CHaMP – ISEMP Habitat Models

ISEMP-CHaMP Work Session Dec. 4, 2013

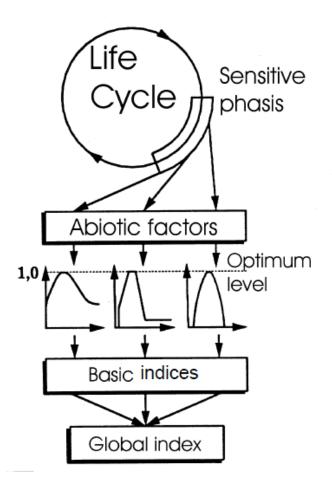
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Habitat Suitability Models

- Describes combined interactions of key habitat variables on survival and carrying capacity for given area
- Combines suitability assessments for individual variables into a combined assessment that predicts ability of a habitat to support a species
- Extent to which habitat requirements are met can be mapped and compared for alternative management actions

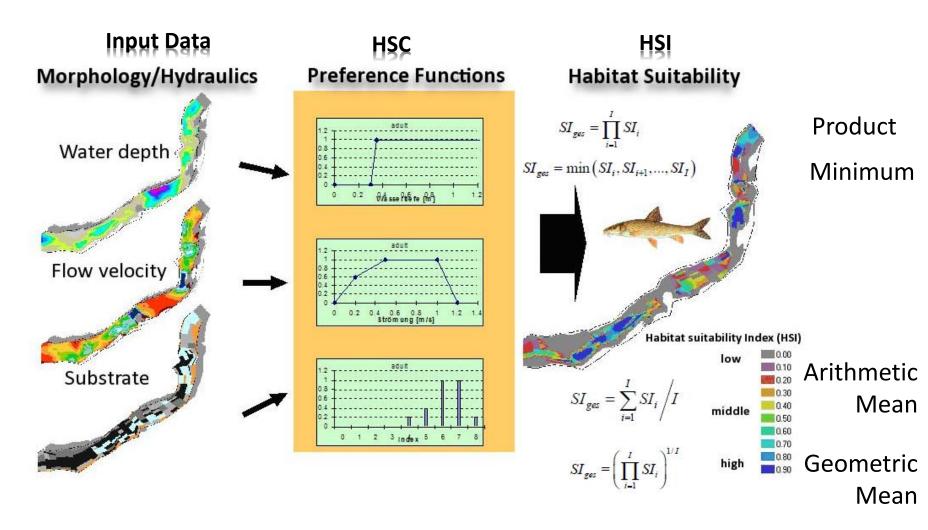
Habitat Suitability Curves (Criteria)

- Describe fish-habitat relationships
- Life stage specific
- Typical variables: depth, velocity, substrate, cover, temperature, fines.
- Develop using literature, expert opinion, laboratory and/or field studies.
- Site specific criteria are ideal



From LeClerc 2005

Habitat Suitability Index



*can weight individual variables

http://www.casimir-software.de/data/CASiMiR_Fish_Handb_EN_pdf

Weaknesses of Traditional HSIs

- Habitat requirements described by precise functions (even though observations are imprecise)
- Independence of habitat parameters is assumed
- New parameters difficult to incorporate (i.e. other then velocity, depth, substrate)
- Limitations associated with HSCs: intensive field data needed for site-specific HSCs, assumptions in using generic HSCs

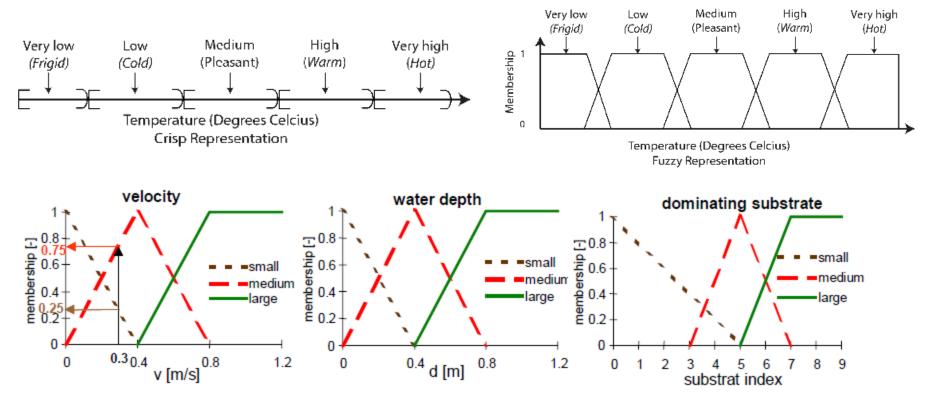
Fuzzy vs. HSI Models

Morphology/Hydraulics Expert Knowledge Habitat Suitability In contrast to HSI WHEN Water Depth "high" Water Depth based approach, AND Velocity "middle" AND Substrate "high" THEN Suitability "high" here we use expert WHEN Water Depth "middle' AND Velocity "middle" Flow Velocity AND Substrate "high" knowledge THEN Suitability "high" low WHEN Water Depth ... 0.10 0.20 AND Velocity ... 0.30 AND Substrate ... 0.40 middle THEN Suitability ... Substrate 0.50 0.60 0.70 0.90 high =0.90 Morphology/Hydraulics **Habitat Suitability Preference Functions** SI,... - ∏.SI, Precision and Significance in the Real World Water depth ** Manfills (M) Flow velocity (\cap) A 1500 kg mass LOOK is approaching " "Yelled his your head at OUT!! witchting 45.3 m/s Index DRSE Substrate Precision Significance

http://www.casimir-software.de/data/CASiMiR_Fish_Handb_EN_2010_10.pdf

FIS Models

- Use imprecise info about fish preferences to specify whether a particular combination of physical criteria = high, medium, or low quality habitat
- Useful for classifying continuous variables



Advantages of Fuzzy Models

- Knowledge about ecological linkages is **imprecise**
- Fuzzy logic calculations consider multivariate effects (no assumption of independence)
- New parameters incorporated easily
- Few observations needed
- Calculation is understandable (no black box effect)
- High **flexibility** and adaptability
- Results often validate better then traditional HSI*

*Jorde et al. 2001. Fuzzy based models for the evaluation for fish habitat quality and instream flow assessment. Proceedings of the 3rd Intl. Symposium on Environmental Hydraulics, Dec 5-8, Tempe, AZ.

Benefits of Habitat Models

- Habitat suitability maps and simulations
 - Before/after habitat restoration
 - Alternative climate / flow scenarios
- Translate results to input capacity parameter for life cycle models
- Identify limiting factors for restoration planning
- Evaluate spatio-temporal relationships; e.g., proximity of rearing to spawning habitat

Objective

- Describe aquatic habitat suitability for species and life stages, using suite of novel tools
- Chinook and steelhead for multiple life stages:
 - Adult passage
 - Spawning and embryo
 - Juvenile rearing
- Build flexible processes and user interface
- Generate comprehensive output reports with results and metadata

Data Inputs

| Habitat Variable | Spatial Resolution | Spatial Data Source | Primary CHaMP Survey Data | Life Stage | | |
|----------------------|-----------------------|-------------------------------|--|---------------------|--|--|
| Velocity, Depth | 10-cm cell | Delft3D hydraulic model | Topographic data, substrate/roughness, flow data | All | | |
| Substrate | Channel Unit | Derived | Areal % substrate categories | Spawner- Embryo | | |
| Cover | Channel Unit | Derived | Cover, Undercut Banks, Areal % Substrate | Juvenile Rearing | | |
| Water Temperature | Site | Derived | Mean, Min., Max at daily, 8-day, or monthly scales | All | | |
| Fines | Channel Unit | Derived | Areal % substrate, pebble counts | Spawner - Embryo | | |

Progress: HSC Library

| | Species | In Database? | Factor Referenced B | | | | | Primary Sour | Study I | ocation | | | | |
|---|------------------|-----------------|---------------------|--------------------|------|----|----------------|----------------|--------------------|-----------|--------|-----|----------|-----------------------|
| | Chinook | Yes | Velocity | Raleigh et al | 1986 | | | Burger et al 1 | Kenai F | R, Alaska | | | | |
| | Chinook | Yes | Substrate | Raleigh et al | | | | Burger et al 1 | Kenai F | R, Alaska | | | | |
| | Chinook | Yes | Velocity | Raleigh et al 1986 | | | | USFWS 1985 | Americ | an River, | | | | |
| | Chinook | Yes | Depth | Raleigh et al 1986 | | | USFWS 1985 | Americ | an River, | | | | | |
| Notes | | | | | HSC | Pg | Table / Fig | Quantitative | adult migration | spawning | embryo | fry | juvenile | juvenile migration |
| Category 2 HSC for juveniles, mean column velocity and nose velocity curves reported. | | | | | 1 | 49 | 18 | 1 | L | | | | | L |
| Categor | ry 2 HSC for juv | veniles, n=880 | | | 1 | 49 | 18 | 1 | 1 | | | | | 1 |
| Juvenile (5.1-10.2 cm, n=948); Category 1 HSC. Derived from two years of American River field studies, professional judgement, Bovee (1978), and a Sacremento River habitat preference study. Developed for lower American R, CA | | | | | 1 | 50 | 19 | 1 | L | | | | : | L |
| Juvenile (5.1-10.2 cm, n=948); Category 1 HSC. Derived from two years of American River field studies, professional judgement, Bovee (1978), and a Sacremento River habitat preference study. Developed for lower American R, CA | | | | | 1 | 50 | 19 | 1 | L | | | | : | L |
| Most fry associated with silt, sand, and rock. Not enough quantitative info for HSC development. | | | | | | | | | | | | 1 | | |
| Concensus on HSCs in formal meetings among fishery experts. Data taken from original HSC spreadsheets provided by Terry Maret, USGS (Sept 2013). Curves provided for Spawning, Adult (holding), Juvenile. | | | | | 1 | | | | | 1 | | 1 1 | . : | L |
| Concensus on HSCs in formal meetings among fishery experts. Data taken | | | | | 1 | | | | | 1 | | 1 1 | | 1 |

Progress: HSI Database

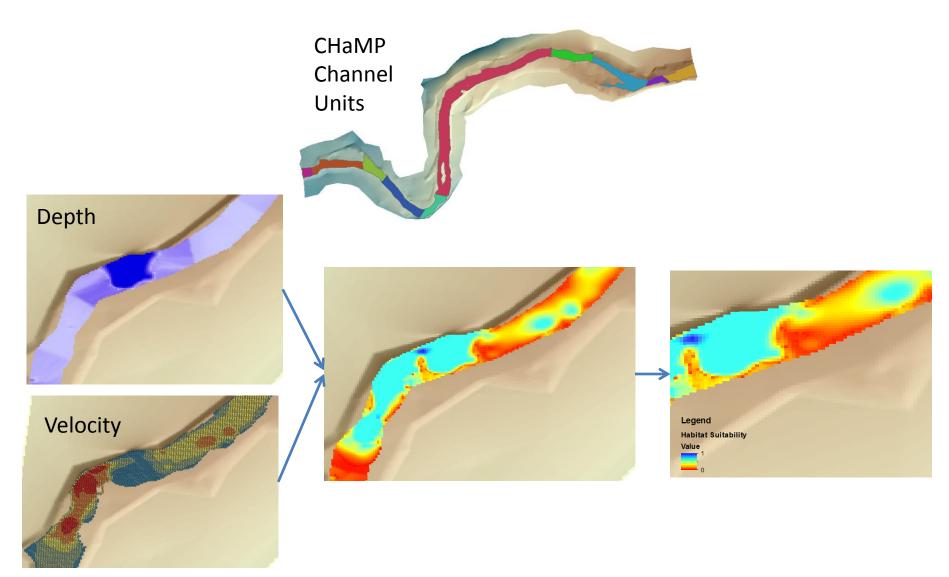
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| HSC HSCPartCategorical | * | Passage Tempe | e depth | Title at velocities less at velocities less Releigh et al 1986 | than 61 cm/s (| Raleigh et a | Chinook | | llt | | Water Dep Water Dep Temperati | oth oth | rpe | • | Units cm cm deg.C | Ra Ra | Soi aleigh aleigh aleigh | |
| HSCPartCoordinatePairs | | | ISCPartO | oordinatePairs | | | | | | | | | | | | | | 23 |
| HSCPartFunctions | | | | dente de la cita | | HSC Part | - b - b - b a | 005 51- 01 | | • | X Value | | HS Value | | | | | |
| HSCParts | | | | depth at velociti | | | | | | | | 0 | | 0 | | | | |
| HSCTypes HSCTypes | | | Passage depth at velocities less than of chirs (naleignet al 1560 Fig.2) - Chirlook - Addit 5.1 | | | | | | | | | | | | | - 8 | | |
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| LookupListItems | | | P Pa / HSIID · Title · Species · Life Stage · Integration Method · | | | | | | | | | | | | | | | |
| LookupLists | | | | 1 | Maret et al 200 |)6 Upper Sal | mon | | Ch | inook | Spaw | ner | | Arithr | netic Mea | n | | |
| Paste Errors | | | e * | LEM_CBW055 | 33_254415 | | | | | | | | | | | | _ | |
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Progress: HSI Software

- Software (vb.net) <u>http://northarrowresearch.com/tools/habitat-</u> <u>suitability-model/</u>
- Video demonstration <u>http://www.youtube.com/watch?v=yomfsk4Q_2</u> <u>Y&hd=1</u>

• Email <u>claire@qcinc.org</u> to get status updates/links

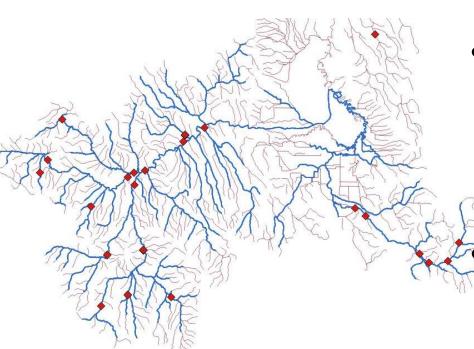
Demonstration Results



Moving Forward - Issues/Needs

- Develop and automate data inputs, model capabilities, outputs
- Validate, compare to fish observations
- Methods for extrapolating site assessments to watershed scale (e.g., GRTS, Riverstyles)

Validation – Grande Ronde



- 25 annual sites for Chinook and steelhead
- Juvenile data: ODFW/CRITFC snorkel and electrofishing surveys at channel unit scale, matched to CHaMP data

Spawner data: ODFW redd surveys

- Chinook index reaches with GPS locations of redds
- steelhead surveys use a GRTS design

Moving Forward - Technical Priorities

- *Data in hydro model and Aux. Streamlining this process.
- Ways to visualize data in (e.g., maps of individual input variables)
- Way to visualize model (plots of HSCs or Fuzzy inference membership functions, description of algorithms used)
- *Model output data tables and maps for individual variables and combined suitability assessment
- Boilerplate report that gets populated for every simulation
 - Description metadata (site, date, flow)
 - Model inputs (velocity, depth, etc maps and histograms)
 - Model structure: describes specific HSC curves or fuzzy membership functions, and model algorithm – likely more than one model run per project
 - Output maps, figures, and tables

