THOUGHTS ON PREFERENCES AND UTILITY IN THE SALMON CASE STUDY

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Pacific salmon are an extremely valuable resource on the Pacific Rim of Canada. On the Skeena River, one of six major salmon watersheds in B.C., the dollar value of the commercial catch is between ten and twenty million dollars annually. In addition, the salmon stocks provide recreational benefits for many residents of British Columbia and contribute strongly to the local recreational economy. Millions of dollars are spent annually on managing the commercial and recreational salmon fisheries; there is a current proposal by the federal government to spend several hundred million dollars enhancing the salmon stocks over the next few years. The current salmon case study has been involved in extensive modelling efforts to determine policy options for salmon management and assess these options. However, we have recently realized that despite our model's optimization techniques and the incredible elegance of our approach, we really don't know what the people of Canada want from the salmon fishery. An example: A recent paper by Walters (1975a) showed that there were alternate methods of management which could substantially reduce the annual variation in harvest with only a small decline in the average catch. Since the fishery currently tends to take a boom or bust pattern, we thought this was an option which

should seriously be considered. However, when we presented this to government biologists familiar with the Skeena River fishermen, they agreed among themselves that the fishermen would probably prefer a high variation in catch to this leveling option. Their reasoning was that the fishermen seem to operate with the secret hope of striking it rich with a few good years. With this hope of a "big" year, they are willing to accept incredibly low incomes ($2000-3000 per year).

We recognize now, as Ralph Keeney pointed out, that sophisticated modelling cannot be beneficial unless you have a way of assessing the utility of your proposed management options for the people affected by the management. It seems very likely that we will receive funds from the Canadian government to undertake a fairly large scale project to assess the preferences of the people affected by the salmon fishery. We plan to begin this work next year when we return to Vancouver. In order to get some experience with the technique and to clarify our understanding of the interaction between preferences, utility and policy assessment, we have begun a small scale project in which we pretend that we are the people affected by the fishery, and attempt to determine our preferences and utilities. This is being done by Ralph Keeney and David Bell, members of the methodology project, who are experienced at determining multi-attribute utility. What we wish to do in the rest of this paper is describe how we think the preference analysis will fit into the rest of our study and propose some techniques for utilizing preference analysis in hierarchical decision processes.

Preferences in the salmon study

The major difference between our approach and the one used by the ecology group's budworm study last year (Bell 1974), is that we explicitly recognize that there is a set of defineable groups affected by the management policies used, and that these groups tend to have vastly different preferences. These interest groups consist of the commercial fishermen, recreational fishermen, Indians, residents of the Skeena River watershed who cater to the fishery, the fish consuming public, and the owners and operators of the commercial canneries. The federal government determines the management policies for the fishery, naturally hoping to make everyone as happy as possible at the least expense. The budworm study faced similar conditions; but instead of explicitly defining the interest groups, the budworm group determined the preferences of some undefined person who seemed to schizophrenically jump from the role of a lumber mill employee to the president of the New Brunswick Audubon Society. In the preference analysis we are undertaking, the goal will be to develop the preferences for each interest group separately. The question then is how to combine all of these different objective functions into a single function which represents how the manager views the entire salmon fishery. Our impression, based on complete ignorance of the literature, is that the traditional method is to develop one or two key indicators for each of the interest groups, and then have the manager construct his objective function from these indicators. This is certainly

what a manager would implicitly do if interrogated about his preferences from a large choice of indicators. He would mentally pick out the indicator that most closely represented each interest group's preferences, and do some mental weighting of each of these indicators. We think that this can produce some problems, because this process assumes that each interest group's preferences are very closely tied to a single indicator, and does not allow for the possibility that there are complex tradeoffs among indicators within an interest group. Therefore we will give our surrogate decision maker his indicators as the utitlity of each interest group (a single number), and he will be asked to construct his utility function from the utilities derived from all interest groups. We will then use the other method, giving the decision maker the raw indicators, and compare the results of these two methods.

From the proposed preference analysis, we hope to construct a single objective function into which we can plug the numbers coming out of our dynamic simulation models to get a method for comparing different management policies. An aspect of our surrogate decision makers' utility function we wish to examine is their willingness to increase our interest group's utility at the expense of another interest group. We suspect that politicians, the usual decision makers, are very unwilling to make anyone unhappy and would forego increasing the utility of several interest groups if it meant decreasing the utility of another interest group. If this is true, it could have serious consequences for management. It

could mean that the decision makers generally reject a policy which would eventually lead to a very desireable situation (all interest groups' utilities increased), if it meant a temporary decrease in the utility of a single group. This is akin to the standard tragedy-of-the-commons aspect of most fisheries. Everyone knows that all concerned parties would be better off if fishing pressure were greatly reduced for several years to allow a stock to recover, but the fishermen, being very vocal, scream bloody murder and the over exploitation continues. This may well be a result of discounting rates more than of the decision makers' aversion to reducing utility of any interest group, but we feel it should be explored.

To summarize, we see three major benfits coming out of our preference analysis in the salmon study.

1) From this analysis, we hope to gain a better understanding of what is and is not valued by the people affected by salmon management. This in itself should be very useful to decision makers.

2) We hope to obtain a realistic objective function to use in evaluating proposed management options.

3) We hope to gain some insight into the dicision making process and see if there are aspects of decision makers' utility function which tend to cause resource management to reject seemingly desirable options.

Utilities in hierarchical decision making processes

As we mentioned earlier, the decision making process for

Skeena River salmon is a simple hierarchy - several interest groups are affected by a single decision maker. However, this is really a gross simplification. The decision making process is very diffuse and different decisions are made at a number of governmental levels. This, combined with the spatial complexity of salmon management, produces a very complicated decision making structure. At the federal level major decisions are made, such as 'will we enhance salmon stocks?' or 'will we eliminate the commercial net fisheries?', etc. At the regional level decisions are made between major salmon areas: given that Ottowa has decided to enhance salmon stocks, should enhancement be done on the Skeena or the Fraser? At the next lower level, decisions are made separately for each major salmon area concerning annual catches, length of the season etc. This entire process is roughly outlined by Walters (1975b). It is difficult to define where people's preferences and utilities come in within such a complex decision making structure. We suspect the decision makers are using their own version of 'horse sense' to decide what to do and we propose another method. This is to set up a hierarchy with the decision maker at each level constructing a utility function based on the utilities of all of his decision making subordinates. The lowest level would be the interest groups of each major watershed. Thus the utilities of the Skeena River fishermen, residents, and Indians would be given to the Skeena River decision maker, who would construct his utility function from the utilities of his interest groups. Then the utilities of the Skeena River manager, the

Fraser River manager, etc., would be the indicators for the British Columbia salmon manager to use in constructing his utility functions. Then at a federal level the salmon managers from throughout Canada, would pass their utilities up for the final utility function.

There are several advantages of this method. It does not require the decision maker in Ottowa to try to figure out what the average fisherman in Prince Rupert (on the Skeena River) wants from the salmon fishery. He needs only to decide what his preferences are between east coast and west coast fisheries. Of course this does assume that he is confident that the utility functions of his subordinate decision makers are similar to his own. A second advantage, and probably the most important, is that if the interest groups are properly selected, and the decision making structure is hierarchical as described, then every decision maker can have a utility function which is not interdependent with his input indicators. These interdependencies arise when there is a common property shared by two indicators. For instance, a fisherman's utility for the total catch of sockeye salmon depends upon the catch of pink salmon. If the sockeye catch is very high increasing the pink catch by 50% would not increase the utility of the fisherman nearly as much as a 50% increase in pink catch would if the sockeye catch were low. These interpendencies should occur only at the interest group level in the proposed hierarchical system. Decision makers' utility functions should not have any interdependencies among the input indicators.

This is an *a priori* hope and will be exained in the preference analysis we will perform.

The above ramblings represent our idea of how we might approach assessing preferences in a complex resource management problem. We propose to stumble ahead blindly, hopefully learning something in the process. We have attempted to follow the research methods of the Urban group: talk about what we are interested in, not what we have done. So, naturally, we welcome any comments. (Anonymous comments will not be considered).