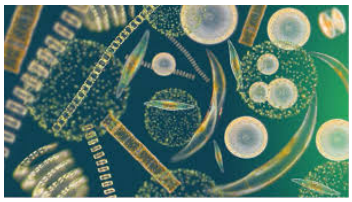
Assignment on Ecosystem Based Management:

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?

(b) zooplankton?

(c) phytoplankton?

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

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?)

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?

(b) phytoplankton?

(5) How do you think this (fishing for the forage fish) affects the recovery of the predatory fish?

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

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?

Part 5. One year it is particularly sunny.

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

(a) phytoplankton

(b) zooplankton?

(c) forage fish?

(d) predatory fish?

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?

(d) predatory fish?

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