Dworshak Reservoir Nutrient Restoration Project Update

May 2018 Clearwater Region

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Daphnia zooplankton

This newsletter provides updated information about the Dworshak Reservoir Nutrient Restoration Project. If you have read past newsletters, you will find some of the same articles in this one. However, this issue contains some new articles and updated information for past articles. We encourage you to review the information provided, as it will help you better understand the project history, results to date, and our upcoming plans.

If you find this newsletter interesting, share it with others. If you have questions or want to share your thoughts, please give us a call or send us an email. Contact information for our 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.

Moving Forward With Nutrient Restoration

For over ten years, the Idaho Department of Fish and Game (IDFG) and U.S. Army Corps of Engineers (Corps) have partnered in an effort to restore ecological function, improve water quality and enhance fisheries in Dworshak Reservoir through nutrient restoration. This began as a pilot project in 2007 to evaluate effectiveness of nutrient addition as a management strategy. In 2017, it was determined that the success of the pilot project was sufficient to warrant implementation of the nutrient project as a part of reservoir operations.

Implementation of the nutrient project does not mean that it is now on autopilot. The project will continue to be operated under the oversight of the U.S. Environmental Protection Agency and the Idaho Department of Environmental Quality. We will still be on the reservoir on a monthly basis monitoring water quality, plankton communities, and fisheries to make sure the project is working as intended. We will also continue to improve and refine the nutrient additions so that the project is as efficient as possible.

What is Entrainment and How Does it Affect Kokanee?

While this winter seemed mild compared to the last, the snow pack is well above average in the high country. Because of this, the Corps of Engineers has been discharging more water than normal through Dworshak Dam. High discharge early in the year tends to "entrain" kokanee, which is just a fancy way of saying fish are being flushed through the dam. In extreme cases, like 1997 and 2011, the majority of the kokanee can be entrained from the reservoir, resulting in low numbers of kokanee for several years afterwards.

It will be a while before the danger is over and we can fully assess the degree of kokanee entrainment, but so far, we have not seen signs to indicate it has been severe. Since a large number of fish could be entrained at any time, IDFG has issued an emergency salvage season for kokanee in the North Fork Clearwater River below Dworshak Dam and the Clearwater River below the confluence with the North Fork. All bag and possession limits for kokanee have been removed for these sections of river through May 31, 2018. In addition to rod and reel, kokanee may also be taken by hand or dip net. Be aware that you can only target kokanee with your hand or dip net. Just because the salvage fishery has been opened doesn't guarantee you will find any entrained kokanee on a given day. However, a pulse of fish could go through without warning. The salvage fishery means that if they do, it's legal to harvest as many as you can.

Dworshak Reservoir Fishing Forecast for 2018

Spring weather is predictably unpredictable. But, as some nice days come our way, anglers are getting out to chase "bluebacks", "smallies", or whatever else may bite. So, if you're itching to go, here's what to expect from the Dworshak Reservoir fishery.

Kokanee

The one constant with kokanee populations is that they are constantly changing. Kokanee numbers declined from a record high in 2015 to a typical number last year (around 210,000 fish). This year, we expect the number of kokanee to decline again, to about 150,000 catchable fish. This is lower than typical, but it isn't uncommon to have fewer than 100,000 fish.

As always, the wildcard is entrainment, or the loss of fish through the dam. High elevation snowpack is higher than normal this year, and operators have been forced to spill more water than normal to make room for the impending run-off. This scenario often leads to high entrainment. In response, IDFG has already opened a salvage fishery in the North Fork and mainstem Clearwater Rivers below the dam. This doesn't mean a lot of fish are being entrained, but allows angers the opportunity to salvage fish if and when they are. High entrainment could mean even lower numbers of kokanee in the reservoir.

> ***" ...if bigger kokanee are more important to you than more kokanee, this should be one of your years."***

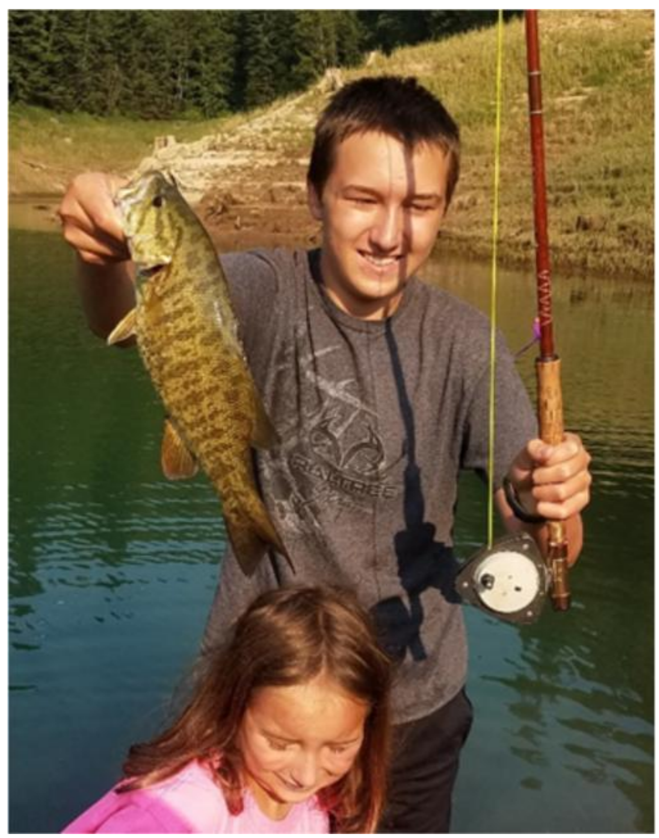
A catch of kokanee from last July. Expect to find fewer, but larger fish in Dworshak Reservoir this year.

On the bright side, fewer fish in the reservoir means that the fish should be bigger than normal. In a typical year, 2 year old kokanee average 10 inches by July. Anglers I've talked to early this year have been consistently catching 10 ½ inch fish, and fish up to 13 inches are not uncommon. So, if bigger kokanee are more important to you than more kokanee, this should be one of your years.

Smallmouth

If you're a bass fisherman, you've either been fishing Dworshak the last two years, or you've been missing out. The smallmouth population has been very healthy and growth of the larger fish has been incredible, particularly during years of high kokanee abundance. However, with declines in kokanee abundance, we expect the growth of bass to slow. As the big ones that were produced in recent years die off from natural causes, the number of larger fish may go down, as the ones taking their place didn't have the benefit of being able to feed in years of high kokanee abundance. But, take heart, kokanee numbers should be expected to go back up again. When they do, expect the bass to grow like crazy.

With that said, there are still plenty of bass out there to catch, including some big ones. If you go, concentrate near creek mouths early on. The bigger fish will move up shallow to spawn by the time the water is 50 degrees. As the water continues to warm, the larger fish will move back out into deeper water and smaller fish will move up along the banks. As this happens, catch rates will pick up, but average size will go down.



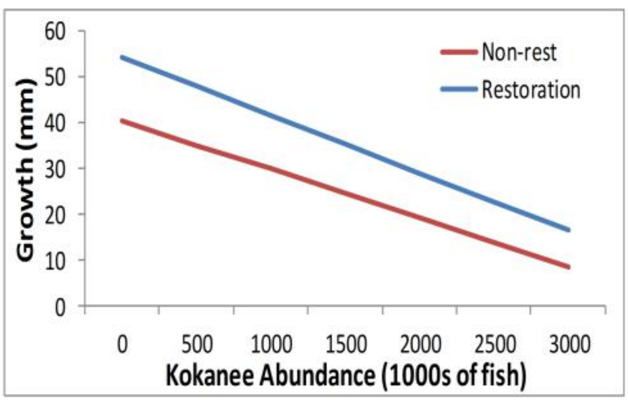
This smallmouth was caught last August on a fly. The number of larger bass may decline following the decline in kokanee

How Has Nutrient Restoration Affected Fish in the Reservoir?

More and bigger fish - that is what anglers usually want. While nutrient restoration is important to maintain good water quality for recreation and other uses, from our standpoint, a successful nutrient restoration program will result in more and bigger fish. So, if that's what we're after, you may be wondering how it has worked so far?

When answering this question for kokanee, it's important to remember that their growth, and ultimately size, depends a lot on how many are out there. Most kokanee anglers know that in years when there are lots of fish they tend to be small, whereas when numbers are down the kokanee tend to be larger.

Not only does this make sense, but we see it in our data as well. When we evaluated factors that influence kokanee growth, the amount of available food was the most important. The more they eat, the more they grow; not a big surprise. We also learned that more kokanee results in less food to go around. This is why we have big kokanee when there are few of them, and small kokanee when there are lots of them. But, when we added nutrients to the reservoir, the abundance of large *Daphnia*, the preferred food of kokanee, increased. That means more food to go around. It doesn't mean that kokanee will always be bigger in every year we add nutrients than in years we don't, but it does mean they'll be bigger than they would have been if we didn't add nutrients.

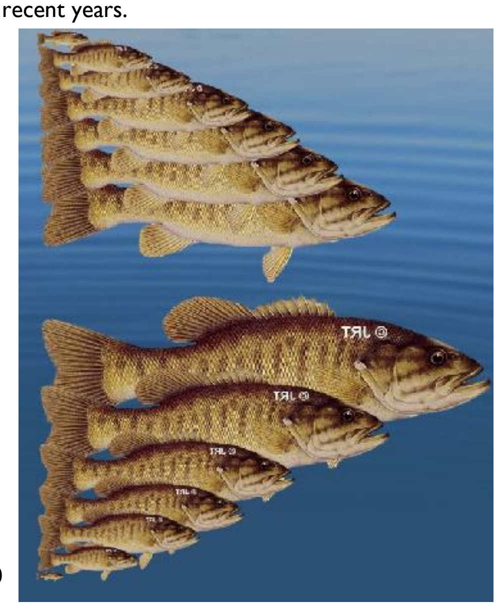


The relationship between growth of age-2 kokanee and abundance of age-1 and older kokanee for non-restoration (red line) and restoration (blue line) years.

But how much bigger are kokanee really getting? To evaluate this we needed to look at the sizes of kokanee in years with similar abundances both when we were fertilizing and when we were not. What we found was, on average, kokanee were about an inch longer and two ounces heavier in years when we added nutrients. This isn't much if you're thinking in terms of a single fish, but it can add up. For example, for a limit of (25) averaged sized kokanee, that will amount to an extra two pounds of fillets.

However, as this nutrient restoration project has continued, the abundance of kokanee has increased. As the number of fish has gone up, the size has come back down. With the addition of nutrients, the reservoir can support many more kokanee of a given size than before. While we are just beginning to see what nutrient restoration will do for the kokanee population, it looks like it will move toward greater numbers of kokanee, but at a similar size to what we had in the past. Of course, kokanee populations tend to be very cyclical. So, when kokanee numbers go down every so often, their size will increase.

Kokanee aren't the only fish that stand to benefit from nutrient restoration. Kokanee are an important prey for larger, predatory fish, such as Bull Trout and Smallmouth Bass. Since the nutrient restoration project started, Dworshak has become an increasingly popular destination for bass fishermen. This is likely due to the number of large Smallmouth Bass that have been caught in recent years.



Growth of a Smallmouth Bass during low kokanee abundance (top) and high kokanee abundance (bottom). Kokanee biomass averaged almost 50% higher when nutrients were added to the reservoir.

For bass to grow big, they have to grow fast. We can determine how fast a fish grew is by viewing its scales or fin rays under a microscope. What we are learning is that bass grow much faster when kokanee abundance is high. For example, we found that a 10 inch bass grew to 18 inches in two years when kokanee abundance was high, whereas in years of low kokanee abundance a 10 inch bass only grew to 14 inches in two years.

We still need to compare the growth of more bass over more years to confirm this, but it appears the higher kokanee abundances we have been seeing in Dworshak Reservoir since we have implemented the nutrient restoration project is resulting in more trophy sized Smallmouth Bass. Kokanee provide a unique food source for this Smallmouth fishery. Now that the nutrient restoration project is improving the abundance of this food source, we expect to see more years where giant Smallmouth Bass can be caught.

Enclosure Experiments to Improve Nutrient Project

Scientist like to learn how things work by conducting experiments. To most of us, an experiment is just trying something new. However, scientists have strict requirements for how experiments are conducted. Strictly speaking, scientific experiments must be "controlled" and "replicated." Controlled simply means there is a group, known as the control group, which is used for comparison. For example, scientists studying new drugs will give the control group a placebo, or a pill that looks like the real drug, but does not contain the drug. They then compare results from the group that took the drug with those who didn't (controls). This allows them to accurately measure the effects of the drug (treatment). Replication means the treatment was given to multiple test subjects, or multiple groups, depending on the design.

With lakes, each lake is essentially an individual test subject. Therefore, unless we have many similar lakes in an area, we can't have a controlled and replicated experiment. In other words, we usually can't conduct scientific experiments at the scale of the whole lake. We can only conduct what scientists call an "observational" study. That is, we can only observe what happens due to natural differences, such as year to year differences in weather, fish populations, etc. We can also observe what happens due to changes we make, such as adding fertilizer to the reservoir. While observational studies can be very valuable, it is difficult, and takes more time, to learn how much of an observed difference is due to natural causes, like weather, and how much is due to something we did, like add fertilizer.

Scientists who study lakes and reservoirs sometimes use enclosures to conduct scientific experiments. By enclosing, or sealing off a small piece of a lake, we can create individual, miniature test lakes. This allows us to have both controls and replication at a small scale when we can't have it at the scale of the whole lake.

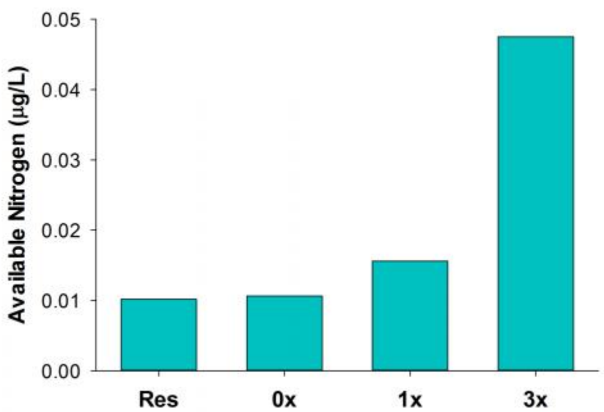
Last year we conducted an enclosure experiment on the reservoir. If you happened to venture up above Dent Bridge, to the mouth of Hodson Creek, you may have seen a dock covered in bird netting and with plastic tubes suspended into the water. These enclosures were treated with different amounts of nitrogen based fertilizer. Some of them received no fertilizer (controls). Others received the same concentration as the

The docks and experimental enclosures near the mouth of Hodson Creek used to study nitrogen addition. Reservoir users are asked not to use the dock or disturb the enclosures.

Enclosures Experiments (continued)

reservoir (1x), and others three times the concentration being applied to the reservoir (3x). These were then sampled throughout the summer in the same way as we check water quality in the reservoir.

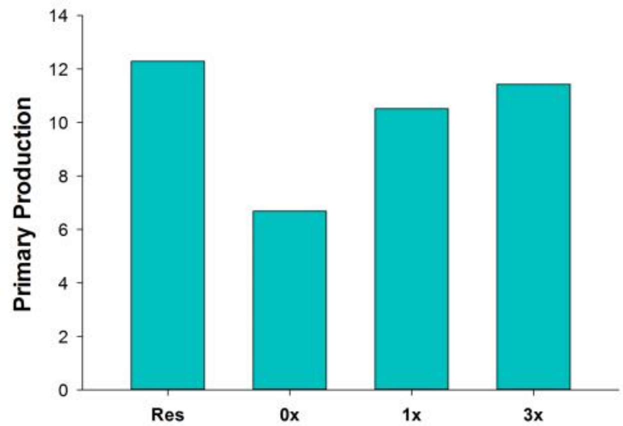
So what did we learn from all this? For starters, it appears that the current fertilizer applications are close to an optimal level. At the concentrations we've been adding to the reservoir, the data suggested that the algal community (food for zooplankton) used all the available nitrogen that was applied. When the amount of fertilizer was tripled, some of that nitrogen was unused.



The average amount of nitrogen available for algae growth in the reservoir (res) and enclosures with three different levels of nitrogen addition, including no nitrogen (0x), the same concentration as the reservoir (1x), and three times the reservoir concentration (3x)..

We also saw an increase in primary production as we added more nitrogen. Primary production is a measure of plant growth. The more fertilizer we add, the more the algae grows. However, the biggest increase occurred with the current level of fertilizer. Tripling the amount of fertilizer did not result in much additional algal growth.

So, if the fertilizer is causing the algae to grow faster, won't it build up in the reservoir and degrade water quality? That's not what we've seen in Dworshak Reservoir. On average, we saw the same amount of algae in years when we fertilized and years when we didn't. Our assumption has been that the fertilizer is increasing the amount of algae which are edible to zooplankton. Zooplankton in turn provide food for fish such as kokanee, which is just what we want.



The average primary production (algal growth) for the reservoir (res) and enclosures with three different levels of nitrogen addition.

In the enclosures, however, we saw an increase in the abundance of algae when we added fertilizer. This increase was almost entirely due to a small, algal species that zooplankton can't digest and only occurs in the reservoir in small amounts. Because this algal species is indigestible by zooplankton, it accumulated in the enclosure. This demonstrates that if the nitrogen added to the reservoir did not go into edible species as we've assumed, total algae would have increased as it did in the enclosures. Therefore, while the enclosures did not mimic the response seen in the reservoir, they do offer some evidence that the food chain in the reservoir is working as expected.

We will conduct the enclosure experiments one more season to build on what we've already learned. While the experiments are underway, we ask the public that they stay off this dock and not disturb it or the enclosures. We will be sure to put signs up on this dock to make sure you can differentiate it from the other docks put out for public use by the Corps of Engineers. The results of this experiment will be used to guide future management of the reservoir. Your cooperation will help us obtain the best information to do so.

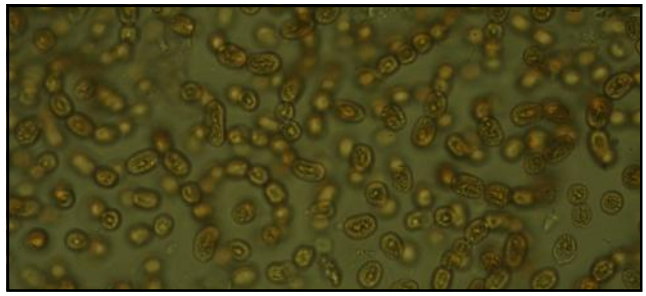
A 65 foot long plastic enclosure stretched out horizontally on the ground prior to deployment in the reservoir. Enclosures were suspended vertically into the water to enclose a portion of the water column to test the effects of nitrogen addition.

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, pets and livestock. 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.

Plants, including algae, need a source of fixed nitrogen, that is ammonia or nitrate, in order to grow. Some plants, like peas and lentils, can take nitrogen out of the air and convert it to a form that can be used by all plants. Farmers may use a crop rotation where they use these types of plants to put nitrogen back into the soil. In lakes, certain types of blue-green algae perform this role. When the lake runs out of fixed nitrogen, these blue-green algae take over. Since they can use nitrogen from the air, they can continue to grow when other types of algae can't. Unfortunately, these types of algae can't be eaten by zooplankton and some can produce toxins. In Dworshak Reservoir, these types of algae commonly become dominant in late summer and early fall once the nitrogen that is available to other plants has been exhausted. Putting nitrogen into the water in a form that other plants can use favors the growth of beneficial types of algae over harmful blue-greens.

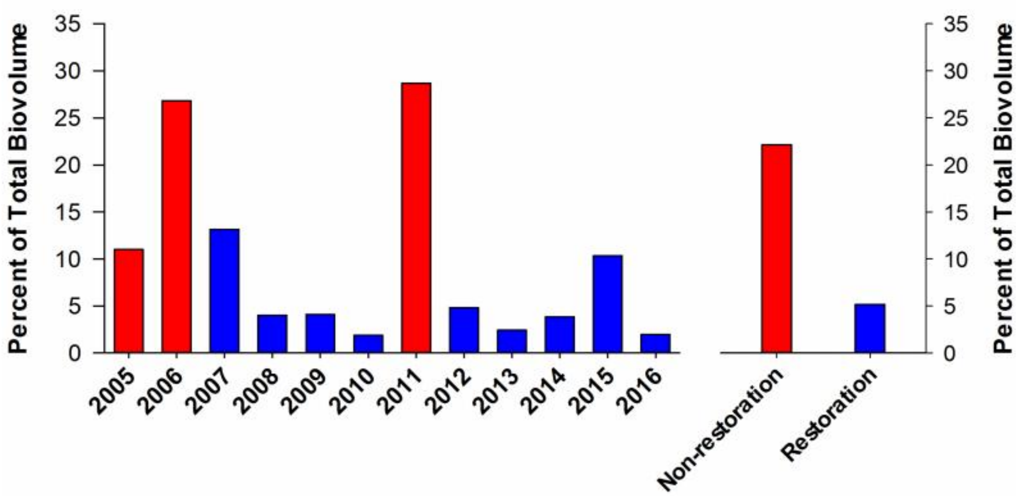
> ***"In years that we didn't fertilize using a nitrogen-based fertilizer, Anabaena was the dominant form of algae during the late summer. In years that we did fertilize, we saw a lot less Anabaena"***



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.

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, of which *Anabaena* is the most common. In years that we didn't fertilize using a nitrogen-based fertilizer, *Anabaena* was the dominant form of algae during the late summer. In years that we did fertilize, we saw, on average, a 75% reduction *Anabaena* (see figure below).

While fertilization may be able to reduce the amount of blue-greens, they won't be eliminated. So how do you know if it's safe to go in the water? IDFG and the Corps 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, the public will be informed and notices will be posted. Even when a bloom occurs, blue-green algae 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.



Anabaena (blue-green algae) response in fertilized (blue bars) and unfertilized years (red bars). Anabaena decreased during fertilization and bounced back quickly in 2011 when fertilization did not occur. It then decreased substantially in 2012 when fertilization was resumed..

How Are Nutrients Added to the Reservoir? Are They a Health Hazard?

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 Corps barge with fertilizer truck onboard. Nitrogen is applied from the tanker truck via pipes off the back of the barge and mixed into the water column by the prop wash.

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.

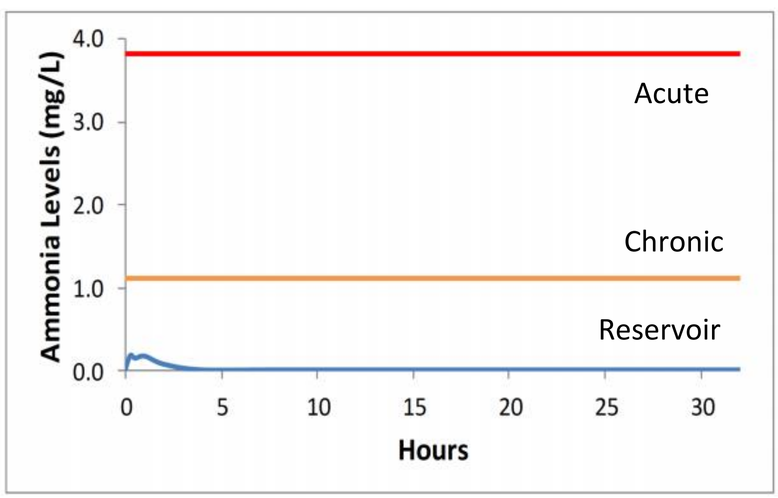
GPS linked application controller

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 unwanted tampering or vandalism. To date we have experienced no tampering or unexpected discharge of fertilizer.

So what happens to the fertilizer once it goes into the water? Some folks have expressed concerns over being exposed to it while they are swimming or recreating in the water. Could all this fertilizer going into the lake cause health problems?

Until recently, we have relied on reports from other projects that noted a rapid uptake of supplemented nutrients. In 2012, we took water samples behind the barge while it was making a normal fertilizer run. This was done in early September, when the amount of fertilizer being added was near the peak and the reservoir level was near its lowest. Samples were taken from a spot in the wake of the barge and two spots 20 yards to either side of the barge, which were located using a GPS. Water was collected from a depth of three feet and analyzed for ammonia content, along with other measures of nitrogen. As expected, ammonia levels in the water behind the barge spiked immediately after the application (see figure below). However, the additional ammonia could no longer be detected after two hours. At the sites to the sides of the barge wake, a spike of ammonia was detected an hour after the barge passed and lasted until four hours after the application. The highest level of ammonia detected was 0.19 mg/L. Under the conditions at the time of the application, humans should avoid long-term exposure to levels above 1.1 mg/L and short term exposure to levels above 3.8 mg/L. Therefore, even under a heavier application, the concentration of ammonia directly behind the barge is well below the long-term exposure limits and also does not come close to levels that cause alarm for short term exposure. This information further demonstrates that nutrient application is being done in a manner that does not pose a risk to human health for those recreating on the reservoir.



Ammonia concentrations (blue line) measured for up to 32 hours after the barge passed a point on the lower reservoir. The orange line denotes chronic (long-term) exposure limits and the red line acute (short-term) exposure limits.

How Much Does the Project Cost?

"...improvements to this fishery could increase its value by millions of dollars, which represents an excellent return on investment considering the cost of the project."

The Corps of Engineers pays approximately $200,000 per year for application of the fertilizer, lab analysis of water and plankton, and fees for a specialist who determines how much fertilizer to add to the reservoir each week. In addition, IDFG spends approximately $70,000 per year monitoring water quality, collecting plankton samples, and conducting kokanee surveys. These funds come from the Bonneville Power Administration to mitigate for the impacts that Dworshak Dam has had on the fishery. The IDFG will also continue to monitor and assess other fish populations in the reservoir, such as Smallmouth Bass and Bull Trout, as part of our regional management activities.

Clearly, this clearly is not an inexpensive project and you might be wondering whether it is worth the cost. The IDFG conducted an economic survey in 2003 that estimated anglers spent $6 million fishing Dworshak that year. Another survey was conducted in 2011 and anglers spent an estimated $4 million fishing Dworshak that year. We believe the drop in spending was because the kokanee in Dworshak were both smaller and fewer in 2011, due to high losses of fish through the dam and poor reservoir productivity. This suggests that improvements to this fishery could increase its value by millions of dollars, which represents an excellent return on investment considering the cost of the project.

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Idaho Fish Health Lab