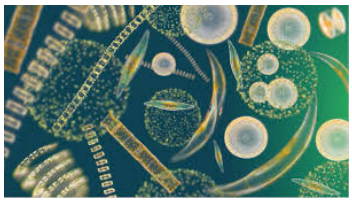
Assignment on Ecosystem Based Management:

You are assigned to design fishery management rules to conserve all parts of a local marine ecosystem that has the following food web:

> **The base of the food web is *phytoplankton*. *Zooplankton* eat the phytoplankton. *Forage fish* eat the zooplankton, and *predatory fish* eat the forage fish.**



Phytoplankton

Zooplankton

Forage Fish

Predatory Fish

Part 1. Before you took this job, fishermen were allowed to take as many fish as they liked.
By the time you showed up, the population size of the predatory fish was dangerously low!

(1) As a result of this fishing, what do you think happened to populations of:

(a) forage fish? High (because of the low number of predators, they weren't getting eaten

(b) zooplankton? Low (because the forage fish numbers were high, they were being eaten alot

(c) phytoplankton? High (because the zooplankton is low, less would be eaten)

(2) What would be a good management decision if you want to see healthy populations of predatory fish?

Some options: limit the number of predators that can be fished, limit the size of predators that can be fished, stop all fishing on the predators

Part 2. Let's say managers decide to stop all fishing for predatory fish.

(3) What do you think the fishermen will do? (e.g., Do they stop fishing, or do they fish for something else?)

They might switch to fishing lower down in the food web (e.g., the forage fish)

Part 3. So, let's say that fishing effort for forage fish increases.

(4) As a result of this fishing, what happens to populations of:

(a) zooplankton? increase

(b) phytoplankton? decrease

(5) How do you think this (fishing for the forage fish) affects the recovery of the predatory fish? Because their food source is being taken out of the ecosystem, it might be bad for their recovery

(6) What would be a good rule to put in place to address any problems you see?

Limit the number of forage fish that can be fished, to make sure there is enough food for the predators

Part 4. Scientists discover that the forage fish populations increase naturally when the average temperature for the year is above 18° C (64° F), but decrease a lot when the temperature is colder than that.

(7) Can you think of a rule (or a set of rules) that would help keep the population stable over all years?

If the average temperature is over 18 C, a larger number of fish can be fished. If the average temp is below 18 C, the number is lower (or no fish can be fished in those years)

Part 5. One year it is particularly sunny.

(8) How do you think this affects populations of:

(a) phytoplankton Increase (phytoplankton use sunlight to grow and multiply

(b) zooplankton? Increase, because there's more phytoplankton to eat

(c) forage fish? Increase

(d) predatory fish? Increase

Part 6. If you remember from yesterday's lesson on impacts to the deep sea, the mesopelagic fish (living from 200-1000 m) are especially vulnerable to ocean acidification and deoxygenation (low oxygen), both of which result from climate change.

For this next question, let's say that the forage fish are in fact mesopelagic fish. The levels of oxygen have gotten very low in the mesopelagic zone.

(9) What do you think the effects are on:

(a) forage fish? Decline, because there is not enough oxygen

(d) predatory fish? Decline because there is not enough prey for them

(10) How would you, as the manager of the ecosystem, address this?

Limit the number of the predatory fish that can be fished, because there will be less of them in the ecosystem due to the loss of the forage fish