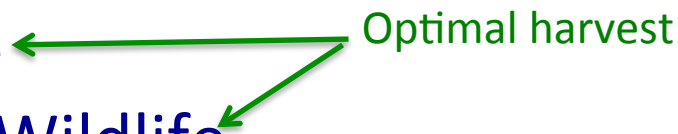
Economics of Renewable Resources: Fisheries

Lecture 6

1. Renewable Resources

- Renewables
  - Trees
  - Fish, Wildlife
  - Wine, Cheese, etc.



- Efficient use over time
  - Rate of harvest
  - Bio-economic Models
  - Often Common Property Resources (Open Access)

2. Fisheries

- Physical Model of Growth – Schaefer Logistic Model for growth of species population

$$F(x) = rx(1 - \frac{x}{K})$$

  - Other forms
  - Stochastic

$x =$ Fish Stock

$r =$ Fish species intrinsic growth rate

$K =$ Carrying capacity

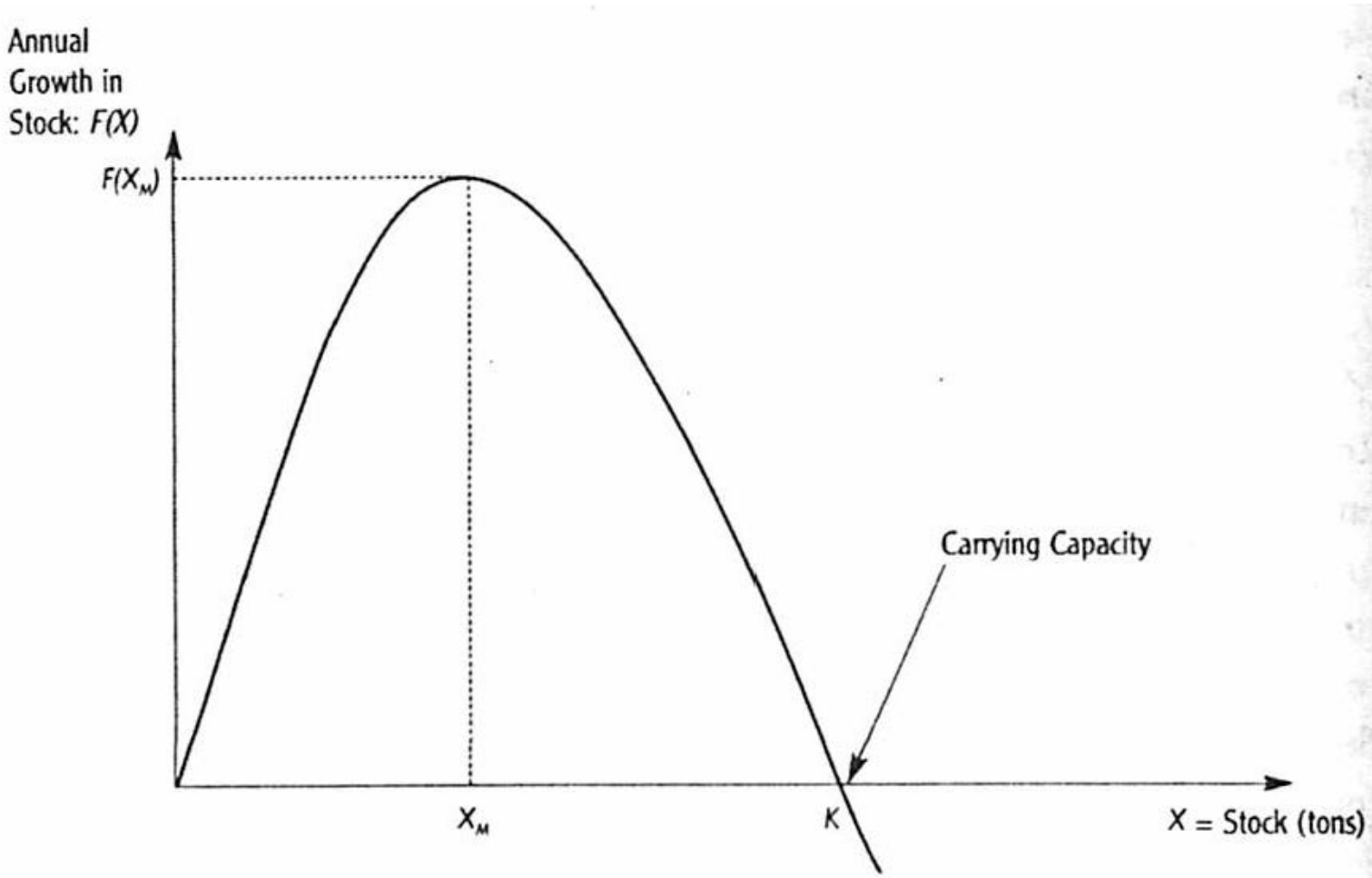


Figure 7.5 The logistic growth curve in the model of a fishery.

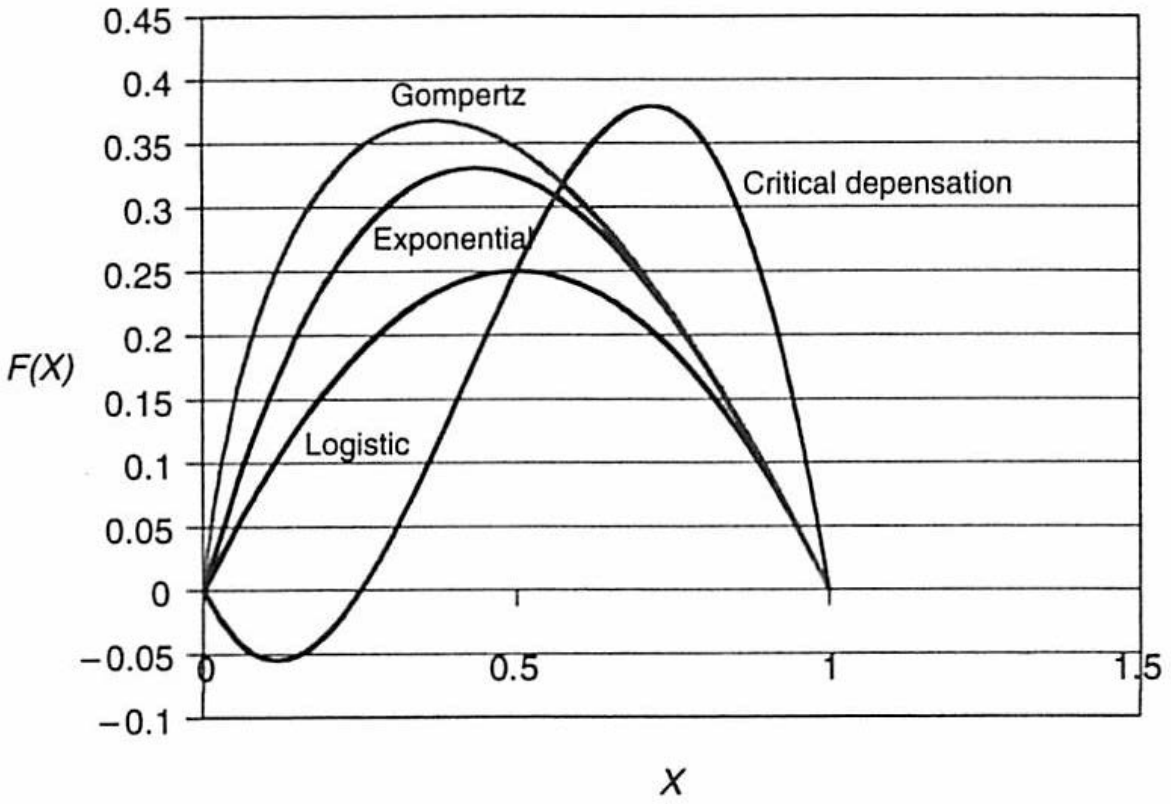


Figure 3.2. Four net biological growth functions $F(X)$.

- Steady state model
  - Think of harvest growth in each period
  - Yield at any level of stock will be "sustained" for ever
  - Maximum Sustainable Yield is $F(x_M)$ -- (MSY)
  - Absent harvesting system goes to K (carrying capacity)
  - Of course, there will be shocks (stochastic models)

- Yield-Effort Function
  - Assume yield per unit effort is proportional to size of fish stock
  - Effort can be use different units. KO uses number of boats
  - Functional form for simplification …

$$Y(E) = 10E - E^2$$

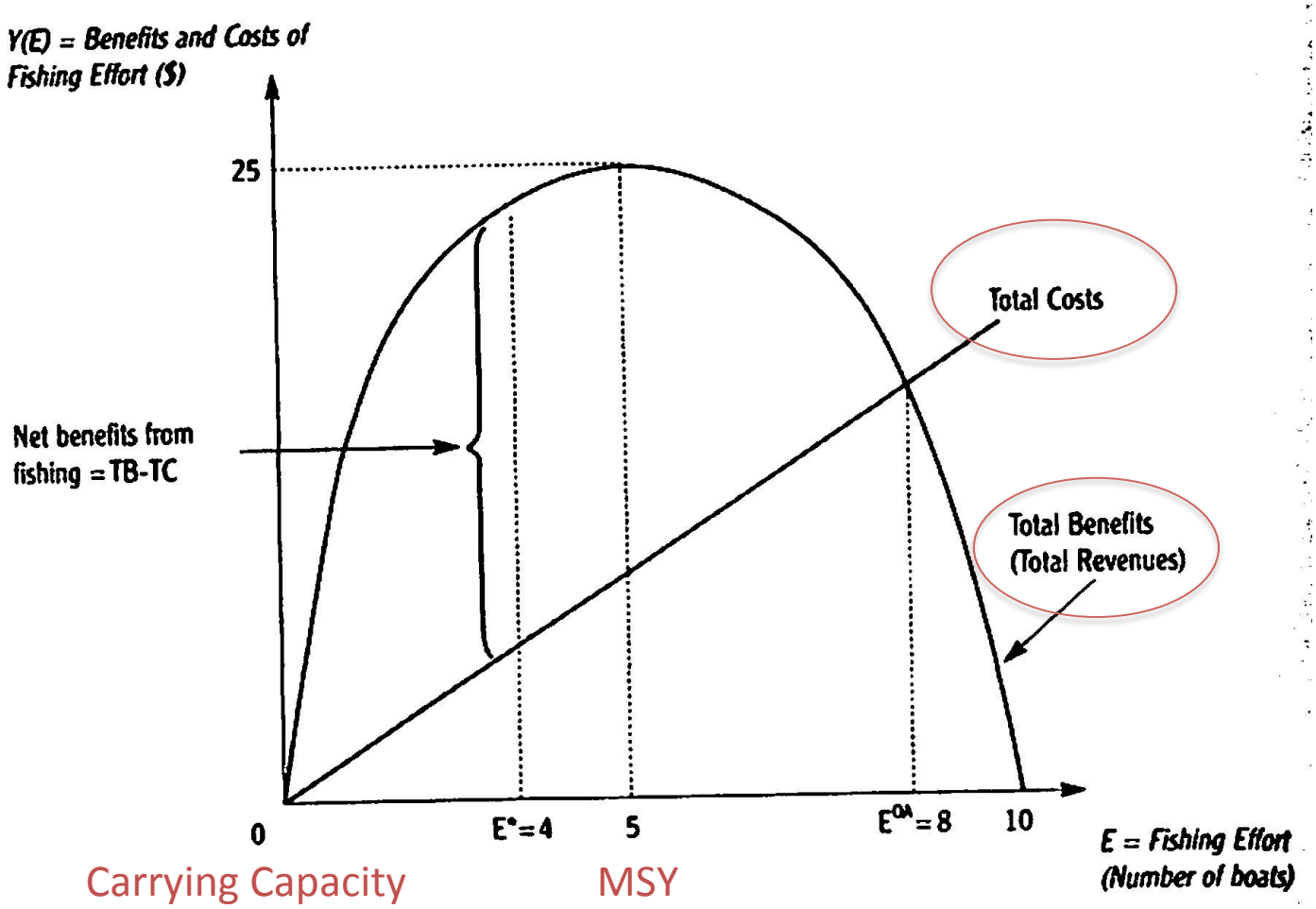
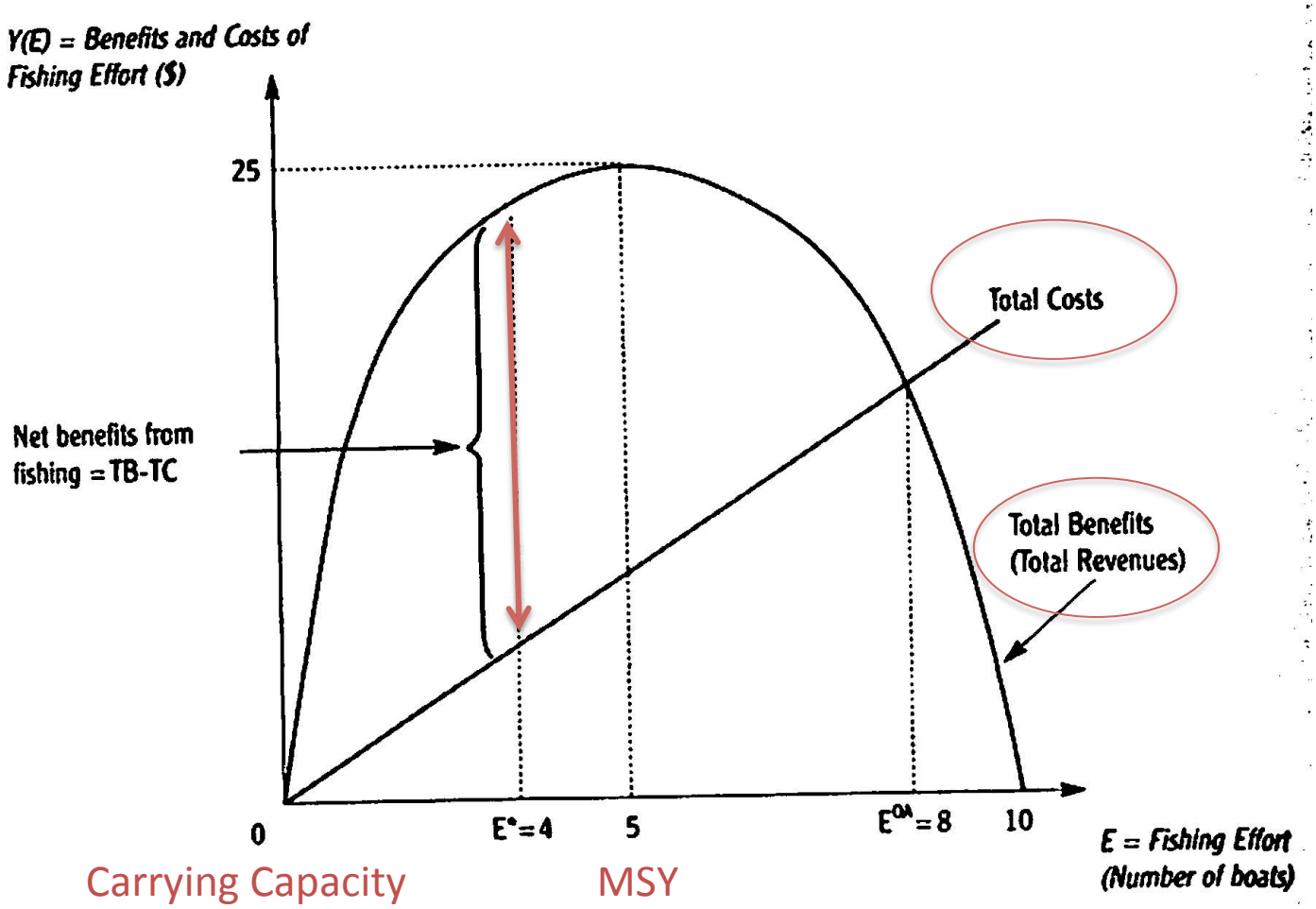


Figure 7.6 Efficiency versus open access. The efficient level of fishing effort, E^*, sets marginal cost equal to marginal benefit. In the open-access equilibrium, total costs and benefits are equal, resulting in a much higher level of effort, E^{OA}.



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Comment: economic and biologic "overfishing"

- Efficient harvest
  - $E^{*} = 4$
  - Where MB = MC or net benefits are max
  - Stock level greater than MSY
  - Recall steady state

- Open access harvest
  - $E^{OA} = 8$
  - Where TB = TC
  - "Rents" are dissipated
  - CPR externality
  - Again, no property rights
  - Overfishing

Actors generate costs external to transactions between buyers and sellers.

- Regulations
  - Gear restrictions
  - Area restrictions
  - Size restrictions
  - Closed seasons
  - Limited entry
  - ITQ preview …

Rents still dissipated. Stories.

- Open Access vs. Common Property
  - Open access implies no restriction on entry and extraction
  - Common Property implies formal or informal institutional arrangements to control entry
    - Explicit rules
    - Social norms
  - Restaurant example
  - Economic gains → incentives to find cooperative solutions

- General Model
  - Maximizing the present value of net benefits over an infinite horizon:

    Choose vector y_t for t = 1,…, T over time to

$$Max\ \pi = \sum_{t=0}^{\infty} \rho^t \pi(x_t, y_t)$$

$$s.t. \quad x_{t+1} - x_t = F(x_t) - y_t$$

$$\text{given } x_0 > 0.$$

$x_t =$ stock of fish in time t

$y_t =$ harvest in time t

$\rho^t =$ discount term

$F(x_t) =$ natural growth function

– First order conditions imply …