Dworshak Reservoir Nutrient Supplementation Project Update

April 2012 Clearwater Region

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Daphnia zooplankton

This newsletter is designed to provide information about the Dworshak Reservoir Nutrient Supplementation Project. Please take a few minutes to review the information provided. We hope it helps you to better understand the project history, results to date, and our upcoming plans.

If you find this newsletter interesting, share it with others who might be interested. If you have questions or want to share your thoughts, please give us a call or send us an email. IDFG program staff are listed on the left margin of this newsletter.

Dworshak Dam blocks access to the North Fork Clearwater River Basin for steelhead and salmon. These fish historically brought important nutrients from the ocean back to the basin.

Nutrient additions expected to resume in May

In 2007, the U.S. Army Corps of Engineers (Corps) applied for a National Pollutant Discharge and Elimination System (NPDES) permit from the U.S. Environmental Protection Agency (EPA). At that time, EPA did not think this permit was necessary. Instead, fertilization activities from 2007 through 2010 were done in accordance with a Consent Order issued by the Idaho Department of Environmental Quality. However, in July 2010 the EPA determined that an NPDES permit should be obtained. As a result, nutrient additions were stopped immediately. The Corps applied for a NPDES permit, but acquiring the permit was time consuming, so nutrients were not added at all in 2011. The EPA issued a final NPDES permit in 2011, allowing nutrients to again be added to the reservoir. Before we re-start fertilization, one final step needs to be completed. The Corps has been working towards completion of a new Environmental Assessment (EA) over the past several months. The public comment period for the EA is complete and this document is in the final review stages. Pending completion of the EA with a finding of no significant impact, all permits and documents will be in place to allow for continued nutrient addition. We expect the EA to be finalized in April and nutrients will not be added until it is done. We are preparing to add nutrients again in 2012 and operations are anticipated to start in May.

How did the project get started?

A member of the Orofino community, working with the Orofino Chamber of Commerce, first brought up the concept of nutrient supplementation in Dworshak Reservoir. At that time there was growing local public concern related to loss of recreational use at Dworshak Reservoir as a result of summer-time reservoir drawdowns being implemented to provide water for salmon and steelhead downstream. Idaho Fish and Game and the U.S. Army Corps of Engineers investigated the nutrient supplementation concept as a way to improve the reservoir ecosystem - and ultimately improve recreational fishing - and determined it was worth further evaluation. Pre-project planning meetings were held with Dr. John Stockner (a nutrient supplementation expert), state, tribal, and federal agency staff and representatives of local government and Idaho congressional staff. Numerous presentations were made to civic groups in the community prior to implementation. The agencies decided to initiate a pilot project in 2007 to evaluate this management strategy because of the potential benefits to the ecological function of the reservoir and the public interest in enhancing recreation. It was started as a pilot project to simply test the idea and then determine whether it works well enough to continue over the long-term. We originally hoped this decision could be made at the end of 2011 but did not have enough information at that time, largely because we had to stop nutrient additions for over a year. Because of the positive results observed during the first four years of the project, we plan to continue the pilot study through 2017. This should give us enough years of information to determine whether nutrient additions have desirable effects and benefit the reservoir fishery.

"IDFG completed an economic survey in 2003 that estimated nearly $6 million are spent annually by anglers visiting Dworshak Reservoir"

How much does the project cost?

Project costs are shared between IDFG and the Corps. The Corps pays for the fertilizer, application of the fertilizer, and consulting fees for the nutrient specialists who determine the amount of nutrients to add to the reservoir each week. These costs typically are about $160,000 per year. IDFG pays for all costs associated with reservoir monitoring, including water quality, plankton, and kokanee sampling, etc. This amounts to about $215,000 per year.

The funds that IDFG uses to pay for this project are not from license buyers. Instead, they are funds received from Bonneville Power to offset the negative impacts that Dworshak Dam has had on fish. We have to compete with other projects in the Columbia Basin for these funds.

This clearly is not an inexpensive project and you might be wondering whether it is worth the cost. Certainly, we are trying to determine whether fertilization will provide the desired benefits to the reservoir and fishery. If we determine that it is not effective, then we'll discontinue the project. However, if it works well then we will try to continue fertilization into the future.

The important part is that we are attempting to improve the fishery and increase recreation opportunity in the reservoir. IDFG completed an economic survey in 2003 that estimated nearly $6 million are spent annually by anglers visiting Dworshak Reservoir. An improved fishery should result in even more money being brought to local communities by anglers.

Why is it necessary to add nutrients to the reservoir?

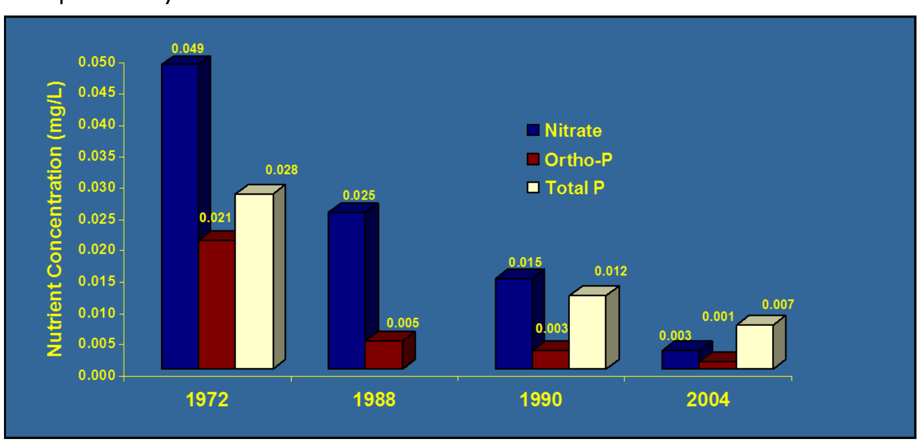
Reservoirs go through a natural aging process after they are created. When a reservoir is first filled it submerges trees, grasses, and other vegetation. The breakdown of this vegetation releases nutrients into the water. The first several years after a reservoir is filled are typically the most nutrient rich conditions in a reservoir. Eventually there will be less vegetation below the high water line to provide nutrients.

In Dworshak Reservoir, there is almost no vegetation below the high water line. Think about what the shorelines look like when the water level is drawn down each year. The banks do not have vegetation on them.

As a reservoir ages, eventually, the rivers and streams that flow into a reservoir become the main source of nutrients. Each spring the North Fork Clearwater and other streams flowing into Dworshak provide a nutrient pulse to the reservoir. But, these nutrients only last for awhile and nitrogen is typically used up by late-June. Afterwards, nutrients decrease rapidly and reservoir productivity declines. Low reservoir productivity leads to less food for kokanee and other fish.

To offset the effects of declining nutrient levels, the idea behind reservoir fertilization is to add nitrogen (the limiting nutrient) to the reservoir. Excessive amounts are not added, but instead small amounts of nitrogen are added that can readily be used up by organisms low on the food chain. Benefitting organisms low on the food chain provides more food for those higher up the food chain. This eventually should provide more food for kokanee that, in turn, can be eaten by larger fish like bull trout and smallmouth bass.

Another nutrient problem is the loss of nutrients that steelhead and salmon once provided to the North Fork Clearwater River Basin. Historically, these fish would return from the ocean to spawn each year. When the fish died, their carcasses would decompose and the nutrients they brought from the ocean would be released into the streams. These nutrients made the streams above the reservoir more productive and benefitted fish, such as bull trout and cutthroat trout. Steelhead and salmon can no longer access the river and streams above the dam, but kokanee in the reservoir migrate upstream of the reservoir to spawn. Kokanee die after spawning and their carcasses provide nutrients to these streams. If fertilizing the reservoir can effectively improve the kokanee population, then they will transport more nutrients upstream like steelhead and salmon once did. This should benefit the cutthroat trout and bull trout fisheries above the reservoir.



Nutrient concentrations in Dworshak Reservoir have declined substantially since the reservoir was created in 1972. Nitrogen is now the limiting nutrient and the ratio of nitrogen to phosphorus is low.

How are nutrients added to the reservoir?

The U.S. Army Corps of Engineers (Corps) handles all aspects of the nutrient applications. Nitrogen is the limiting nutrient in Dworshak Reservoir, so urea ammonium nitrate (a nitrogen fertilizer) is added to the reservoir. The liquid fertilizer is applied weekly, typically from May through September.

After being ordered, the fertilizer is delivered to Dworshak Dam and stored in commercial agricultural tanks until it is used. The storage tanks are located behind locked gates and have secondary containment around them to prevent escape to the environment in the event of spills or leaks.

The fertilizer is transferred to an application truck and driven onto the Corps maintenance barge. Once on board, application hoses are connected to the tank, the tank is pressurized and the computer controlled application system is activated. The application system is an agricultural spray system that is linked to GPS satellites. This is the same system that is used in agricultural spray equipment across the country.

GPS linked application controller

The barge travels up the lake following the centerline of the reservoir at approximately 6 mph. The fertilizer application system automatically adjusts for variances in speed along the route to ensure proper dosing in each lake section. Prop wash from the barge allows for mixing of the fertilizer into the water column. This system has proven to be very accurate in evenly delivering fertilizer the length of the lake.

When the weekly fertilizer application is complete, the barge is tied off in the Grandad area to await the return trip downstream the following week. During this time, the barge is secured offshore and all valves are locked to prevent any wanted tampering or vandalism. To date we have experienced no unwanted tampering or unexpected discharge of fertilizer.

The Corps barge with fertilizer truck onboard.

What effects did fertilization have on water quality and plankton?

Reservoir monitoring is a critical part of the nutrient project. During nine months per year, IDFG is out on the water collecting samples needed to make sure the project is in compliance with state and Federal regulations, while getting the necessary information to make adjustments to the fertilizer applications and see how the plankton communities are changing. Maintaining good water quality is a primary concern. Two measures of water quality that are watched closely are water clarity and chlorophyll (a measure of the amount of 'green' in the water). As a rule, water clarity is considered good if a Secchi disc (a standard size black and white circle) can typically be seen at a depth of 10 feet or more. This rule was met or exceeded for all years that the reservoir was fertilized. Regulatory agencies also require that the amount of chlorophyll typically not exceed 3 micrograms per liter. The amount of chlorophyll remained below this mark for every year that the reservoir was fertilized. In fact, chlorophyll has stayed the same regardless of whether or not fertilizer was added.

Plankton, which forms the base of the food chain in lakes and reservoirs, is the key to the success of this project. The kinds of plankton that grow are just as important as how much of it grows. While some types of plankton provide good quality food for fish and the things fish eat, other types of plankton are either low quality food or cannot be eaten at all. Simply growing more plankton will do no good unless it provides good quality food for kokanee and other fish.

Phytoplankton, or algae, are the first step in this process. These are small plants that use nutrients from the water and energy captured from the sun to grow and reproduce. Some of these are the right size and provide the nutrition that zooplankton, the small creatures that many fish feed on, can use to grow. Others form large colonies that can't be eaten by zooplankton due to their size or their ability to produce toxins. Thus, we need to look at both how much algae is growing and what types are growing.

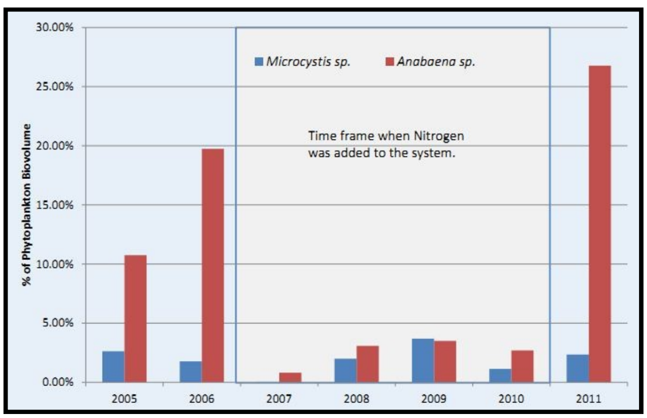
Due to year to year variation in climate, such as the amount of rain and sun, we see a lot of variation in the average amount of algae in the reservoir. However, the amount of algae in the reservoir tends to be about the same for years when it was fertilized and years when it wasn't. What has changed is the portion of algae that can be eaten by zooplankton. By the second year of the project, the proportion of edible algae increased by 50%. This means that there was more algae that could be eaten by zooplankton, which in turn becomes food for fish.

Of course, the reason to grow more edible algae is to grow more zooplankton. As the project progressed, we saw a gradual building of the numbers of zooplankton in the reservoir. In years that the reservoir was fertilized, we saw on average 50% more zooplankton than years that is wasn't. As with phytoplankton, the type of zooplankton is as important as how much. Kokanee grow best when they eat large zooplankton. Kokanee also prefer to eat a particular species, known as *Daphnia*. *Daphnia* are large, easy for kokanee to catch, and very nutritious. In years that we fertilized, we saw on average 50% more *Daphnia* than in years we didn't. These *Daphnia* also tended to be 10% larger. Together, the number and weight are used to determine the biomass (the total weight) of all *Daphnia* in the reservoir. In years that we fertilized, we saw on average, nearly twice the biomass of *Daphnia* compared to years we didn't fertilize.

Has the nutrient project caused more blue-green algae?

While the goal of the nutrient project is to grow more beneficial algae, there has been a lot of concern that it has caused more blue-green algae as well. Why is this a concern? Well, not all blue-green algae, but certain types, can produce toxins that can be harmful to people and pets. These types do not produce the toxins all the time, but no one knows when they will, so they should be avoided whenever they reach high concentrations.

Toxin producing blue-green algae live in lakes and reservoirs all over the world. But they thrive when sources of nitrogen are low or completely gone. This is because, while other types of algae can't grow without a source of nitrogen in the water, these blue-greens can either fix their own nitrogen out of the air, much like peas and lentils, or can use what's available in the water even at very low levels. Under these conditions, beneficial types of algae will fade out and the blue-greens will come on strong. Blue-greens tend to be the dominant form of algae in late summer and early fall when the reservoir runs out of nitrogen. Because these are large, colony forming types of algae, they are inedible to zooplankton and do not provide food for fish. One of the goals of the nutrient project is to promote the growth of beneficial types of algae instead of blue-greens by providing nitrogen in a form that other types of algae can use.



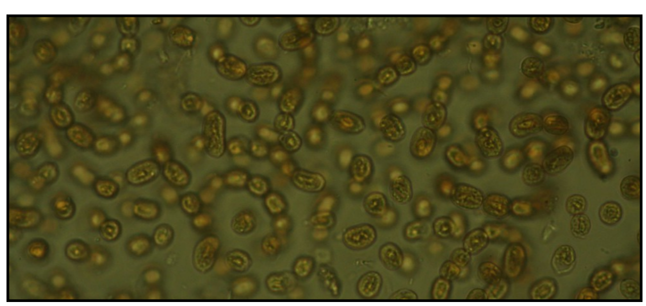
Blue-green algae response in fertilized (2007-2010) and unfertilized (2005, 2006, 2011) years. Anabaena (shown in red) decreased during fertilization and bounced back quickly in 2011.

So has this worked? That depends on the type of blue-green algae. There are four types that have been found in Dworshak Reservoir that produce toxins. Two of these, *Anabaena* and *Microcystis*, have been observed at high enough levels to cause concern. In years that we didn't fertilize using a nitrogen-based fertilizer, *Anabaena* became the dominant form of algae during the late summer. In years that we did fertilize, we saw a lot less *Anabaena*. This is because more desirable forms of algae could outcompete *Anabaena* when more nitrogen was available. But, average levels of *Microcystis* stayed about the same in fertilized years. This is likely because *Microcystis* doesn't fix nitrogen from the air like *Anabaena*, and desirable forms of algae had less of a competitive advantage. Overall, levels of toxic blue-green algae have been lower during years that fertilizer was applied as compared to years that is wasn't.

While some blue-green algae remained in Dworshak Reservoir during periods when it was fertilized, we are confident that the project did not cause the observed blooms. For one, blooms of toxic blue-green algae were present in seven out of eight years they were sampled when fertilization did not occur. In fact, toxic blue-greens were present the first year the reservoir was built in 1972. Further, neither the percent composition or the amount of toxic blue-green algae observed in samples taken during the fertilization years were ever higher than samples collected before the project started, and in many cases were lower. Also, blue-green blooms observed during the treatment period were observed in arms of the reservoir that were not fertilized (experimental control areas) as well as in fertilized areas. Finally, blue-greens bounced back in 2011 even though fertilization did not occur.

While fertilization may be able to reduce the amount of blue-greens, they won't be eliminated. So how do you if it's safe to go in the water? IDFG and the CoE will monitor for blue-green algae, both as part of the regular water sampling program, and also whenever we are out on the water. If high concentrations are observed, we will alert the public and post notices. Even when blue-greens are found at high concentrations, they are usually only of a concern in areas where they are concentrated by wind. These will occur along shorelines and in coves where the wind concentrates the algae. This may form bands of green, or mats of algae along the shoreline. Always avoid swimming in or letting pets drink from these areas.

It might seem alarming to hear about all the blue-green algae concerns in recent years. A natural reaction might be to think that this is a new problem being caused by fertilization. However, keep in mind that toxic blue-green algae were present before the nutrient project started. There just wasn't much monitoring done before this project started to document their presence. The frequent monitoring done now is helpful because we can identify when blue-greens are present and alert the public when this occurs. This information was not available before the nutrient project started. As a result, we believe our monitoring benefits those who recreate on the reservoir because we can inform them when toxic blue-greens are present.



Blue-green algae from Dworshak Reservoir viewed under a microscope. Notice the string-like shape of the cells. Because of they form large colonies, blue-greens cannot be easily eaten by zooplankton.

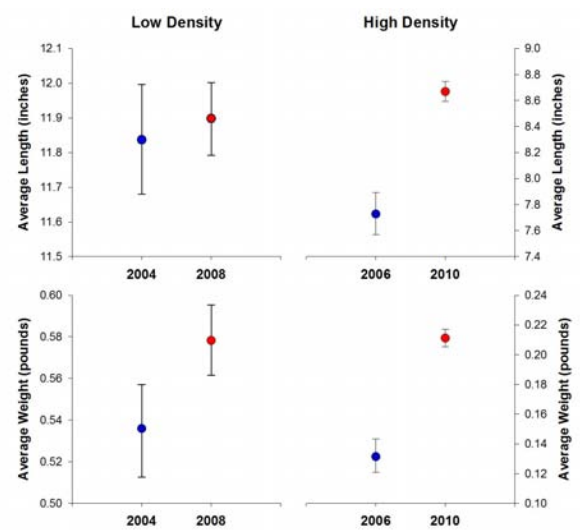
Did fertilization lead to improvements in the kokanee population?

For IDFG, the primary goal of the nutrient project is better fishing for anglers. By providing more food for kokanee, they should grow larger, or be more numerous. Either of these is expected to provide better fishing on the reservoir. If you're a fisherman, this sounds good, but how has it worked?

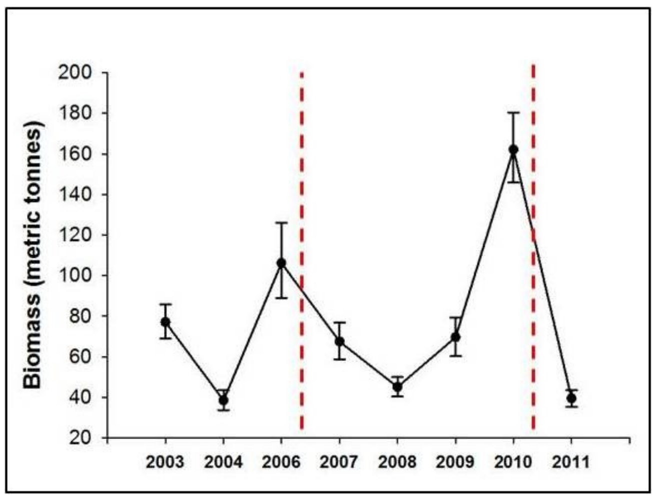
Assessing kokanee growth is difficult. Kokanee tend to be larger when there are fewer of them and smaller when there are a lot of them. This makes sense if you think about it. If there are fewer fish, then each one gets more food. The more they eat, the bigger they get. By the second year of the nutrient project, the kokanee were as big as they had been in recent years. That means the project was working, right? Not so fast. The number of kokanee was way down that year, so we would expect to see larger fish. By the fourth year, we were back to small fish again. So maybe it wasn't the nutrients after all. But we were back up to nearly record numbers of fish in the reservoir by then, so we shouldn't expect them to be very big. The question we need to answer is, "How big would they have been if we didn't fertilize?"

A simple way to get at this is to compare the size of kokanee in years when their numbers were similar, one with fertilizer and one without. There are two pairs of years we can use for this. The years 2004 and 2008 are years of low fish numbers, but we fertilized in 2008 and not in 2004. In 2008, the average length of a two year old kokanee was the same as in 2004, but the fish in 2008 weighed more. The years 2006 and 2010 had high numbers of fish, but we fertilized in 2010 but not 2006. In 2010, the average adult fish was about an inch longer than in 2006 and weighed 50% more.

The biomass, or total weight of all the kokanee in the reservoir, was also 50% more in 2010 than in 2006, even though we estimated slightly more fish in 2006. While these fish were smaller than they would be in a year with fewer fish, they were much longer and heavier than we saw prior to fertilization. This indicates that the nutrient program is resulting in better kokanee growth.



Non-fertilized years are shown in blue and fertilized years are shown in red. In low density years, kokanee weighed more when fertilization occurred. In high density years, kokanee were about an inch longer and weighed almost twice as much when fertilization occurred.



Biomass of kokanee increased substantially during the fourth year of fertilization (2010). In 2006, there was no fertilization and fish density was similar, but kokanee size was greater following fertilization and resulted in almost twice the biomass in 2010.

It is important to understand that it takes a few years for fertilization to benefit higher levels of the food chain, such as kokanee. We were just starting to see what looked like a very positive response from kokanee to the fertilization project when we had to stop adding nutrients. So, we still need more information to fully understand the effects that fertilization has on kokanee. As a result, we have decided to continue the pilot study for several more years to make sure we have enough information to best decide whether fertilization works well and should be continued over the long-term.

Methods for monitoring the kokanee population

IDFG uses two primary methods for monitoring changes in the kokanee population in the reservoir. Midwater trawling surveys are conducted in spring, summer, and fall. And, a hydroacoustics survey is conducted each July.

Midwater trawling involves towing a large net behind a 29 foot boat. Hydraulic winches are used to lower and eventually retrieve the net (see photo below). This work is done at night during the dark phase of the moon so that kokanee cannot see the net and try to avoid it. Sampling is done throughout the entire reservoir to collect a representative sample of kokanee. The net captures all sizes of kokanee. Once fish are captured in the net they can be measured, weighed, and scales are removed that are later used to age each fish.

Hydroacoustics, also commonly referred to as sonar, is used to estimate the number of kokanee in the reservoir. This technology is basically a much more advanced version of a fish finder. A Simrad echosounder and split-beam transducer are used to collect the data, which is stored on a laptop computer. Computer software is used to process the information collected to eventually estimate the number and size of kokanee. This survey is done once per year and, like midwater trawling, is done at night when kokanee are most effectively sampled. Transects that zigzag throughout the reservoir are sampled during the survey.

A 29 foot diesel-powered boat with hydraulic winches is used to tow a midwater trawl net for capturing kokanee.

Hydroacoustic equipment setup inside the survey boat.

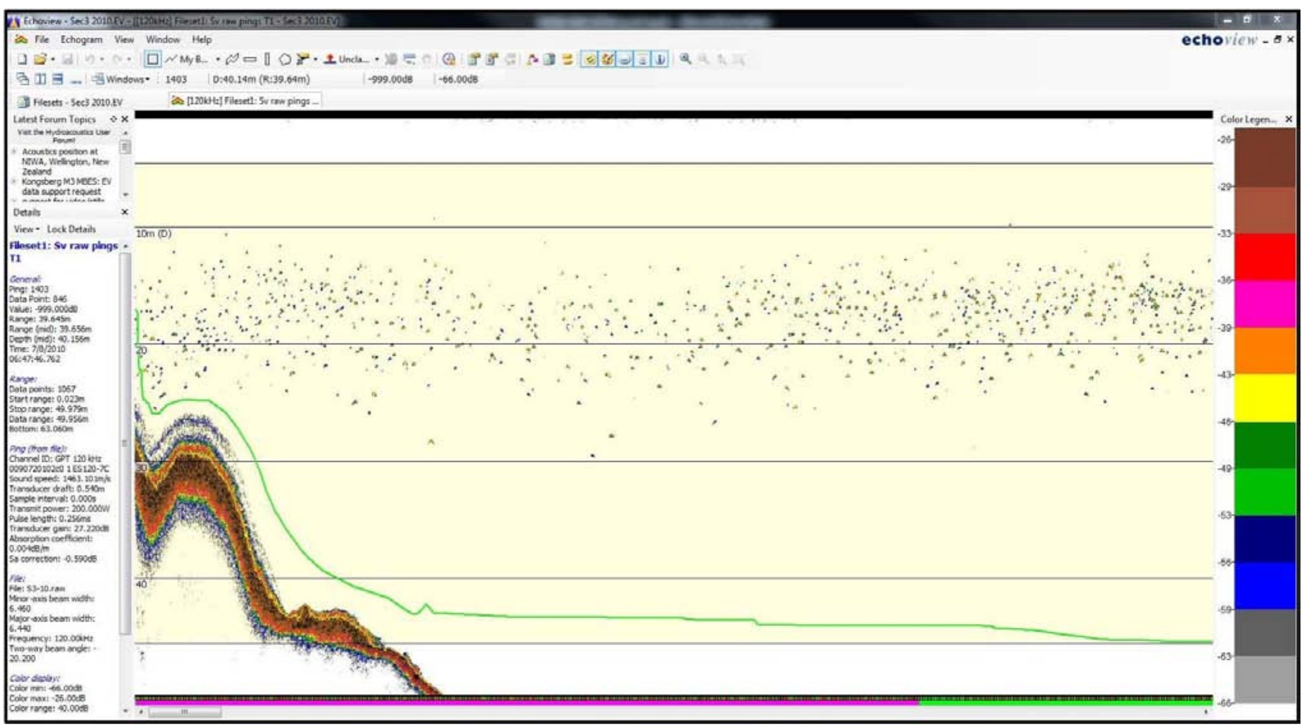


Image of an echogram, which shows the kokanee detected using hydroacoustics in a section of Dworshak Reservoir. Notice that kokanee form a distinct layer in the water column. The software counts these fish and calculates the volume of water sampled. This information is used to estimate the density of kokanee in each transect that is sampled. Density estimates from all of the transects are then combined to estimate kokanee abundance in the entire reservoir. Size information is used to determine how many fish are in each age group.

High runoff leads to kokanee entrainment into Dworshak Dam

The amount of winter snowpack and spring runoff is a major influence on kokanee abundance in some years. In 2011, we had lots of snow and spring runoff was high. As a result, Dworshak Dam had to be operated to make room in the reservoir for all the upstream runoff. In years with lots of expected runoff, the reservoir is dropped earlier and more rapidly. This can present problems for kokanee because they are attracted to the current created in the reservoir near the dam and follow it downstream. Ultimately, many fish go through the dam, or what we refer to as being entrained, and are either killed or washed downstream and cannot return.

Kokanee entrainment is not much of a problem in most normal runoff years, but in high runoff years it can have negative consequences for the population. In 2011, kokanee abundance and biomass declined sharply from the previous year. Recall that we did not fertilize the reservoir in 2011, but continued monitoring to see if kokanee declined following the stoppage. Unfortunately, we were unable to really understand how the lack of fertilization influenced kokanee because much of the decline was a result of entrainment.

This scenario illustrates the importance of collecting data over multiple years before deciding whether the nutrient project should be continued into the future. We certainly have information that suggests that kokanee responded favorably to fertilization during the years it occurred, but we need to have additional years of monitoring to better understand if these benefits can be sustained over a longer time period. As a result, we currently are planning to continue the pilot study for several more years. That will allow us to collect much more information and to make an informed decision about the future of nutrient additions in Dworshak Reservoir.

As for entrainment, we'll unfortunately have to expect to see kokanee losses in years of high flows. There are ways to potentially reduce entrainment by keeping kokanee from getting too close to the dam, but we currently do not have funding available to further investigate or implement these strategies. In the future that may become an option, but we are unsure at this point when that might be. In the meantime, dealing with declining reservoir productivity is more important for benefitting kokanee. The lack of nutrients is a problem every year, whereas entrainment is only an issue in high flow years.

What effect will the nutrient project have on other fish species?

While the primary goals of the nutrient project focus on improving the kokanee fishery, other fish species stand to benefit from this project if it works effectively. Smallmouth bass and bull trout eat kokanee and should have more available food if kokanee biomass increases. Also, juvenile smallmouth bass may take advantage of increased zooplankton abundance.

In future years we hope to have more funding available to study the effects that fertilization has on species besides kokanee. But, for now we are focusing our monitoring on kokanee since they will be most sensitive to changes in the reservoir from fertilization.

Kokanee spawn in streams upstream of the reservoir and they transport nutrients from the reservoir during this process. If kokanee biomass increases from fertilization, more nutrients will be transported to streams entering the reservoir. Increased nutrients in streams means more food for stream-dwelling fish, such as cutthroat trout and bull trout. Eventually, this may lead to improved fishing above the reservoir.

Kokanee die after spawning and their carcasses release nutrients into streams above Dworshak Reservoir.

Dworshak Reservoir kokanee fishing forecast for 2012

Spring is here and the water is warming. If you haven't been out already, it's time to start thinking about kokanee fishing on Dworshak Reservoir. Of course, how good the fishing will be depends on the size and number of fish. Here's a look at what kokanee anglers should expect this year.

Last summer, we estimated there were around 360,000 age-1 kokanee. If half of these survived, there should be around 180,000 age-2 kokanee for anglers to catch. Our fall trawl survey indicated that a few age-2 from last year have held over to spawn this year as age-3. Our best guess is that there will be another 16,000 age-3 kokanee. Age-2 fish should average around 8 ½ inches at the beginning of the year and age-3 should average 9 ½ inches. We'll get a better idea of fish size and numbers after we trawl again in late-April.

So how does this compare with past years? Over the last ten years, estimates of age-2 kokanee have ranged from as low as 70,000 (2004 and 2008) to over a million (2006 and 2010). In an average year during the past decade, we estimate a little over 200,000 age-2 kokanee. So this year is shaping up to be fairly typical in terms of the number of fish available to catch.

Even though the reservoir has not been fertilized since 2010, kokanee should be large enough this year to be desirable to anglers. The number of fish is not high, so the fish that are out there should have enough food to reach acceptable size.

The number of fish isn't the only thing that determines how good kokanee fishing will be. Past research shows that as kokanee get larger, they are easier to catch. Of course most of us prefer to put larger fish in the cooler as well. Age-2 kokanee typically average 10 inches by July in Dworshak Reservoir. Based on kokanee sampled last October, the age-2 fish should reach 10 inches by this July.

Bottom line, it's shaping up to be a fairly typical year compared to what anglers have experienced over the past decade. With a return to fertilization in 2012 we hope that kokanee will respond as well as they did during the first four years of the nutrient project. If so, fishing in coming years should be even better. So, get out on the reservoir and do some kokanee fishing. And, don't forgot about what should be good fishing for other species, such as smallmouth bass. Good luck!

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