Nutrient Enhancement

SALMONID HABITAT RESTORATION

How-To-Guide for Washington State

Fish First | P.O. Box 1505 | Woodland, WA 98674

NUTRIENT ENHANCEMENT

Marine-derived nitrogen, phosphorous and carbon once delivered to rivers by spawning salmon are a critical part of Pacific Northwest ecosystems. The benefits that marine-derived nutrients provide to juvenile salmon cannot be overstressed. Juvenile salmon consume both salmon eggs and the bodies of adults after they have spawned. Current estimates suggest only 6-7 percent of marine-derived nitrogen and phosphorous historically available to salmon in the Pacific Northwest is currently available.[1] This food limitation may be one of the main impediments to the restoration of salmon populations.

This is one in a series of Salmonid Habitat Restoration How-To-Guides for projects in Washington State. It was written to help groups and individuals undertaking similar projects and presumes some knowledge of salmon, habitats and project planning.

Other guides in the series:

- Rearing Pens
- Culvert Replacement
- Nutrient Enhancement
- Live Plants
- Habitat Restoration
- Permitting
- Project Funding
- Streamside Incubation

Because many of the streams in which salmon spawn and rear are inherently nutrient poor, the delivery of marine-derived nutrients may be crucial to survival of juvenile salmon and recovery of depleted salmon populations.[2] Repopulation projects such as egg boxes are fruitless unless done in conjunction with habitat restoration and nutrient enhancement. If the habitat can't support the increased numbers of fish, mortality rates will rise. And if the stream doesn't have sufficient nutrients to support the new stocks, they won't survive their first year—much less their voyage to saltwater.

Before undertaking a nutrient enhancement project, check with the appropriate local and federal agencies to ensure it is legal in your region. For more information on obtaining permits see the related how-to-guide on permitting. You'll also need to identify property owners where you plan to access streams, and secure their permission.

This guide is an overview for projects in Washington State, and uses Coho salmon, or silvers, as an example throughout. Requirements and specifics for similar projects in other states and involving other species of salmon will vary.

AN OVERVIEW

Historically, large numbers of salmon returned to birthing rivers to spawn. Their eggs and carcasses provide are directly eaten by fish (and invertebrates). Young salmon are also likely indirect beneficiaries of increased primary production and insect abundance associated with salmon carcasses.[2]

But dwindling salmon returns directly relates to lower numbers of nutrients which causes a vicious cycle of salmon decline.

Coho salmon spawn in late fall, typically October-December. As they die, their decomposing bodies fill the stream, generating a nutrient-rich environment. The eggs they've just laid and fertilized will hatch within 30-90 days, and the newborn fish will eventually rely on the nutrients provided by that decomposition to survive.

Those fish will remain in the stream for more than a year, and the following year will again feed on nutrients created by salmon decomposing after spawning. This second cycle of decomposition is especially important, as the fish will need the energy for their migration into the saltwater.

The process is similar for fish hatched in egg boxes. When they leave the boxes and enter the stream, they rely on nutrients in the water to survive. Except in streams where returning fish numbers are healthy, there typically aren't enough nutrients in the water to support the juveniles.

EQUIPMENT & METHODS

To supplement natural nutrients, additional nutrients are manually added to the stream using one of two sources—either actual salmon carcasses, or carcass analogs—pelletized fish meal.

Following is a description of each method of enhancement.

Carcass Distribution

Distributing salmon carcasses directly into a stream is effective, but messy and time consuming, and a potential source of disease. It also requires a source for carcasses—typically a hatchery—and in most cases, significant freezer capacity.

And because salmon have an inherent immune system that protects them from disease prevalent in their birth stream, distributing carcasses in another stream could spread disease to native fish. For this reason, the Washington Department of Fish and Wildlife requires that any salmon carcasses dispensed into a stream be native to that watershed. Wildlife agencies in other states may have similar requirements.

SOURCES

Partnering with a hatchery is the best source for fresh salmon carcasses. Typically, hatcheries can pro-

vide any nonedible salmon as well as the surplus that exists after the hatchery has met its numbers for eggs and milt. The number of carcasses hatcheries can provide depends on both the size of the hatchery and the number of groups vying for carcasses.

METHODS

Carcasses are picked up in trucks and transported either to a freezer for later distribution or directly to a stream. At the stream, they are manually tossed into the water, where they will begin breaking down within a week. They can be tossed by hand or using spiked poles.

TIMELINE

Carcasses should be distributed at the same time as the spawn, in October-December.

PRACTICES

If remote incubators (eggboxes) are being used, care should be taken to ensure sufficient numbers of carcasses are distributed in the area of the eggboxes—10 to 20 per week, about 100 yards upstream.

Typically distribution sites should be spaced throughout the spawning areas of a stream to ensure that as the carcasses move with the current, nutrients are adequately dispersed.

When determining a distribution site, consider:

- Accessibility, as trucks carrying carcasses must be able to reach the stream.
- Permission, as public or private landowners may oppose the disturbances caused both by accessing the site and by the smells of decomposing carcasses.

Distribute carcasses upstream of target sites rather than downstream. Spread them out so single spots are not overwhelmed. Plan ahead, as the carcasses break down over time, and space distributions in repeat sites out over several weeks.

ADDITIONAL CONCERNS

In some cases, local wildlife agencies may specify certain requirements. WDFW, for example, requires in some streams that tails be removed from carcasses prior to distribution so they can be distinguished from naturally spawning fish during population counts.

You may also be required to post signs at distribution sites. This is a good idea either way. The smell of decaying carcasses can be strong, and can attract the attention of both passers-by and animals. Neighboring residents with pets should be made aware of the practice because dogs can become very ill if they ingest raw salmon flesh. Signs will prevent nuisance complaints being called in to local authorities.

Analog Distribution

A newly developing method of nutrient enhancement is the use of bio-technologically manufactured “carcass analogs.” Analogs are processed fishmeal pasteurized and sterilized to minimize the likelihood of spreading disease.

They're designed to dissolve over time when placed in a stream.

The benefits are many. Because they are compact and mess-free, analogs can be easily distributed. A handful of volunteers can carry analogs to remote stream sites in backpacks where a truck full of decomposing salmon carcasses can not, or they can be dropped by helicopter into more remote locations.

They have a much longer shelf life and don't need to be frozen. They take up much less storage space. Once distributed in a stream, they don't attract animals or create a smell. And they begin to break down almost immediately.

SOURCES

To create analogs, fish carcasses are boiled down in a pressure-cooker and compacted into a rigid thumb-sized pellet—small enough to be trapped by rocks but large enough to not sink beneath substrate, out of reach of fish.

The high temperatures of the "cooking" process destroys harmful microorganisms and diseases. This means any species of fish can be used, as can fish from any watershed, without risk of transporting disease between watersheds.

Therefore, abundant sources of marine-derived nutrients are available, including waste from commercial fishing. This expands the potential for sourcing, and can even be combined with a nuisance fish kill program to remove harmful, non-native fish from a watershed while restoring wild salmon stocks.

Check with fish and wildlife biologists in your region to see if analogs are permitted. They can also point you toward providers. One such provider is Bio Oregon. Contact information is provided elsewhere in this document. It's also possible to acquire the equipment needed to manufacture analogs and make them your-self.

METHODS

Analogs can be distributed by hand, or dropped from a helicopter in more remote locations. While they have a much longer shelf life than carcasses, and require less storage space, they can mold when exposed to moisture. For this reason it's probably best to purchase only what you think you'll need.

TIMELINE AND PRACTICES

Analogs, like carcasses, should be distributed at the same time as the spawn, in October-December. If remote incubators (eggboxes) are being used, care should be taken to ensure sufficient analogs distributed in the area of the eggboxes—10 to 20 per week, about 100 yards upstream.

Typically distribution sites should be spaced throughout the spawning areas of a stream to ensure that nutrients are adequately dispersed.

Distribute analogs upstream of target sites rather than downstream. Spread them out so single spots are not overwhelmed. Plan ahead, as the carcasses break down over time, and space distributions in repeat sites out over several weeks.

ADDITIONAL CONCERNS

Analogs are new enough that the technology is evolving, and monitoring and evaluations still taking place. At this stage, however, they appear promising as a more convenient method of nutrient enhancement.

Preliminary results of a study that used analogs in Yakima River tributaries found that "…the analogs probably reproduced both of the major food pathways that salmon carcasses produce: direct consumption and food chain enhancement. Trout and salmon fed directly on the carcass analogs during the late summer and presumably benefited from the increased invertebrate biomass later in the year."

> "The risks of using carcass analogs also appear to be low. Pathogens appear to be killed in the manufacturing process of the analogs. In addition, preliminary results suggest that fish exposed to the analogs did not have higher incidences of pathogens. The water quality was also not degraded by the analog additions with the exception of a temporary surface film. Finally, our anecdotal observations, suggested that there was not an increase in the number of predators during the first year of analog distribution. In summary, the risks of analog placement appear to be low but the benefits appear to be high."[1]

They've been in use for some time in Canada with good results, though their use is still relatively rare in the United States.

Quantities

There is a formula to determining the amount of nutrients to supplement in a given stream, but a general rule of thumb is that you are unlikely to overwhelm it. Ocean-derived nutrient in Pacific Northwest Streams is well below historical levels due to dwindling salmon populations. In healthy natural watersheds, ocean-derived nutrients density can be up to 1.9kg/m2 of streambed.

Budget and supply is likely to run out before the maximum nutrient level is reached on an enhancement project. Local fish and wildlife biologists can help determine how much supplemental nutrients should be added to streams.

OTHER CONSIDERATIONS

Nutrient enhancement projects should be done in collaboration with a local hatchery. Hatchery officials can provide any state or local permits needed for such projects, and have experience and expertise with local fish stocks.

They can also provide the raw materials for nutrient enhancement as well as helping determine the levels to which it should be carried out.

ADDITIONAL INFORMATION & RESOURCES

Copies of this document are available through Fish First, and can be found on the Web at www.fishfirst.org. You'll also find a library of how-to guides and fact sheets as well as other resources and information to help with salmon restoration projects.

In addition, here's a list of links to help with nutrient enhancement projects.

- "Influences of Stocking Salmon Carcass Analogs on Salmonids in Yakima River Tributaries." Bonneville Power Administration Environment, Fish and Wildlife division http://www.efw.bpa.gov/Publications/P00005636-1.pdf
- Washington State Department of Ecology

  www.ecy.wa.gov
- Washington State Department of Fish and Wildlife

  www.wdfw.wa.gov

Bio Oregon, which develops, manufactures, and markets aquaculture diets, is one provider of carcass analogs. They can be reached at (800) 962-2001, on the Web at www.bio-oregon.com.

FOOTNOTES

1. Pearsons, Todd, Christopher Johnson, Michael Schmuck, Timothy Webster, Dennis Roley, Robert Bilby, "Influences of Stocking Salmon Carcass Analogs on Salmonids in Yakima River Tributaries", 2001-2002 Technical Report, Project No. 200105500, 44 electronic pages, (BPA Report DOE/BP-00005636-1)
2. Sanderson, Beth, Peter Kiffney, "Assessment of Three Alternative Methods of Nutrient Enhancement (Salmon Carcass Analogs, Nutrient Pellets, and Carcasses) on Biological Communities in Columbia River Tributaries", 2001-2003 Technical Report, Project No. 200105500, 23 electronic pages, (BPA Report DOE/BP-00007621-2)

Written and produced by Chris Bernard at *italics media*. www.italicsmedia.com

Fish First
P.O. Box 1505
Woodland, WA 98674
360.713.7460

Information in this document came from Fish First volunteers and contractors. It was made possible with the help of grants from Beneficial and HFC, members of the HSBC Group.