Assignment # 11: Modeling Fish Banks Ltd.

From class handouts and your own familiarity with the system, formulate a model of the Fish Banks group simulation game. Specify the reference mode in advance and compare your model's behavior patterns to it. Formulate your model in three major sectors, Fish, Boats, and Finances.

The Fish Sector

It is advisable in an initial model of this system to start simply: assume that there is one fish population — let's say the deep sea population. The coast fish population can be added once one understands the structure and dynamics of the simplified system. [However, if you feel you can handle it, or if you quickly get a one-population model running to your satisfaction, formulate a full fish sector comprising both coast and deep sea populations, identical in structure but differing appropriately in parameter values.] The net growth factor for fish, and the number of fish caught per boat, depend upon the population density, as described in the information handed out in class.

> As an aid to model formulation, ***Always have a model that runs.*** In this case, that would mean starting with one population in the fish sector, formulating the fish level and its flows with all the appropriate effects, putting in reasonable constant values for variables not included yet, some of which will come from other sectors, and being sure that the model runs, and runs reasonably. As you add more model structure, proceed one or two steps at a time and be sure you model still runs reasonably. [Of course, "reasonably" does not mean that the graphs will match the reference modes yet, but just make sense given the limited structure you have included so far.] If you always have a model that runs, you can track down strange new behavior more easily, and you can stop at any time and still have working structure and simulation output to show for your efforts.

The Boats Sector

For simplicity, consider one fleet of boats under one set of management policies designed to capture the competitive dynamics of the total real fishing economy. Formulate the number of boats as a single level, which is increased by purchases. Some fraction of the fleet will go fishing, while the remaining fraction will stay in harbor. The fraction fishing probably depends upon the difference between perceived profit per boat and the net income one would get by leaving the boat in the harbor.

The decision to purchase boats probably depends upon the Cash available. You might try to model what your group did, or what you perceived the typical group did, or what you think represents what is happening in international fishing. Be sure not to assume too much wisdom, conservatism, or unrealistic access to accurate information. To have a

useful policy model, it must first simulate the sort of collapse of fish populations that we saw in the game and we observe in reality.

The Finances Sector

Income comes from catching and selling fish at the going price. Fishing costs come from the cost of operating each boat sent out of harbor. Net profit is simply income minus total costs. As long as net profit (or loss) per fishing boat is perceived to be greater than the cost of leaving a boat in the harbor, most if not all of the fleet will be sent out of the harbor to fish. [Depending on how you formulate profit per boat, you may need to formulate perceived profit per boat as a smooth of current profit per boat, in order to simulate the natural delays in the system and to prevent a loop with no level. You may still end up with "simultaneous initial values;" see below.]

Net profits accumulate over time in a Cash level, from which flow operating costs, harbor costs, and the money to purchase more boats. The decision to acquire boats is probably based on the number of boats that the fleet can afford to buy, perhaps modified by a boat's payback period (cost/income per year) or some similar measure of perceived profitability.

Analysis

Outline (sketch and discuss briefly) the feedback structure of the model responsible for the tragedy of this commons. If you have time, can you find realistic, implementable policies that can prevent the tragedy?

Two Fish Populations

If you end up modeling both coast and deep sea fish populations, you must incorporate the decision of where to send boats. If perceived profit per boat is less than the net income received by leaving a boat in the harbor, most if not all boats would stay in harbor. Of those boats that go fishing, some fraction fishes in deep waters while the remainder fishes nearer the shore. The decision of what fraction of the fleet to send where probably depends upon the difference in perceived profits in the two regions. [Note the order here: one first decides whether to fish at all or to stay in the harbor; one then decides where to fish with the boats you (and your model) decided to send out. And these decisions are formulated as *fractions* of the single stock of boats.]

When formulating perceived profit per boat and its effects, you may encounter "simultaneous initial values." You have three options: (1) you may see a simpler way to formulate perceived profit per boat that does not involve dividing by boats, or (2) you can formulate the SMOOTH explicitly as a level with a net rate formulated as a "goal-gap" adjustment, or (3) you can use Vensim's function SMOOTHI. In SMOOTHI there are three arguments: the variable being smoothed, the smoothing or averaging time (perception time), and the initial value of the stock implicit in the SMOOTH. Thus: SMOOTHI(variable, time constant, initial value).