



SMR.478 - 57

THIRD AUTUMN COURSE ON MATHEMATICAL ECOLOGY

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Glossary of Technical Terms in Fisheries Management

These are preliminary lecture notes, intended only for distribution to participants.

Glossary of Technical Terms *in Fisheries Management.*

ADAPTIVE MANAGEMENT -

A form of management (qv) which involves continuous active response to new information about the behavior or current state of the resource.

AGE CLASS - A group of individuals of the same age range in a population. This term usually refers to a year class in long-lived annually breeding species, but shorter units of time are also used.

AGE-SPECIFIC - The dependence of a factor, such as fishing mortality (qv), on the age of fish.

AGGREGATION - The practice of incorporating groups of individuals or species into a single, indivisible component when building models of complex systems.

ASSEMBLAGE - A collection of species inhabiting a given area, the interactions between the species, if any, being unspecified.

ASSESSMENT - A judgement

ASSESSMENT (continued) - made by a scientist or scientific body on the state of a resource, such as a fish stock (e.g., size of the stock, potential yield, whether it is over- or underexploited), usually for the purpose of passing advice to a management (qv) authority.

BY-CATCH - Catches of a species in a fishery which is directed primarily at another species. These are sometimes discarded.

CATCH - Is usually expressed in terms of wet weight. It refers sometimes to the total amount caught, and sometimes only to the amount landed. The catches which are not landed are called discards.

CATCH PER UNIT EFFORT

(CPUE) - The catch obtained by a vessel or fishery per unit of fishing effort (qv) expended. This term is often used as a measure of abundance of the target stock(s), with greater or lesser degrees of justification.

CATCH RATE - Means sometimes the amount of catch per unit time,

CATCH RATE (continued) - and sometimes the catch per unit effort.

CATCHABILITY - The fishing mortality on a stock generated by a unit of fishing effort (qv). It is usually denoted as q in the equation:

$$F = qf,$$

where F and f represent fishing mortality and fishing effort, respectively. q will depend on the habits of the fish as well as on the type and deployment of fishing gear; it may also depend on the abundance of the fish (less abundant fish may be more catchable due to less saturation of gear).

COLLAPSE - Reduction of a fish stock by fishing or other causes to levels at which the production is only a negligible proportion of its former levels. The word is normally used when the process is sudden compared with the likely time scale of recovery, if any, but is sometimes used melodramatically for any case of overfishing (qv).

COMMUNITY - The collection of organisms or species inhabiting an area. This term usually implies particular known or hypothesized interactions between the organisms

COMMUNITY (continued) - (as opposed to ASSEMBLAGE).

COMPENSATION - A compensatory mechanism is a process by which the effect of one factor on a population tends to be counteracted or compensated for by a consequential change in another factor. For example, a reduction in the egg production of a stock may be compensated for by an increase in the survival rate of the eggs. Compensation can be partial or complete. In some cases, **OVER-COMPENSATION** can occur: a reduction in egg production could, for example, lead to an increase in the resultant production of larvae. Many density-dependent (qv) mechanisms are compensatory.

COMPETITION - The detrimental interaction between two or more organisms of the same or different species which utilize a common resource.

CONCENTRATION PHASE - A stage in the life cycle of a fish at which the individuals are particularly concentrated. For example, the adults of a species may inhabit an entire sea for most of the year, but the larvae may be confined to the beaches.

DEMERSAL - Inhabiting the sea

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DEMERSAL (continued) - bottom. The application of the term to a species usually refers to the adult stage of the species.

DENSITY-DEPENDENCE - The dependence of a factor influencing population dynamics (such as survival rate or reproductive success) on population density. The effect is usually in the direction that contributes to the regulative capacity (qv) of a stock.

DEPENSATION - The opposite of COMPENSATION (qv).

DETERMINISTIC MODEL - A model whose behavior is fully specified by its form and parameters, unlike a stochastic model (qv).

DISCOUNT RATES - The rate at the relative weight attached to benefits or losses is reduced in proportion to their distance into the future. Discounting is often used when making investment or policy decisions and can have serious consequences for future generations. For example, a discount rate of 10% means that gains or losses occurring n years into the future are ascribed a weight equal to their nominal value multiplied by 0.9^n .

DIVERSITY - The variety of species in a community, sometimes expressed by various quantitative measures which reflect not only the total number of species present but also the degree of domination of the system by a small number of species.

ECOSYSTEM - The sum total of biological populations and abiotic factors present in a region, and their relationships to each other. No ecosystem is a closed system, hence the precise meaning of the term varies according to the scale of the region to which it is applied.

EFFORT or **FISHING EFFORT** - This term is defined to varying levels of precision. It can be simply the total number of boats operating in a season, or the actual total number of net hauls per unit time. When different types of fishing gear are deployed, the amounts of effort expended by each are usually standardized according to their relative fishing power (qv) before being summed as an index of total effort.

ESCAPEMENT - That part of the stock which survives at the end of the fishing season.

EXIT FISHERY - A fishery directed at a transient phase in the life

EXIT FISHERY (continued) - cycle of the prey, for example, a fishery catching only the juveniles of a species.

F - See MORTALITY.

PECUNDITY - In fish this term usually refers to the production of eggs per individual.

FISHING POWER - The relative fishing power of two vessels or gear types is the ratio between the catches they would obtain per unit time for a given level of abundance of the resource.

GROWTH RATE - In fish this is often measured in terms of the parameter K of the von Bertalanffy curve for the mean weight as a function of age;
 $W = W_{max}(1 - \exp(-K \cdot \text{age}))$.

HABITAT REFUGES - A part of the range of a stock which is not accessible to fishing. If the species in question is not too diffusive, the existence of such refuges may enable it to persist under a higher level of fishing mortality than it otherwise would.

ICES - International Council for the Exploration of the Sea.

INTERACTIONS - Between species these are the processes by which the fate of one species in an ecosystem (qv) can influence another. Interactions can include predation, competition, etc.

LEVEL OF EXPLOITATION - This can mean the amount of catch or the level of fishing mortality (qv), or is sometimes used without any precise quantity in mind.

LICENSING - Restriction of the right to fish to those persons or vessels issued with licenses for the purpose.

LIMITED ENTRY - Restriction of the right to join a fishery, by the use of licenses or other means.

LINKAGES - See INTERACTIONS.

LONG-LINING - Fishing using baited hooks on lines.

MANAGEMENT - The art of taking measures affecting a resource and its exploitation with a view to achieving certain objectives, such as the maximization of the production of that resource. Management includes, for example, fishery regulations such as catch quotas or closed seasons. **MANAGERS** are

MANAGEMENT (continued) - those who practice management.

MESH SIZE - The size of holes in fishing net. Minimum mesh sizes are often prescribed by regulations in order to avoid the capture of the young of valuable species before they have reached their optimal size for capture.

MORTALITY - Is usually defined as an instantaneous death rate of fish, usually expressed in units of (years)⁻¹. Thus a proportion e^{-Z} of a population would survive a constant mortality rate, Z , operating for one year. The mortality rate is divided into **FISHING MORTALITY**, usually denoted by the symbol F , and **NATURAL MORTALITY**, usually denoted by the symbol M . When both are expressed as instantaneous rates, the total mortality is simply the sum of these two. Natural mortality is usually taken to include not only mortality due to natural causes (predation, disease, etc.) but also mortality due to non-fishing artificial causes such as nuclear weapons testing or chemical waste dumping.

OVERCAPITALIZATION - The situation in which an excessive investment has been made in fishing or processing capacity in relation to the yield which the

OVERCAPITALIZATION (continued) - resource can sustain (also referred to as **OVERCAPACITY**).

OVERFISHING - In the wider sense, any level of fishing greater than some defined, optimal level. In the classical sense, a level of fishing effort or fishing mortality such that a reduction of this level would, in the medium term, lead to an increase in the total catch. Two distinct types of classical overfishing are recognized: **GROWTH OVERFISHING** is the situation where a reduction in the proportion of fish caught would be more than compensated for by an increase in their average size; **RECRUITMENT OVERFISHING** is the situation where a reduction in the proportion of fish caught would be more than compensated for by the increased number of recruits to the fishery that would accompany the increased escapement (q_v) of mature fish.

PELAGIC - Inhabiting the open sea, not bottom-dwelling. Usually refers to the adult stage of a species when not otherwise stated.

PERSISTENCE - The tendency of a population (q_v) to continue to exist in the long term, despite short-term fluctuations.

POPULATION - Strictly, a distinct

POPULATION (continued) - group of members of a species inhabiting a certain region, which are reproductively isolated from other populations. In loose usage, the term is often synonymous with **STOCK** (qv).

PRODUCTIVITY - Generally used loosely to refer to the capacity of a stock or ecosystem to provide a yield of some useful kind.

PROPERTY RIGHTS - (Varying degrees of) ownership of a resource by particular individuals or associations.

QUOTA - A limit placed by an authority on the amount of fish which may be caught, often applying to a particular species and/or area and/or fishing gear type.

RECRUIT - A young fish entering the exploitable stage of its life cycle. **RECRUITMENT** can mean either the rate of entry of recruits into the fishery or the process by which such recruits are generated. Recruitment can be defined as the attainment of a particular **AGE AT RECRUITMENT**, being the youngest age group which is considered to belong to the exploitable stock. The age at recruitment depends both on the biological characteristics of the

RECRUIT (continued) - fish itself and on the nature of the fishery (location, mesh size (qv), etc.). Alternatively, recruitment can be defined as the attainment of a certain size, or as the appearance on a particular fishing ground, or as the attainment of a particular level of catchability (qv) relative to that of older fish. **PRERECRUIITS** are fish which have not yet reached the recruitment stage.

RECRUITMENT OVERFISHING - See **OVERFISHING**.

REGULATIVE CAPACITY - Is a population's tendency to revert towards some typical average level of abundance rather than to increase or decline indefinitely or to drift aimlessly. The **REGULATIVE MECHANISMS** by which this can be achieved include, for example, inverse dependence of survival rate and/or reproductive success on population density (often used synonymously with **DENSITY-DEPENDENCE** (qv) and sometimes called homeostasis).

RELIABILITY - The extent to which a resource, if managed properly, can be depended on to provide a reasonably constant yield (qv). An unreliable resource is one which may fail suddenly due to causes not obviously related to fishing. As used in Beverton et al. (this volume), this term is distinct from **ROBUSTNESS** (qv).

RESILIENCE - The tendency of a community or ecosystem not to change greatly despite heavy disturbances such as intensive fishing.

REVERSIBILITY - The extent to which a change in a stock or ecosystem induced by exploitation will reverse itself when the causative factor is removed. Extinction of a species is an example of an irreversible change.

ROBUSTNESS - The capacity of a population to persist in the presence of fishing. This depends on the existence of compensatory (qv) mechanisms.

SINGLE-SPECIES MODEL - A model describing the dynamics of a species which does not explicitly incorporate the effects of interactions with other species.

SPATIAL HETEROGENEITY - The nonhomogeneous nature of habitats or spatial distributions of organisms, often ignored in simple models.

SPAWNING BIOMASS - The total biomass of fish of reproductive age during the breeding season of a stock.

SPAWNING SUBSTRATE - The type of habitat required by a fish species for spawning.

STABILITY - This term is applied very loosely to ecosystems or communities, but it usually means their tendency to retain their essential characteristics in the shorter or longer term. It sometimes refers to the more particular capacity of systems to return to their original state following a disturbance.

STATUS QUO - Can mean the general current state of affairs in a fishery, but in certain fora, such as ICES (qv), it refers specifically to the current level of fishing mortality (qv).

STOCHASTIC MODEL - A model whose behavior is not fully specified by its form and parameters, but which contains an allowance for unexplained effects which are represented by random variables.

STOCK - In its strict sense, a distinct, reproductively isolated population (qv). In practice, the term is applied to the members of a species or group of species inhabiting any conveniently defined area, which is regarded as a discrete population for management purposes.

STOCK-RECRUITMENT RELATIONSHIP - The dependence of recruitment (qv) on the size of the parent breeding stock, the latter usually being measured in units of spawning biomass (qv). Such a relationship always exists in principle, in that the existence of a parent stock is a prerequisite for the generation of recruitment. However, in many cases there exist regulatory mechanisms (qv) such that the number of recruits is not strongly related to the parent stock size over the range of stock sizes observed: this situation is sometimes described as the absence of a stock-recruitment relationship, but is more logically described as a special case of a stock-recruitment relationship.

STOCKING - The practice of putting artificially reared young fish into a sea, lake, or river. These are subsequently caught, preferably at a larger size.

UPWELLING - An oceanographic phenomenon whereby deep, nutrient-rich water is forced up to the surface, often leading to an exceptionally productive area.

VITAL RATES - Rates (such as natural mortality, fecundity, and growth rates) affecting the

VITAL RATES (continued) - dynamics of a stock.

WHITE NOISE - A random effect in a stochastic model (qv), which is taken to be independent, identically distributed over the time intervals in which the model is expressed. Other types of noise such as red and blue noise are also recognized, but these terms are less common and should not be used without explanation.

YIELD - Sometimes synonymous with CATCH, but usually with the implication of a degree of sustainability, especially when potential yields are under discussion. The YIELD CURVE is the relationship between the expected yield and the level of fishing mortality or (sometimes) fishing effort.

- Compiled by J.G. Cooke

