THE USE OF COMPUTER SIMULATION GAMES IN THE TRAINING OF APPLIED ECOLOGISTS

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The primary function of the applied ecologist is to determine levels of human activity which will perturb the ecological community to such a degree that its homeostatic mechanisms will be severely damaged. If the ecologist is employed by a regulatory agency then decisions must be made concerning allowable limits of specific activities. These decisions are influenced by political, sociological, economic, and biological factors. Many resources have been abusively treated because the wrong factors were given higher priority in the formation of policy. The collapse of the Peruvian anchovy fishery occured, in part, because of the weight given to economic influences. Political aspects of whaling have led to the demise of several cetaceans. The total collapse of the fisheries for Pacific sardines and Norwegian herring can be attributed to the choice of the wrong population model from which exploitation levels were derived.

Fisheries ecologists are beginning to use computer simulation games as a training device to expose students to the complexities involved in resource management (1, 2, 3). Titlow and Lackey (2) created DAM, a teaching game which simulates problems involved with water resource allocation such as conflicts involving the maintenance of a sports fishery, water for hydroelectric power and water for agricultural purposes. I have participated in the development of three simulation games: TUNA, SALMON, and PLAICE which simulate the dynamics of the Eastern Pacific Tropical tuna, the Skeena River sockeye salmon and the North Sea Plaice. The objective of each game is to manage each population for maximum sustained yield (MSY), the maximum allowable catch without imparing the reproductive capacity of the population. The student is placed into a realistic setting. He is given a contract to manage the fisheries and will be promoted or fired depending upon his performance. From the interpretation of catch and fishing effort data, the student must determine which of three classical fisheries models to base his strategy: Schaefer's surplus yield model (4) which assumes that population growth is limited by density-dependent factors, Ricker's spawner-recruit model (5) which has an additional restriction that there are no overlapping generations in the population, or Beverton and Holt's dynamic pool model (6) which has as its critical assumption that the number of offspring recruited into the population is constant regardless of the size of the parental stock.

Each game begins by displaying a data sheet on the CRT. It contains information on catch(in pounds), the fishing effort expended, the price per pound of fish, and the money each boat made and the money earned by the entire fishery during that season. The manager of the fishery has two tools at his disposal. He can control the harvest by adjusting the length of the season and the number of fishing vessels which are granted licenses. Once a license has been granted, a boat is added to the fleet. Licenses are not revoked. The fleet decreases in number only if boats go broke. With the exception of sinkings, fishing wars and limit violations, this simulates the real world. Once a decision on the length of the season and the number of boats has been made, the game iterates and updates the data sheet. If the manager does well, the fishery turns a profit and his rating goes up. However, good fishing stimulates more applications for fishing licenses. If every applicant is permitted into the fishery, the manager is left with only one tool, regulation of season length. If the season is too short, boats lose money, go broke and people are laid off work. If the season is too long, there is the possibility that the fishery will be overexploited. In either case, the biologist is in trouble. This is why there are few well managed fisheries in the world. There are only a few limited entry fisheries.

In the game SALMON, if too many potential fishermen are denied licenses, political pressure in the form of a memo from the supervisor warns,

> "YOU ARE RECEIVING PRESSURE FROM YOUR SUPERIORS ABOUT THE LOW NUMBER OF APPLICATIONS YOU ARE GRANTING. THIS COULD AFFECT YOUR RATING".

If the biologist remains stubborn and refuses to accept further applications, the following directive appears,

> "YOU HAVE BEEN CALLED IN BY THE BOSS FOR ACCEPTING TOO FEW APPLICATIONS. THIS IS SURE TO AFFECT YOUR RATING. PLEASE REENTER THE NUMBER OF APPLICATIONS".

If the resource becomes overexploited, the manager is notified immediately with,

> "BETTER START LOOKING FOR A JOB OUTSIDE THE FISHERIES MANAGEMENT FIELD. YOUR RATING IS 0.0 AND THE SKEENA RIVER SOCKEYE SALMON IS EXTINCT AND YOU ARE IN DEEP TROUBLE".

The game is rigged. Its rigged to favor my biases; that is, if the student makes decisions based upon the biological condition of the fisheries, he will always be promoted. He may accrue demerits if he resists political pressures, but the fishery will always be economically and biologically solvent.

Data used in the games are obtained from records of specific fisheries. The economic data was taken from the National Marine Fishery Services Statistical Digest series. As there are monographs concerning the history of the fishery, the student can reconstruct to a limited extent, past events and learn from them. There are several other advantages to these games. Time is condensed, experience which would normally take years can be acquired in a few hours. Computer simulation may be the only feasible way that students can conduct ecological experiments on a global scale. The act of making a decision is a creative one; it forces students to synthesize theory presented in lectures and from the reading. They learn more about the assumptions upon which the models are based. Simulation games are forgiving; if you were fired, you can easily obtain a new position by punching in the name of game.

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