Economics of Renewable Resources II

1. The Idea of sustainable yield

The sustainable yield of renewable natural resources is traditionally defined as the extraction level of the resource which does not exceed the growth. However, this definition is too restrictive in many cases. For a given stock of a biological resource, many sustainable yields can be defined in principle. Forests have several functions besides logging (such as, habitat protection, recreation and biodiversity) and the sustainable yield has to be defined on the basis of a particular objective. Ideally, the sustainable yield should be determined by forest experts on the basis of modelling, but if no such information is available natural growth can be used as a proxy. With respect to timber, the sustainable yield refers to fellings which are not more than growth of timber during the accounting period (i.e. net growth is positive or zero).

The sustainable yield refers to total fellings and not only to timber removed for own consumption and use. Another way of putting this is to say that if the closing stock is at least as high as the opening stock the yield for the accounting period is sustainable. During transitional periods (for example, after afforestation) the sustainable yield will differ from natural growth. The same may apply during transition from a previously virgin forest to a regularly managed forest.

The sustainable yield of natural capital is the ecological yield that can be extracted without reducing the base of capital itself, i.e. the surplus required to maintain ecosystem services at the same or increasing level over time. The term only refers to resources that are renewable in nature as extracting non-renewable resources will always diminish the natural capital. The sustainable yield of a given resource will generally vary over time with the needs of the ecosystem to maintain itself, e.g. a forest that has recently suffered a blight or flooding or fire will require more of its own ecological yield to sustain and re-establish a mature forest. While doing so, the sustainable yield may be much less. The term sustainable yield is most commonly used in forestry, fisheries, and groundwater applications.

2. Maximum Sustainable Yield (MSY)

Maximum Sustainable Yield is a theoretical concept used extensively in fisheries science and management. In fisheries, MSY is defined as the maximum catch (in numbers or mass) that can be removed from a population over an indefinite period. The concept of MSY relies on the surplus production generated by a population that is depleted below its environmental carrying capacity. Despite many concerns about MSY, MSY remains a key paradigm in fisheries management. However, MSY has evolved from a fisheries management target to a limit on fishing mortality and biomass depletion. The concepts involved in determining MSY for fisheries are similar to concepts in forest and wildlife management.

In population ecology and economics, maximum sustainable yield (MSY) is theoretically, the largest yield (or catch) that can be taken from a species' stock over an indefinite period. Fundamental to the notion of sustainable harvest, the concept of MSY aims to maintain the population size at the point of maximum growth rate by harvesting the individuals that would normally be added to the population, allowing the population to continue to be productive indefinitely. Under the assumption of logistic growth, resource limitation does not constrain individuals' reproductive rates when populations are small, but because there are few individuals, the overall yield is small. At intermediate population densities, also represented by half the carrying capacity, individuals are able to breed to their maximum rate. At this point, called the maximum sustainable yield, there is a surplus of individuals that can be harvested because growth of the population is at its maximum point due to the large number of reproducing individuals. Above this point, density dependent factors increasingly limit breeding until the population reaches carrying capacity. At this point, there are no surplus individuals to be harvested and yield drops to zero. The maximum sustainable yield is usually higher than the optimum sustainable yield and maximum economic yield. In population ecology and economics, optimum sustainable yield is the level of effort (LOE) that maximizes the difference between total revenue and total cost. Or, where marginal revenue equals marginal cost. This level of effort maximizes the economic profit, or rent, of the resource being utilized. It usually corresponds to an effort level lower than that of maximum sustainable yield.

In traditional models of renewable resource, the rate of harvesting said to be **optimal** where the steady-state rate of harvest equals the rate of growth so that the stock level is maintained at the optimal level.