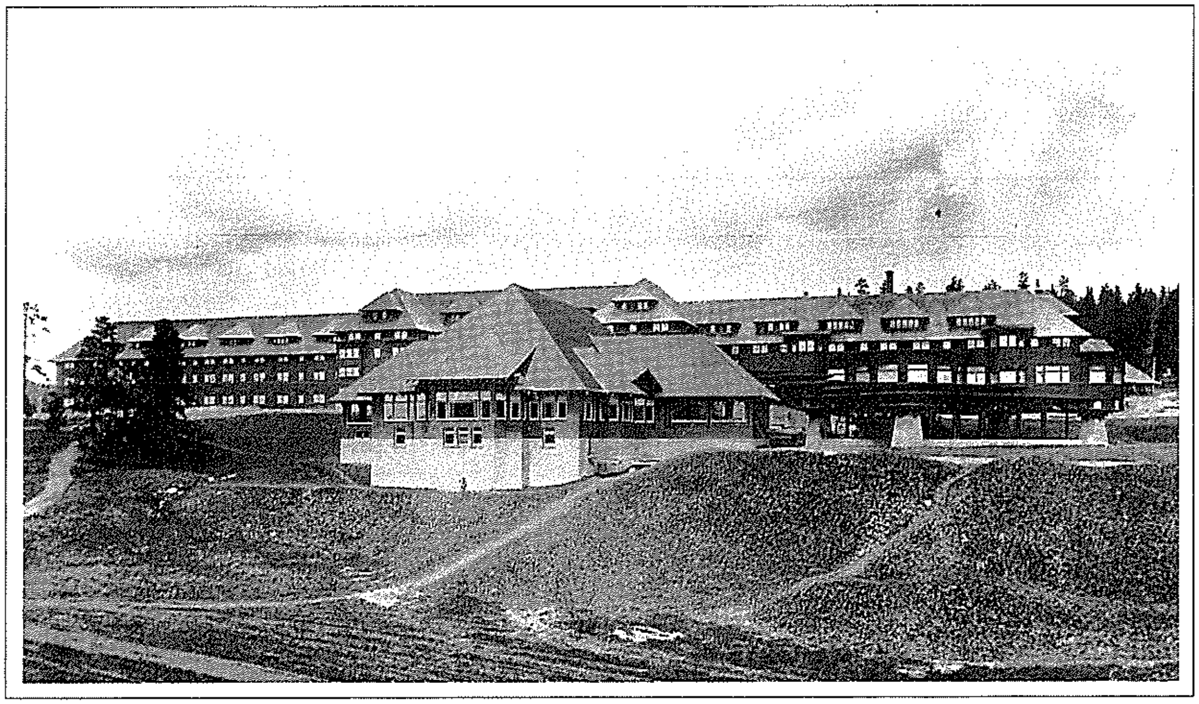
Yellowstone Science

A quarterly publication devoted to the natural and cultural sciences

Yellowstone Lake in Change
Litter Invertebrates and Fire
Roads and Culture
Bison Planning

Volume 4 Number 2



Canyon Hotel, 1914

The Cultural Component

If a representative sample of the American public were asked. "Who works in Yellowstone National Park?" it seems certain that the most common answer, perhaps the only answer, would be "rangers." We like to think that if those asked had seen *Yellowstone Science*, they'd also say "scientists," but even if they know that both rangers and scientists work here, they quite literally don't know the half of it. While the ranger has always been an important symbol of the national parks, and admitting even that rangers play an amazing variety of roles in the parks (from fire fighting to public education to emergency medicine), it is part of the irony of the Yellowstone experience that historically it has depended even more on people the visitors never saw or heard of.

At least half of the park's budget goes to maintenance of the elaborate, historic, and ever-aging infrastructure of the park: roads, trails, buildings, and all the other conveniences that both facilitate and complicate our experience of the park's wild setting.

Through Eric Sandeen's review essay of a newly published history of the park's road system (page 10), we are introduced to perhaps the single most important element in the average visitor experience here. Yellowstone's road system was laid out a century ago by a few foresightful engineers to whose esthetic sensitivities we owe much of the pleasure of a park visit. They understood more than construction techniques; they understood landscapes, and how to move people through them in a way that would make the most of the experience. Through studies like Culpin's, and essay's like Sandeen's, we are reminded that Yellowstone is truly a cultural landscape as well as an ecological one, and that something as seemingly mundane as a strip of pavement is in fact a powerful force in defining our relationship with nature.

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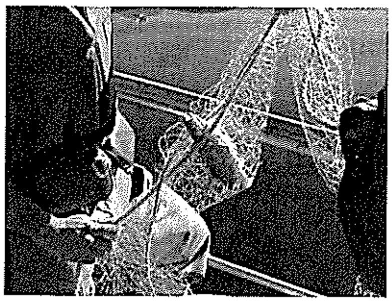

On the cover: The Corkscrew bridge near Sylvan Pass in 1913 captures the spirit of the more leisurely pace in early park travel as it reveals changing esthetics in road design. See the review essay on Yellowstone's road history beginning on page 10. NPS photo.

Above: Gillnetting may become the most effective way to contain the lake trout that threaten Yellowstone Lake's cutthroat trout population. See the interview with Bob Gresswell beginning on page 4.

Yellowstone Science is published quarterly, and submissions are welcome from all investigators conducting formal research in the Yellowstone area. Editorial correspondence should be sent to the Editor, *Yellowstone Science*, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190.

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Terrestrial Litter Invertebrate Communities in Yellowstone National Park

by Tim A. Christiansen

Invertebrates comprise a major portion of the faunal density contained within forest and sagebrush habitats. Generally, vertebrates comprise less than 0.2 percent of the fauna in most ecosystems. Invertebrate communities include species of insects, spiders, mites, millipedes, pillbugs, centipedes, round worms, and pseudoscorpions. Invertebrates comprise a vast amount of fauna species within the litter environment, that complex habitat that covers the soil. Litter consists of dead leaves, twigs, logs, fungus, bacteria, small mammals, and many species of invertebrates. The litter helps to provide nutrients to the soil as well as provide cover to hold moisture in the soil.

Invertebrates can directly and indirectly influence many aspects of a forest and sagebrush ecosystem. This influence includes almost every process (i.e., nutrient cycling, decomposition, seed dispersal, etc.) in forest and sagebrush ecosystems and every life stage of dominant and subordinate species of forest and sagebrush vegetation. Without insects and other invertebrates, current patterns of plant reproduction, growth, death, organic material decomposition, and nutrient cycling would not exist.

Following the fires of 1988, my colleagues and I studied insect communities in burned and unburned forest sites and sagebrush sites across the park.

A total of 134 litter invertebrate species were found in forest stands, and 60 invertebrate species in sagebrush habitats. The majority of these species were mites (*Acari*) and springtails (*Collembolla*). The majority of species found in forest stands were different than invertebrate species found in sagebrush habitat.

An older pine stand. These stands usually contained lower diversity of litter invertebrates than younger-aged stands.

Lodgepole pine stands in Yellowstone National Park contained a higher forest litter diversity than found in several other lodgepole pine forest sites located in Wyoming. We measured diversity by using the Shannon-Wiener Diversity Index, a commonly used measure of the diversity of a ecological setting. This index seldom goes above 5.00, with an average range of 1.50 to 4.50. Thus, an index of 3.65 is an ecosystem that is above average in terms of species numbers, and the density of those species is fairly high. A number below 1.50 (as is found in many of the Yellowstone National Park sagebrush areas) indicates a low number of species.

The Shannon-Wiener Diversity Index in Yellowstone National Park averaged 3.65, whereas diversity in south-central Wyoming was 2.96, and 2.73 in the southeastern corner of Wyoming. Diversity in sagebrush was 1.21 for Yellowstone National Park, as compared to a diversity of 0.62 in south-central Wyoming. Thus, the park contains some of the higher litter invertebrate diversities found in either forest or sagebrush sites in Wyoming.

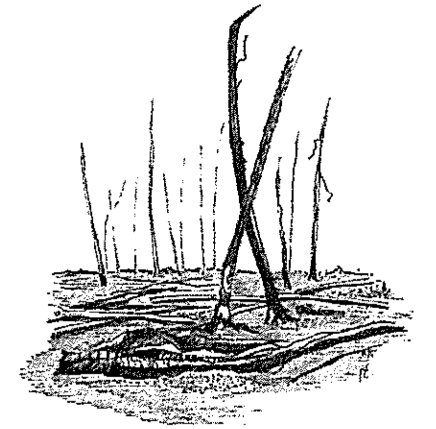
Habitat stage (that is, the plant community's age since its last fire) and habitat condition (such as the density of the trees or other vegetation) are important to the invertebrate community. Forest-floor invertebrate diversity was lower in tree stands that contained above-average densities of tree seedlings. Higher invertebrate diversity was found in middle-aged forest stands that contained higher than average densities of mature trees. Diversity was generally greater in middle-aged stands (30- to 60-year old pine stands) than in stands that were older than 60 years. Noninsect diversity (i.e., mites, spiders, centipedes, and millipedes) was higher than insect diversity in lodgepole pine stands.

Standing dead tree density influenced invertebrate diversity. Tree stands that contained large amounts of standing dead trees (such as those killed by fire, insects, or disease) contained lower invertebrate diversity than stands that had few standing dead trees. Lodgepole pine stands that contained high amounts of fallen trees supported higher litter invertebrate density.

Preliminary analysis indicated that a minimum criteria of habitat herbaceous cover (which includes shrubs, trees, and

Renee Evanoff

A studied forest stand, adjacent to a burned pine stand, the type used as a reference site for diversity and fire studies.



A burned pine stand, representative of those used in the fire study.

Above: A sagebrush site like that was used as a reference site in both the diversity and the fire studies.

Below: A fire-disturbed sagebrush site, typical of a site two years after the 1988 fires.

grasses), tree seedling density, litter, and number of logs were necessary to support high densities of mites and springtails.

What species were found, and where?

Mites and springtails comprised the majority of both species and density of forest-floor and sagebrush-floor invertebrates. Mite density was significantly higher in forest stands that contained a minimum of 40 percent herbaceous cover, 10 pine seedlings per square meter, 45 grams litter per square meter, and 14 logs per hectare. Springtail density was higher in stands containing at least 50 percent herbaceous cover, 10 pine seedlings, 50 grams litter per square meter, and at least 12 logs per hectare.

Millipedes are important litter decomposers in coniferous forests. These invertebrates were found in higher densities in stands containing at least 100 grams of litter per square meter. A large amount of log debris was required to maintain millipede density.

Ants are important in a forest ecosystem. Ants help spread seeds, break up soil crusts, and create pores in soils for better water penetration into the soil. Ant density was higher in pine stands that contained at least 70 grams of litter per square meter.

Diversity and density of litter invertebrates in sagebrush habitats increased with an increase in percent herbaceous cover. Sagebrush shrub density was important for invertebrate diversity. Areas with few shrubs supported fewer species and contained lower litter invertebrate density than areas with higher shrub densities.

What were the effects of fire?

Fire can influence litter invertebrate communities in both forest stands and in sagebrush habitats. Forest and sagebrush litter habitats were severely damaged during the 1988 fires. Diversity declined 63 percent in severely burned forest stands and had only slightly increased two years after the fire. Density declined 77 percent in severely burned stands. Sagebrush invertebrate communities were almost wiped out from the fire. Diversity declined 90 percent, whereas density declined 94 percent in severely burned sagebrush areas. Neither invertebrate diversity nor invertebrate density in sagebrush areas had increased significantly two years after the fire.

The invertebrate predator:prey ratio fell from 1:24 to 1:7.9 in burned forest stands as compared to unburned stands, whereas the ratio increased from 1:4.5 to 1:5.8 in burned sagebrush areas as compared to unburned sagebrush areas. Thus, severe fire events are a strong influence on forest-floor and sagebrush litter invertebrate communities.

What can we conclude about Yellowstone's invertebrates?

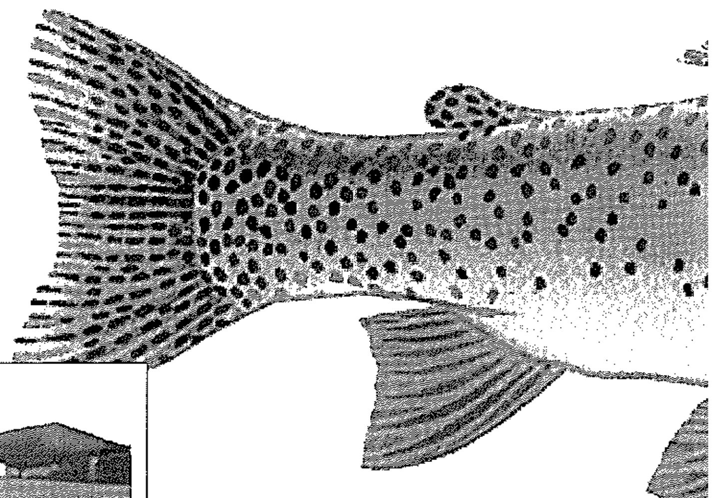
Several conclusions can be made about

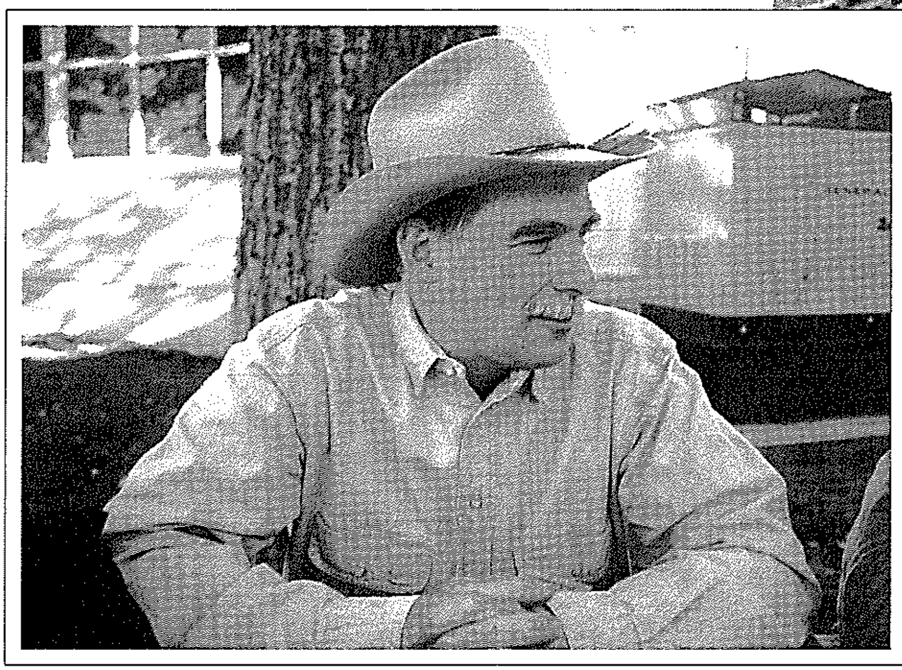
the forest-floor and sagebrush litter invertebrate communities in Yellowstone National Park. Yellowstone contains a higher litter invertebrate biodiversity than several other areas in Wyoming. Sagebrush habitats are as important as forest stands for the preservation and study of invertebrate biodiversity within the park system.

Fires can, obviously, disrupt invertebrate communities. A major question is how long before invertebrate communities can be considered stable after a major disruption. Also, the role of litter invertebrate communities is not well known in either forest or sagebrush systems. More information is necessary on both invertebrate habitat requirements and the role invertebrates play in ecosystems.

Tim Christiansen recently completed a post-doctoral fellowship in the Division of Forestry at West Virginia University. He is currently working on several technical manuscripts based on the research summarized in this article, as well as a volume on the ants of Yellowstone.

Yellowstone Lake and Change





What can natural history tell us about the fate of the Yellowstone Cutthroat?

Robert Gresswell has been studying and working on Yellowstone Lake for more than 20 years, first as a fisheries biologist with the U.S. Fish and Wildlife Service, and more recently as an adjunct assistant professor at Oregon State University. A member of the special lake trout workshop held early in 1995 to deliberate on the lake trout crisis, Bob has published many important articles and reports on the Yellowstone cutthroat trout. This interview, conducted last September, provided us with an opportunity to invite Bob to expand on the ideas and information presented at that workshop, and more especially on the results of his own recent research.

YS: Of course the big issue these days with the Yellowstone cutthroat trout is the much- publicized illegal introduction of lake trout in Yellowstone Lake. You've worked on Yellowstone Lake for more than 20 years now, and must be one of the most widely published Yellowstone Lake researchers now active. How would you characterize what is going on there?

BG: Well, speaking as someone who tries to be an eternal optimist, it's hard to view that situation optimistically. The recent population modeling work we've done makes me even more of a pessimist. The results of this summer's [*1995*] sampling and the angler catch suggest that the lake trout are well established in the lake and their population seems to be expanding quite rapidly. Perhaps the best that we might be able to do is maintain persistance of Yellowstone cutthroat in the system. I think that we have to try, and the sooner that we get to work on it, the sooner we begin to move, the better.

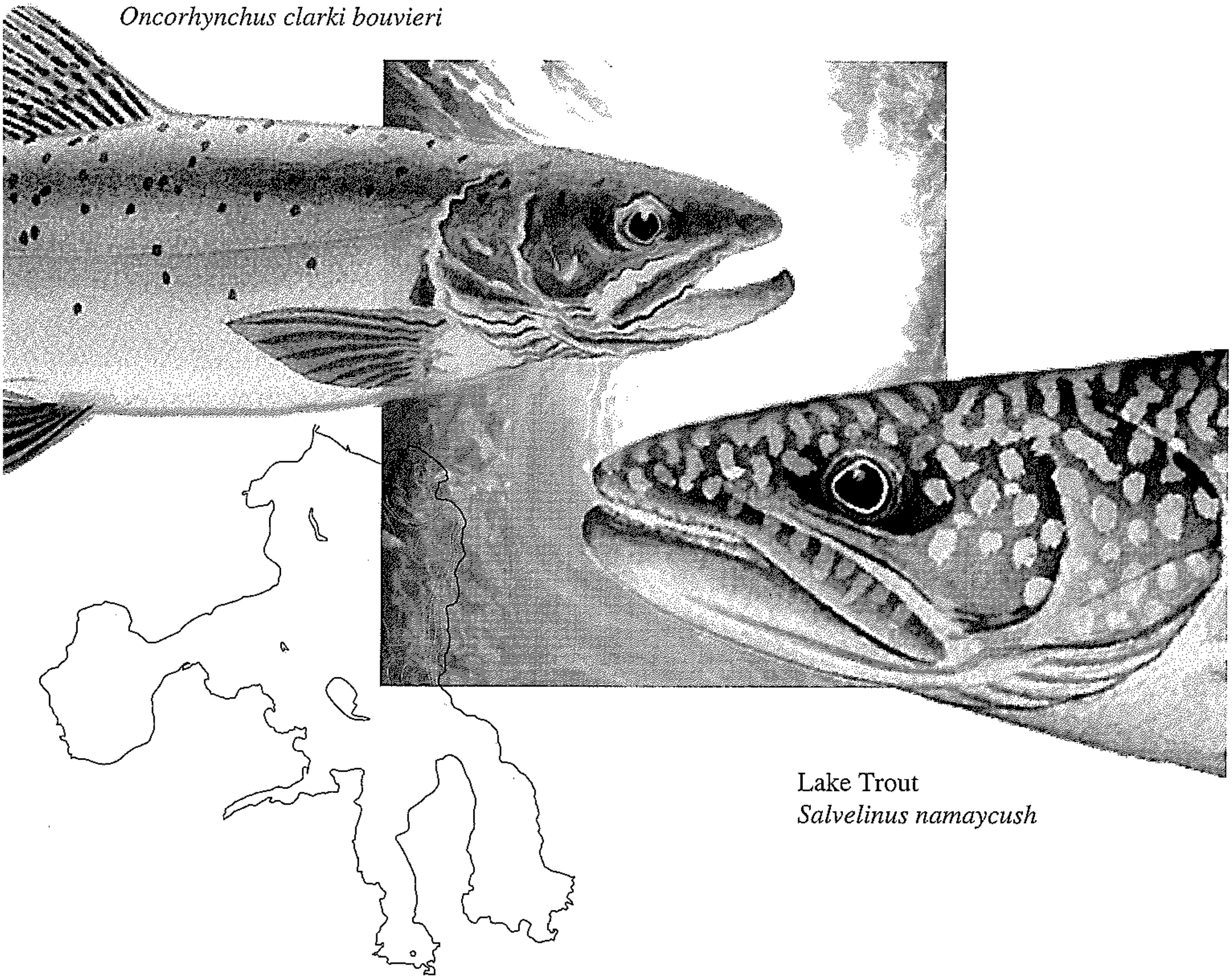
YS: Do we know enough to do that well?

BG: Even in the absence of better information we have to act while the lake trout population is still expanding. At the same time, there are a lot of information gaps that we'll need to work on, to improve our ability to reduce lake trout numbers.

YS: How much can we hope to reduce them?

BG: First, it's important to acknowledge

Cutthroat Trout
Oncorhynchus clarki bouvieri



Lake Trout
Salvelinus namaycush

that there is no way that we're going to be able to remove them completely. But with enough intervention, we might be able to stabilize the situation at a point where the lake trout population is low and the cutthroat population can be maintained.

YS: Tell us more about the modeling that you've been involved in.

BG: Our primary interest is the interaction of the juvenile lake trout with both the adult and juvenile cutthroat trout. Our understanding of their food habits, based solely on the scientific literature, suggests to us that the lake trout might actually compete with both the juvenile and the adult cutthroat trout.

YS: The juvenile lake trout would compete with the juvenile cutthroat trout for zooplankton?

BG: Right. But they might also compete with the adult fish.

YS: How?

BG: At this point we're not sure exactly where these young lake trout are going to hang out in Yellowstone Lake. If they have more of a littoral existence, that is if they live in shallow water and near the shore, then they could become a direct competitor with the adult cutthroats. The adult cutthroats don't eat many small fish, and so the juvenile lake trout aren't going to provide them with a significant food source, but there is a possibility that there will be substantial overlap of preferred foods.

The models are designed to predict consequences of certain scenarios, and when you ask the model to predict what will happen when the cutthroat trout get this double whammy—of competition at all ages, and from another species that will eventually grow up and prey heavily on them—the model goes into some wild oscillations.

YS: As you know, there are people who are skeptical of wildlife models. The criticisms are usually aimed at the answers that the models provide, because they're just predictions and aren't certain. But what you're saying is that the model