Shortened Lake Michigan Decision Analysis (LMDA) Presentation

Slide 1
A public meeting was held in 2005, prior to the 2006 Chinook salmon reduction. Fishery managers came to that meeting with 4 options for the public to consider. Along with the change in stocking, managers agreed to conduct a 5-year study on natural recruitment of Chinook salmon and report back to the public at the end of the study. In preparation for the next public meeting, a series of workshops is being held to enable anglers to be more actively involved in selection of stocking options to be presented at the next public meeting.

Slide 2
The second workshop was held in November and a new tool, called the Lake Michigan Salmon Decision Analysis Model, that fishery managers are utilizing to help develop stocking strategies was introduced. The SIMPLE and CONNECT models were utilized in the 1998 stocking discussions and an earlier version of the Decision Analysis Model was run prior to the 2005 lakewide public meeting. The latest version includes more data, has a longer time-series, models things considered constants in previous models, includes uncertainties, and is more user-friendly.

Slide 3
So what is Decision Analysis? It is a way of comparing possible outcomes of decisions. First, objectives are identified. Then, options to achieve those objectives are proposed. Next, uncertainties such as alewife reproduction are accounted for and added to a model that is used to identify possible outcomes. Managers and stakeholders can then use the model results to choose an option that best meets their objectives.

Slide 4
Prior to the first workshop, fishery managers met with the model designers to identify options and objectives. These were the options and objectives identified by the fishery management agencies.

Slide 5
Options and objectives were identified by Michigan and Indiana constituent representatives at a meeting this past April. Options presented in red are relevant to what the model is designed to analyze. Others are critical and may be important to consider but are not addressed by model.

Slide 6
These are options and objectives identified at the June meeting of Wisconsin and Illinois constituent representatives.

Slide 7
The basic management question is how many fish to stock. Stocking too few doesn't satisfy anglers' desires and may cause food web problems but stocking too many could potentially collapse the prey population.

Slide 8
For the model to provide possible outcomes, there are four key questions that must be answered.

Slide 9
To build a model that makes credible predictions observations from the past are used to determine what changes have occurred previously and what this tells us about “how things work”.

Slide 10
The first question is "how many fish are out there and eating".
[animation]
Various sources of data including agency assessments, creel surveys, and hatchery records are used to answer the first question.
[animation]
Formulas are developed to mimic the past and present abundance of fish.
[animation]
This analysis allows us to determine the number of fish that were likely present in the past, based on the data.

Slide 11
These are the actual data used by the model to answer the first question.

Slide 12
The plot on the left represents the numbers of fish stocked. The majority of fish that are stocked have been Chinook salmon. The plot on the right is the recruitment of wild Chinook salmon from studies and missing years were estimated from the surrounding years. The most recent natural recruitment data comes from the OTC study where tails were collected from Chinook at tournaments and launch ramps.

Slide 13
From the model, the number of fish out in the lake can be estimated (plot on left). The model can also be used to look at age-specific numbers of fish. On the right is the number of age-3 Chinook in the lake. You'll notice it looks different from the graph on the left. Increases in stocking covered up the decline in older Chinook due to Bacterial Kidney Disease in the late 1980s.

Slide 14
Even with the past salmon stocking reductions, there has not been a significant change in the number of salmon in the lake since the early 1990s, due to natural recruitment at or near 50% and better survival.

Slide 15
To determine consumption, we now know the numbers of fish in the lake. The second part of determining consumption deals with conversion efficiency. Or, how many pounds of food do you need to produce a pound of fish?

Slide 16
Consumption, like abundance, is estimated to have varied little in the recent past and has been around 175-200 million lbs. (left graph) The majority of consumption is by Chinook salmon. (top right) Large alewife are the prey item most frequently consumed. (bottom right)

Slide 17
The model tells us that consumption has been fairly stable. Chinook salmon consume the most prey, and large alewife make up most of the prey consumed.

Slide 18
The third question that needs to be answered is related to the prey supply side. It is important to balance predator demand with prey supply. The adult prey and their production, or offspring, are the supply side.

Slide 19
Stock recruitment graphs tell us how many new fish are potentially produced by a particular number of adults. This is vitally important for determining the stability of the prey population. Strong recruitment indicates more juveniles can be produced by a smaller number of adults.

Slide 20
Data from forage fish assessments and diet studies are used to determine recruitment of juvenile fish.
[animation]
Total recruitment in the model is the number of fish estimated from the surveys plus the number that were eaten prior to the survey.

Slide 21
The solid black line is the model’s output and the measured survey data is represented by the black dots. The model’s estimates fit the data quite well, but not perfectly. The solid blue line is predation mortality which is the percentage of available prey that are eaten.

Slide 22
From the forage fish surveys and predator consumption data, this is the best estimate of a stock-recruitment relationship for alewife. The line is not an exact fit so this is one area where there is considerable uncertainty. Uncertainty will be addressed later.

Slide 23
So for the question about consumption, the model tells us that 25-45% of the prey in the lake is being consumed each year and the data indicates that there is a weak stock recruitment relationship for alewife.

Slide 24
The fourth question that needs to be answered is ‘what happens when prey abundance is low’. A functional response is the predator’s ability to find and eat prey when numbers are low.

Slide 25
The functional response analysis works for Chinook and lake trout but there is not enough information on the other species to determine their response. This suggests that feeding by other species is less sensitive to changes in prey abundance.

Slide 26
This plot generated by the model shows that when alewife numbers, represented by the black line, are low, consumption of alewife by Chinook (blue line) decreases. That seems logical but this is a vital component of the model as it operates. Consumption by other species, such as steelhead, does not change to the same extent.

Slide 27
These are the functions used by the model. Notice that Chinook (red line) are the least effective at finding prey when alewife numbers are low.

Slide 28
One of the uncertainties in the model is the weak stock recruitment relationship for alewife. The Decision Analysis model uses alternative stock recruitment curves in addition to the best fit line. The others are consistent with the data but may not provide the best fit – we argue that they are plausible explanations for the data however and therefore should not be ignored. The use of the curves in the model is weighted by their ability to fit the data. Regardless of which curve is used, we also account to variation in recruitment that has nothing to do with adult abundance is also accounted for – this may be represented by the difference between the points and the curves on this plot. This variation is probably due to year-to-year differences in other factors affecting recruitment, such as winter severity.

Slide 29
Three other sources of uncertainty also are included in the model: (1) Chinook and lake trout search rates, (2) Chinook natural reproduction, and (3) how catch rates affect angler effort.

Slide 30
Up to this point you have seen how the model uses the available data to mimic what has been observed in the past. The simulation model then forecasts out into the future what the possible outcomes of various stocking strategies may be.

Slide 31
The model operates by starting with numbers of predators and prey including stocking and recruitment. Predator feeding rates and prey consumption are calculated. Numbers of predators and prey are then recalculated and the cycle begins for the next year. A single simulation run over a 25 year period results in one possible outcome. The model is then run 100 times to determine the range of potential outcomes. Each time, the stock-recruitment and functional response variables (the uncertainties) are changed.

Slide 32
The model has already been run to produce results for these four strategies. Status quo is if there are no changes in stocking over the 25 year time span. The 25% reduction or increase is at year one only and then held constant. In the feedback policy, stocking of all species is reduced 25% each time that the weight of Chinook salmon falls below 15lbs and restored if it rises above.

Slide 33
The next few slides represent outputs from the model using those four scenarios. This is a plot of 100 simulations showing alewife biomass using the status-quo strategy.
[animation]
Half of the time the result is bad since we would like to be in the 100-500kt range for alewife. Either alewife abundance drops below what we think is acceptable or rises above an acceptable level. This is an indication that factors other than the stocking policy have an important influence over alewife abundance.

Slide 34
In a comparison of those four policies, the likelihood that the alewife biomass falls below 100kt increases with a 25% increase in all species. The feedback policy results in the fewest “bad” outcomes.

Slide 35
The model also provides outputs for Chinook weights. Increases in stocking result in a decrease in weights. Notice that the 25% reduction in stocking does not have as significant an impact as the 25% increase.

Slide 36
Chinook harvests can change as stocking strategies change but the effects are less dramatic than those for weight or alewife.

Slide 37
The model also allows us to assess the impacts of stocking changes on catch-per-unit-effort or fish per hour.

Slide 38
The Decision Analysis model is a tool for helping make informed decisions about the potential outcomes for different stocking strategies. It can be used to assess the risks associated with different actions. It is not designed to take over the process of choosing stocking strategies but rather can provide additional information to individuals that make decisions.

The fishery management agencies would like to know what strategies you would like to be modeled and reviewed at the next workshop. At the workshop, agency staff and the constituent representatives will review the results and select the most suitable strategies to then present at the public meeting in summer 2012.

Discussion of potential stocking strategies