How Are the Borders of an Ecosystem Defined?

The borders between ecosystems may be well-defined, gradual, or vague. Those considered well-defined are often, as in the case of freshwater streams, studied separately from surrounding ecosystems by researchers with different training and with different methods. Recent research on streams of southeast Alaska, in which salmon spawn, has raised questions about the usual practice of studying aquatic and terrestrial ecosystems separately.

Salmon are one group of anadromous fish—those that come from the ocean to spawn in freshwater streams. In southeast Alaska, enormous numbers of salmon spawn in over 5,000 streams. In 1985, 147 million salmon were harvested in that area of Alaska alone. Although salmon are born in freshwater, they migrate to the ocean where most of there growth occurs. After they return to their home streams, they spawn and die. In one sense, therefore, salmon are a means of transporting resources from the ocean to freshwater. Because of their large numbers, salmon have the potential of making significant contributions to organic and mineral content of streams.

Salmon have a high lipid content compared to many other fish and are thus a good energy source for animals that prey on them. In addition, their decay adds nitrogen, phosphorus, carbon, and other inorganic elements to freshwater. In one lake in western Alaska, its 24 million fish add 170 tons of phosphorus to the lake each year—an amount equal to or greater than recommended rates for applying fertilizers to trees. When the fish die, their carcasses decay and provide nourishment for algae, fungi, and bacteria. Invertebrates feed on these and decaying bits of fish. Other fish feed on the invertebrates. Finally, bears and other carnivores eat salmon, both live and dead, during their upstream migration. In that way, nutrients derived from salmon pass into the soil and vegetation surrounding the streams.

Because spawning fish have higher proportions of heavy isotopes of nitrogen and carbon (^{15}N and ^{13}C), they can be used to trace the relative contributions of anadromous fish to the nitrogen and carbon content of organisms in the food web. One such study showed that spawning salmon contributed 10.9% of the nitrogen found in invertebrate predators and 17.5% in the foliage of riparian plants.[3] While it is not surprising to find aquatic invertebrates, which feed on salmon eggs and juveniles, with large amounts of nitrogen derived from salmon, researchers were surprised at the high levels in stream side vegetation. When terrestrial mammals and birds feed on salmon, their feces and any uneaten salmon carcasses decay and add nutrients to the soil, where they can be taken up through the roots of plants. In southeast Alaska, over 40 species of mammals and birds feed on salmon. Salmon migrations attract large numbers of predators to streams and lakes. Salmon and other anadromous fish appear to link the ocean, freshwater, and land to an extent that is only beginning to be appreciated.

Critical Thinking Questions

1. Given the intricate connections between the aquatic and terrestrial ecosystems along salmon streams, how would you define the boundaries of the ecosystem?
2. Numbers of adult salmon that reach the spawning grounds and are above those needed to maintain the population have been considered excess. How might the research described here affect that view?
3. Some biologists have called salmon a keystone species. Given what you know about keystone species, how would you argue for or against this designation?
4. In recent years, the numbers of anadromous fish along the Pacific Coast of North America have declined precipitously due to overfishing and habitat destruction. What effects would you predict this might have on the ecology of freshwater streams and their adjoining land areas?
5. What types of management decisions about fish, wildlife, and forests would follow from recognizing the connection between aquatic and terrestrial ecosystems?

References

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