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# OREGON Fish&Wildlife JOURNAL

**Furthering The Concept of Multiple-Use of Our Lands For More Than 35 Years!**

# What's Inside...





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Our cover photo is of Brian Donne with his buck out of the Alsea Unit, see page 23.

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# Newton's Paradox:

## Why Fish Prefer Clearcuts Over Streamside Buffers

By Dr. Bob Zybach, PhD.

Dr. Mike Newton is the well-known Professor Emeritus of forest ecology at Oregon State University (OSU). During the past 20+ years he has performed detailed research on a number of western Oregon streams, measuring temperature, volume, primary production ("fish food"), and fish volumes in forest streams displaying a wide variety of forest conditions. His measurements have taken place in clearcuts, mature forests with no logging, and in single-buffered and doubled-buffered stretches of fish-bearing streams in the Coast

Range and western Cascades.

In 1971 Oregon became the first State to adopt a Forest Practices Act requiring streams be protected from negative impacts by logging operations. There was no scientific basis to the adopted rules at that time, and streamside buffers (undisturbed vegetation left along the banks of fish-bearing streams) were primarily for the purpose of reducing soil erosion and water pollution.

In 1987 the rules were amended to require larger buffer widths; in 1992 the NW Forest Plan extended buffer widths to 150+ feet, now with a focus on enhancing or maintaining fish habitat. It was thought that shade and fallen trees from buffers maintained cooler water temperatures, and that was a good thing for fish – particularly salmon and trout ("salmonids").

Newton's forest research in western Oregon began in 1959. In 1990 he began establishing long-term studies on select forested streams. Now, in 2013, those studies are beginning to reveal the true scope of logging effects on native fish populations. Newton's most surprising finding: fish and their food did better in areas of streams that had been opened to sunlight by logging or tree fall gaps, compared to areas heavily shaded beneath forest canopies. They also did better in full sunlight than in logged areas with required buffers. Others have observed the same.

That was the paradox: Why do fish do better (more and larger fish) in areas with little or no streamside vegetation than they do in "habitats" specifically designed and legislated for their well-being? In fact, it appeared that required buffers actually inhibited fish populations and were counterproductive for their intended purpose: that is, salmonids did much better in streams that had been clearcut with no buffering vegetation than they did in streams with partial buffering; which in turn did better than streams with full buffering, or that hadn't been logged at all, even when warmer than the regulatory standard.

## *Current Oregon Regulations*

I was involved in forest management issues as a reforestation contractor when riparian vegetation first became a topic of general discussion and new regulations in Oregon during the 1970s. Prior to then, and even for a while thereafter, the US Forest Service had "stream cleaning" contracts, where contractors were charged with removing all evidence of logging and other management activities from streams – even leaves and small twigs! The work made little sense: twigs, leaves, limbs and trees would keep falling into the stream after the workers left, and were being washed downstream to the ocean in any instance. The first contract I ever did of that nature was also my last; about 15 stream miles from the ocean, in the late 1980's.

During that same time period, efforts were successfully being made to preserve remaining old-growth trees from harvesting activities, and large amounts of forest were thus being set aside and put off limits to logging. Soon, hydrologists and fish biologists followed this lead and began championing similar set asides for riparian areas, claiming the trees and shrubs were needed to 1) help offset erosion, and 2) provide good habitat for fish. Regulations followed, and harvesting next to streambanks was soon forbidden.

The argument then became how wide unlogged buffers should be, and regulations began being revised and more riparian land began being removed from active management operations. The subsequent research of Newton and others examined whether buffers actually led to acceptable regulatory standards for fish-bearing streams. These studies revealed that small differences within buffer rules could make the difference between meeting or not meeting the new regulations.

Thirty-two streams with full (two-sided) buffers were measured over time, but several had somewhat wider buffers than the current Department of Forestry rules required, due to the Protection of Cold Water Standard criterion set by the Oregon Department of Environmental Quality (DEQ). Fish were not evalueated.

This triggered the question of whether wider buffers were actually more effective. The DEQ study considered only buffer width on both sides of a stream -- and water temperature -- but did not consider other factors influencing the fishery; i.e., the fish themselves. As a result, the several reports of general increase in fish productivity when clearcuts extended to the water's edge were not considered in the state-sponsored study of the use of buffers in meeting the regulatory criteria. Temperature data was accepted from Newton's work; fish and primary production data were not.

## *The Importance Of Stream Temperature To Salmonids*

One of the earliest studies of the relation between water temperatures and salmonid populations was by Geoffrey Greene in North Carolina in 1950, comparing the different temperatures and trout populations in two streams: one that ran through a forested area, and another exposed to full sun as it ran through farmland. He asserted and confirmed that the "maximum temperature limit" for rainbow and brown trout was about 80 degrees Fahrenheit.

The maximum year-long measures of the farm stream varied from 65 to 79 degrees F., while the forest stream never became more than 66 degrees -- which Greene considered the "optimum temperature" for brook trout. Neither stream reached the fatal 80 degrees during the year. From these findings he concluded:

"once-productive trout streams can be restored by the control of stream temperatures through good watershed management." To achieve that objective he thought it important to manage "all aspects of a watershed as a unit," rather than be managed "on a piecemeal basis."

Greene also recognized that trout obtained almost all their food from aquatic organisms, "which are believed to thrive more abundantly at higher temperatures." He therefore advised: "the most satisfactory practices would be those that raised the feeder stream temperatures to the maximum productivity of the aquatic organisms, yet did not increase the downstream temperatures above the limit of tolerance" via "the careful manipulation of vegetation and other kinds of land use practices." Many of Greene's 1950 findings and edicts remain excluded in determination of the basis for managing salmonids and water temperatures in trout bearing streams to this time.

Of greater scientific significance, because of geographic range, technical sophistication of measures, and sheer volume of research over time, is the numerous papers and reports by J. R. Brett, beginning in 1952 and continuing into the 1990's. Brett's research showed that the warmer the water, the more productive for well-fed fish up to about 64 degrees F.; whereas at 68 degrees well-fed fish grew at 90 percent of the maximum rates observed at lower temperatures -- thus confirming, with greater precision, Greene's findings.

## *The History Of Disturbance*

History tells us that fish have evolved and survived disturbances far more severe and widespread than clearcut logging or farming, including: windstorms, catastrophic wildfires, volcanic eruptions, mass flooding, major landslides, extended droughts, etc. Such disturbances have almost always resulted in significant long-term changes to streamside shading. Native fish have therefore survived and evolved with fluctuating stream temperatures — daily, seasonally, and occasionally. Their ability to swim to more favorable conditions during these changes should not be discounted.

As one result, the DEQ standard of 64 degrees F. for most of the salmonids and their habitats in Oregon fits neither the streams nor the fishery. The streams vary so much, and the environments in which they flow vary so much, that one standard cannot be made to adapt the fisheries that are acclimated to those streams. Neither the streams nor the fish are as static or as homogenous as the standards: they never have been and they never can be.

The DEQ criterion currently under consideration for protecting the cold water standard is that no forest practice shall allow an increase in the 7-day mean temperature of water of 0.5 degrees F. or more downstream from a forestry operation, regardless of the natural temperature of the stream. A major technical problem is that existing temperature measuring equipment is only sensitive to plus or minus 0.32 degrees F., with a range of 0.64 degrees. The regulatory 0.5 degree variation can't even be accurately measured.

This requirement eliminated any forestry operation intended to maintain the riparian forest, or to provide improved growth and health of affected fish. Moreover, year-to-year variation in natural stream temperature is well over one degree. That meant the only way to enforce this criterion was to require there be no change at all in riparian forest cover; i.e., no logging or other active management allowed.

## *Research Methods*

The question then became: What, other than temperature, limits primary productivity of streams? Answer: short-wave light energy, and the related photosynthetic process that supports the food chain. Newton's research in the past 22 years, conducted in large part with research assistant Liz Cole, has employed well over 100 "thermistors" registering summer-long stream temperatures at ½ hour intervals along several streams. Their placements bracketed clearcuts, partial buffers, and Oregon Department of Forestry's (ODF) Best Management Practices (BMP) streamside buffers. The instruments have recorded the years before harvests and from 5 to 17 years following harvests of several kinds.

Study streams ranged from eastern Douglas County to northern Lincoln County, all in western Oregon, in both the Coast and Cascade mountain ranges. This work is part of the OSU Watershed Research Cooperative (WRC), an organization with several other large watersheds under close examination. Streams in the WRC study have ranged from maximum summer temperatures of 50 to 68 degrees F. – all well within the desired range of temperature conditions for salmonids.

Newton and Cole's research within the WRC involved four low to medium elevation streams with basins of 600 to 1000 acres each, to determine how the arrangement and amount of streamside buffers in clearcut units influenced stream and air temperatures. Conditions included no-tree buffers, partial buffers 40-feet wide, and two-sided BMP buffers 50 to 100 feet wide. Impacts of clearcut logging on stream temperatures were determined based on time series analyses of post-harvest trends compared to pre-harvest trends.

## *Research Findings*

Trends for daily maximums and means significantly increased after clearcutting in no-tree buffer units. Partial buffers led to slight (less than 2 degrees F.) or no increased warming. BMP units led to significantly increased warming, slight warming, or no increased warming, depending upon the stream. The effects of clearcutting and different buffers on daily minimum temperatures also varied by stream. Maximum temperature peaks were not maintained in downstream units; that is, elevated temperatures within logging units quickly returned to average stream temperatures within short distances of leaving the units.

Clearcutting led to increases in daily maximum and mean air temperatures above the stream for most buffer designs, with the greatest increases in the no-buffer units. Changes to daily minimum air temperatures varied among buffer design and streams. Although there were some inconsistencies in trends with different buffer designs among the streams, there were also differences related to buffer implementation, changes in solar radiation, and stream features.

Several studies have described fish tolerance to elevated temperatures, the ability of fish to readily adapt to such changes within a 24 hour time period, and the very critical role of food availability with rising temperature. The survival of salmonids at temperatures 77 degrees F. and above depends on the duration of exposure. The importance attached to stream temperature in regards to fish has been widely cited, but seldom with respect to the variability with which fish can respond to a range of such temperatures

Clearcuts with no buffers showed the largest positive response — but all cut units measured better than any unlogged units.

Peak temperatures above 64 degrees F. are necessary to achieve mean temperatures in the optimum range for salmonid metabolism. The daily fluctuations of temperatures ranged from 2 degrees to 4 degrees F. in most forest streams within the study areas, with brief peaks and very productive means.

Stream reaches with some direct sun on them were the most productive for both the food chain and the fishery as long as they didn't exceed 71 degrees F. To this point, none of the 32 study area streams have reached that level.

Temperature changes in logged units did not persist more than briefly downstream as water moved into other environments, gaining heat each day and losing it each night.

## *Why Fish Like Light*

Brome Creek, a tributary to Hinkle Creek, the site of a major WRC subbasin-scaled study in the western Cascades of Douglas County, demonstrated that full sunlight on the stream provided twice as much fish biomass as any other harvested unit, and all three harvested units produced more fish than any of the uncut units between harvested units. Other streams in the Hinkle Creek study also increased fish productivity after harvest.

Light clearly is responsible for fish growth. This result was despite the completely clearcut units reaching maximum (but not mean) temperatures of 71 degrees F., and were frequently above 64 degrees. Newton's studies in several of these streams showed that the periphyton and macroinvertebrate abundance ("fish food") was greatest where the most light reached the streams. On all streams peak temperatures were within the range in which fish growth was roughly 80 to 100 percent of growth observed at 62 degrees: the optimum.

## *The Argument Against Homogenized Standards*

Several factors weigh against a single set of criteria for all streams. First, fish tolerate a wide range of temperatures. Mortality of salmonids begins only when held above 75 degrees F. for an extended period of time. Brief excursions to such temperatures reduce feeding rate and raise respiration reversibly, but extended exposure leads to slower, or even cessation, of growth before mortality begins.

Newton's observations of highest stream productivity occurred when streams were fully exposed to sun, sometimes when summer temperature peaks were well above the numeric criteria, revealing serious and costly flaws in the regulatory process.

The notion of requiring more shade when less shade equates to more biological productivity of streams represents a conflict between regulatory convenience (meeting a numerical criterion) and resource sensitivity (increasing fish biomass). Moreover, many streams are far too cold for optimum fish metabolism, and yet the Protecting Cold Water Standard prohibits operations that would provide both a more productive temperature range and more efficient harvesting operations.

***Recommendations***

Newton makes the following recommendations, based on his own research and on the research of others:

1) The approach to stream quality should be one that first reflects that water quality in most Oregon commercial forestlands is excellent;

2) There should be flexibility in management options that allow optimizing tree harvest in order to improve fisheries productivity; and

3) Such an approach allows (or encourages) periodic entry into buffering forests in order to maintain optimum conditions — an activity not allowed by current rules.

Newton's paradox: and at a steep cost to Oregon taxpayers, businesses, counties, and fish populations.

*Note: A longer version of this article, with active links and references, was first posted on A New Century of Forest Planning blog, where it received nearly 50 comments of interest*