InSTREAM and InSALMO

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Topics:

- Model purposes and design goals
- History and heritage
- Example applications

Purposes of InSTREAM and InSALMO

- Instream flow assessment:
  How do alternative flow and temperature regimes affect salmonid populations?
- Evaluation and design of habitat restoration projects:
  What are the relative benefits of alternative restoration measures or channel designs?
- Evaluation of watershed management, especially via turbidity
- Testing ecological theory in a virtual ecosystem
- (Ecotoxicology: relating individual-level stresses to population and community effects)

InSTREAM vs. InSALMO

- InSTREAM: Simulates long-term dynamics of resident trout populations
- InSALMO: Simulates freshwater life stages of salmon
  - Adult arrival and holding
  - Spawning
  - Egg incubation
  - Juvenile rearing and outmigration
  - One year at a time (no population dynamics)

Design goals (1)

- Overcome fundamental limitations of habitat suitability models by:

  Representing time and effects of habitat variation over time

  Representing the interacting effects of flow, temperature, competition, etc.

  Producing outputs that have clear management meaning and are testable

Design goals (2)

- Put more biology in instream flow assessment

  We know a lot about salmonids, so let's make it easy to use more of that knowledge in management decisions

Design goals (3)

- Make assessments more rigorous, transparent, and reproducible:

  Document more of our assumptions in words and computer code

  Make it easy to test assumptions and replace them when we need to

  The models are complex but we don't have to struggle to determine what their results mean

Who owns InSTREAM and InSALMO?

- Development has been funded by >10 government, electric power industry, and academic organizations
- The models and the NetLogo platform are free, open-source
- The model software and documentation are copyrighted but licensed under the GNU GPL:

  You can copy, use, modify, and distribute the models without restriction

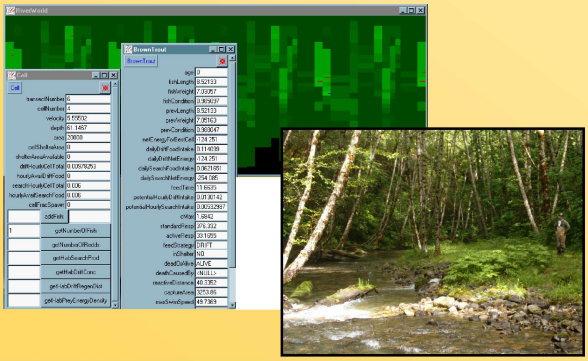
  You cannot make the models proprietary

Some history

- InSTREAM started as a re-implementation and update of an individual-based trout model developed at Oak Ridge National Laboratory

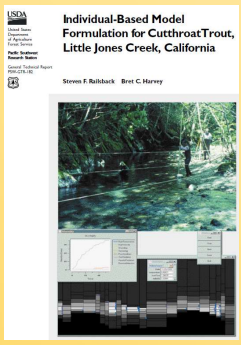
Van Winkle et al. 1996

InSTREAM v. 1, 1999
Little Jones Creek, CA



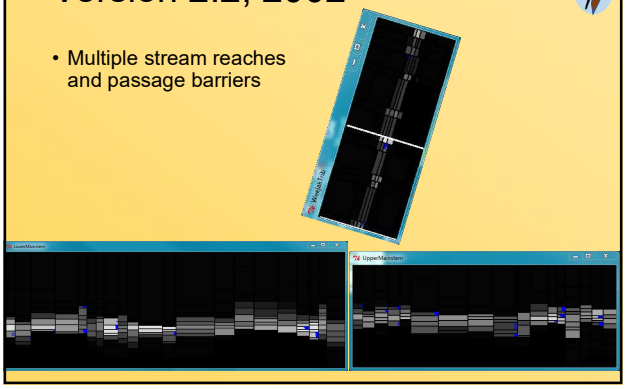
Version 2, 2001

- No longer site- or species-specific
- Turbidity added as a driving variable



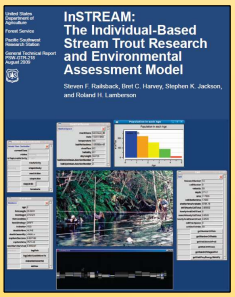
Version 2.2, 2002

- Multiple stream reaches and passage barriers



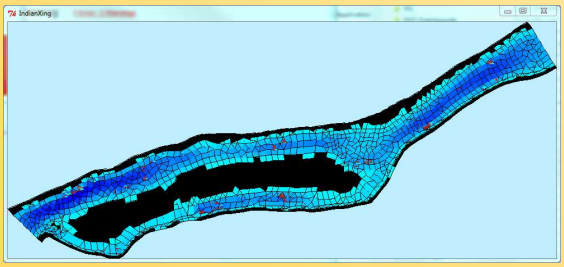
Version 4.x, 2009

- A USEPA grant to Humboldt State funded development of InSTREAM as a public decision-support tool



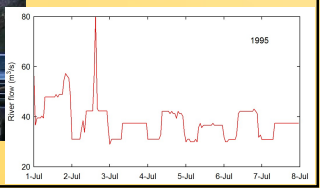
Version 5, 2013

- Two-dimensional habitat
- Linkage to modern 2-D hydraulic models



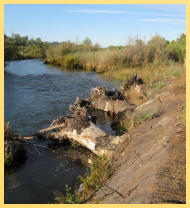
Versions 3 (2008), 6 (2013)

- Modification for assessment of hydropower peaking
- Explicit representation of day vs. night



InSALMO (2012): InSTREAM does salmon

- We spend $$$ restoring salmon habitat
  - *Is it worthwhile?*
  - *Which restoration actions are most effective?*
  - *If we improve stream habitat, will we produce more or fewer steelhead vs. resident trout?*



Versions 7.x, 2021

- Completely new software, infinitely easier to use and modify
- Explicit representation of the full daily light cycle: dawn, day, dusk, & night
- Light intensity as an explicit driver of feeding, risk
- Comprehensive update of assumptions, parameter values, etc.
- New User Manual

In summary:

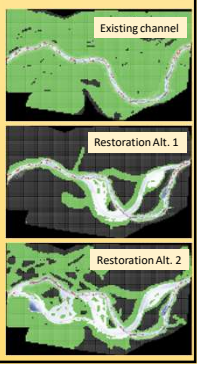
- 9 major versions in 24 years
- Applications at ~50 sites (in US, Iran, Spain, Sweden)
- ~30 open-literature publications that describe, test, and apply the models

Example applications (1): Instream flow assessment

- McCloud River hydroelectric project (FERC relicense)
- Applied InSTREAM 4 at two PHABSIM sites
- (Unfortunate) conclusions:
  - Higher minimum flows would benefit trout little
  - Varying summer vs. winter flow could tip dominance of Rainbow vs. Brown trout

Example applications (2): Restoration project design

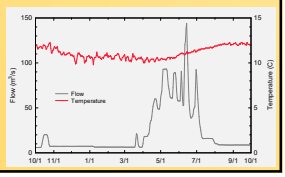
- ~5 sites
- Simulate existing conditions and alternative restoration designs
- Provide a meaningful, comprehensive framework for using field data and modeling
- Help identify cost-effective restoration actions



Example applications (3): Evaluation of passage benefits

- If we provide adult salmon passage to a stream, does it have the right:
  - Physical habitat
  - Flows
  - Temperatures

  at the right times to support spawning, incubation, and rearing?
- Again, the model provides a comprehensive framework for using available information



Now let's try it...