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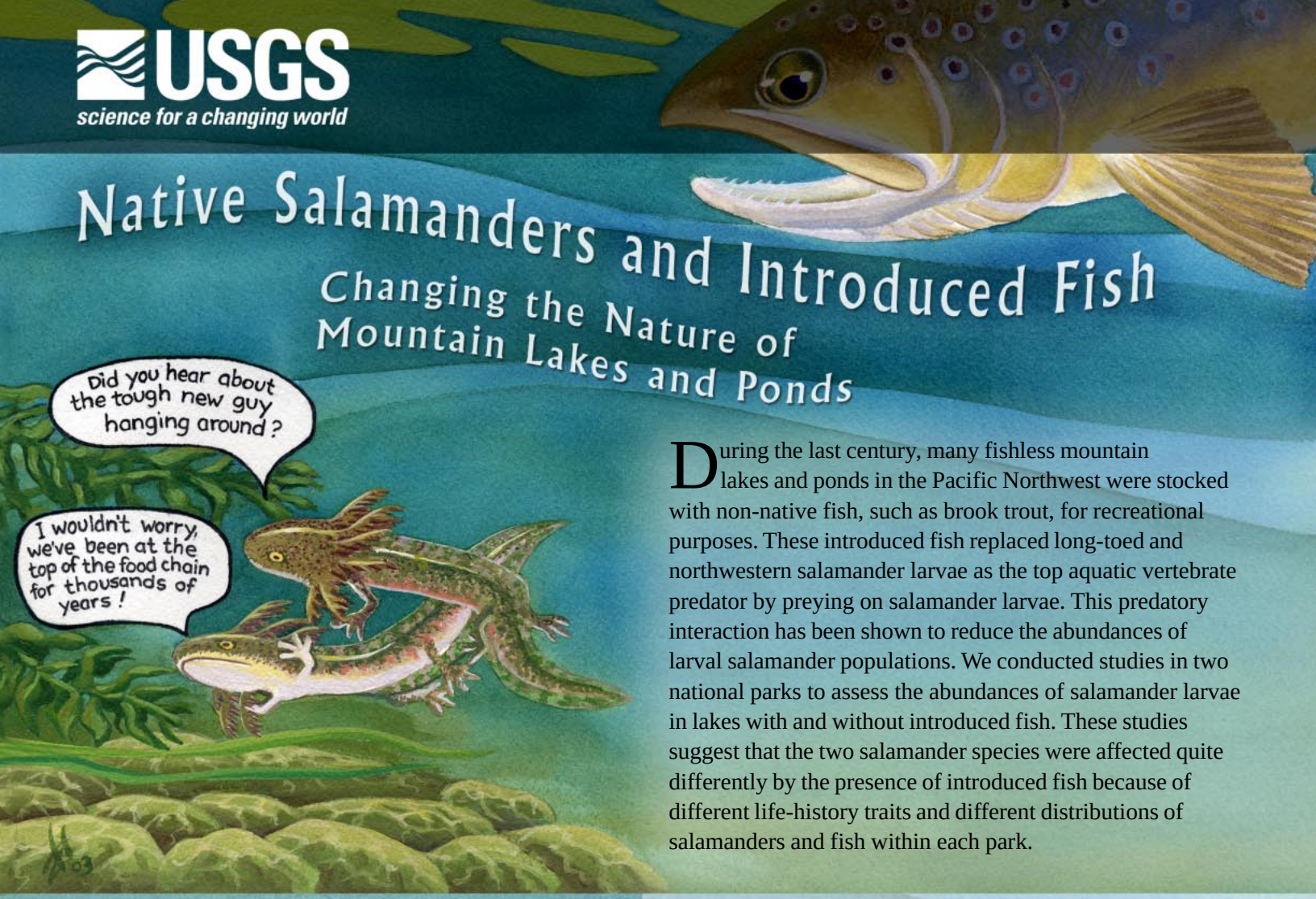
Native Salamanders and Introduced Fish

Changing the Nature of Mountain Lakes and Ponds



During the last century, many fishless mountain lakes and ponds in the Pacific Northwest were stocked with non-native fish, such as brook trout, for recreational purposes. These introduced fish replaced long-toed and northwestern salamander larvae as the top aquatic vertebrate predator by preying on salamander larvae. This predatory interaction has been shown to reduce the abundances of larval salamander populations. We conducted studies in two national parks to assess the abundances of salamander larvae in lakes with and without introduced fish. These studies suggest that the two salamander species were affected quite differently by the presence of introduced fish because of different life-history traits and different distributions of salamanders and fish within each park.

The Biology of Salamander Larvae

Long-toed (*Ambystoma macrodactylum*) and northwestern (*Ambystoma gracile*) salamanders are common in mountain lakes and ponds in the Cascade Mountains of the Pacific Northwest. Salamander larvae are often the top native aquatic vertebrate predator. After they hatch, larvae of both species feed on animal plankton. Once they attain a sufficient size, they feed on other organisms, such as aquatic insects.

Larvae of both species undergo physical, biochemical, and behavioral changes to become adults. In some cold lakes and ponds, long-toed salamanders over-winter as larvae and become terrestrial adults in the second or third year of life. Although northwestern salamander larvae can transform into terrestrial adults in one to two years after hatching, most mature in the larval, gilled form and remain aquatic their entire lives in mountain lakes and ponds.

Long-toed salamanders live in lakes and ponds with a wide range of depths, whereas northwestern salamanders are usually found in lakes greater than seven feet in maximum depth in the Cascade Mountains. Recent evidence suggests that when northwestern salamanders are present they exclude long-toed salamanders.

How are Introduced Fish Affecting Mountain Lakes and Ponds?

When fish are introduced to naturally fishless lakes they reduce the abundance of larval salamander populations and can affect changes in larval behavior. Introduced fish also prey on organisms that live in bottom sediments and on terrestrial insects that become stranded on the water's surface. These food habits alter the nutrient cycle of a lake, which in turn alters other ecosystem processes. This creates complex challenges for managers trying to simultaneously protect mountain ecosystems and manage them for recreational uses.

photo © Bill Leonard

Adult long-toed salamander

photo by Torrey Tyler

Adult northwestern salamander

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Current Research

Our studies at Mount Rainier National Park (MORA) and North Cascades National Park Service Complex (NOCA), in Washington State, examined the abundances of salamander larvae in mountain lakes with and without introduced trout. Overall, there were fewer larvae in lakes and ponds inhabited by introduced trout than in naturally fishless lakes (Figure 1). Also, in response to fish predation, larvae appeared to restrict their daytime distributions and activity to nearshore areas with abundant bottom cover, and they were active primarily at night when they emerged from refuges to forage.

To evaluate the finding that introduced fish affect salamander abundance and behavior, fish were removed from a small lake in MORA that had a population of northwestern salamander larvae. The fish were removed over a period of six years, with most removed within the first two years. Once fish were removed, the total number of larvae observed (Figure 2), and the proportion of larvae observed offshore compared to nearshore, increased during daytime surveys.

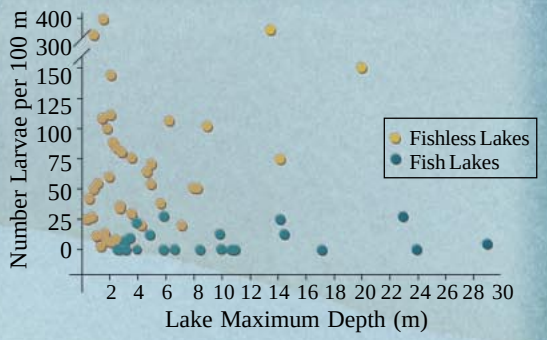

Figure 1.

The number of salamander larvae per 100 meters surveyed was less in ponds and lakes with fish regardless of depth in MORA.

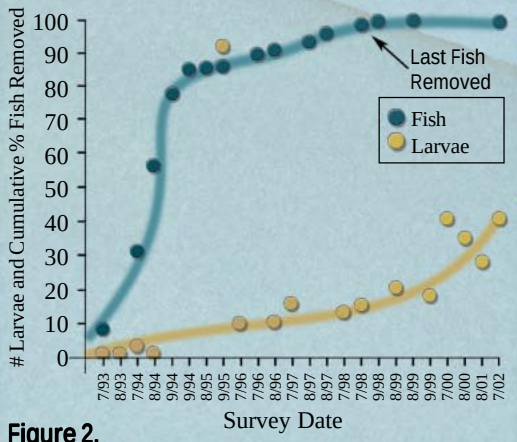

Figure 2.

The number of salamander larvae observed per 100 meters surveyed during day surveys increased from 1993 through 2002 when fish were removed.

Which Salamander Species are Eaten?

Larvae of both long-toed and northwestern salamanders are present in MORA and NOCA. The distribution of the two species differs between the parks, and this influences which species interacts with introduced fish.

At MORA, both salamander species are found in forest and subalpine lakes and ponds. Long-toed salamanders typically occupy ponds less than seven feet deep that have hard bottom sediments. Northwestern salamanders typically occupy lakes greater than seven feet deep that have soft bottom sediments. Fish do not survive well in lakes and ponds less than seven feet deep because these shallow systems either freeze to the bottom in winter or fill with snow and ice. Therefore, in MORA, the long-toed salamander rarely interacts with introduced fish.

The story is considerably different at NOCA. The northwestern salamander does not occur east of the hydrologic divide of the Cascade Range. In the absence of northwestern salamander larvae, long-toed salamander larvae are able to inhabit deep lakes and ponds as well as shallow lakes and ponds on the east-side of NOCA. West of this divide, both salamander species are present, although the distribution of the northwestern salamander is patchy because in NOCA it is at the northern and eastern edge of its range. When they do occur on the west-side of NOCA, populations of northwestern salamander larvae inhabit relatively deep lakes with soft-bottom sediments, whereas long-toed salamander larvae inhabit a diverse array of systems including deep lakes not inhabited by northwestern salamander larvae. Overall, the long-toed salamander is the species primarily impacted by introduced fish on both sides of the hydrologic divide.

Implications

Our studies suggest that resource managers need to develop separate management strategies for each salamander species. Managers need to be aware of the different habitat requirements and patterns of distribution for salamanders and for fish. Pond and lake variables, such as size and depth, should be considered. Understanding how introduced fish impact aquatic ecosystems and how larval salamanders respond to the presence of fish can help managers monitor the ecological integrity of these ecosystems.

For More Information

Larson, G.L. and R.L. Hoffman. 2002. Abundances of northwestern salamander larvae in montane lakes with and without fish, Mount Rainier National Park, Washington. Northwest Science 76: 35-40.

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