

The What and How of Salmonid Habitat Intrinsic Potential Modeling

Start of Presentation: No notes

(Introductory Slide 1)

1) Salmonid Habitat Intrinsic Potential (IP) models are a type of habitat potential model. (Not on Slide)

- a) The model output is spatially explicit
 - i) Depicting location, extent, and suitability of a Salmonid species' habitat on a map
 - ii) Uses Geographic Information Systems (GIS) software, such as ESRI's ArcGIS and ESI's NetMap
- b) Salmonid IP Modeling is different from Ecosystem Design and Treatment (EDT) models
 - i) Input parameters
 - (1) Habitat IP models generally use only what are deemed the most important parameters
 - (2) EDT uses a much more detailed list of parameters
 - ii) Input Stream reaches
 - (1) Habitat IP modeling uses reaches defined by hydrologic characteristics and are predefined
 - (2) EDT does not use predefined reaches, characteristics must be selected to define them
 - (a) Can be a mixture of extrinsic and intrinsic properties, or even species specific preferences
 - iii) Data Environment
 - (1) Habitat IP modeling runs on geographic data and a few parameters in table form
 - (a) Stream networks divided into predefined reaches
 - (2) EDT models require geographic data to be converted into "flat file" format in the form of tables
 - (a) Each reach in the network is defined by river mile and are ordered in tables
 - iv) Output
 - (1) Habitat IP models output geographic data
 - (2) EDT models output tables, which must be converted to geographic data
 - v) Summary
 - (1) Salmonid IP models are easier to implement
 - (2) Purpose of both approximately the same
 - (3) Geographic units of analysis (reaches) are approximately the same
 - (4) EDT modeling much more detailed at runtime
 - (5) Salmonid IP Modeling simpler at runtime, and post-output GIS analysis can be used to refine output
 - (6) EDT model output requires post-processing to obtain maps
 - (7) Salmonid IP Model output ready for use in GIS mapping software

2) Salmonid IP Models Are Spatially Explicit Habitat Potential Models (Slide 2)

- a) IP Models relate habitat preferences to landscape features
 - i) The landscape features are stream **reaches**
 - (1) Stream segments with like properties
 - ii) Salmonid life cycle habits define **habitat preferences**
 - (1) Spawning, rearing, migrating etc require different conditions

2) -- continued

(Slide 2)

- b) IP Models estimate **potential** habitat quality and quantity
 - i) The reach properties determine the suitability score for each **habitat suitability curve** in a set
 - (1) Suitability is the measure of how well each reach's' properties match the habitat preference of a species
 - ii) Suitability scores for each curve are combined into a single **IP** score and assigned to each stream reach
 - iii) Scored reaches analyzed using GIS software or other means
 - (1) We use Environmental Systems Institute's (ESI) NetMap software

3) IP Models Relate Habitat Preferences to Stream Reaches

(Slide 3)

- a) Influences , characteristics, properties and parameters can be:
 - i) **Intrinsic**
 - (1) innate, hard to change
 - ii) **Extrinsic**
 - (1) easy to change, ephemeral
- b) Stream reaches are identified by intrinsic **properties**
 - i) **Characteristics** are built from geomorphic, hydrologic, topologic and climate **influences**
 - ii) **Characteristics** determine **properties** of reaches
 - (1) Channel width
 - (2) Gradient
 - (3) Mean Annual Flow
- c) This hierarchy is intended **only as a guide** for understanding the underlying structural relationships of model **parameters**

(Slide 4)

- d) Spawning, rearing, migration, or other life cycle habits are selected for modeling
 - i) More than one life cycle habit **may** be selected
- e) Habitat preferences are represented as **suitability** and are scored against **parameters** on a curve
 - i) Parameters are composed of **one or more** reach properties
 - ii) The appropriate range of **parameter values** is on the **x-axis** of the curve
 - (1) The x-axis units will be meters, for example, if the parameter represented is channel width
 - iii) The range of possible **suitability scores** is on the **y-axis** of the curve
 - (1) Suitability ranges are fixed, between 0 and 1
 - iv) **Break points** are created where a suitability score is plotted against a parameter value
 - (1) Fish biologists determine at what parameter value the suitability changes and records that as a point on the curve

4) IP Models Hypothesize About Potential Habitat Suitability

(Slide 5)

- a) Depending on parameters, an IP model can present a specific answer to the question "What would the **current** river system be like if human influences were removed?"
 - i) Barriers such as culverts and dams
 - ii) Pollutants such as nonpoint and sewer discharge
 - iii) Impacts such as clear cuts and development

4) -- continued

(Slide 5)

- b) IP models provide a hypotheses about where the best habitat for the species modeled would be located if such influences were removed
 - i) IP Models do **not** simulate historical habitat conditions!
 - (1) This is a very important distinction. Intrinsic properties are **not** absolutely permanent, an example is how withdrawal of water for irrigation can affect mean annual flow downstream of the withdrawal point. **It may not be feasible or cost effective to ameliorate such influences**, in which case historical conditions are **not** simulated, nor are they desired.
 - ii) They **do** simulate potential future habitat conditions!
 - (1) There are many possible "futures", not all are realistic:
 - (a) It is the job of the fish biologists to determine which intrinsic and extrinsic parameters are the most significant and provide for the most realistic among possible "futures".
 - (b) It is the job of the GIS analyst implementing the model to ensure that the selected parameters are implemented in appropriate fashion. The old modeling caveat "Garbage in, garbage out" definitely applies.
 - (2) If the stream network does not such influences described immediately above in 4) b) i), then historical conditions can certainly be one of the future possibilities.

5) Salmonid IP Models Identify Priorities

(Slide 6)

- a) IP models help provide answers the question of what salmon restoration projects would be most effective.
 - i) The current scale (Level 7 sub-watersheds) may not be appropriate for some projects.
 - (1) Many smaller scale restoration projects are assisted by IP modeling at much finer scales, sometimes involving smaller aggregations of reaches.
 - (a) Proximity and confluence issues can be addressed in NetMap with the Aquatic Habitat Indices toolset
 - ii) Given that the scale is appropriate, IP modeling helps answer these questions:
 - (1) Which projects would provide more "bang for the buck"?
 - (2) Which projects would have the widest impact?
 - iii) Currently, IP modeling is limited to evaluating terrestrial fresh water / estuarine habitat
- b) IP modeling helps identify the most effective fish management strategies
 - i) Where and when they should be implemented
- c) IP modeling helps to identify the most effective conservation efforts.
 - i) Where and when they should be implemented
- d) IP modeling provides well grounded data to any cost / benefit analysis
 - i) The benefit side of the equation is very difficult to assess, as the benefits clearly have not happened yet

6) Setting The Stage: Constructing the Fish Bearing Network

(Slide 7)

- a) **Cutoff** variables limit the fish bearing network
 - i) They define the upstream limits of the fish bearing network
 - (1) Elevation, channel width, maximum gradient
 - (2) Seasonality, flow and other variable types
 - ii) They also define the downstream limits
 - (1) Tidal elevation, salinity
 - iii) Localized upstream limits are defined by barriers
 - (1) Natural barriers like waterfalls above a certain height
 - (2) Man made barriers too expensive or not cost effective to remove

7) Relating Reaches To Habitat Preferences: Building Intrinsic Parameters (Slide 8)

- a) Intrinsic parameters are constructed by fish biologists
 - i) Deemed most important factors affecting habitat suitability for the species being modeled
 - ii) Intrinsic parameters can be composed of one or more reach properties
 - (1) Example: channel confinement is ratio of two reach properties: floodplain width to channel width
 - (2) Example: gradient as a reach property **and** an intrinsic parameter
 - (a) Many Salmonid species have different gradient preferences for different life cycle habits
 - (b) Many Salmonid species have different gradient preferences within a life cycle habit
 - iii) May be proxy for other parameters that are not amenable to representation
 - (1) Channel confinement is a proxy for stream complexity
 - (a) Channels in very narrow floodplains are generally single stream beds, with low or now complexity
 - (b) Channels in wider floodplains have much greater complexity
 - (i) Presence of smaller side channels
 - (ii) Meanders and oxbows still connected to stream
 - (c) Good rearing habitat for some species, providing cover and protection from predation

8) Relating Reaches To Habitat Preferences: Building Extrinsic Parameters

(Not On Slide)

- a) Extrinsic parameters may be included in the model by implementing them with the 'Create Aquatic Habitat Index' tool in the Aquatic Habitat Indices toolset in NetMap.
 - i) They may be implemented with HS curves
 - ii) There are other methods of implanting extrinsic variables
 - (1) NetMap includes a variety of tools for this purpose
- b) These have yet to be implemented in the model

9) Generating Habitat Suitability (HS) Curves

(Slide 9)

- a) **HS curves** depict how habitat suitability scores change across a range of intrinsic parameter values
 - i) The suitability index is on the **y-axis**
 - (1) The scores ranges from **zero** (unsuitable) to **one** (best possible)
 - (2) Suitability is indexed the same way on all HS curves
 - ii) The parameter range is on the **x-axis**
 - (1) The appropriate range of parameter values is represented
 - (2) Only one parameter is represented on each curve
 - (3) Units are in accordance with parameter type i.e gradient is usually represented as a ratio of rise over run and is expressed as a decimal fraction. Others like Mean Annual Flow may be un CMS (Cubic Meters per Second)
 - iii) Fish biologists estimate impact on habitat suitability at each step in the parameters' range
 - (1) Break points, where changes in impact on suitability occur, define the curve
- b) See any of the species specific HS Curve reference sheets for examples of HS curves

10) Loading HS Curves Into NetMap

(Slide 10)

- a) Each HS curve is entered into the 'Create Aquatic Habitat Index' tool interface in the Aquatic Habitat Indices toolset in NetMap.
 - i) The left hand side of the tool interface (1) and (2) are for choosing the type of parameter, of which Habitat Intrinsic Potential is just one.
- b) Each parameter is entered in one of the rows below (1) on the interface as x and y values for each break point

10) -- continued

(Slide 10)

- c) The six break point **x** parameter values and **y** suitability scores on the curve for each parameter are loaded into NetMap.
 - i) The six break point **x** parameter values are entered in the six boxes in the center of the interface (6)
 - ii) The six break point **y** suitability scores are entered in the six boxes at the left of center on the interface (7)
 - iii) Weighting of each parameter is entered in the single box on the far right.

NetMap Tools: Create Habitat

The screenshot shows the NetMap software interface. The main window is titled "NetMap Aquatic Habitat / Create". It features a map of a watershed with a red fish-bearing network. A graph plots "Suitability" (y-axis, 0.0 to 1.0) against "Mean Annual Discharge (m³/s)" (x-axis, 0 to 100). A red line represents the suitability curve. Below the graph is a table for parameter configuration. The table has columns for parameter names, break point values, and weights. A "Time Requirements" box indicates the function takes up to 1 minute. A "Get Help For This Tool" button is also visible.

Parameter	Break Point 1	Break Point 2	Break Point 3	Break Point 4	Break Point 5	Break Point 6	Weight
Mean Annual Flow (CFS)	0	1,765	706	2683	4000	5000	0.7
Foodplain Width / Channel Width	0	2	4	6	8	10	1
Channel Gradient	0	0.02	0.04	0.06	0.08	0.1	1
							0.5
							0.5
							0.5
							0.5
							0.5
							0.5

11) Running The NetMap Model

(Slide 11)

- a) In NetMap, the model is run on the fish bearing network which defines the spatial extent.
 - i) The fish network setup is species specific and must be implanted prior to running the model
 - ii) The model generates spatial data with **Intrinsic Potential (IP)** scores assigned to each reach
 - iii) Fish biologists and local experts use field knowledge to critique results
 - (1) This is the purpose of this workshop

12) Binning the IP scores

(Slide 11)

- a) "Binning" is the categorization of possible IP scores assigned to the reaches in a species' fish bearing network.
 - i) Each category, or range of values, is called a "bin"
 - ii) Example on maps: ">0 to 0.2", "0.2 to 0.4": each is a bin
- b) On the maps provided today, each of the bins represent five equal intervals between above 0 and including 1, plus a bin for zero values.

- i) This is not an appropriate method as "Low", "Medium" and "High" IP scores may be different for different species.
- ii) Zero values should not be segregated, as zero means unsuitable, not lethal, like some cutoff variables.
- iii) Binning by applying algorithms to the sample of all reaches on a fish network are also a possible choice
 - (1) All the reaches of a fish bearing network are evaluated into a histogram of IP values
 - (2) An algorithm such as Jenks' natural breaks, quantile ranking, or standard deviation intervals is applied
 - (3) This method enables analysis to determine what "Low", "Medium" and "High" IP scores might be for a given species

13) Analyzing The Model Results: Binned Values

(Slide 12)

- a) A wide variety of standard analysis tools are available in GIS software such as ESRI's ArcGIS
 - i) Histogram based analysis
 - (1) percent share of binned IP scores by river mile in a watershed (Example on slide)
 - ii) Aggregation based analysis
 - (1) river mile totals for each binned IP score in a watershed
 - iii) i) and ii) above are two different views of habitat quality at the watershed level (Level 7)
 - iv) Overlay operations can further refine analysis
 - (1) Non-hydrologic area based categorization (such as ownership) habitat quality
 - (2) Model validation and correlative evaluation

14) Tasks for IPM Peer Review

(Slide 13)

- a) Review break points for each HS curve in set
 - i) Current HS curve sets are defaults, and may need refinement
 - ii) Review for each species: Chinook, Chum, Coho and Steelhead
- b) Define high, medium, and low IP values for each species
 - i) Current default binning scheme simple 5 step plus zero
 - ii) Review for each species: Chinook, Chum, Coho and Steelhead
- c) Determine if sub-regional models are needed
 - i) Current model applied to the entire OWC study area
 - ii) Review for each species: Chinook, Chum, Coho and Steelhead

End of Presentation: No notes

(Acknowledgments Slide 14)