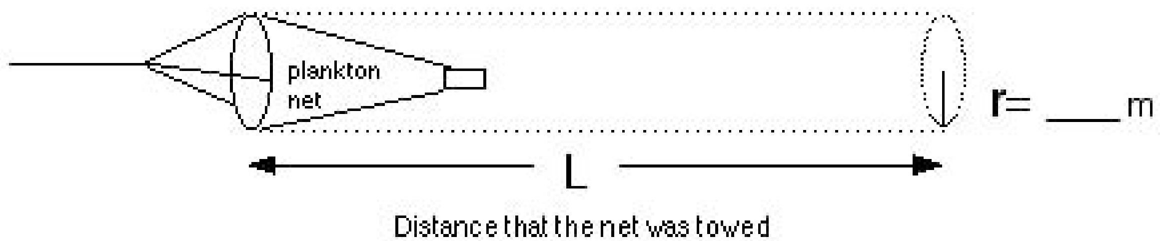
Classroom Activity by Bill Andrake, Swampscott Middle School

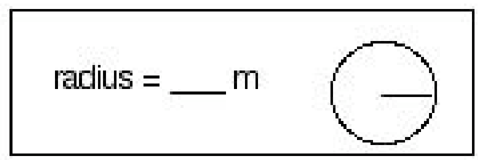
How Much Plankton is in a Cubic Meter of the Sea?

The amount of plankton in a sample doesn't mean much unless you consider the volume of water that you filter with the plankton net to get those plankters.

So how do we do that????



Volume of water filtered = Area of Net Opening x Dist. the net was towed



Step 1. Find the Area of the net opening below:

Area = π r^2

Area = 3.14 x r x r *(show your work below)*

Area of Net Opening = _________ m2
square meters

Step 2. Find the distance that the net was towed: Dist. = Speed x Time

Speed of the boat: ___________meters per min.

Time of the Tow: _________ minutes.

Distance the net was towed = Speed x Time *(show your work below)*

____

•Distance of Net Tow = _________ m

(Density Activity – cont on page 2)

(Density Activity – cont from page 1)

NEXT STEP

Volume of water filtered = Area of Net Opening x Dist. of the Tow

Volume of water filtered = ________________ m^2 x ___________

Volume of water filtered = ___________________ m^3

cubic meters

So....How Much Plankton is in a Cubic Meter of the Sea?

$$\text{Population Density} = \frac{\text{Number(or mass)of Plankters}}{\textbf{the number of } m^3 \textbf{ of water filtered}}$$

(Show your work below)

Population Density = __________

Population Density =

(Density Activity – cont on page 3

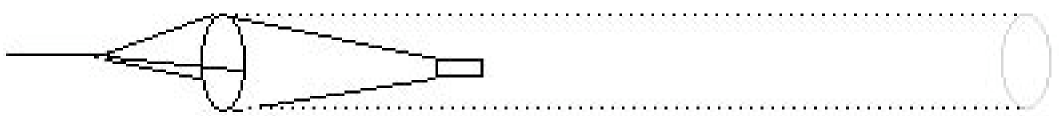
(Density Activity – cont from page 2)

Plankton Population Density Worksheet

Date of Sample ____________

Speed of Tow = _____ m per min. Time of the Tow _________ minutes

- **Distance of Tow = __________ meters**
  (speed x time)
- **Area of Net Opening = _________ square meters**



Volume of the Water Filtered = Area of Net Opening X Dist. of Tow

- **Volume of the Water Filtered __________m^3 or ___________liters**

There are 1000 liters in a cubic meter (m3) .

- **Population Density** = number or mass of plankters ÷ Volume of water filtered
- **Population Density** = ____________ ÷ ______________
- **Population Density = _____________________ per m^3**

or

____________________ per liter

(Density Activity – cont on page 4)

(Density Activity – cont from page 3)

Follow up:

At the time of its collection a lot of plankton has been concentrated in the jar or bottle at the end of the net. This observation often misleads students into believing that the ocean is densely populated with plankters when in reality a lot of water may have been filtered to capture just a few grams of plankton.

- Its useful to have a model of a cubic meter in the classroom as a visual so students get a real sense of how much plankton one might find in that volume of seawater.

- Students may begin to appreciate just how much water must be filtered by a baleen whale (or other plankton feeders) in order to be adequately nourished.

- *From the population density per cm^3...*

What are the chances of a little barnacle capturing a few zooplankters each time it scrapes the water with its legs *(cirri)* or that a swimmer might swallow a copepod in a mouthful of water?

Determining the distance of that very long cylinder of water filtered by your plankton net can be a nice math lesson.

Measuring the distance of a plankton tow is straightforward if you walk the net along a dock or pier; or if you do a vertical tow and know the water's depth.

It becomes a bit more challenging when towing the net behind a boat as you need to calculate the boat's speed in meters per minute and record the number of minutes for your tow.

Boat Speed....

If you estimate the length of the boat in meters and time how long it takes to pass a floating object in the water (I like to use an apple), you can get a speed in meters/ second which can then be converted to meters per minute

For a plankton net sitting in a current, deployed from a bridge or dock, you would need to estimate the current's speed by timing a floating object drifting a measured distance. You also need to record the time that the net is in the water.

For example:
A plankton net sitting in a current traveling at about 0.5 meters/ sec. , filters a cylinder of water (with the diameter of your net opening) that is 30 meters long for every minute that the net is in the water.

(Density Activity – cont on page 5)

(Density Activity – cont from page 4)

Sample problems from actual data

1) Calculate the biomass of copepods per cubic meter of water filtered.

Data from Oceanography Cruise aboard the RV Mysis in Nahant Bay. Sept. 22, 2005.

- Plankton Net with 153 micron mesh: Net diameter = 50 cm (0.5 m)
- Duration of the plankton tow: 5 minutes
- Boat speed: 5 meters in 3 seconds
- Biomass of copepods in sample: 78.8 grams

(Collection was nearly all copepods with a few crab megalops larvae in sample)

Photo of Calanoid Copepod **Photo of Crab megalops**
from: Invertebrates in the Plankton: Arthropoda
depts.washington.edu/fhl/zoo432/plankton/plarthropoda/plarthropoda.html

2) Calculate the number of copepods per cubic meter of water filtered.

Data from collection along Fishermen's Beach Pier, Swampscott, Mass. May 22, 1998.

- Plankton net diameter = 30 cm (0.3 m)
- Net was towed along pier a distance of 50 meters
- 14,860 copepods were counted in the sample.

(Density Activity – cont on page 6)

(Density Activity – cont from page 5)

Answer key to Sample Problems.

Problem 1: Nahant Bay Oceanography Cruise. September 22, 2005.

Distance of net tow = Boat speed x minutes towed

(Speed = 5m/ 3 sec or 100 m per minute)

Distance of net tow = 100m/ min. x 5 min. = <u>500 meters</u>

Volume of Water Filtered by Net in Cubic Meters …(radius of net = 0.25 m)

V = area of net opening x distance it was towed

$V = \pi \times r^2 \times$ distance of tow

V = 3.14 x 0.25 m x 0.25 m x 500 m

V = 98 cubic meters of water filtered

Biomass of copepods per cubic meter.

78.8 grams ÷ 98 cubic meters **= 0.8 g / m^3 (or 0.8 mg per liter)**

Problem 2: Fishermen's Beach. Swampscott, MA. May 22, 1998.

Volume of Water Filtered by Net in Cubic Meters …(radius of net = 0.25 m)

V = area of net opening x distance it was towed

$V = \pi \times r^2 \times$ distance of tow

V = 3.14 x 0.15 m x 0.15 m x 50 m

V = 3.53 cubic meters of water filtered

Number of copepods per cubic meter.

14860 ÷ 3.53 cubic meters **= 4210 copepods / m^3 (or about 4 copepods per liter)**