DEPARTMENT OF ECOLOGY
State of Washington

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An Overview of the Instream Flow Incremental Methodology (IFIM)

The Instream Flow Incremental Methodology (IFIM) is regarded as the best available method for determining the relationship between stream flows and fish habitat. It is one of the most commonly used stream flow study methods in Washington State.

IFIM and other study methods are an essential part of determining instream flow levels. Washington State law requires that instream resources and values, including fish (see sidebar), are protected and preserved with adequate instream flows. Setting flow levels in rule is one of our most important management tools for protecting streams. The intent is to set instream flows throughout the state.

Q: What is IFIM?

A: IFIM is a series of computer-based models which calculate how much fish habitat you gain or lose as you increase or decrease stream flow. It is based on the understanding that fish prefer water with a certain depth and velocity. These preferences vary for different species of fish, and for each of their life stages.

IFIM was developed in the late 1970s by the U. S. Fish and Wildlife Services. It involves putting site-specific stream flow and habitat data into a group of models collectively called PHABSIM (**P**hysical **HAB**itat **SIM**ulation). PHABSIM was and is the most commonly used hydraulic modeling program within IFIM to predict depths and velocities in streams.

In the 1990's, Thomas R. Payne and Associates (Arcata CA) rewrote the PHABSIM program creating a version called RHABSIM (**R**iverine **HAB**itat **SIM**ulation). It is a more user-friendly program, compatible with the Windows operating system. PHABSIM and RHABSIM both produce depth and velocity predictions.

IFIM uses four variables
IFIM only uses four variables in hydraulic simulation (depth, velocity, substrate and cover), which are key measurements for determining instream flow numbers. At certain flows, such as

DEFINITIONS

Calibrate: To check and adjust the computer model so its prediction for a velocity or depth at a specific point on a transect matches the velocity or depth actually measured at that point on the transect.

Habitat: The environment in which a fish lives and grows.

Hydraulic: The study of the behavior of moving liquids.

Hydrology: The study of the quantity of stream flow that has historically been in the stream, along with the movement of water from the surface into the ground and back.

Instream flow: A stream flow regime established in a Washington State administrative rule (WAC). An instream flow is a water right for a stream, which protects instream resources from future withdrawals.

Instream resources and values: As defined in Washington State law, these include fish and wildlife, aesthetics, water quality, navigation, livestock watering and recreation, all of which depend on adequate amounts of water in our rivers.

Stream flow: The amount of water flowing in a stream or river.

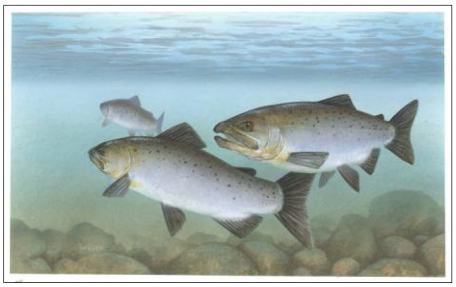
Substrate: The gravel or other material that covers the river bottom.

Velocity: How fast water is flowing.

extreme low flows, other variables such as food supply (aquatic insects) and predators (birds, larger fish, etc.) may be of overriding importance to fish survival and production. In addition to the PHABSIM or RHABSIM models, IFIM may include water quality, sediment, temperature and other variables that affect fish production.

Q: Why do we need to understand the relationship between fish habitat and stream flows to set instream flows?

A: Fish needs are a key element in determining instream flow levels because fish are considered an "indicator species" – if the fish are doing well, then generally other instream resources are too. And fish needs can be more easily quantified than other instream values. This is why looking at the different flows and conditions fish need during their lives is often the basis for determining instream flow numbers.



Pacific Salmon
Credit: Timothy Knepp/USFWS

At certain flows, for example, the water may be too fast for juvenile fish or velocities may be too high for fish to spawn. At other flows, the water may be too shallow for spawning or suitable spawning gravel may not be covered by water. What kind of gravel (or substrate) covers the river bottom is important to fish, especially for spawning. Substrate is a variable addressed by the PHABSIM/RHABSIM models. In short, flow determines the kind of activities fish can engage in at particular spots in a river.

Of course, the quality of fish habitat depends on a number of other factors. Fish also may prefer protective, cooling cover provided by large woody debris, overhanging vegetation and undercut stream banks. IFIM does not address all stream flow-related (e.g predation, water quality) that may affect fish production. Other habitat information also needs to be considered.

Q: How are IFIM studies done?

A: IFIM studies are complex and are usually done by a qualified expert with training in IFIM and a background in hydrology and fish biology. IFIM studies begin with the investigator researching the history of a river to determine what fish species are present and to understand their life histories. The investigator will want to know, for example, when and where fish typically spawn and rear, and what kind of habitat is found in the river. The investigator will review written reports and talk to biologists knowledgeable about fish in the study river.

Q: What do biologists do in the field?

A: After reviewing the hydrologic history of the river, and in consultation with other biologists, the investigator identifies appropriate study sites. Because it is not practical to study every square foot of a river, selected study sites are used to represent larger river segments. At each study site, the investigator will establish transects (basically, a straight line marked by a tape measure; see photo on next page) across the river.

The investigator will measure the depth and velocity of the river at fixed points along each

Biologist taking stream measurements along a transect

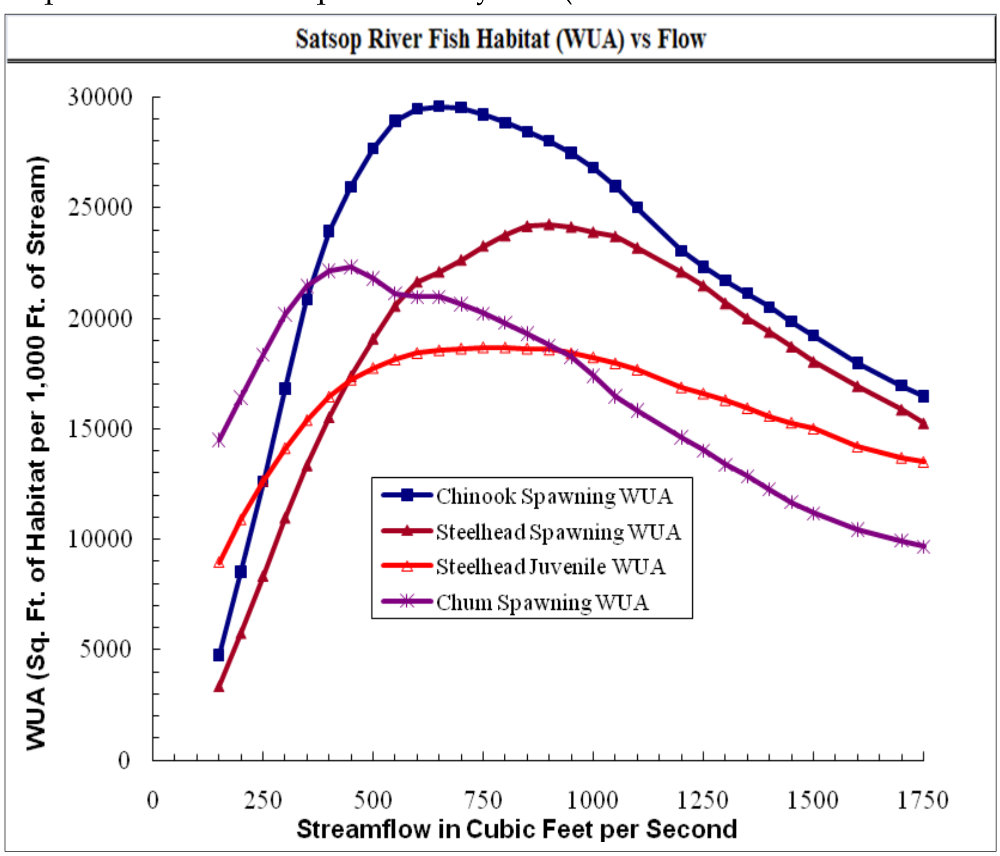
transect and record other information about the habitat, such as what kind of substrate is present at each point. The investigator will often return to measure these same fixed points at high, medium and low flows.

Often, an investigator will snorkel the river and observe what kind of fish are present, what kind of areas they are using and what they are doing (e.g. rearing or spawning). The investigator will record the fish habitat data. If there are enough fish present, the biologist will create site-specific preference curves, which will be used to model the fishes' habitat preferences.

Q: What is done with the data?

A: Once the field data is collected (velocity, depth, substrate and cover, and if possible, site-specific fish habitat preferences), the process of using RHABSIM is (briefly) as follows:

1. Enter data into hydraulic model and calibrate.
2. Enter data into habitat preference model.
3. Calculate Weighted Usable Area (WUA): Combine the predicted depths and velocities (from the hydraulic model) with the depths and velocities preferred by fish (from the habitat preference model). This provides what flows the fish prefer based on the depths and velocities they prefer: the WUA.



The WUA for each species and life stage of interest is the outcome of the model calculation. WUA expresses (in square feet per 1,000 feet of stream) how the availability of fish habitat is affected by incremental changes in stream flow levels. The information can be easily illustrated as a graph (see Satsop River example at right). Finally, model results need to be verified.

At low flows, the stream is generally too shallow and slow to provide good habitat, represented by a low WUA. At higher flows the stream gets too deep too fast to provide good habitat and the WUA starts to decline.

Q: How is an IFIM study used?

A: Because different species and life stages have different flow needs, no single flow level can simultaneously maximize habitat for all species. The challenge is to reconcile these varying flow needs in a way that adequately protects all species. This requires fish biologists to use the model results in combination with other information to develop a final "flow regime." This may involve some negotiation and clarification of management priorities. Other stream flow-related values, like channel maintenance and recreation, also need to be considered.

IFIM allows investigators to model flows that actually are not observed, or that have not been present for a long time. A number of Washington rivers, for example, have been subject to extensive withdrawals. Land use practices also affect stream flows. Flows may no longer match historic levels. Nonetheless, with sufficient water, presently dry portions of river channels could once again become suitable fish habitat. An IFIM study can provide an indication of habitat loss as a result of reduced flows.

IFIM studies often indicate that optimum flow levels exceed those that actually occur during parts of the year. In Washington, streams typically reach low levels in late summer and early fall because of low rainfall. Fish would not remain productive if stream levels stayed low all year, just as plants could not survive a year-long drought period. Thus, IFIM studies help indicate whether surplus water is available for new out-of-stream uses.

Q: What are the advantages of IFIM?

A: IFIM is invaluable for water resources managers. To effectively protect rivers, managers must understand how flow reductions affect fish habitat. By providing the ability to illustrate this relationship for different fish species and life stages, IFIM allows managers to consider different needs in reaching a balanced decision. IFIM provides a rational framework within which to address stream flow issues in a scientific, quantifiable and flexible manner.

Q: Where can I find more information?

A:

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IFIM technical reference documents on-line:
Ecology: http://www.ecy.wa.gov/programs/wr/instream-flows/isfrs.html
USGS: http://www.fort.usgs.gov/Products/ProdTopics_Index.asp (click on Instream Flow Incremental Methodology)

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