# PRINCIPLES OF STOCK ASSESSMENT

# Aims of stock assessment

- Stock assessment involves using mathematical and statistical models to examine the retrospective development of the stock and to make quantitative predictions to address the following fisheries management questions:

# AIMS OF STOCK ASSESSMENT CONTED…….

1. What is the current state of the stock?
2. What has happened to the stock in the past?
3. What will happen to the stock in the future under alternative management choices?

- **Stock assessment** is the process of collecting and analyzing demographic information about fish populations to describe the conditions or status of a fish stock.
- The result of a stock assessment is a report that often includes an estimation of the amount or abundance of the resource,

# AIMS OF STOCK ASSESSMENT CONTED.....

- An estimation of the rate at which it is being removed due to harvesting and other causes, and one or more reference levels of harvesting rate and/or abundance at which the stock can maintain itself in the long term.
- Stock assessment often contain short-term (1-5 years, typically) projections or prognoses for the stock under a number of different scenarios
- This information on resource status is used by managers to determine what actions are needed to promote the best use of our living marine resources.

# AIMS OF STOCK ASSESSMENT CONTED.....

- Stock assessment reports describe a range of life history characteristics for a given species, including age, growth, natural mortality, sexual maturity and reproduction, stock boundaries, diet preferences, habitat characteristics, species interactions, and environmental factors that may affect the species
- Assessment reports also include descriptions of the fishery for a species, using information from both scientists and fishermen
- Additionally, stock assessments describe the assessment model, or the collection of mathematical and statistical techniques that were used to perform the stock assessment.

# AIMS OF STOCK ASSESSMENT CONTED.....

- Stock assessment analyses rely on various sources of information to estimate resource abundance and population trends
- The principal information comes from the commercial and recreational fisheries (**fishery-dependent information)**
- For example, the quantity of fish caught and the individual sizes of the fish, their biological characteristics (e.g. age, maturity, and sex), and the ratio of fish caught to the time spent fishing (catch per unit of effort) are basic data for stock assessments.

# Aims of stock assessment conted.....

- Understanding the natural history of the harvested species and the other species with which they interact is crucial to understanding the population dynamics of living marine resources.

# Fish abundance

- **Fish abundance** or population size can be expressed as either the number of fish or the total fish weight (or biomass)
- Increases in the amount of fish are determined by body growth of individual fish in the population, and the addition or **recruitment** of new generations of young fish (i.e. **recruits;** recruits from the same year are said to comprise a **year-class** [or **cohort**]).

# COHORT

- A cohort or annual class or a generation, is a group of individuals born in the same spawning season.
- For example, with the egg phase. The phases that follow will be larvae, juvenile and adult. The number of individuals that arrive in the fishing area for the first time is called recruitment to the exploitable phase. These individuals grow, spawn (once or several times) and die. After the first spawning the individuals of the cohort are called adults and in general, they will spawn again every year, generating new cohorts.

# FISH ABUNDANCE CONTED .....

- Those gains must then be balanced against the proportion of the population removed by harvesting (called **fishing mortality, *F***) and other losses due, for example, to predation, starvation, or disease (called **natural mortality, *M***).
- In stock assessment work, removals of fish from the population are commonly expressed in terms of rates within a time period.
- The **fishing mortality rate** is a function of **fishing effort,** which includes the amount, type, and effectiveness of fishing gear and the time spent fishing.

# FISH ABUNDANCE CONTED .....

- **Catch per unit of effort (CPUE)** is an index showing the ratio of a catch of fish, in numbers or in weight, and a standard measure of the fishing effort expended to catch them.
- **Surplus production** (or production) is the total weight of fish that can be removed by fishing without changing the size of the population.
- It is calculated as the sum of the growth in weight of individuals in a population, plus the addition of biomass from new recruits, minus the biomass of animals lost to natural mortality

# FISH ABUNDANCE CONTED .....

- The **production rate** is expressed as a proportion of the population size or biomass. The production rate can be highly variable owing to environmental fluctuations, predation, and other biological interactions with other populations
- On average, production decreases at low and high population sizes, and biomass decreases as the amount of fishing effort increases
- This means there is a relationship between average production and fishing effort. This relationship is known as the production function

# FISH ABUNDANCE CONTED .....

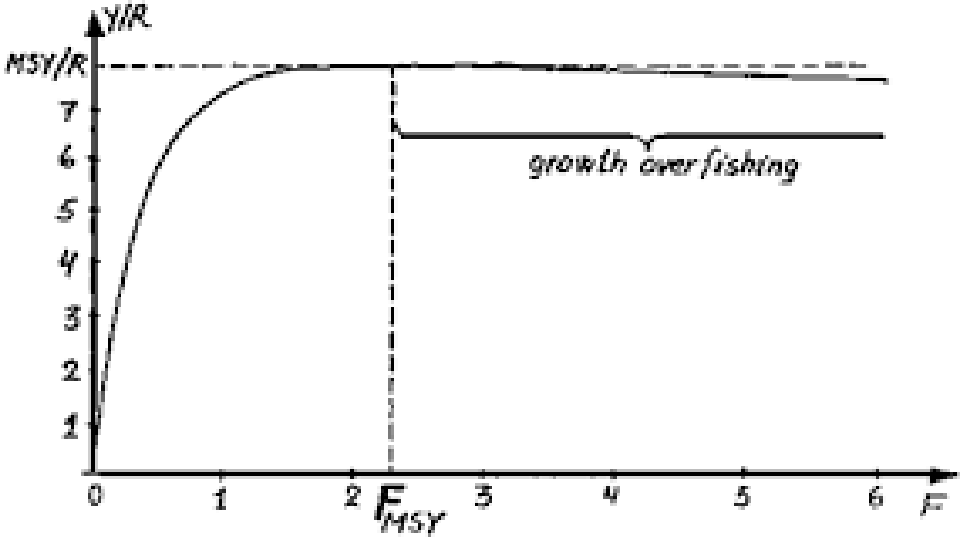
- **Production functions** are the basis for certain important concepts like: **maximum sustainable yield.**
- In addition, the term **stock level** is employed as a biological reference for determining resource status relative to the biomass that would on average support the sustainable yield.
- Recent average yield also is reported in order to allow comparison of the current situation to the sustainable yield.

# FISH ABUNDANCE CONTED .....

- Many other **reference levels** are used as benchmarks for guiding management decisions
- A number of these are expressed as fishing mortality rate levels that would achieve specific results from the average recruit to the fishery if the stock were subjected to fishing at those rates indefinitely
- Some of these **benchmarks** are used to index potential fishery production, and others are used to index potential reproductive output.
- $\boldsymbol{F}_{\mathbf{max}}$ is the fishing mortality rate that maximizes the yield obtained from the average recruit.

# FISH ABUNDANCE CONTED .....

- **Growth overfishing** occurs over the range of fishing mortality, at which the losses in weight from total mortality exceed the gain in weight due to growth. This range is defined as beyond $F_{max}$ /$F_{msy}$.
- Growth overfishing occurs when fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit.


Y/R
MSY/R
7
6
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F
$F_{MSY}$
growth overfishing

# Recruitment overfishing

- Recruitment overfishing occurs when the mature adult population (spawning biomass) is depleted to a level where it no longer has the reproductive capacity to replenish itself—there are not enough adults to produce offspring.
- The rate of fishing above which the recruitment to the exploitable stock becomes significantly reduced. This is characterized by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year. May lead to stock collapse if prolonged and combined with poor environmental conditions.

# Maximum Sustainable Yield (MSY)

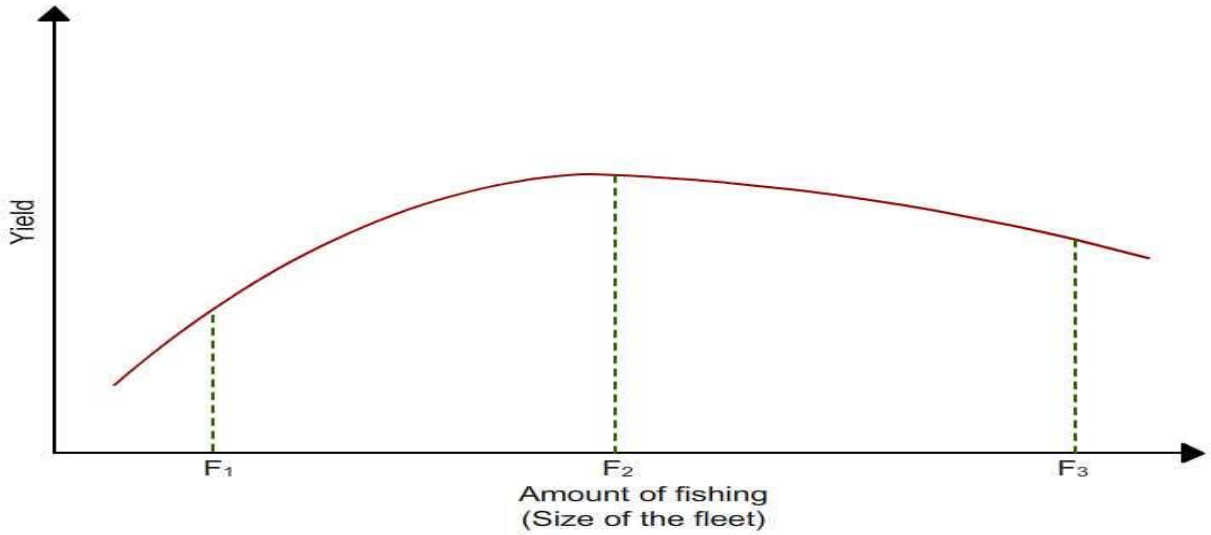
- MSY is the maximum long-term average yield that can be achieved through conscientious stewardship by controlling F through regulating fishing effort or total catch levels. MSY is a reference point for judging the potential of the resource.
- However, it is not necessarily the goal of fishery managers to always set the maximum yield
- Other factors influence the choice of a management objective, such as socioeconomic considerations or conservation and ecosystem concerns for other marine life indirectly affected by fishery harvests.

# Maximum Sustainable Yield conted .....

- The methods of estimating MSY, and MSY itself, may be controversial.
- One of the major objectives of fish stock assessment is regularisation or optimisation of effort.
- Standardization of fishing effort – increasing the effort in the long term gives highest yield.
- The basic principle is smaller a population, when effort is not put at required level, the greater will be production.

# Maximum Sustainable Yield conted .....

- At optimal level of effort, the production will be maximum for a given Fmsy.



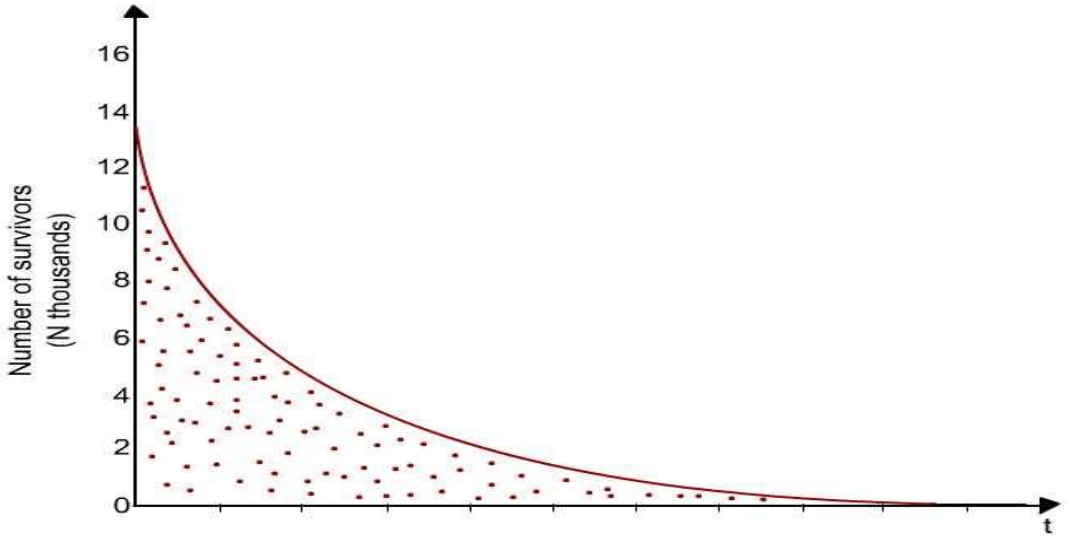

levels of fishing mortality.

# Maximum Sustainable Yield conted .....

- The basic principle in stock assessment models is to provide estimates of optimum yield.
- The environmental factors, economic factors are to be taken into account for arriving at appropriate management decisions.
- When intensity of fishing is not monitored, the population of a stock show sign of depetion and there will be a decrease in mean length of fish and length at minimum maturity.

# Maximum Sustainable Yield conted .....

- In principle as age increases the number of survivors will be less.

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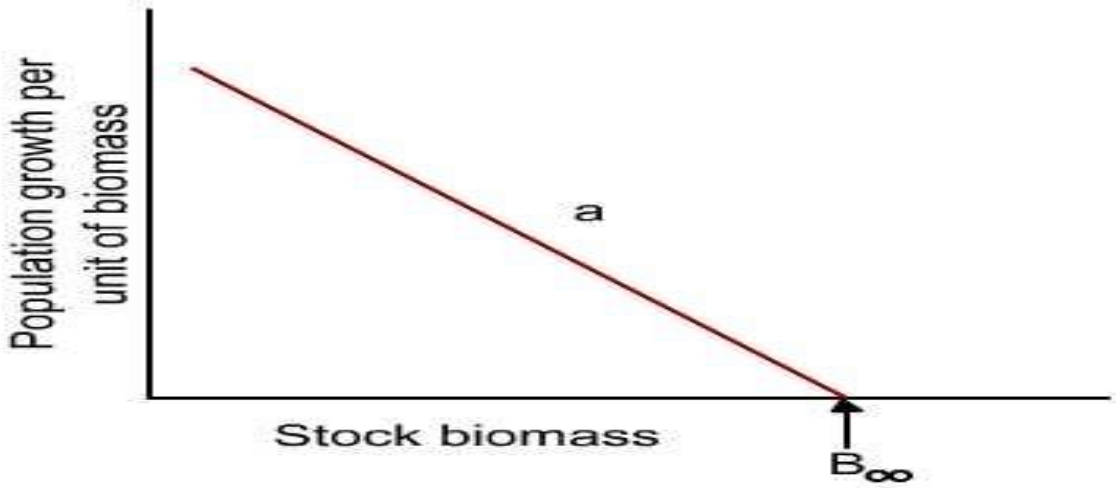
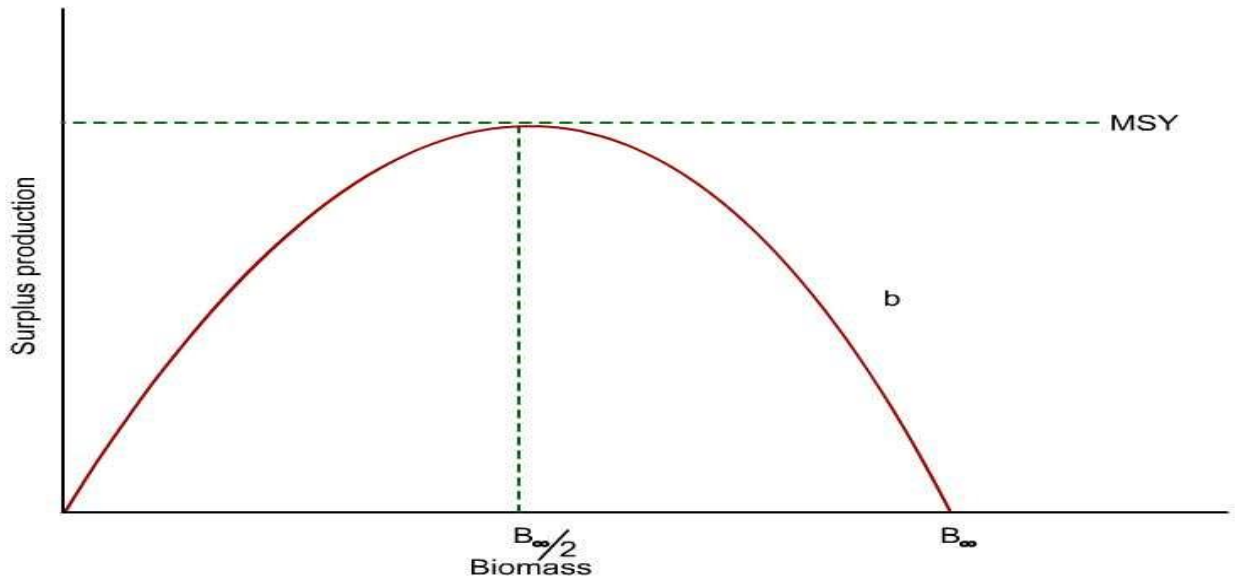
# Maximum Sustainable Yield conted .....

- The population neither grows nor declines which means that each year's recruitment is balanced by each year losses due to mortality.



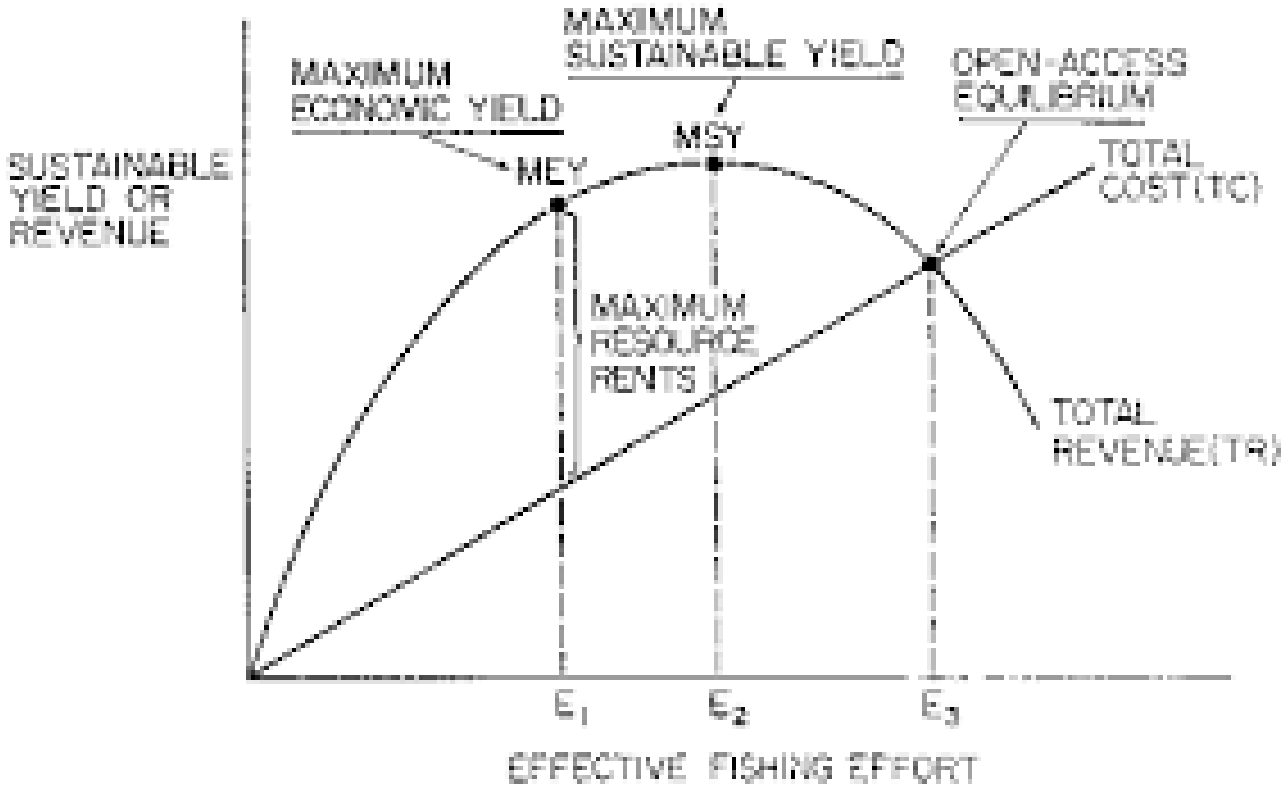
# Maximum Sustainable Yield conted .....




In principle, the highest yield achieved on a long term basis for a particular effort is the Fmsy and the corresponding yield is MSY or Maximum Sustainable Yield.

# Maximum Economic Yield (MEY)

- Maximum economic yield is that yield level, which coincides with the level of harvest or effort that maximized the sustainable net returns from fishing.
- Maximum Economic Yield (MEY) which includes the monetary terms of the effort and returns in sustainable yield formulation.
- In fisheries terms, maximum sustainable yield (MSY) is the largest average catch that can be captured from a stock under existing environmental conditions. Relating to MSY, the maximum economic yield (MEY) is the level of catch that provides the maximum net economic benefits or profits to society.


MAXIMUM SUSTAINABLE YIELD
MAXIMUM ECONOMIC YIELD
OPEN-ACCESS EQUILIBRIUM
MSY
MEY
SUSTAINABLE YIELD OR REVENUE
TOTAL COST (TC)
MAXIMUM RESOURCE RENTS
TOTAL REVENUE (TR)
E1
E2
E3
EFFECTIVE FISHING EFFORT

# THANK YOU