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## IMPACTS OF TROUT STOCKING ON AMPHIBIAN POPULATIONS

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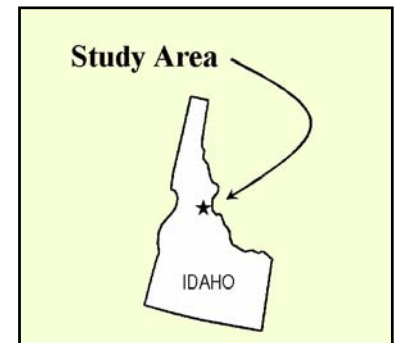
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**Keywords:** fish stocking, long-toed salamanders, Columbia spotted frogs, western toads, cutthroat trout, rainbow trout, golden trout

**Background & Management Issues:** Trout and other non-native sport fishes have been introduced into high-elevation lakes in western North America to provide recreational opportunities in the backcountry. Many of these lakes were historically fishless, and consequently, fish stocking has been implicated in the decline of native amphibian populations. Previous research has either examined spatial distributions of amphibian populations within individual water bodies decades after stocking occurred or focused on the effects on single species. Life history traits vary among amphibian species, however, and fish stocking may affect species differently. In addition, amphibian population structure may be affected at a broad scale when a portion of lakes and streams in an watershed are stocked. This habitat fragmentation may isolate amphibian populations and result in increased extinction rates.

### **Project Objectives:**

- ❖ To evaluate the effects of introduced trout on two species of amphibians with different life-history characteristics: the long-toed salamander, a species in which larvae overwinter two years before metamorphosing; and the Columbia spotted frog, a species in which the larval stage is completed in one summer.
- ❖ To examine the broad-scale effects of fish stocking on amphibian populations within drainage basins.



**Project Description:** Fish and amphibian surveys were conducted in the Bighorn Crags region of the Frank Church River of No Return Wilderness. Historical and state records, hook-and-line angling, gill netting, and visual observations were used to determine the presence of fish. Visual encounter surveys were used to determine the distribution and abundance of amphibians. Observers searched the perimeters of lakes, ponds, and entire flooded meadows, and recorded life stages of individuals encountered. Snorkel surveys in 11 lakes were used to evaluate the accuracy of visual encounter surveys for salamanders, and mark-recapture population estimates from 39 lakes permitted evaluation of frog surveys. In addition, the physical, chemical, and biological characteristics of lakes and wetlands were recorded.

**Results:** Historical records indicated that Idaho Fish and Game stocked over 60,000 cutthroat and rainbow trout into 12 to 30 previously fishless lakes in 1937 and 1938 in the Bighorn Crags area. Beginning in the 1960s, fish were restocked every three to six years. In total, 37 lakes were stocked with 300,000 fry or fingerlings.

Cutthroat, rainbow, and golden trout and their hybrids were found in all 11 basins searched. Overall, 43% of sites were occupied by fish. Large, deep lakes (greater than 1 ha in surface area and more than 4 m deep) were more likely occupied than small, shallow wetlands. As a result, 90% of the available surface area of water in the basins was occupied by fish. More importantly, only two basins had more than one deep, fishless lake.

Densities of both long-toed salamanders and Columbia spotted frogs were lower in sites with fish than in those without fish. Indeed, when site characteristics of deep lakes were held constant, fewer amphibians of all stages were found in stocked lakes than in lakes without fish. Moreover, densities of salamander larvae at least two years old, and both adult and juvenile frogs in fishless sites decreased as the proportion of wetlands in the basin occupied by trout increased.

### ***Management Implications:***

- ✓ Survival of salamander larvae and juvenile frogs may depend on deep lakes (>2 m), yet few of these habitats are not stocked with fish.
- ✓ Negative effects of stocked lakes may extend across a landscape. Lakes with fish may have insufficient juvenile recruitment to compensate for adult mortality. Amphibians with extended larval periods may be forced to breed in shallower wetlands where the risk of extirpation due to desiccation, anoxia, and freezing are higher than in the deep, lentic environments. Likewise, amphibians that complete their life-cycle in one summer may breed in shallow wetlands but may be forced to immigrate to deep lakes to overwinter. If those lakes are stocked with fish, the progeny may be completely eradicated.
- ✓ Information necessary to evaluate the effects of fish stocking in high-elevation lakes should include knowledge of:
  - (1) **the amphibian and fish species in the area** – Because little information is available about distributions of many amphibian species, surveys should be based on what species are potentially in the wilderness area and the life histories of those species. Different types of surveys conducted at various times of the year may be needed to assess abundances and life stages (see Table 1).
  - (2) **the extent of area impacted** – Surveys of entire watersheds provide the most unbiased information to determine production, habitat use, and potential interaction between fish and amphibians and allow the most accurate assessment of management actions. Because watershed sampling requires considerable time and effort, the number of watersheds in a wilderness that can be sampled may be limited. Surveying a subset of wetlands in different watersheds using stratified sampling may broaden the scope if all wetland types can be adequately represented. Integrating fish and amphibian surveys may also expand sampling ability.
  - (3) **the effect of management actions** – Because the basin-wide effects of fish stocking have only recently been identified, information on the results of specific management actions is unavailable. Potential management actions include: cessation of stocking and/or removal of fish, which reduce the number of lakes supporting fish; reduction in stocking

frequency/density/fertility (stocking sterile fish or limiting access to spawning habitat), which may result in fishless habitats for short periods; and alteration of the species stocked (e.g. cutthroat trout may be less predatory than brook or rainbow trout) (see Fig. 1).

**Project dates:** The project was initiated in August 1994 and completed in January 2000.

**Publications / Products / Presentations:**

- Pilliod, David S.; Peterson, Charles R. 2000. Evaluating effects of fish stocking on amphibian populations in wilderness lakes. In: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference – Volume 5: Wilderness ecosystems, threats, and management; 1999 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 328-335.
  
- Pilliod, David S.; Peterson, Charles R. 2001. Local and landscape effects of introduced trout on amphibians in historically fishless watersheds. *Ecosystems* 4(4): 322-333.

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*For additional information...*

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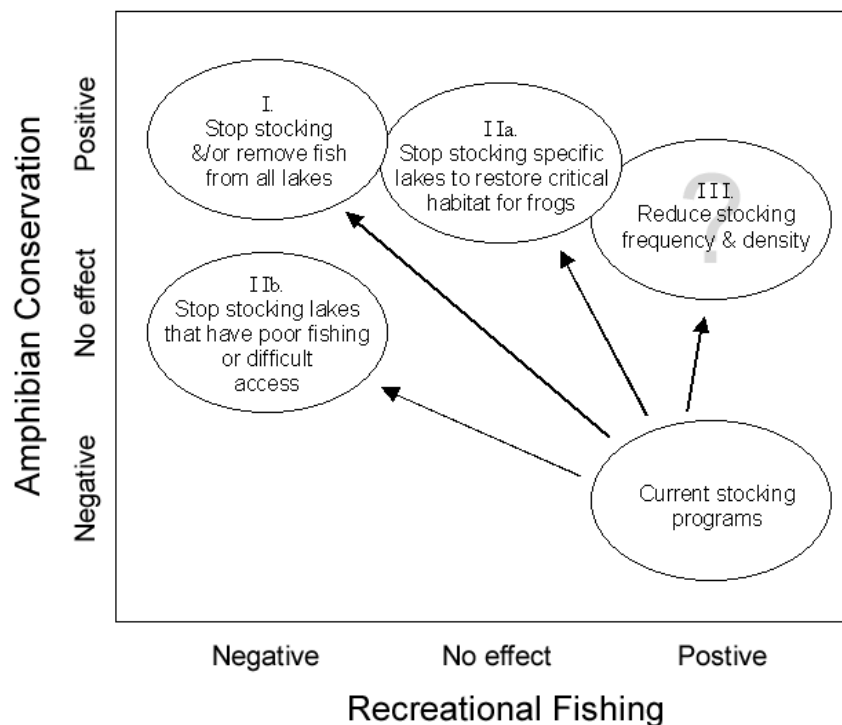
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**Table 1.** A summary of collection and detection techniques for three common lentic-breeding amphibians found in the Pacific Northwest: aquatic funnel traps (aft), calling surveys (cal), turning cover (cov), dip netting (dip), night driving (drv), spot lighting (lit), pitfall traps (pit), electroshocking (sho), snorkeling (snk), and/or visual encounter surveys (ves) (from Pilliod and Peterson 2000).

| Life Stage                                                   | Location                 | Season                   | Technique          | Difficulty | Remarks                       |
|--------------------------------------------------------------|--------------------------|--------------------------|--------------------|------------|-------------------------------|
| <b>Long-toed Salamander (<i>Ambystoma macrodactylum</i>)</b> |                          |                          |                    |            |                               |
| adult                                                        |                          |                          |                    |            |                               |
| breeding                                                     | lakes, ponds, creeks     | late winter/early spring | aft, pit, ves, cov | easy       | best during rain              |
| active                                                       | wetlands, uplands        | spring to summer         | cov, pit           | difficult  | eggs deposited at ice-out     |
| eggs                                                         | lakes, ponds, ox bows    | late winter/early spring | ves                | easy       | in shallows & open water      |
| larvae                                                       | lakes, ponds, ox bows    | all year, overwinter     | aft, dip, snk      | easy       |                               |
| metamorphs                                                   | under cover at shoreline | late summer              | pit, cov           | difficult  |                               |
| juveniles                                                    | uplands                  | spring to summer         | pit, cov           | difficult  |                               |
| <b>Western Toad (<i>Bufo boreas</i>)</b>                     |                          |                          |                    |            |                               |
| adult                                                        |                          |                          |                    |            |                               |
| breeding                                                     | lakes, ponds, creeks     | spring to summer         | ves, cal, lit      | variable   |                               |
| active                                                       | wetlands, uplands        | spring to fall           | ves, drv           | variable   | crepuscular                   |
| eggs                                                         | lakes, ponds, ox bows    | spring to summer         | ves                | moderate   | may be covered by silt        |
| larvae                                                       | lakes, ponds, ox bows    | all year, overwinter     | ves, dip           | easy       | aggregate in shallows         |
| metamorphs                                                   | shoreline                | summer to fall           | ves, pit, cov      | easy       | may be very numerous          |
| juveniles                                                    | wetlands, uplands        | spring to fall           | ves                | difficult  |                               |
| <b>Columbia Spotted Frog (<i>Rana luteiventris</i>)</b>      |                          |                          |                    |            |                               |
| adult                                                        |                          |                          |                    |            |                               |
| breeding                                                     | lakes, ponds, ox bows    | spring                   | ves, dip, pit      | variable   | calls difficult to hear       |
| active                                                       | riparian, wetlands       | spring to fall           | ves, dip, pit      | easy       | near water or in wet meadows  |
| eggs                                                         | lakes, ponds             | spring                   | ves                | easy       | floating communal oviposition |
| larvae                                                       | lakes, ponds, ox bows    | spring to summer         | ves, dip, aft      | easy       | may hid in bottom detritus    |
| metamorphs                                                   | Shoreline, meadows       | late summer to fall      | ves, pit           | easy       |                               |
| juveniles                                                    | riparian, wetlands       | spring to fall           | ves, dip, pit      | easy       |                               |



**Figure 1.** The effects of different management actions on recreational fishing and amphibian conservation (from Pilliod and Peterson 2000).