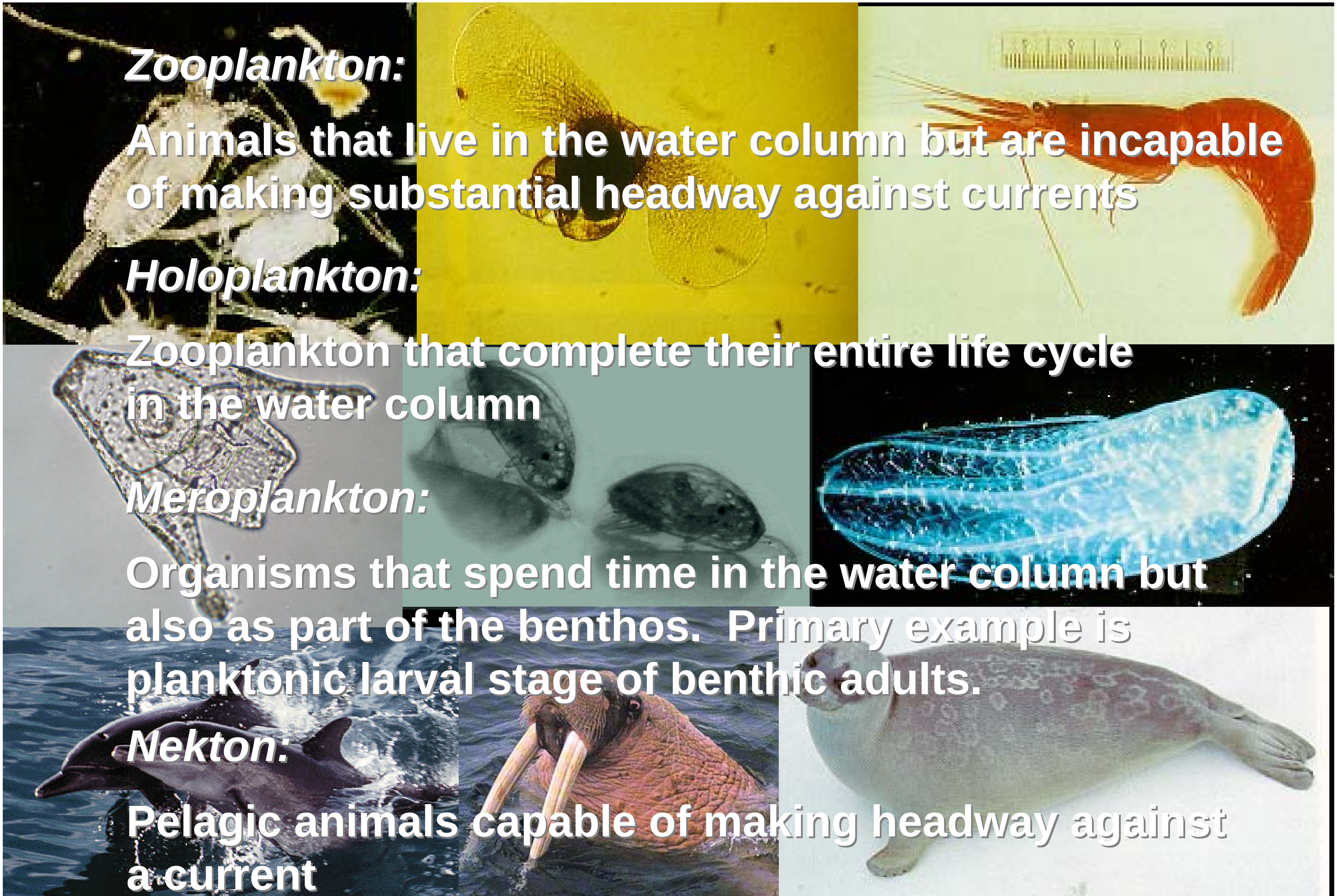


SeaWifs - Sea-viewing Wide Field-of-view Sensor

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

Problems

- **Nearshore (other particles**
- **Cloud, fog**
- **Surface veneer only**



Zooplankton:

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

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.

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)

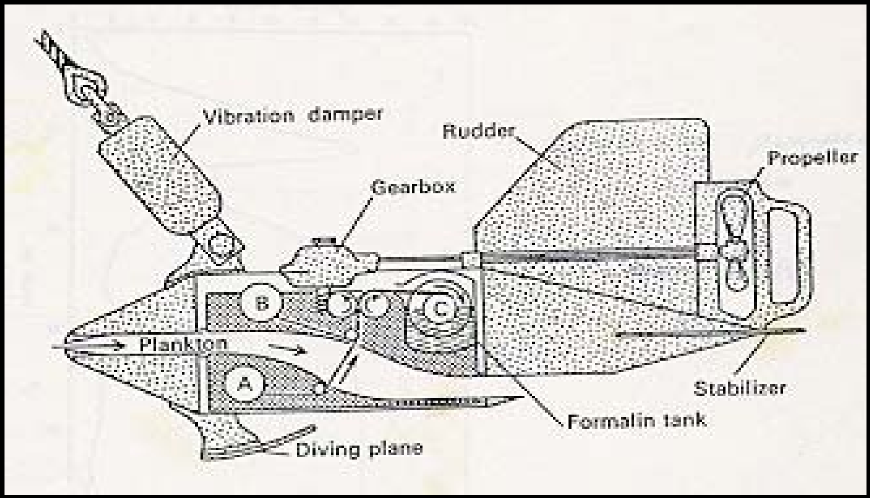
Bongo nets

-oblique or vertical tows

-paired samples for various analyses

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

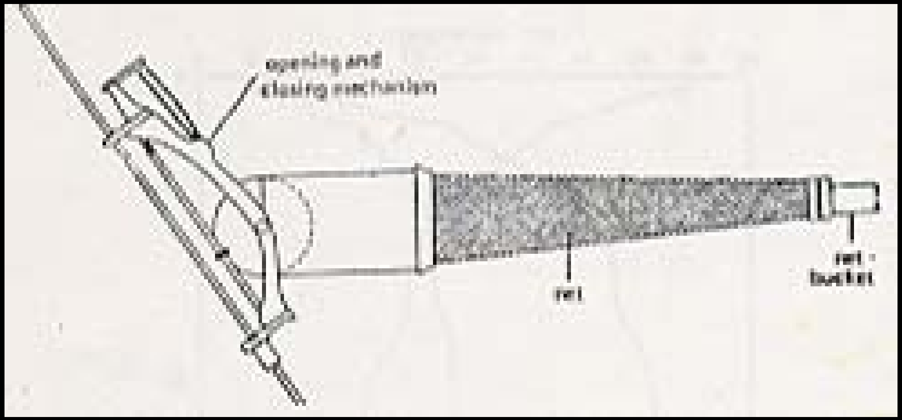
Hardy-Longhurst Plankton Recorder



-towed behind ships of opportunity

-collects multiple zooplankton samples for wide spatial coverage

Moored version (with pump, computer)



<u>Opening-closing nets</u>

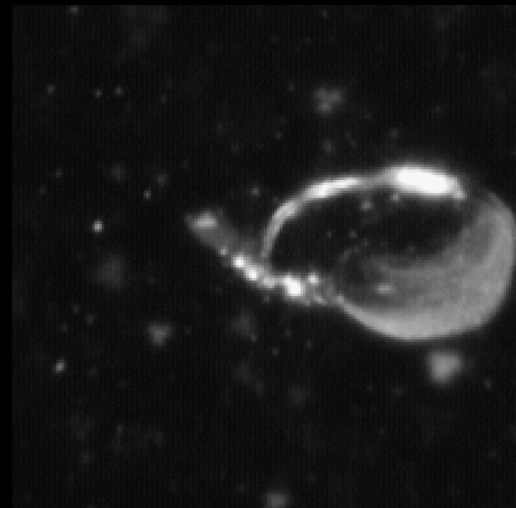
-allow sampling at a discrete (single) depth

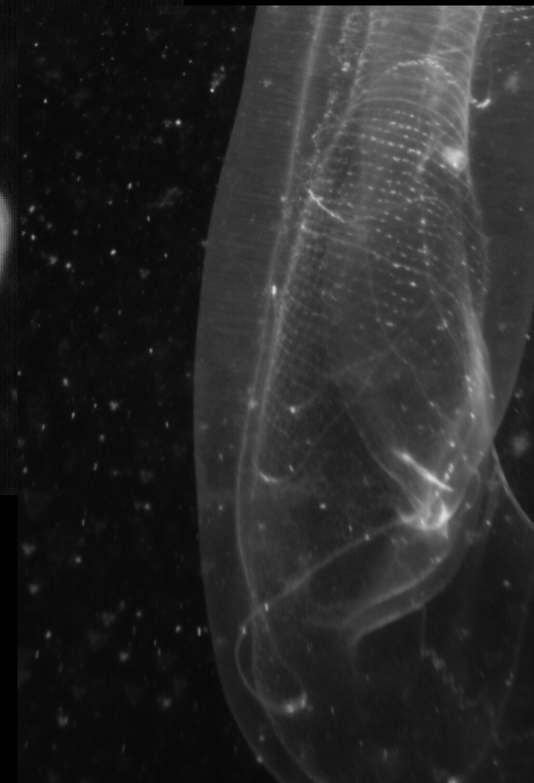
<u>MOCNESS</u>

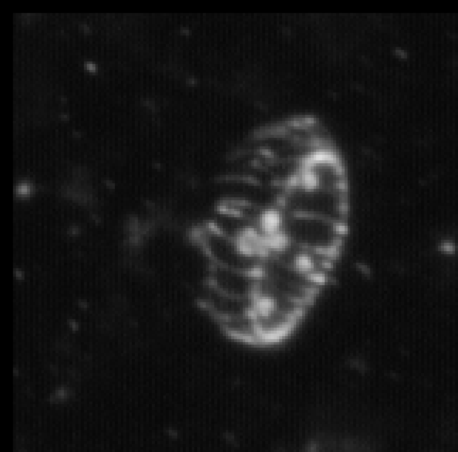
-Multiple Opening / Closing Net & Environmental Sensor System

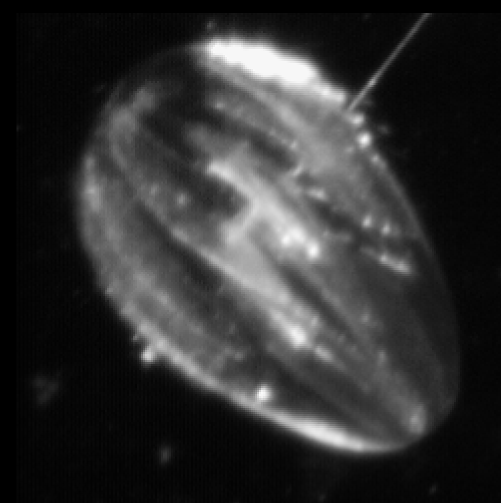
-allows collection of multiple discrete samples

-expensive and difficult to handle



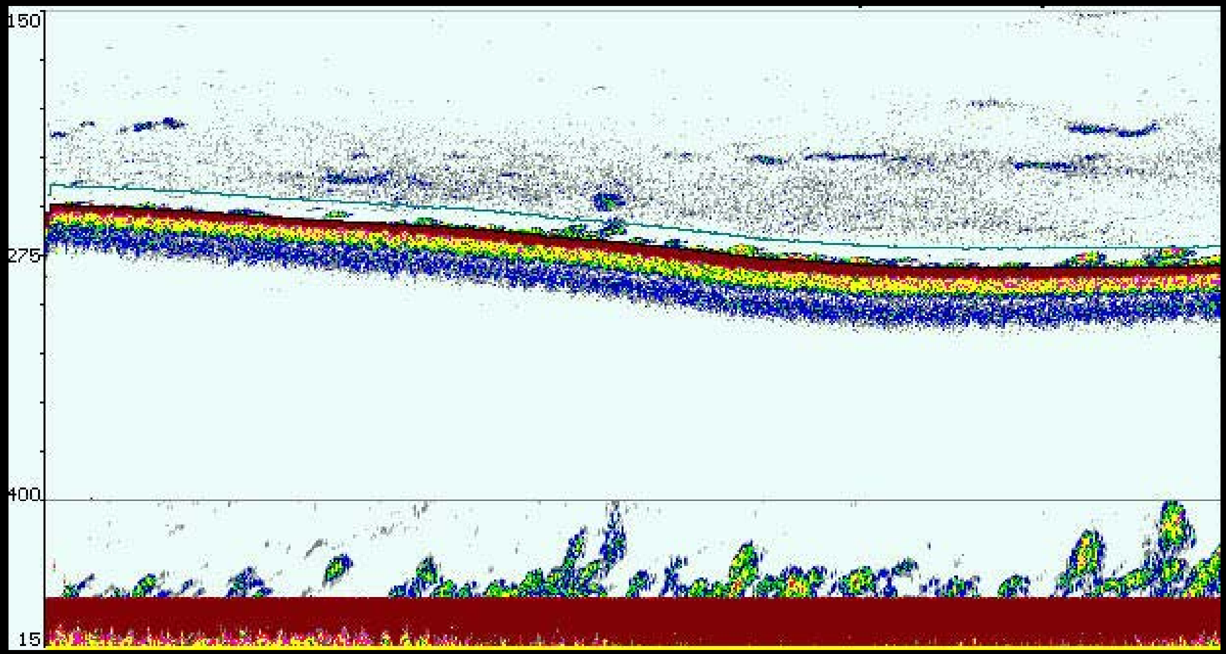


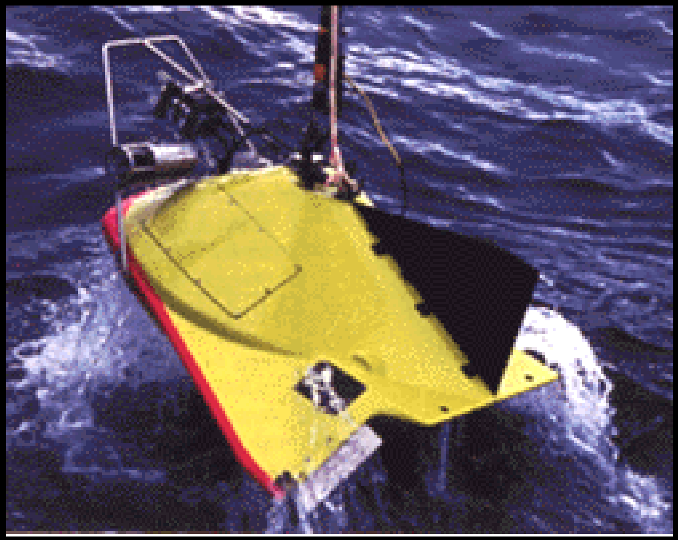




Video Plankton Recorder

-very fine resolution
-animals in context
-limited taxonomy, no good for low densities





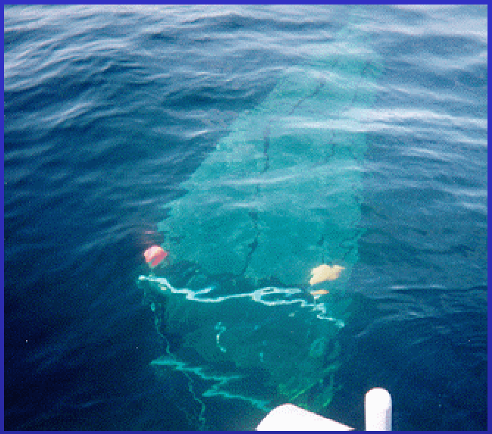
<u>Acoustic towed body</u>

-fine scale resolution
-broad coverage
-poor taxonomic resolution

Sampling for Plankton

Gear	Deployment	Advantages	Disadvantages
Plankton nets (fine)	Small boat	Cheap, any platform	poorly quantitative for some taxa (net avoidance, bow wave), integrates depth
Plankton nets (coarse)	Small boat	Cheap, any platform large volume sample	poorly quantitative for some taxa, misses smaller taxa, integrates depth
Opening/ Closing nets	Larger boat	Quantitative, any depth	Need big ship, cumbersome expensive
Pumps	Medium boat	Quantitative, no hydrodynamic bias	Can be expensive, small volume
Towed Video/ acoustic	Medium boat	Quantitative, broad coverage	Expensive, poor taxonomic resolution

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

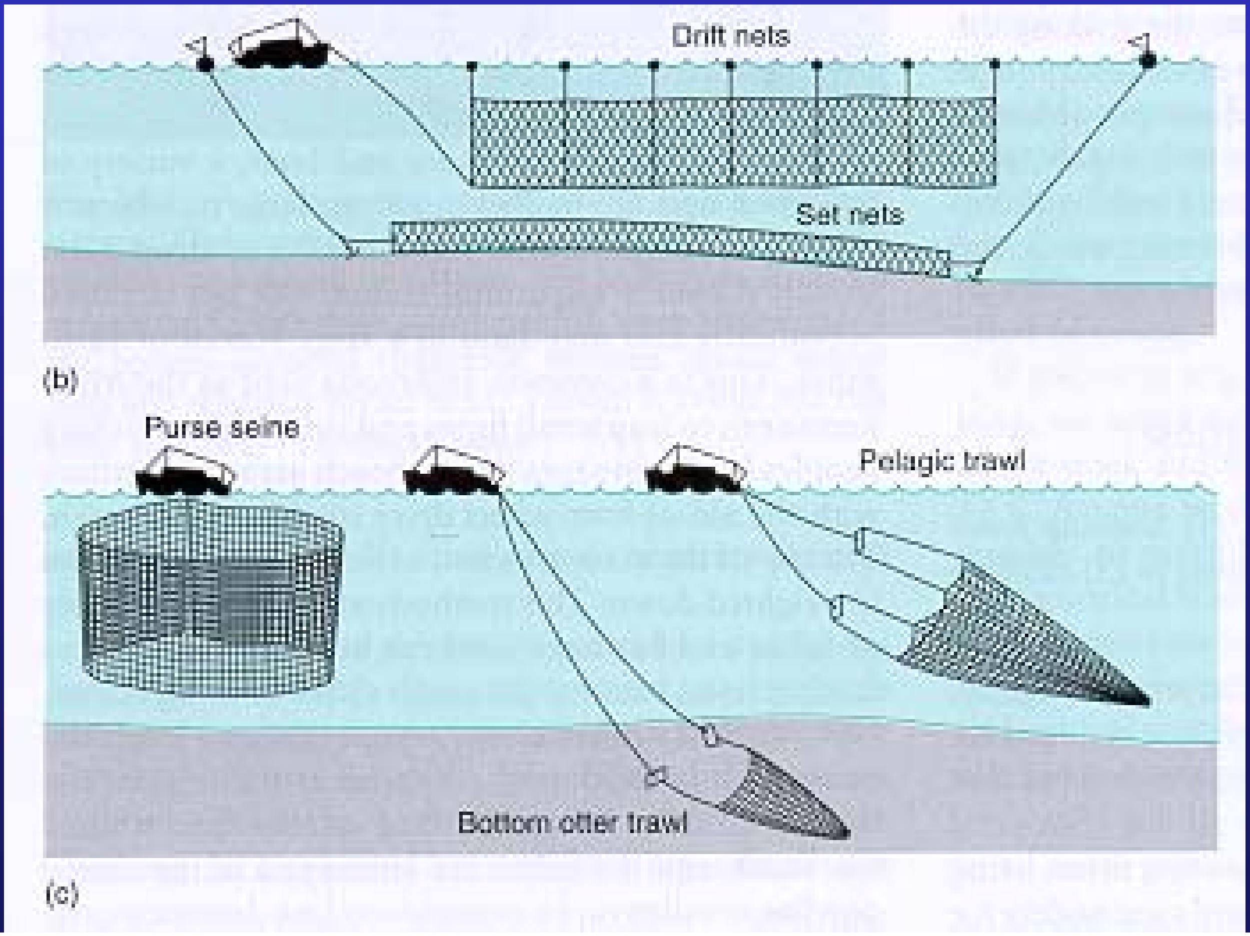
Adults

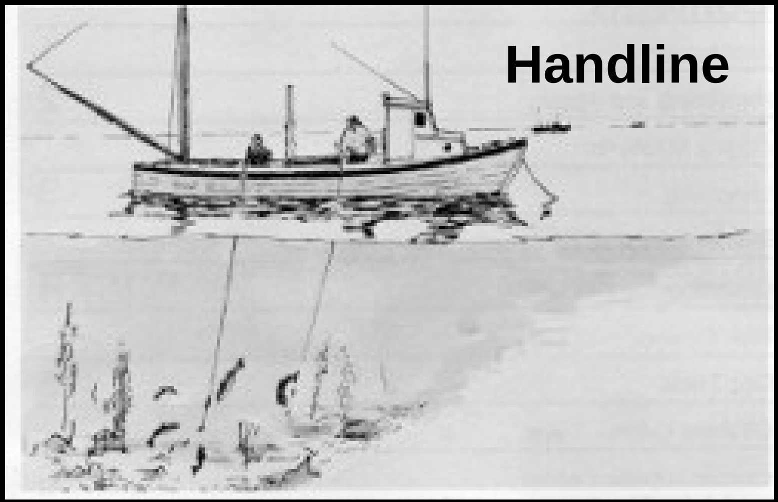
Nets (e.g. Campelan Trawl)
Acoustics
Ladders
Tagging
Fisheries Data
Submersibles
Scuba
Aerialsurveys

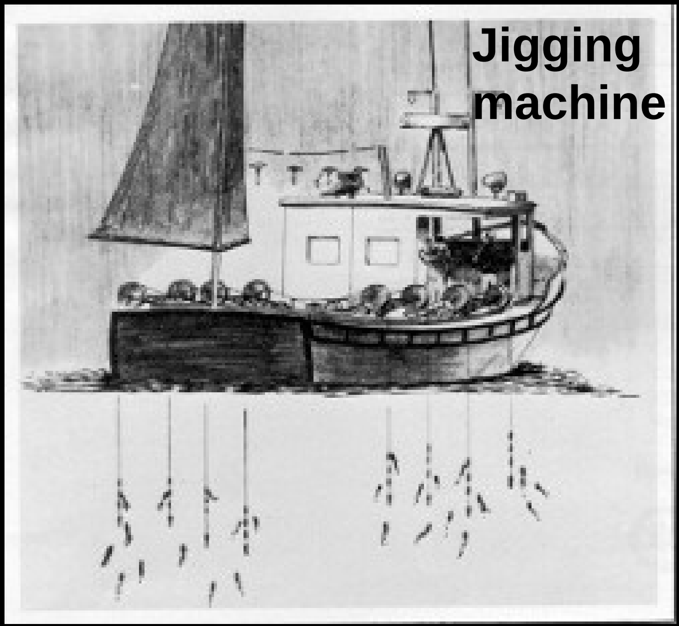
Passive versus Active Entrapment Gear

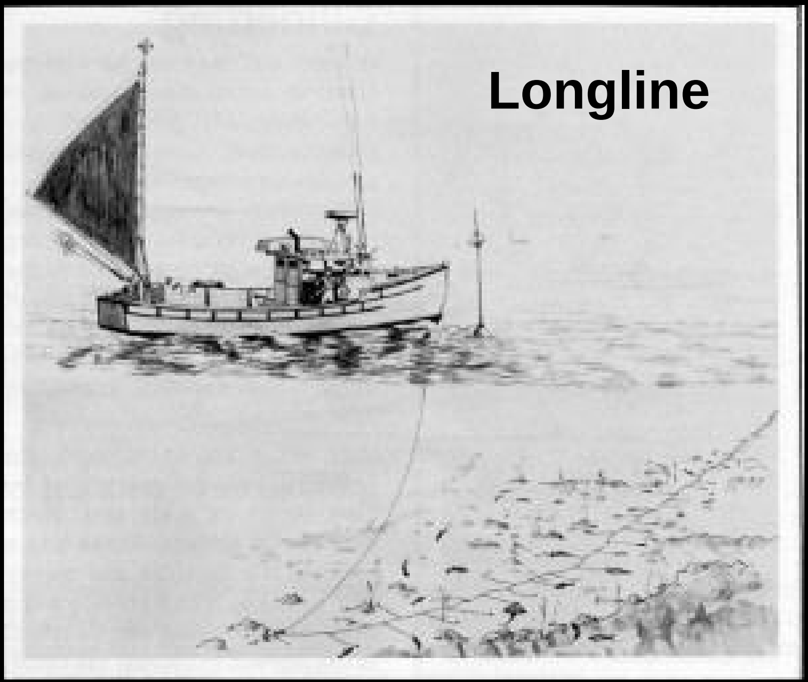
Active Entrapment Gear is towed or pulled through the water

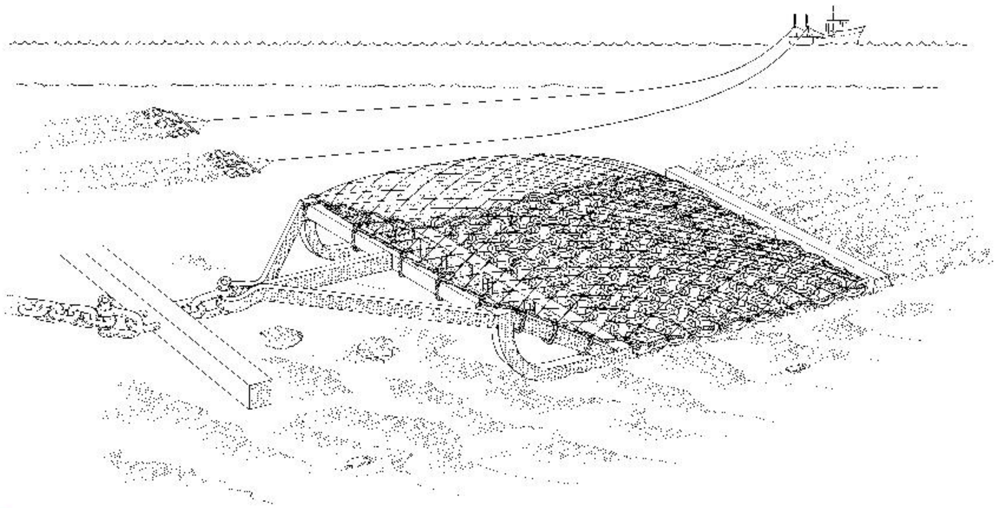
Passive Entrapment Gear is fixed gear
- -attraction to bait
- -predictable paths of movement



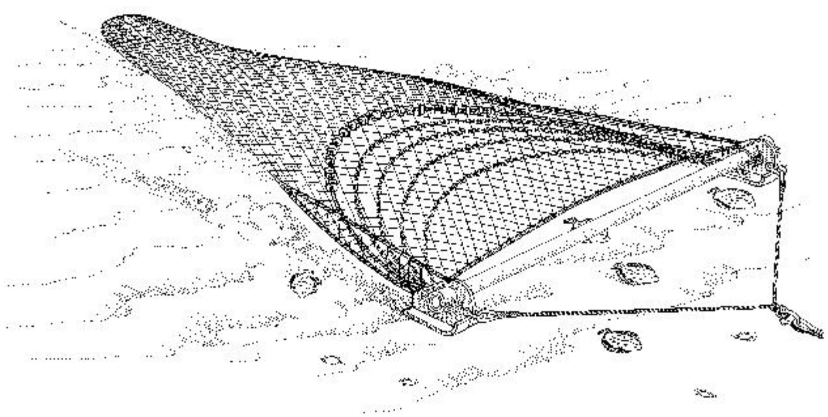

Handline


Jigging
machine


Longline

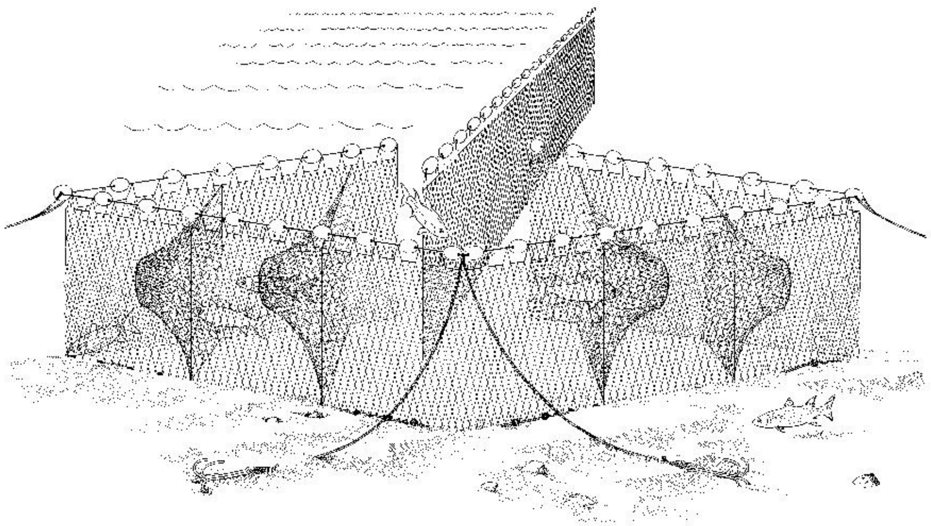


b Jennings, Kaiser, Reynolds
Marine Fisheries Ecology



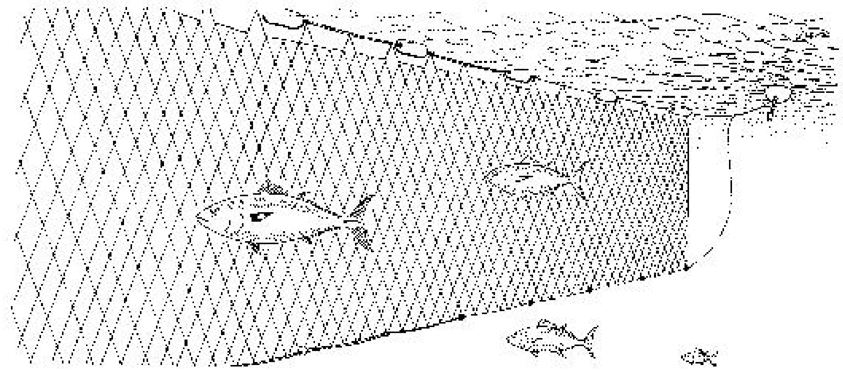
b Jennings, Kaiser, Reynolds
Marine Fisheries Ecology

Bottom dredges



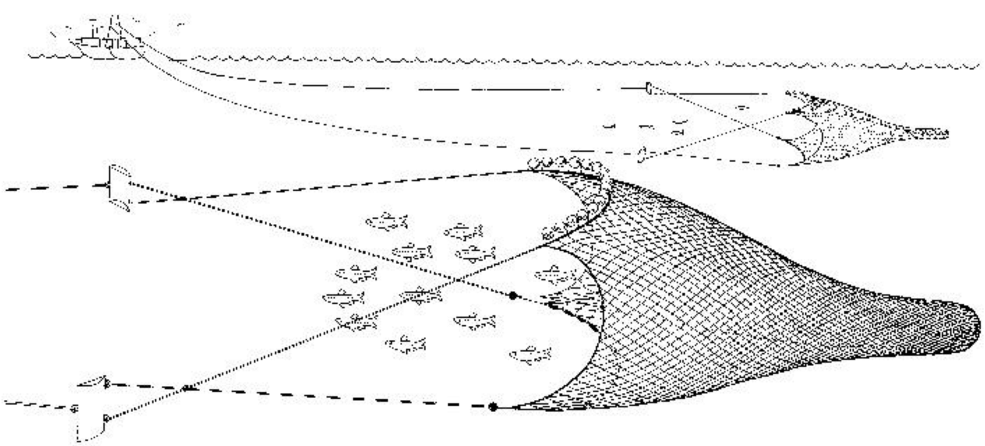
Jennings, Kaiser, Reynolds
Marine Fisheries Ecology

Trap



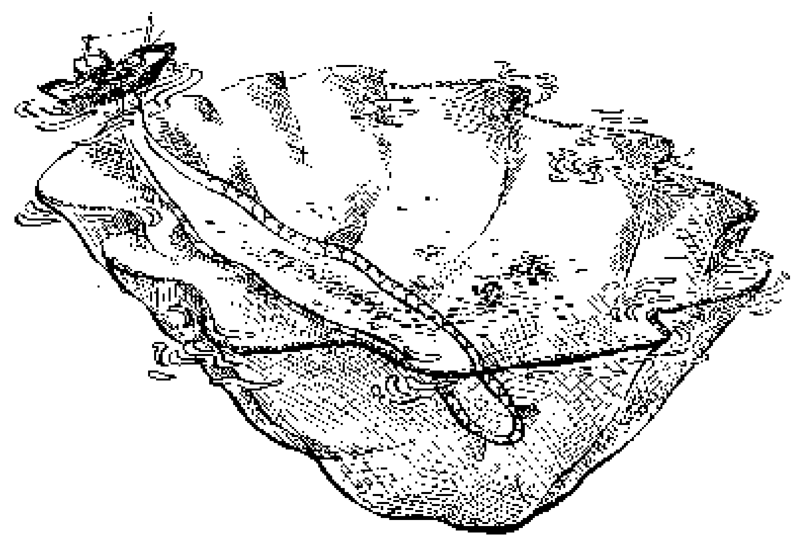
Jennings, Kaiser, Reynolds
Marine Fisheries Ecology

Gill net



Jennings, Kaiser, Reynolds
Marine Fisheries Ecology

Pelagic trawl



Purse seine

Species Selectivity

Longlining

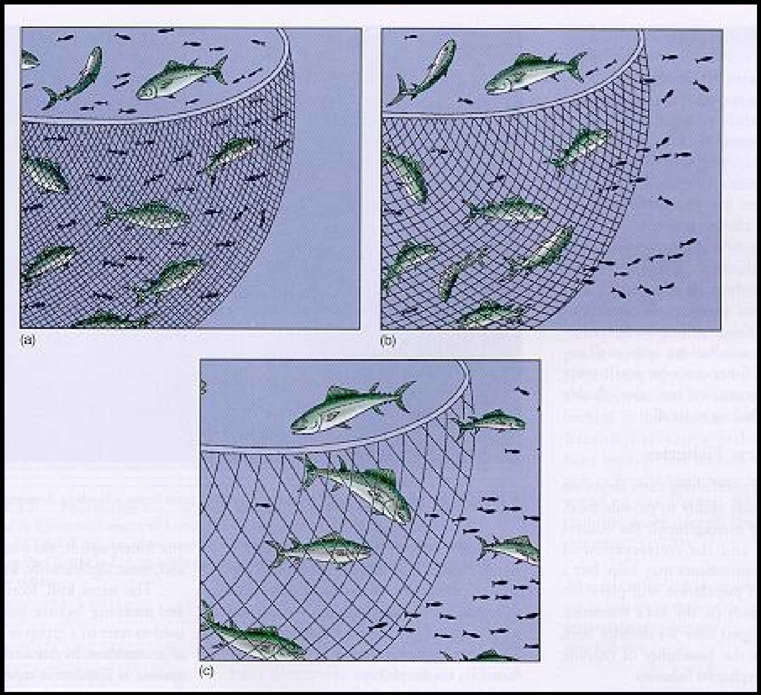
- **-bait, hook shape and size very important**

Trawling

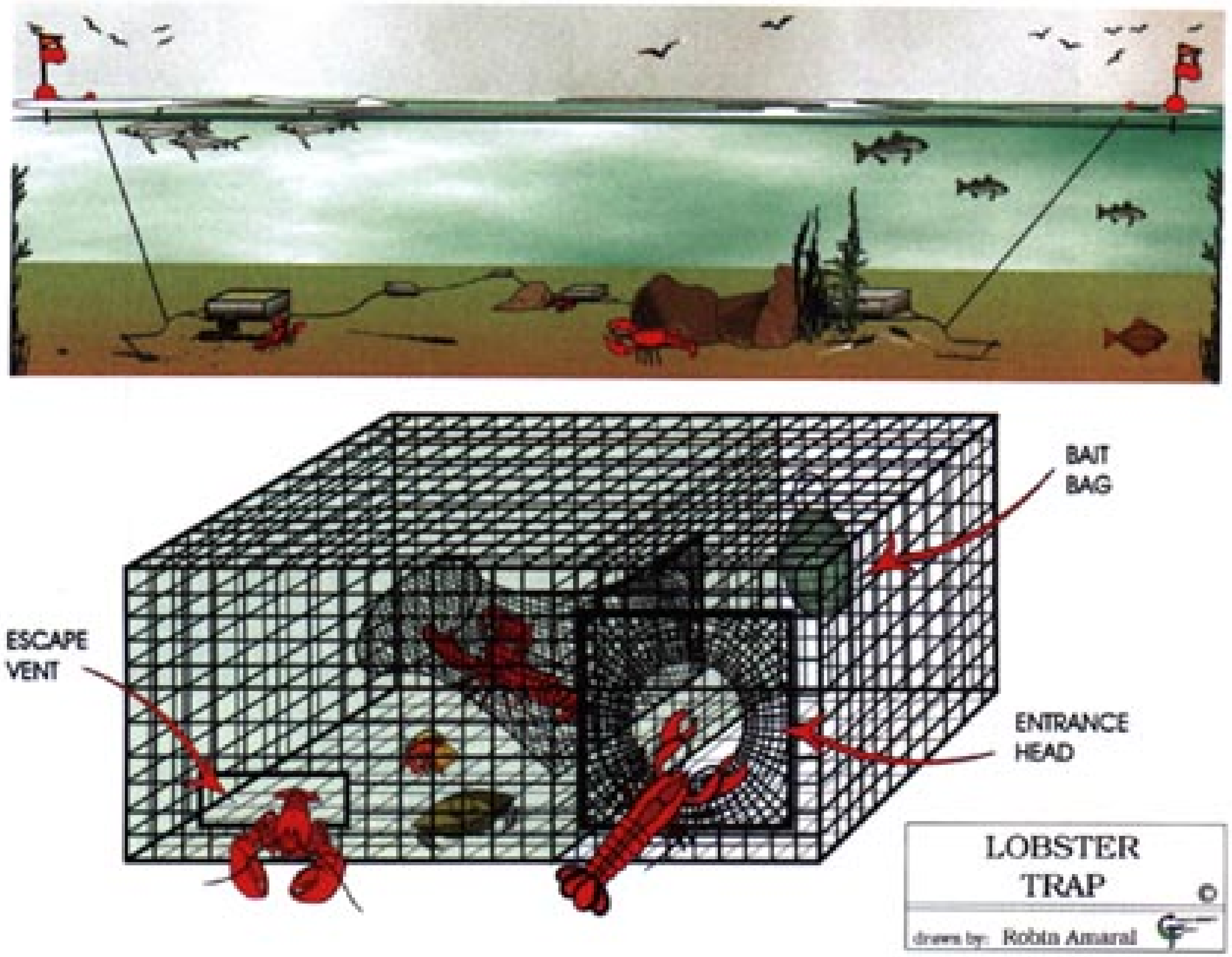
- **-mesh size and selectivity**
- **-bycatch**
- **-behavior of fish**
- **-habitat structure**

Nets

- **-square versus diamond mesh**
- **-length of cod end and net**
- **-mesh size**

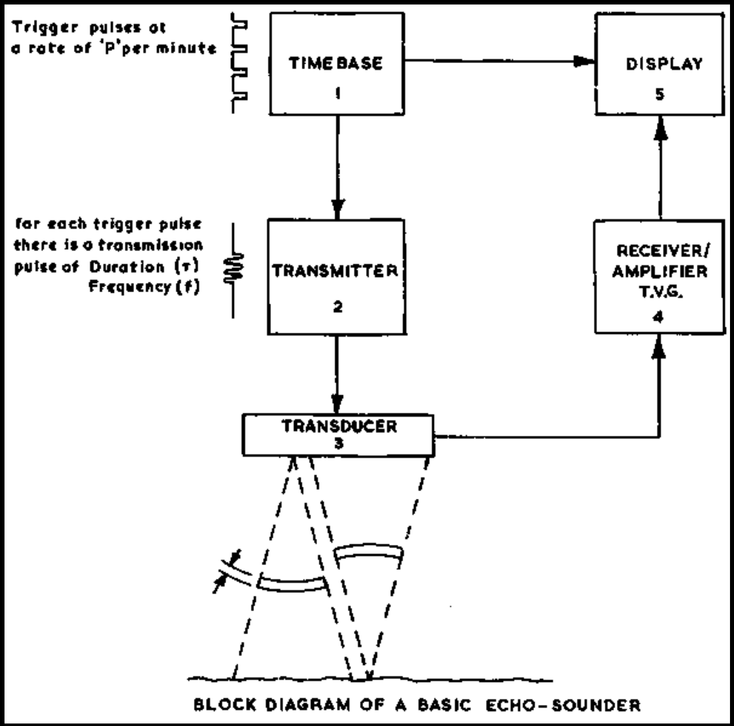


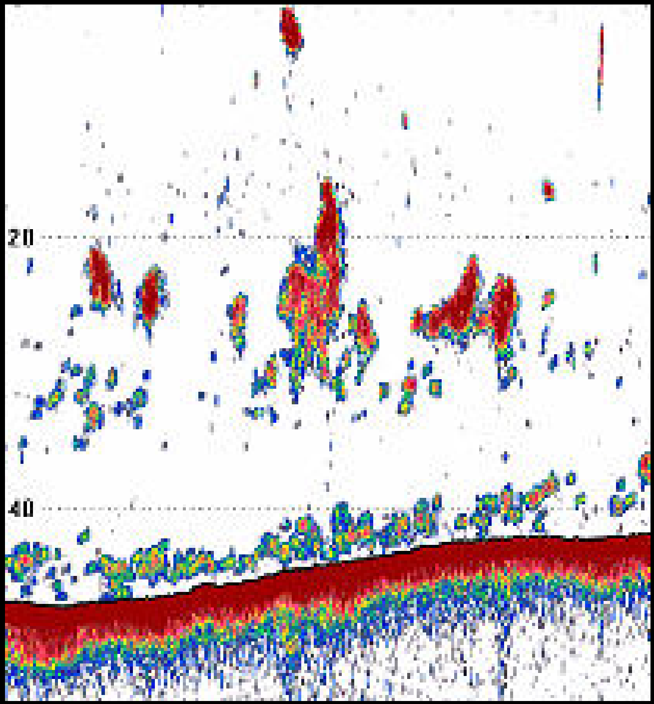
SMOLOWITZ FIGURE 5 (page 51)
Lobster traps. Drawing by Robin Amaral.



b Jennings, Kaiser, Reynolds
Marine Fisheries Ecology

Fisheries acoustics…





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

molluscs

echinoderms

decapods

Megafauna
visible in photos

polychaetes

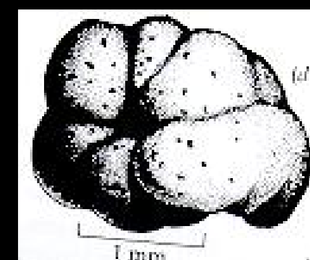
molluscs

crustacea

Macrofauna
> 300 μm

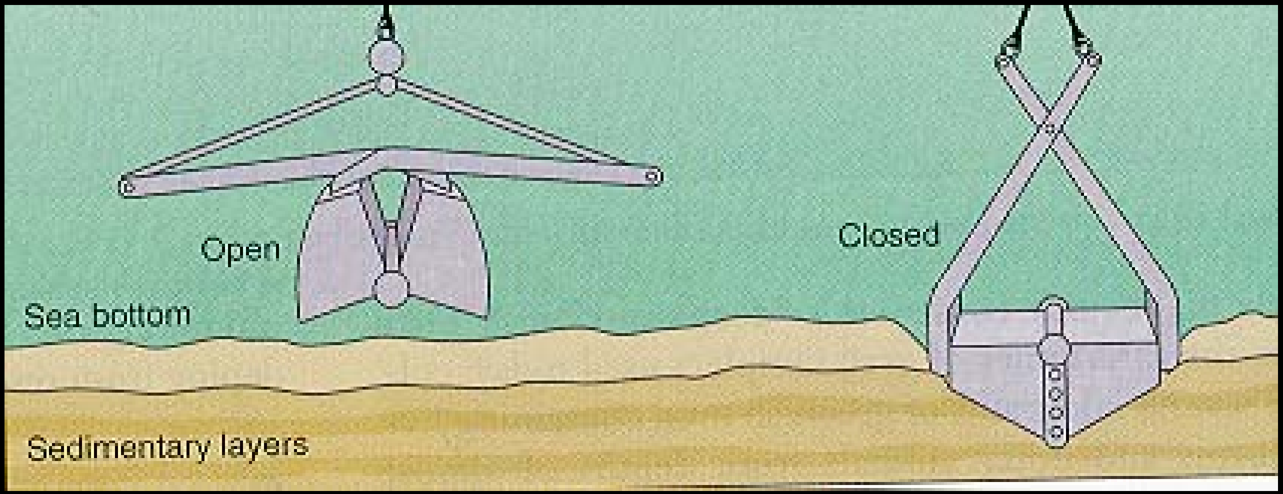
copepods

foraminifera



nematodes

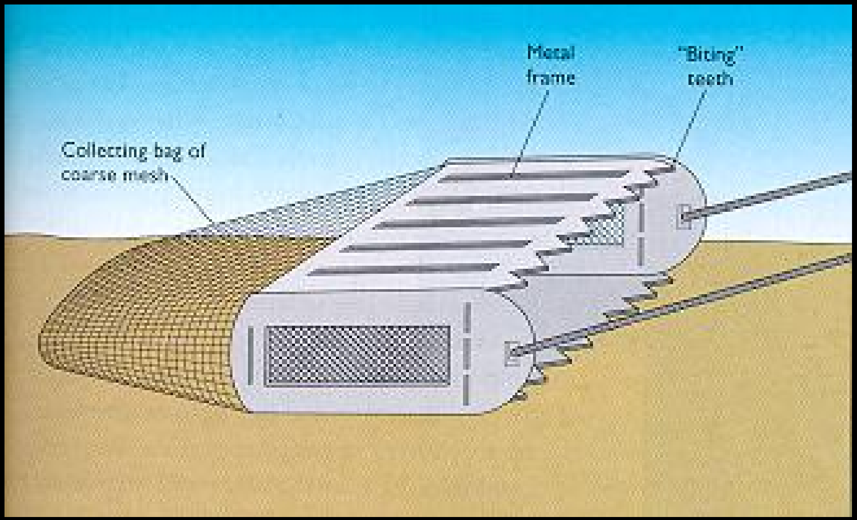
Meiofauna
> 44 or 63 μm



Grab sampler
-semi-quantitative
-bow wave
-shape of sample
-shallow only

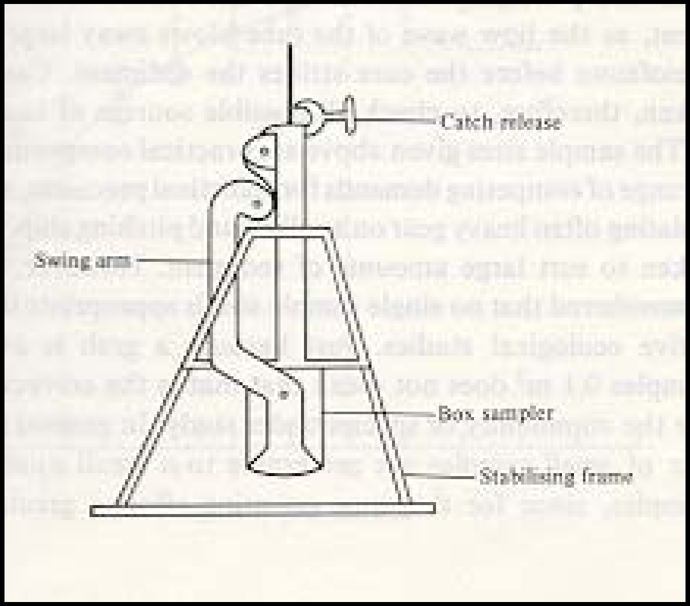
Epibenthic sled

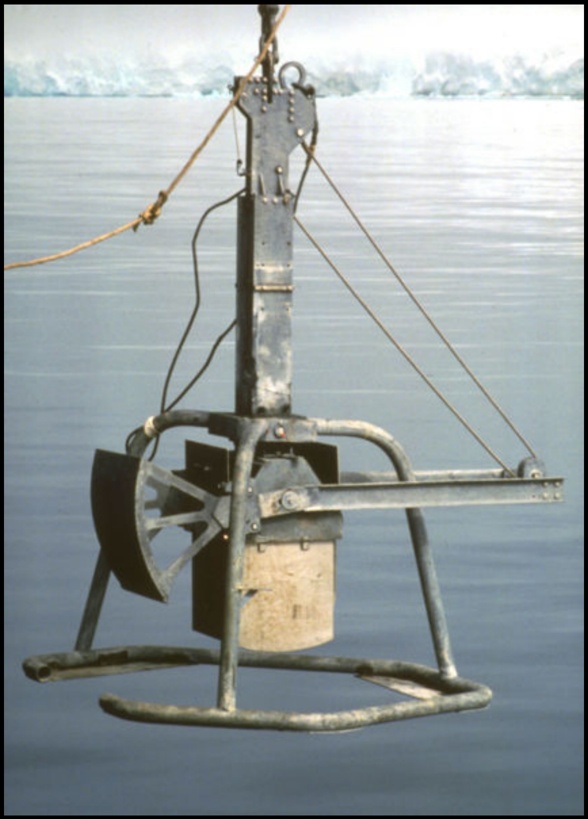
- semi-quantitative
- deep and shallow
- Hyperbenthos and epibenthos



Box / Spade corer

- quantitative
- deep and shallow

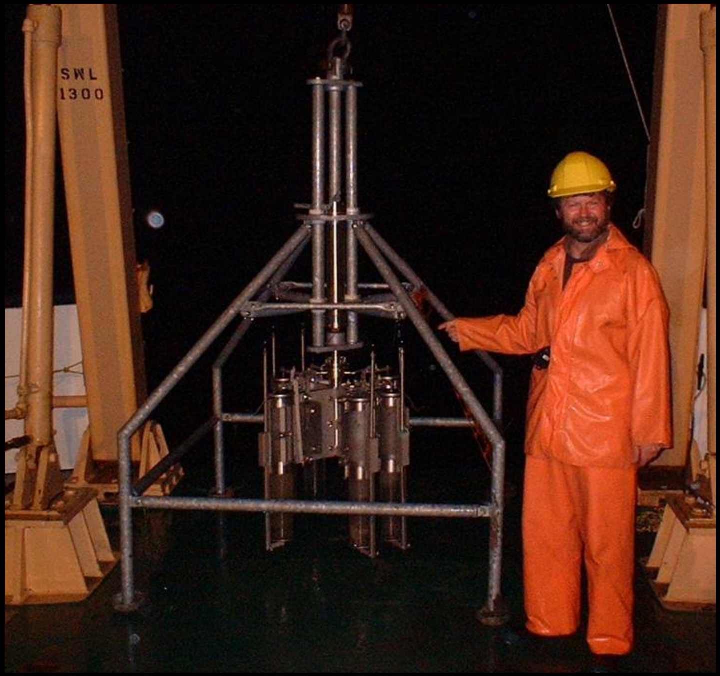




Multi corer

•Quantitative for macro and meiofauna

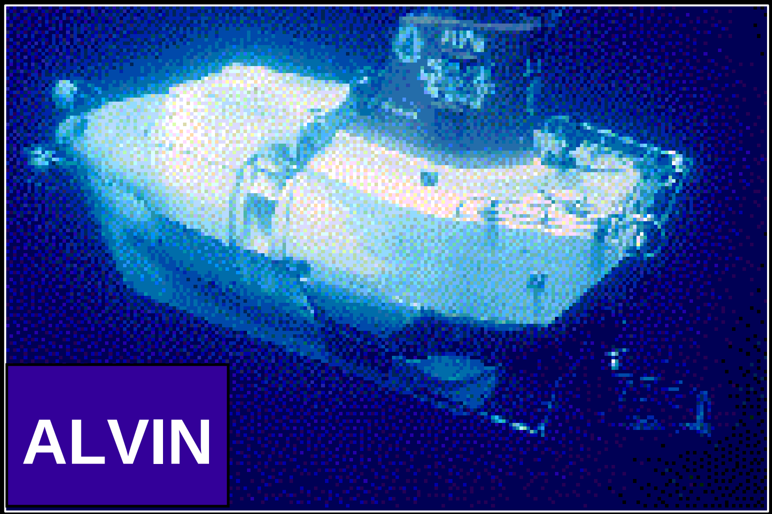
•deep and shallow

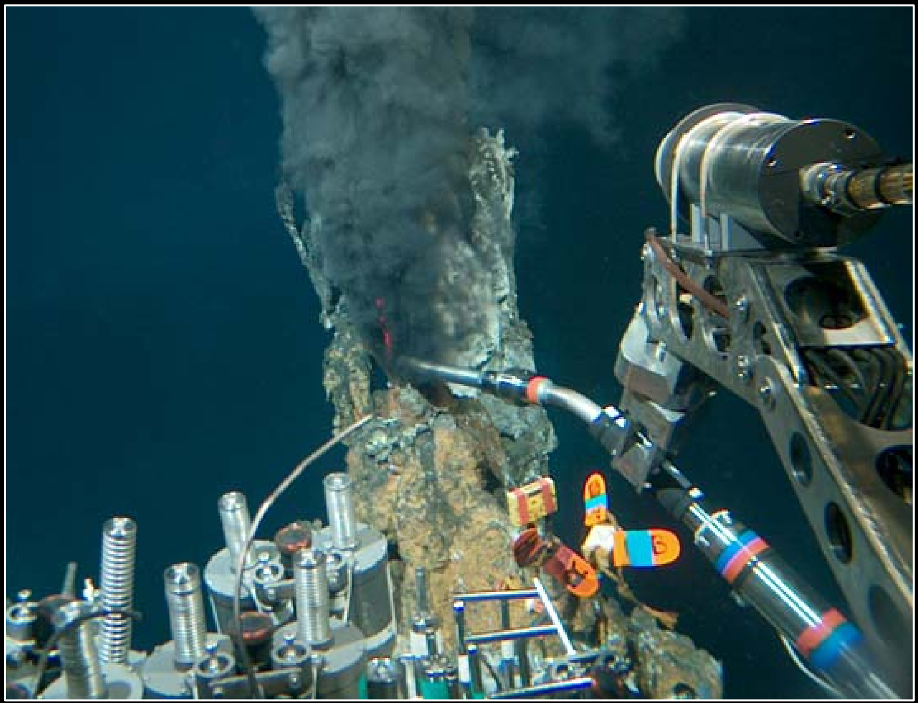


Submersibles

•allow collection of samples at precise scales and locations

•very expensive, difficult to get





SCUBA divers

-can access only a very restricted subset of habitats

-time consuming and difficult to access broad areas

-tropical diving not the norm!