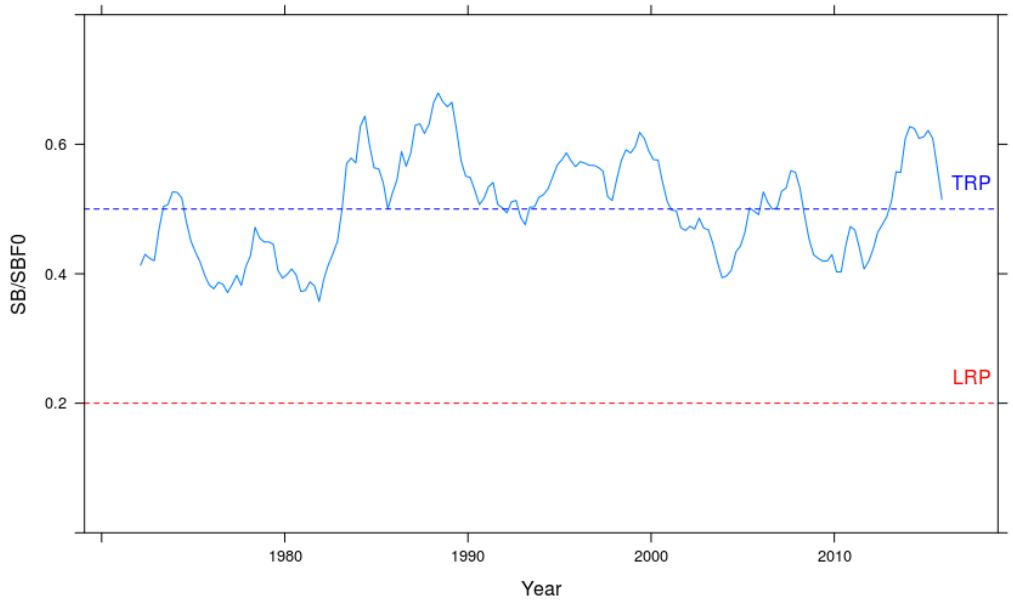
Reference Points

REFERENCE POINTS

Reference points are used to identify the conditions in a fishery (such as the quantity of adult biomass or the level of exploitation) that are considered desirable (targets) or that you specifically want to avoid (limits).

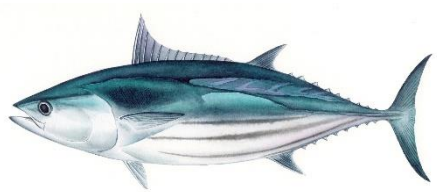
Limit Reference Points

- Identify the conditions that you want to avoid
  - eg. the point at which recruitment is impaired
- Often based solely on biological considerations
- Typically expressed in terms of biomass (but not always)
  - eg. adult biomass relative to unfished adult biomass



Target Reference Points

- Identify the conditions that are considered desirable, or optimal
- Often include social and economic considerations as well as biology
- Can be expressed as biomass, exploitation rate, CPUE, …



LIMIT REFERENCE POINTS

Limit Reference Points (LRPs) - identify the conditions in a fishery that you want to avoid.

Overfishing

- Growth Overfishing
  - Fishing mortality exceeds the optimum level such that fish are caught before they have grown to the optimum size.
  - Can be rectified in the short term

- Recruitment Overfishing
  - Fishing mortality exceeds the optimum level such that the population is reduced to levels where recruitment is impaired
  - More serious – often requires long term measures to rebuild the stock

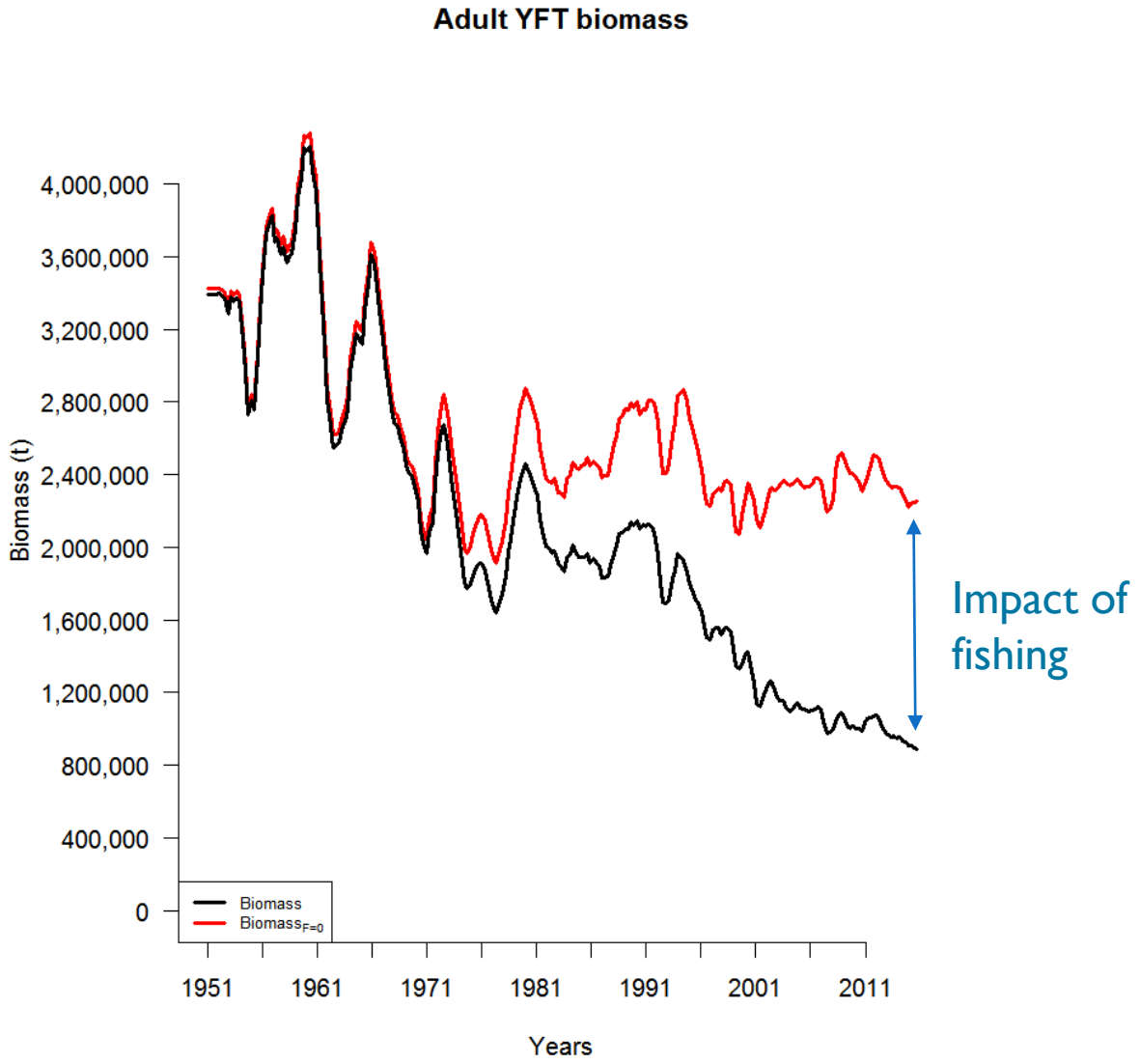
SB/SBF0

Black line - Estimate of Adult Biomass.

Red line - What Adult Biomass would be if there was no fishing.

- We use the stock and recruitment relationship and recruitment trends estimated from the stock assessment
- Growth, maturity, etc. remain the same
- Estimate what the population would be if there was no fishing

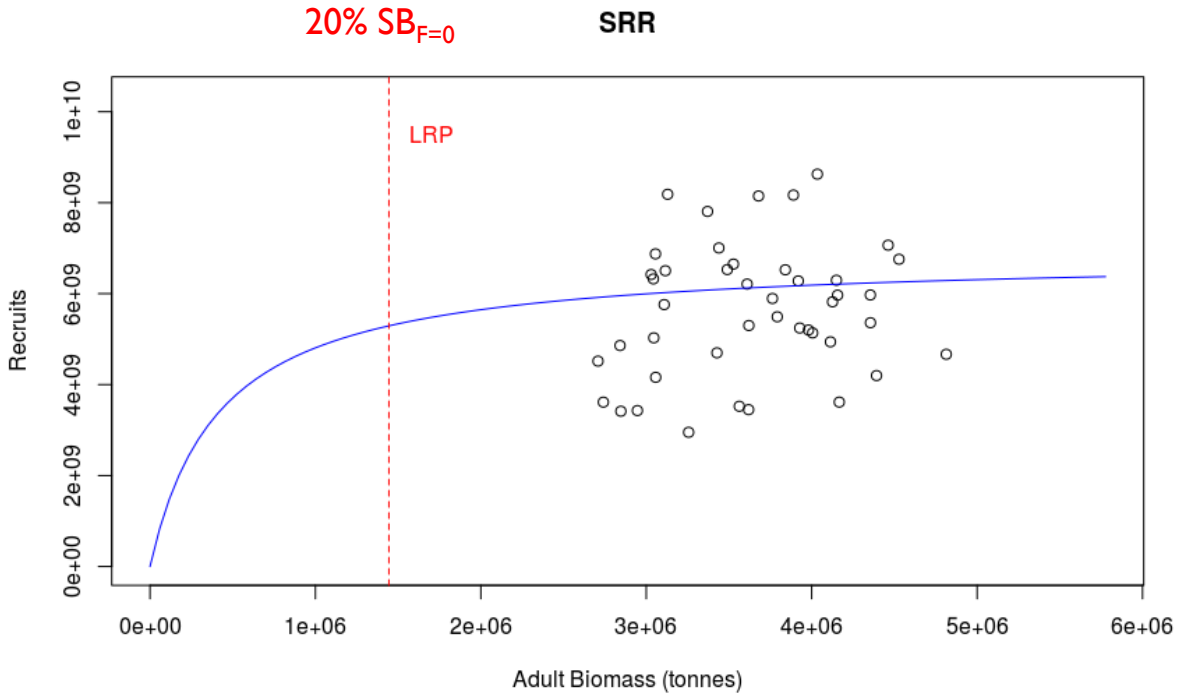
- 90% SB/SBF0 – small impact of fishing
- 20% SB/SBF0 – large impact of fishing



LIMIT REFERENCE POINTS

Types of Limit Reference Point (LRP)

- Spawning potential per recruit (SPR)
  - The potential contribution to spawning biomass of an average fish over its lifetime.
  - Advantage: does not need an SRR (steepness)
  - Disadvantage: Only addresses growth overfishing
- Depletion based LRPs (eg. x% SBF0)
  - Based on the depletion of adult (or total) biomass
  - Disadvantage: Requires an SRR (steepness)
  - Advantage: Specifically addresses recruitment overfishing
  - Advantage: Relatively stable from assessment to assessment
- Maximum Sustainable Yield (MSY)
  - Theoretical maximum long term yield
  - based on equilibrium dynamics

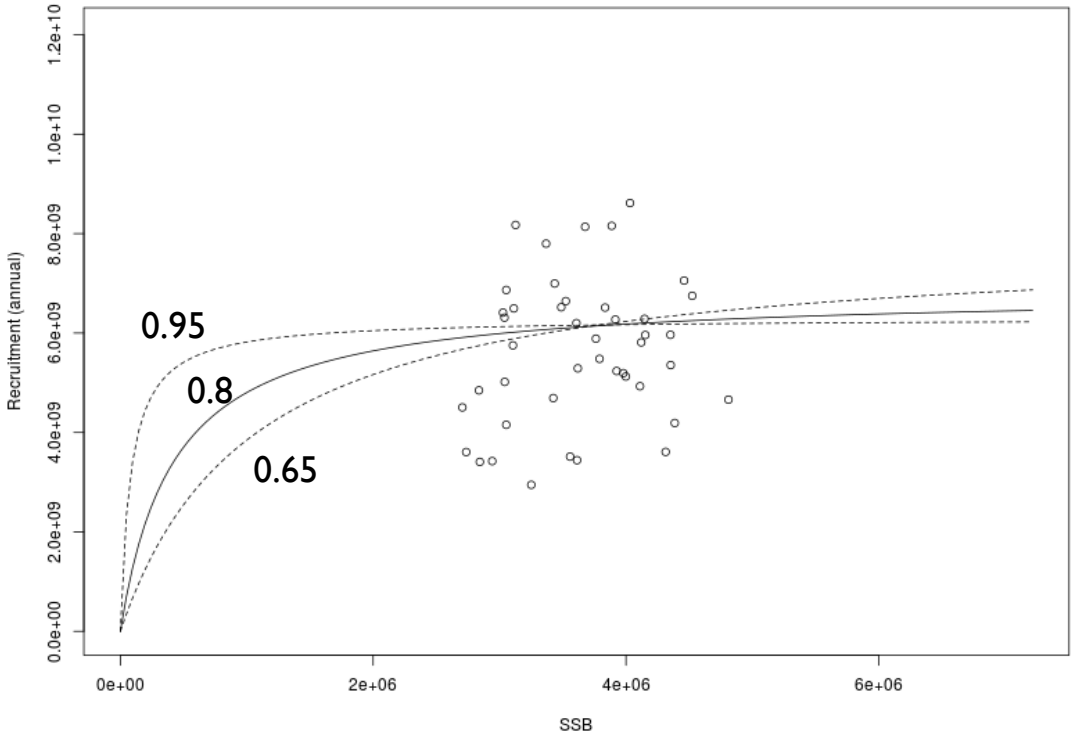


LIMIT REFERENCE POINTS

Why is steepness an important consideration when setting a limit reference point?

Steepness in the stock and recruitment relationship

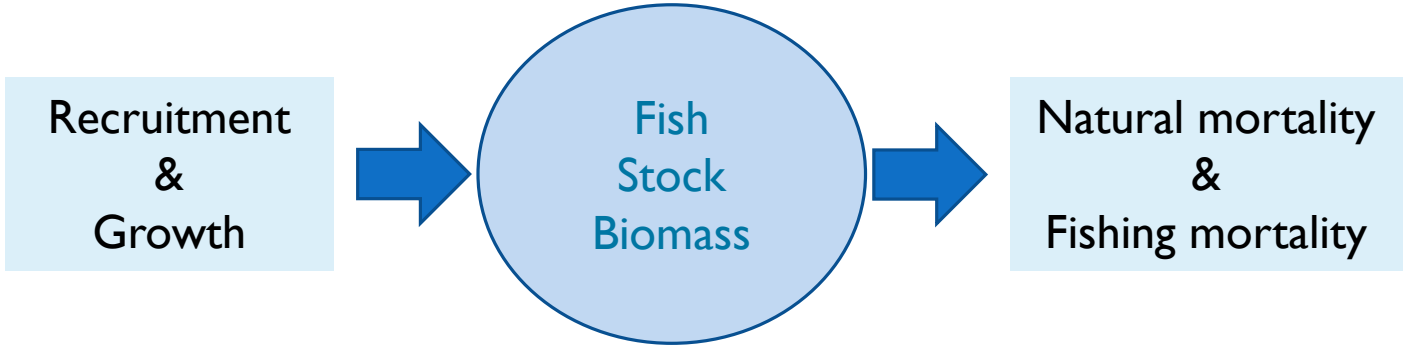
- The rate at which recruitment declines at low biomass
- High steepness = resilient stock
- Low steepness = more susceptible to overfishing
- Often no information on recruitment at low biomass
  - Not possible to estimate steepness in stock assessment
  - Need to make an assumption
- Depletion based LRPs require some assumption about steepness

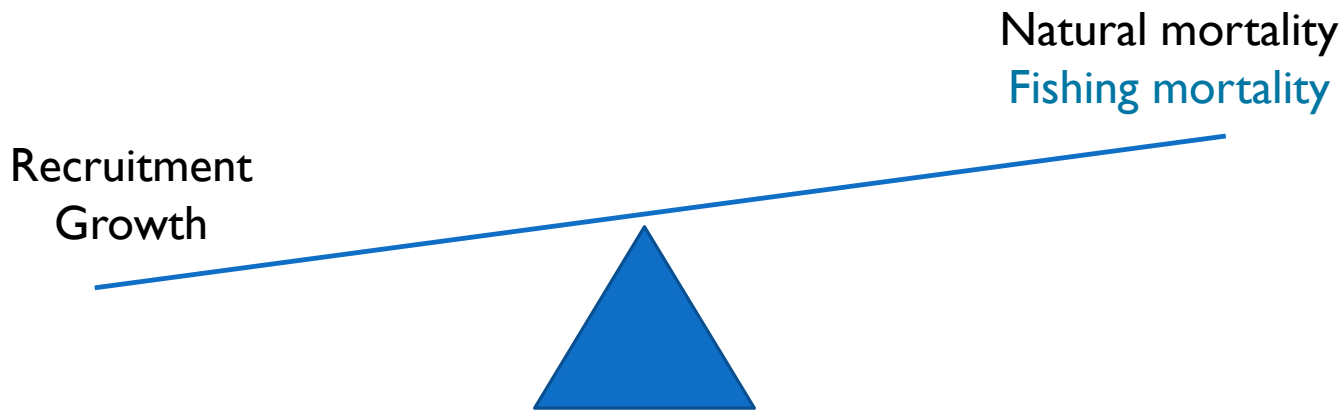


FISH POPULATION DYNAMICS

What makes a population increase or decrease?

- Population increases through recruitment and growth
- Population decreases through natural mortality and fishing mortality





MAXIMUM SUSTAINABLE YIELD

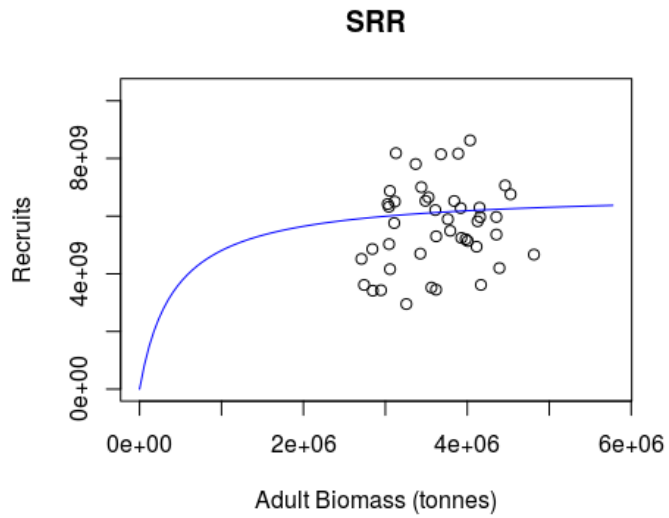
MSY is theoretically, the largest yield (or catch) that can be taken from a stock over an indefinite period

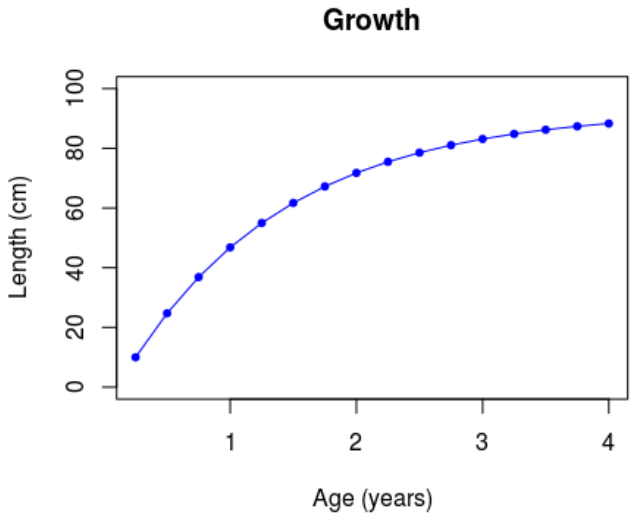
MSY assumes equilibrium conditions

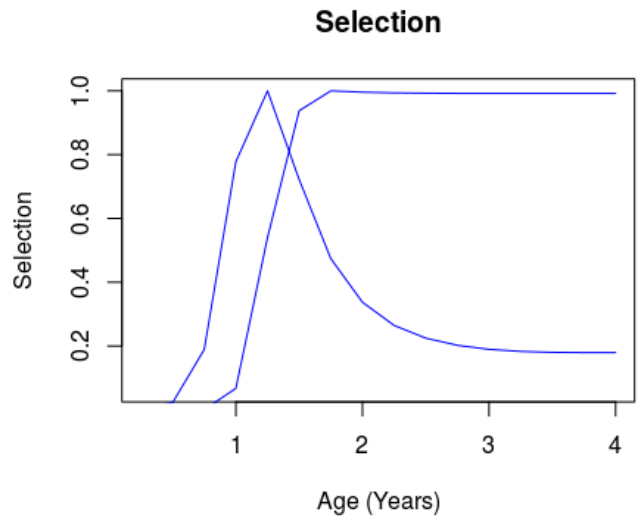
- ie. annual variability (eg. recruitment) is not taken into consideration

The calculation of MSY depends on

- Biological characteristics of the stock
  - Growth, Maturity, Natural Mortality
  - Stock recruitment relationship
- Fishery characteristics
  - Selection patterns of each of the fleets operating in the fishery





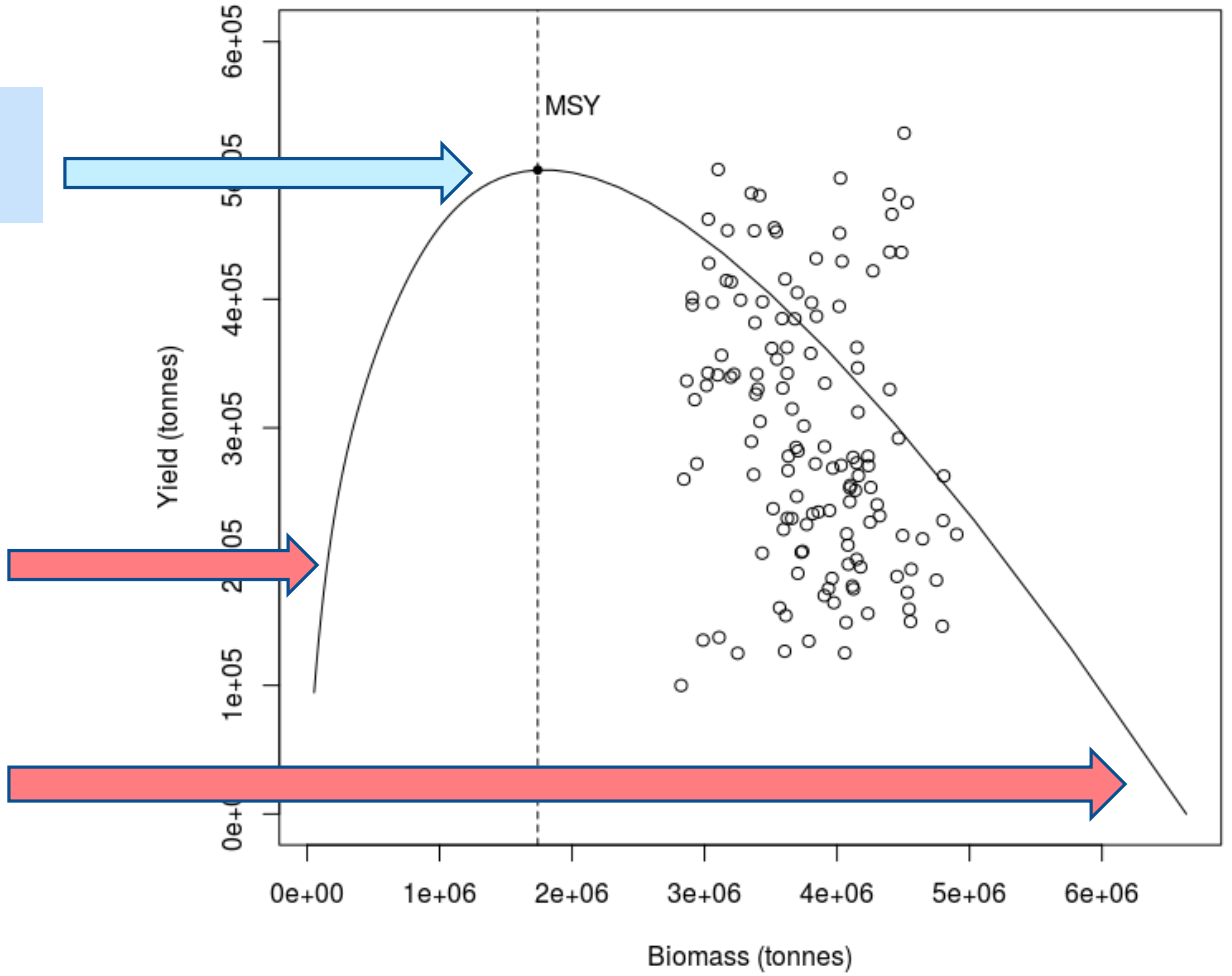


MAXIMUM SUSTAINABLE YIELD

Optimally exploited :
Optimal fishing effort = maximum yield

Over exploited :
High fishing effort = low biomass and low yield

Under exploited :
Low fishing effort = high biomass and low yield

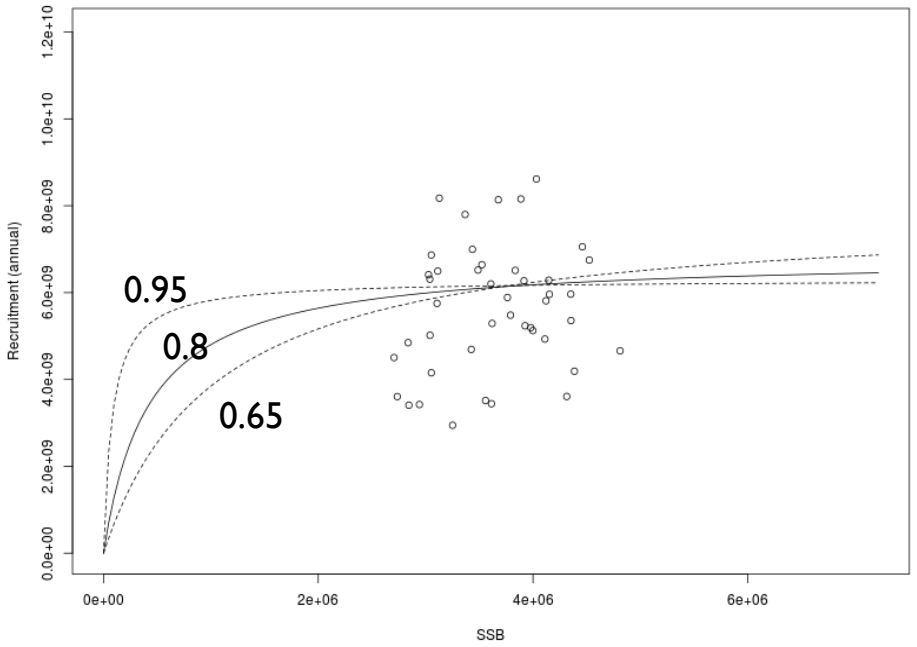


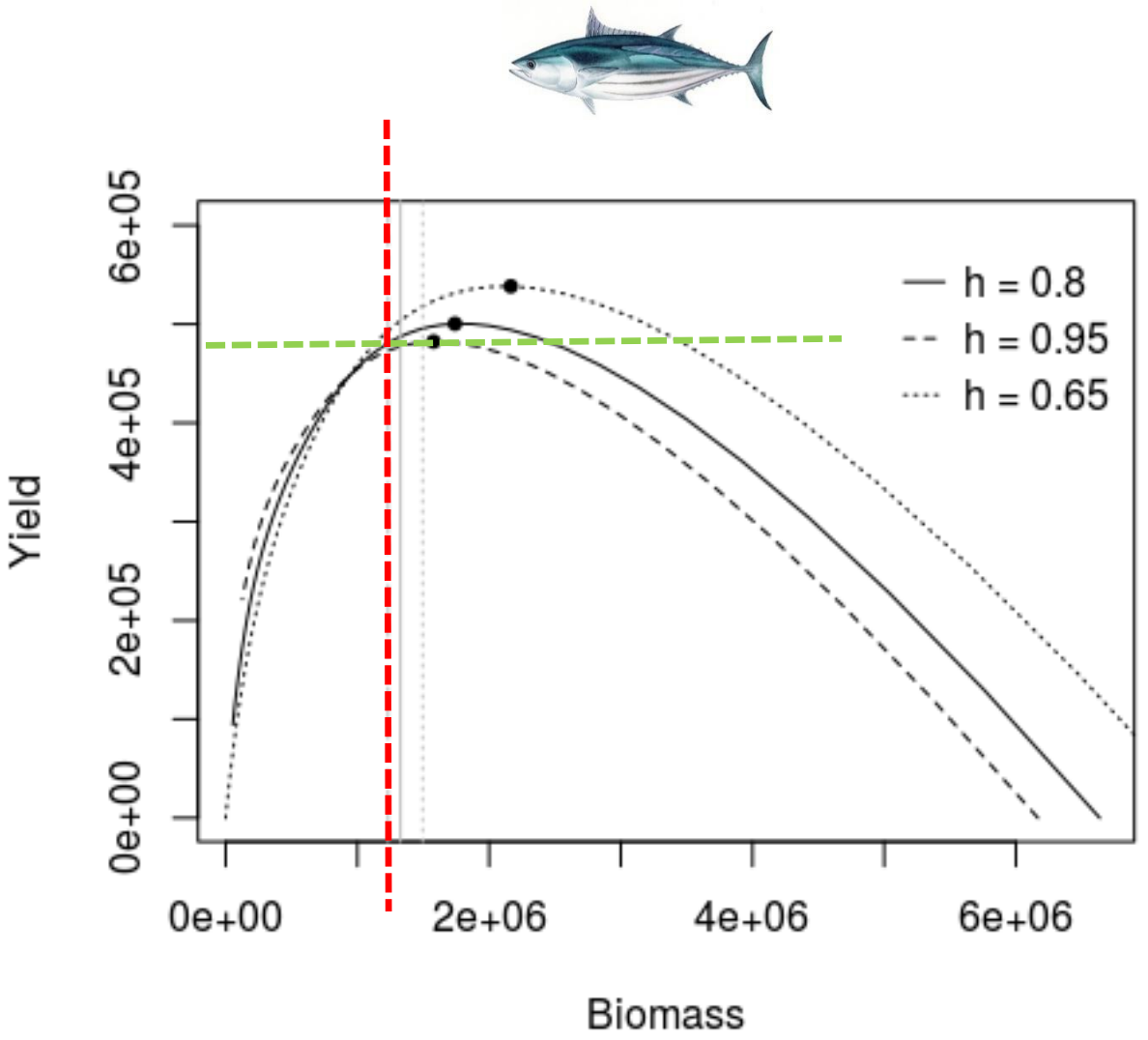
MAXIMUM SUSTAINABLE YIELD – EFFECT OF STEEPNESS

Pacific Community
Communauté du Pacifique

How does steepness affect MSY?

- Greater steepness – Lower MSY ☹
- Greater steepness – Lower LRP ☹
- MSY can vary depending on biological and fishery assumptions





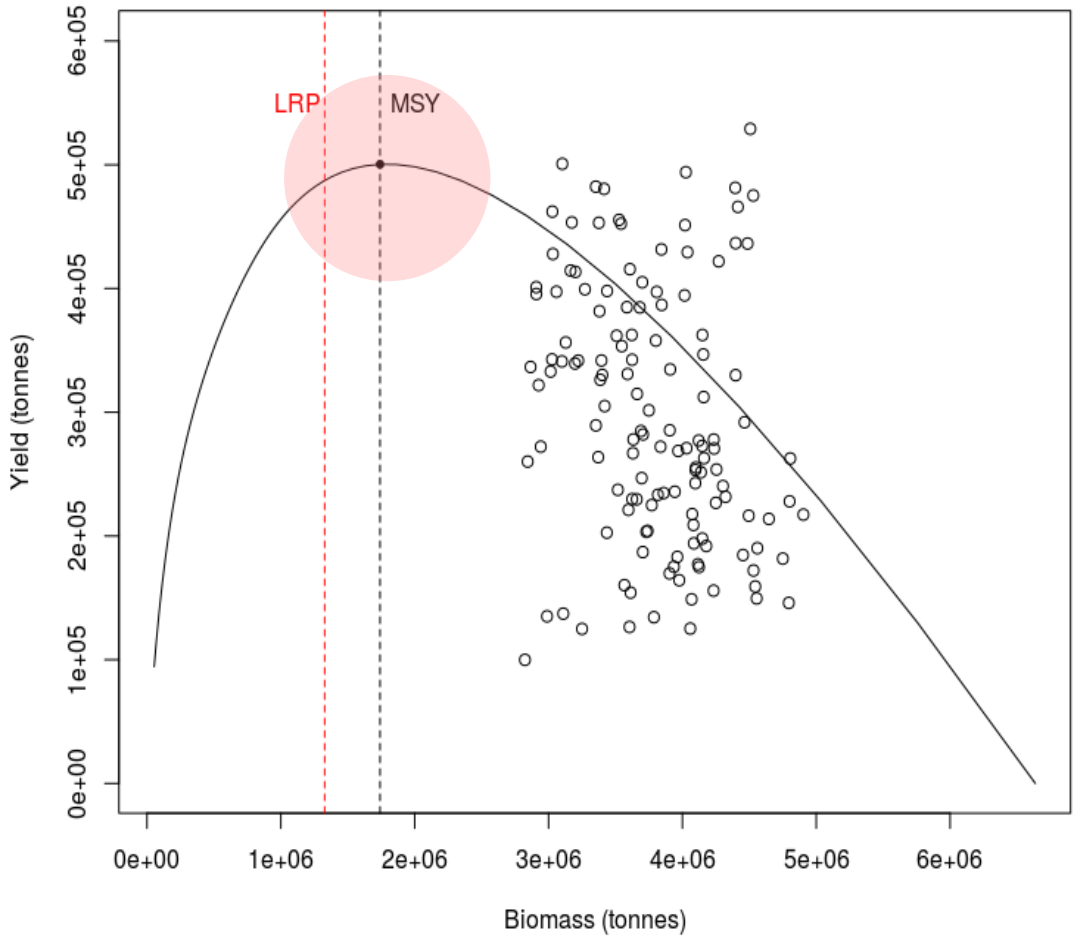
MAXIMUM SUSTAINABLE YIELD

Pacific Community
Communauté du Pacifique

Should MSY be a target or a limit ?

- Many organisations specify MSY as a management target in the absence of any other TRP
- Increasingly MSY is considered to be a limit rather than a target.

- Depending on the characteristics of the stock and fishery, managing to MSY may incur a high risk of falling below the LRP.
- In addition, MSY rarely gives you the same level of yield as maximum economic yield (MEY).



LIMIT REFERENCE POINTS

Preece et al (WCPFC-SC7-2011/MI-WP-03) recommend the following three level hierarchical approach to setting limit reference points.

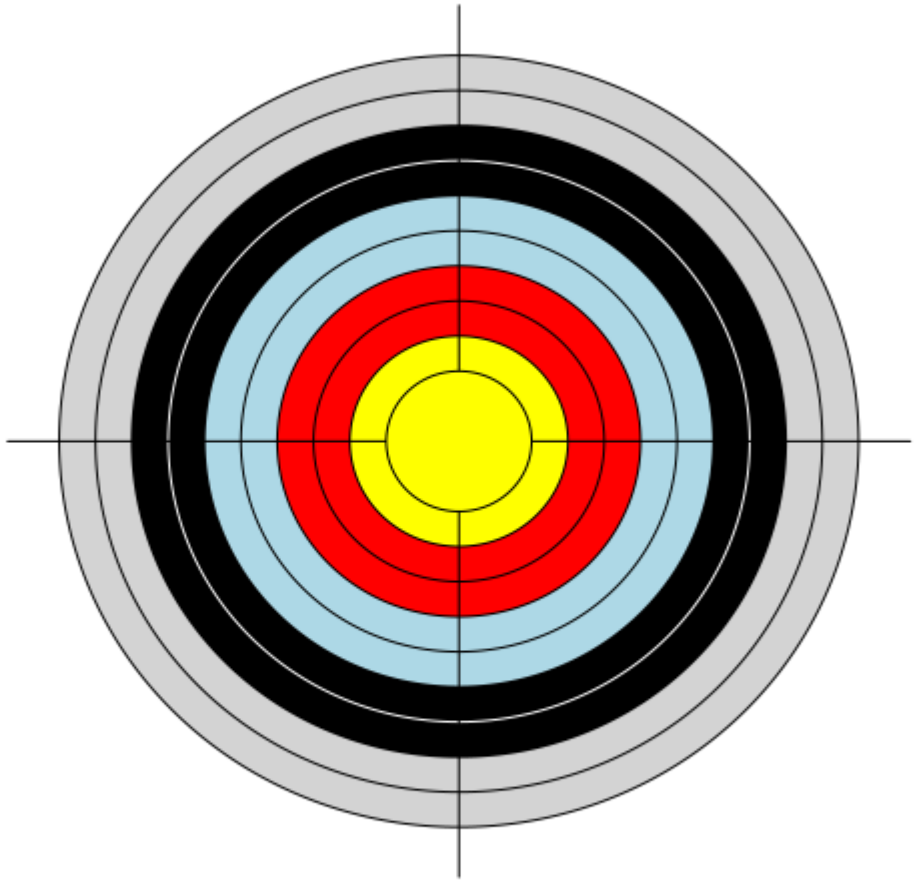
1. If steepness is well estimated, then FMSY and BMSY are appropriate limit reference points

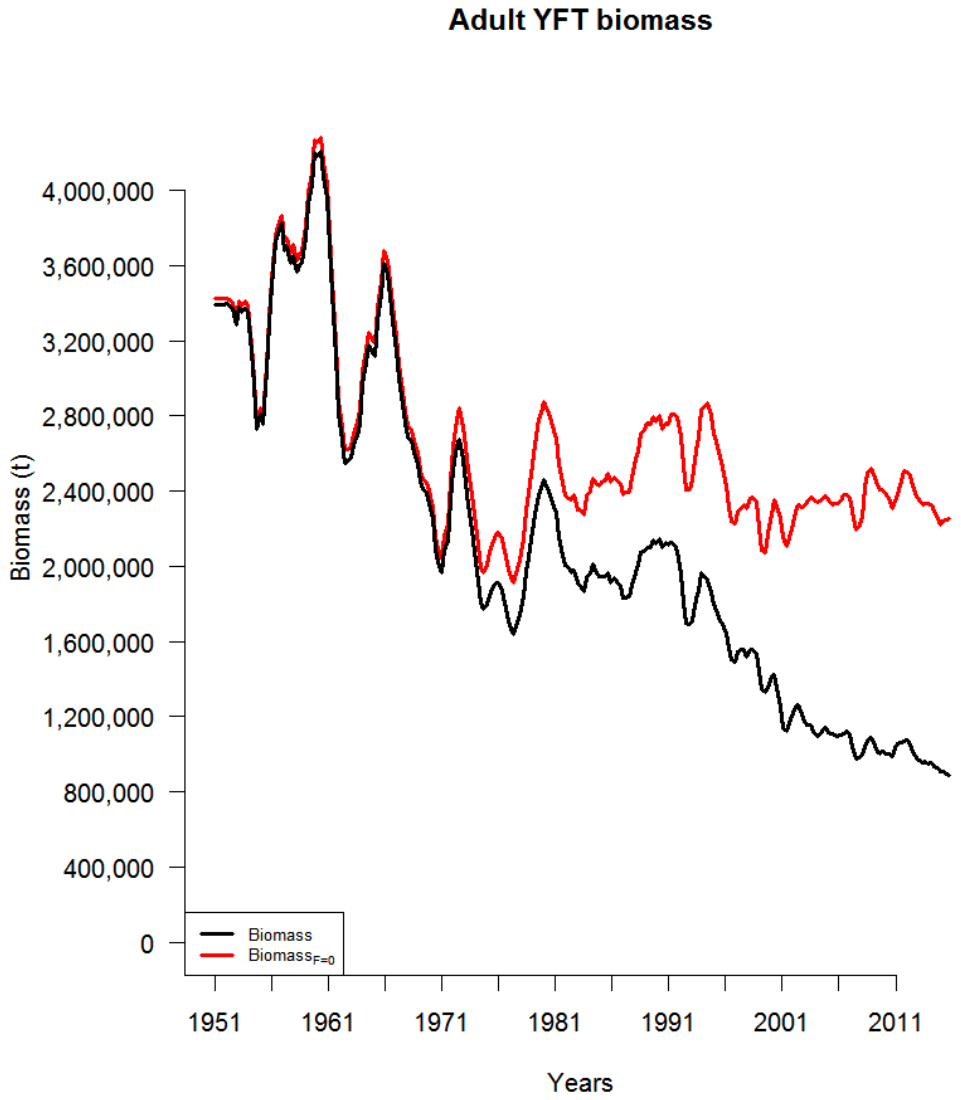
2. If the steepness is not well estimated (and essentially unknown) and if the relevant life-history and fishery information (natural mortality, selectivity, maturity) are both available and reliably estimated then FSPRx% and x% SBF0 are appropriate candidate F and SSB limit reference points, respectively.

3. If the relevant life-history and fishery information are not reliably estimated then only use the SSB-based limit reference point, x% SBF0.

TARGET REFERENCE POINTS

Target Reference Points (TRPs) - identify the conditions in a fishery that you want to achieve.

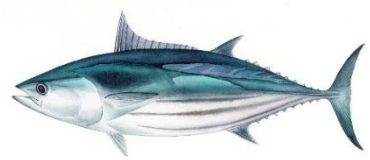



Adult YFT biomass
Biomass (t)
4,000,000
3,600,000
3,200,000
2,800,000
2,400,000
2,000,000
1,600,000
1,200,000
800,000
400,000
0
Biomass
Biomass$_{F=0}$
1951
1961
1971
1981
1991
2001
2011
Years

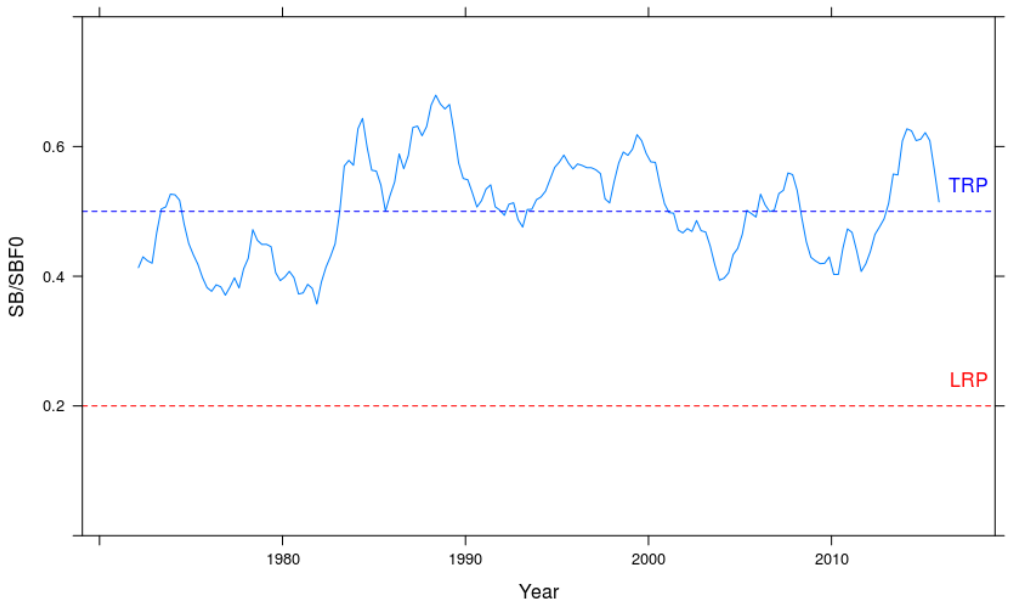
TARGET REFERENCE POINTS

Target Reference Points (TRPs) - identify the conditions in a fishery that you want to achieve.

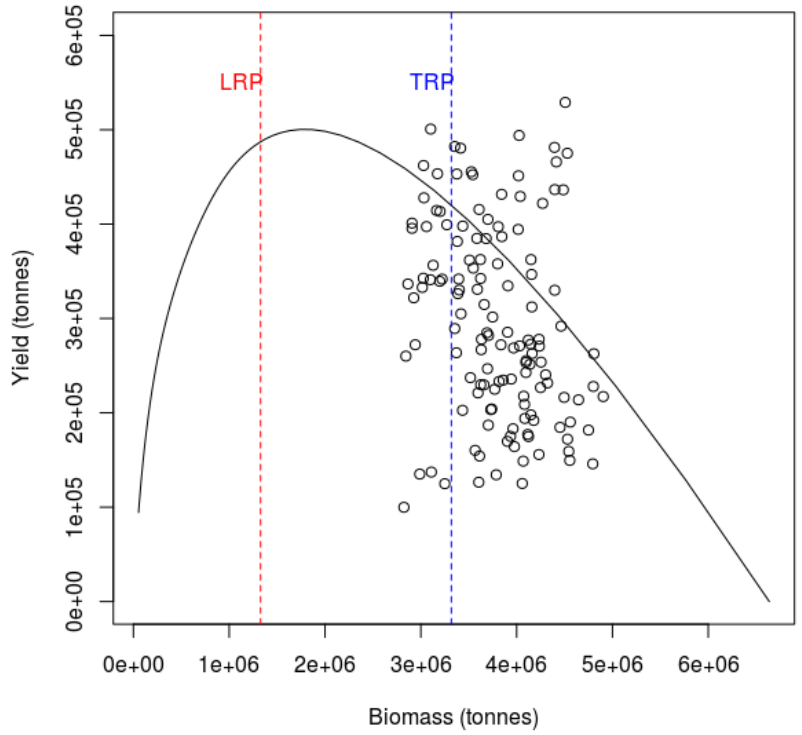
- May include economic, social and ecosystem considerations as well as stock sustainability



Adult Biomass relative to unfished Adult Biomass



Equilibrium Yield

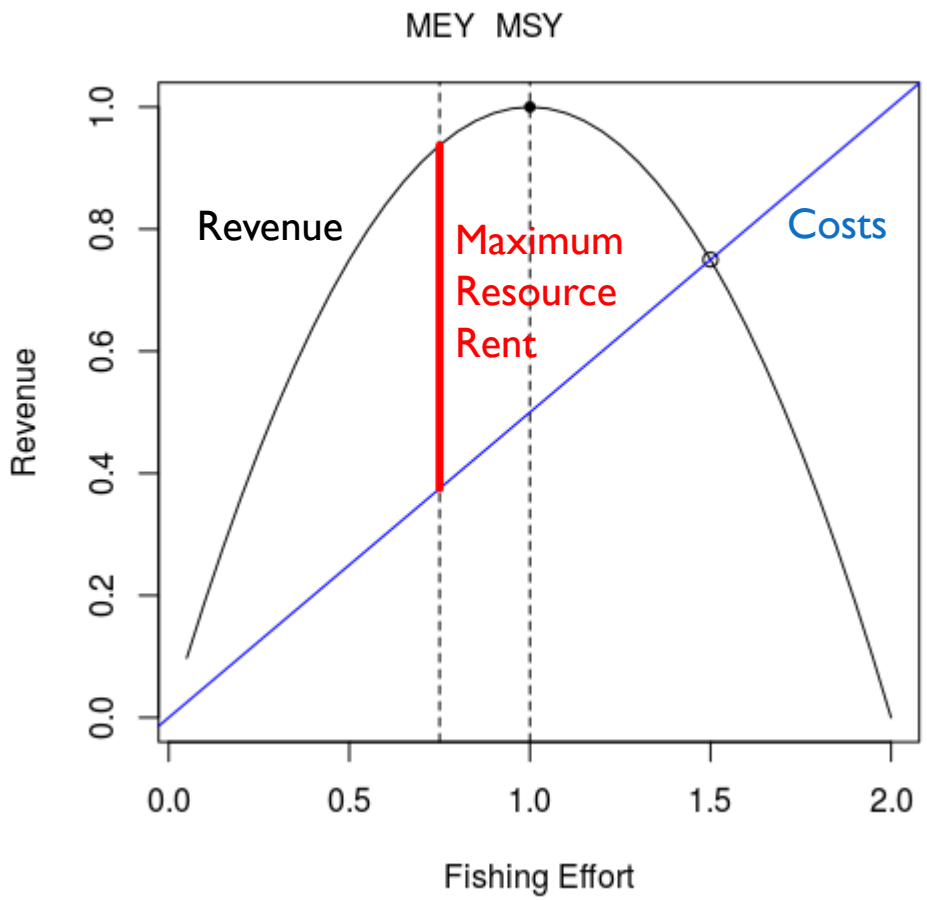


TARGET REFERENCE POINTS

Target Reference Points (TRPs) - identify the conditions in a fishery that you want to achieve.

Things you may want to consider when setting a TRP

- Economics
  - The cost of fishing vs revenue - MEY
  - Catch per Unit Effort and resource rents
- Social Considerations
  - Employment in fishing and related sectors
  - Food security
- Ecosystem Effects
  - Bycatch of non-target species
  - Mixed fishery considerations



MIXED FISHERY ISSUES

How do you set a TRP for a fishery that targets more than one stock ?

BET and YFT have contrasting life history dynamics but are caught in the same fishery

- YFT – larger and more productive stock
- BET – smaller, less productive stock and more susceptible to over-fishing
- Maximising catches for YFT would lead to over-exploitation of BET
- Maximising catches of BET would mean under-exploiting YFT.