

COLUMBIA SPOTTED FROG

Rana luteiventris Thompson, 1913
(Ranidae)

State rank S2? (1999-09-30)

Global rank G4 (1997-07-11)

State rank reasons

Restricted range in Southeast Alaska. Population status unknown, although suspected low. Needs more study. Major threats include habitat loss/degradation due to development and glacial rebound.

Taxonomy

Formerly included in *Rana pretiosa*. Green et al. (1996) examined allozyme and morphometric variation in *R. pretiosa* from 26 and 38 localities, respectively, and concluded that at least two species were represented, although morphometrically, the two species are "almost indistinguishable."

Green et al. (1997) determined that frogs from the vicinity of the type locality of *R. pretiosa* are conspecific with the species residing in south-central Washington and the Cascade Mountains of Oregon. Hence, they concluded that populations from southwestern British Columbia, western Washington, western and central Oregon, and northeastern California are *R. pretiosa* and that spotted frogs from the remainder of the range are *R. luteiventris*. *R. luteiventris* was regarded as possibly comprising multiple weakly-differentiated species.

Further analyses of taxonomic relationships among range-wide spotted frog populations were performed by Bos and Sites (2001); this study revealed four genetically distinct lineages. Two of these lineages are represented in Utah: (1) the Deep Creek lineage (Deep Creek-Ibapah population in the West Desert distinct population segment or DPS), and (2) the Bonneville lineage (all other populations in Utah, including the Wasatch Front and the remainder of the West Desert DPSs). The Wasatch Front DPS appears to have originated from the West Desert populations in relatively recent evolutionary time, during the recession of Lake Bonneville (Toline and Seitz 1999, Bos and Sites 2001). Therefore, genetic differences between these populations have not yet been established. However, separation of the West Desert and Wasatch Front DPSs is supported by ecological and demographic distinctiveness due to geographic



isolation and habitat differences, including disparate biological, chemical, and thermal characteristics of occupied springs and wetlands (Hovingh 1993, USFWS 1993). In addition, due to the dependence of spotted frogs on aquatic habitats (Bos and Sites 2001) and population isolation (Toline and Seitz 1999), there is likely no gene flow existing between the Wasatch Front and West Desert DPSs.

Spotted frogs on Mitkof Island near Petersburg, Alaska, may exhibit a distinct phenotype of heavy dusky gray ventral coloring (MacDonald 2003).

General description

A bumpy-skinned, medium-sized frog with relatively short hind legs, inconspicuous dorsal folds, and fully webbed toes. Individuals vary from light to dark brown above with a scattering of large black spots often with light centers. Underside is creamy or mottled gray, with a covering of bright salmon or red on lower abdomen and undersurfaces of hind legs in adults. Light stripe on the upper jaw, and the eyes are upturned. Adults to 7.6 cm. This species is larger than the wood frog (*R. sylvatica*), has bright salmon color over ventral surfaces, and lacks a dark eye mask or light vertebral stripe. Distinguished from the introduced red-legged frog (*R. aurora*) by its shorter legs (heel of hind leg when extended forward falling short of snout), with greater webbing, rougher skin, upturned rather than out-turned eyes, shorter jaw stripe, and lack of mottling on the groin (MacDonald 2003).

Length (cm) 7.6

Reproduction

Breeds in February at sea level in British Columbia, mid-March at 1,395 m in Utah, May-June at 2,377 m in Wyoming, mid-April through mid-May in Southeast Alaska; generally as early as winter thaw permits. In northeastern Oregon,

eggs were not deposited on days when maximum water temperature was below 9.4° C; at 18 sites, duration of egg deposition ranged from 1 to 20 days (Bull and Shepherd 2003). Females may lay egg masses in communal clusters. Eggs hatch in 3-21 days (12-21 days in northeastern Oregon; Bull and Shepherd 2003), depending on temperature. Metamorphosis occurs before fall or tadpoles may over-winter and metamorphose the following spring. Sexually mature in 2-6 years, depending on location and elevation (matures later at high elevations). In Wyoming, individual females breed yearly at low elevations, every 2-3 years at high elevations (Nussbaum et al. 1983).

Ecology

In the Toiyabe Range in Nevada, Reaser (2000) captured 887 individuals over three years, with average mid-season density ranging from 2 to 24 frogs per 150 m of habitat. Columbia spotted frogs may pass the winter in a torpid state underwater or under soil or rocks, especially at higher latitudes (James 1998).

Migration

May make short movements between breeding and non-breeding habitats. Males arrive in breeding areas prior to females.

In central Idaho, frogs moved up to 1030 m to reach summer habitats; females (the more mobile sex) moved less than 500 m on average from breeding or over-wintering sites to summer foraging areas (Pilliod et al. 2002). Pilliod et al. (in Koch et al. 1997) reported that individual high mountain lake populations of *R. luteiventris* in Idaho are actually interdependent and part of a larger contiguous metapopulation that includes all the lakes in the basin. In Nevada, Reaser (1996 in Koch et al. 1997) determined that one individual of *R. luteiventris* traveled over 5 km in a year.

In a three-year study of *R. luteiventris* movement within the Owyhee Mountain subpopulation of the Great Basin population in southwestern Idaho, Engle (2000) PIT-tagged over 1800 individuals but documented only five (of 468 recaptures) over 1,000 m from their original capture point. All recaptures were along riparian corridors and the longest distance between capture points was 1,765 m. Although gender differences were observed, 88 % of all movement documented was less than 300 m from the original capture point. Engle (2001) found a two-year-old individual 6.5 km downstream from its natal pond (a year after being marked and released).

Though movements of up to 6.5 km have been recorded, these frogs generally stay in wetlands and along streams within 1 km of their breeding pond (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001, Pilliod et al. 2002). Frogs in isolated ponds may not leave those sites (Bull and Hayes 2001).

Food

Opportunistic. Eats a wide variety of terrestrial and aquatic insects as well as different mollusks, crustaceans, and arachnids. Larvae eat algae, organic debris, plant tissue, and minute aquatic organisms.

Phenology

May move overland in spring and summer after breeding. Inactive in winter in north.

Global habitat

Highly aquatic; rarely found far from permanent quiet water; usually occurs at the grassy/sedge margins of streams, lakes, ponds, springs, and marshes (Hodge 1976, Licht 1986). May disperse into forest, grassland, and brushland during wet weather. Uses stream-side small mammal burrows as shelter (Blomquist and Tull 2002). Overwintering sites in the Great Basin include undercut stream banks and spring heads (K. Hatch, pers. comm., cited by Blomquist and Tull 2002). Breeds usually in shallow water in ponds or other quiet waters. See Munger et al. (1998) for quantitative information on habitat in southwestern Idaho.

State habitat

Closely associated with permanent water. Found predominantly in outwash ponds and backwater lakes, beaver ponds, muskeg ponds, river channels, and streams (Waters 1992, MacDonald 2003).

Global range

Extreme southeastern Alaska, southwestern Yukon (Slough 2002), northern British Columbia, and western Alberta south through Washington east of the Cascades, eastern Oregon, Idaho, and western Montana to Nevada (disjunct; Mary's, Reese, and Owyhee river systems), southwestern Idaho (disjunct), Utah (disjunct; Wasatch Mountains and west desert), and western and north-central (disjunct) Wyoming (Stebbins 1985, Green et al. 1996, 1997). Disjunct populations occur on isolated mountains and in arid-land springs. Elevation range is from sea level to about 10,000 ft (Stebbins 1985). West Desert

(Bonneville) population occurs mainly in two large spring complexes, with several additional concentrations in smaller nearby springs; extirpated from the northern portions of the range. The Wasatch Front population occurs in isolated springs or riparian wetlands in Juab, Sanpete, Summit, Utah, Tooele, and Wasatch counties. Extirpated from the Salt Lake Valley and tributaries to the Jordan River and Great Salt Lake (USFWS 2002). Currently, there are seven localized populations that comprise the Wasatch Front population or DPS. The largest known concentration is currently in the Heber Valley; the remaining six locations are Jordanelle/Francis, Springville Hatchery, Holladay Springs, Mona Springs Complex/Burraston Ponds, Fairview, and Vernon (USFWS 2002).

State range

Present in coastal forests of Southeast Alaska, although range limits are not precisely known (Hodge 1976, MacDonald 2003). Present distribution confined to coastal transboundary river corridors of continental mainland in Southeast, such as Salmon, Taku, Stikine and Unuk rivers and the Agassiz Peninsula (MacDonald 2003). Have been documented on Mitkof, Sergief and Vank Islands within the adjacent Alexander Archipelago (Waters 1992, Lindell and Grossman 1998). Mitkof Island population (in and near the city of Wrangell) possibly introduced. Carstensen et al. (2003) reported frogs at one location along the Juneau road system, suspected this was also an introduction. Also reported but not confirmed in Haines area (MacDonald 2003).

Global abundance

Total adult population size is unknown but likely exceeds 100,000. Numerous in many areas in Canada and the Rocky Mountains.

West Desert population: over 6,000 spotted frog egg masses were observed in 1993 (D.Ross, Herpetologist, Utah Division of Wildlife).

State abundance

Current population size unknown. Population studies conducted at isolated ponds in the Taku, Stikine and Unuk River corridors estimated local populations ranged from 7 to 594 Columbia spotted frogs per pond and densities ranging from 0.07 to 1.49 spotted frogs per m² of pond habitat (Lindell and Grossman 1998).

Global short term trend

Significant declines have occurred in some areas of Utah and Wyoming. Possibly has declined in Idaho, but numbers still apparently are high (Phillips 1990, Groves pers. comm. 1992).

Declines have been reported for disjunct populations in the Wasatch Front in Utah, but the recent trend is toward more secure populations, reduced threats, and improved habitat conditions (USFWS 2002).

The West Desert (Bonneville) population has declined in range and abundance.

Recent intensive surveys indicate severe declines in the Great Basin populations. See Federal Register, 7 May 1993 (USFWS 1993) and 2 April 1998 (USFWS 1998). In the Toiyabe Range in central Nevada, demographic parameters exhibited significant spatial and temporal variation, some of which likely was due to extreme variations in annual weather patterns (Reaser 2000). Recent reports suggest Alberta populations may be in decline (James 1998).

Global long term trend

Relatively stable in most of the range, but populations in the arid southern portion of the range have declined.

State trend

Population status in Alaska is unknown.

Global protection

Somewhat protected in several federal and state parks and refuges, though management usually ignores this species.

A considerable portion of the range of the West Desert population is under management of the Bureau of Land Management. Conservation activities implemented for the least chub (*Lotichthys phlegethontis*) should also benefit the West Desert population.

Wasatch Front population occurs mainly on private land, with some federal ownership along Jordanelle Dam and the Provo River. Habitat acquisition and protection are in progress for the Jordanelle/Francis, Heber Valley, Mona/Burraston, and Fairview populations. Current ventures are focused on acquiring habitat easements along approximately 9.7 kilometers (6 miles) above Jordanelle Dam, including occupied and suitable spotted frog habitats. Easements are

currently being pursued with 7 Fairview landowners to protect approximately 162 hectares (400 acres) of occupied spotted frog habitat and migration corridors from potential water and residential development. The remaining 15 percent of the Provo River corridor in the Heber Valley is projected to be purchased and protected by 2004. In the Mona/Burraston population, fee-title purchase or conservation easements are currently being negotiated for 7.9 hectares (19.5 acres) which would allow for protection of all spring and potential spotted frog habitat on this site.

Great Basin population occurs primarily on lands managed by the U.S. Forest Service and Bureau of Land Management.

State protection

Most areas of occurrence in Alaska are federally owned, administered by the USDA Forest Service. These include portions of the Tongass National Forest and Misty Fiords Monument (which are managed as no or low development areas) (Lindell and Grossman 1998). In Alaska, amphibians are managed by Alaska Department of Fish and Game under statute 16.05.030, in which amphibians are legally included in the definition of "fish." This statute makes it illegal for anyone to "hold, transport or release" any native amphibians without a valid permit.

Global threats

Populations in western Utah are limited by scarce habitat (springs) and are potentially threatened by habitat degradation from cattle grazing and agricultural activities. Oil and gas exploration is an increasing threat. Water development could lower water tables and adversely impact spring habitats. Introduced bullfrogs and fishes may have an adverse impact, but the current degree of threat is unknown. Mosquito control agents pose a potential threat. A recent conservation agreement among the state of Utah and other agencies has significantly reduced the level of threat to the West Desert population (Federal Register, 2 April 1998).

Wasatch Front population is facing serious threats from habitat loss and modification, especially water development associated with the Central Utah Project; current and imminent threats include the Provo River Restoration Project and Wasatch County Efficiency Project; wetlands created as mitigation for the Central Utah Project have contributed only minimally to spotted frog

reproduction. Additional threats include continued development along the Wasatch Front, water diversions for irrigation, cattle grazing, timber harvesting, and construction of roads and trails. Introduced bullfrogs and fishes may have an adverse impact on this population, but the current degree of threat is unknown. Mosquito control agents also pose a potential threat. However, USFWS (2002) concluded the following: The overall level of threats to the long-term persistence of the Wasatch Front population has decreased in recent years, particularly since 1998. Although most of the human activities that contributed to these threats still occur to some extent throughout the Wasatch Front, there is no longer the same level of impacts on the frog that resulted from past wide-spread habitat destruction and loss of populations. Much of the occupied habitat is under state or federal ownership, and ongoing management of these lands emphasizes the long-term persistence of *R. luteiventris*. Threats still exist in localized areas, but mechanisms are in place through federal, state, and local conservation and land-use plans to identify and correct the problems, and protect spotted frog populations. To date, these actions have been successful at reducing threats to extant populations, largely by acquiring important habitats and implementing management actions that improve habitat conditions. Success is evidenced by the stable to improving status of the spotted frog throughout the Wasatch Front in the most recent time period evaluated.

Great Basin population has been adversely affected by habitat degradation resulting from mining, livestock grazing, road construction, agriculture, and direct predation by bullfrogs and non-native fishes. In central Nevada, introduction of exotic trout and cattle are likely the most important anthropogenic factors limiting the distribution and persistence of *R. luteiventris* (Reaser 2000).

This species is not likely to be at risk from present acidification inputs in the Rocky Mountains (Corn and Vertucci 1992). Global climate changes are possibly a factor (Hayes and Jennings 1986). UV-B radiation to frog embryos does not currently seem to be contributing to population declines (Blaustein et al. 1999).

State threats

Human-caused direct impacts are low due to protection throughout a large part of its range in the Tongass National Forest and Misty Fiords

National Monument. Filling or draining of wetland habitat and alterations to ground or surface water flow from development are potential hazards. Chronic or acute water contamination from existing and proposed mining activities on the Canadian reaches of the Taku and Stikine Rivers may be of concern. Existing wetlands in the Taku and Stikine River corridors may be significantly reduced as postglacial rebound continues (Lindell and Grossman 1998).

State research needs

Identify threats or limiting factors. Establish monitoring programs to track population trends.

Global inventory needs

Range-wide population inventories are needed to determine abundance and distribution.

State inventory needs

Additional inventory to precisely determine the species' range is needed; possible locations of occurrence include the vicinity of Haines, Skagway, Whiting and Taiya Rivers. Population estimates for each area of occurrence are needed; establish programs to monitor population trends. Periodic population estimate surveys should continue where baseline estimates have been established (Lindell and Grossman 1998).

Global conservation and management needs

See Mullen (1999) for a brief description of a draft conservation strategy and agreement for spotted frogs in northeastern Nevada.

For the Wasatch Front population, USFWS (2002) concluded that the focus of conservation efforts can reasonably shift to acquisition of additional occupied and unoccupied suitable habitats and range expansion efforts, including: (1) Land protection mechanisms, such as conservation easements and fee-title acquisitions which generally provide the most long-term benefits for sensitive species. Voluntary conservation actions on parcels of private land may provide site-specific benefits to the frog. Future conservation should continue to focus on land acquisition and easements that include buffer zones sufficient to minimize direct and indirect impacts from land use as well as protection and maintenance of dispersal or migration corridors. Furthermore, steps should be taken to protect water sources (i.e. Juab Valley) where potential threats are identified. (2) Although there is no specific number of populations necessary to prevent extinction, reintroduced populations provide

ecological redundancy in ecological function and genetic and demographic stochasticity. There are several habitats already identified which may provide suitable reintroduction sites. Future conservation should include reestablishment of Columbia spotted frog populations, and associated research and land management necessary to maintain new populations in: (a) Areas where populations previously occurred if suitable habitat remains and (b) other suitable habitat within the natural range of the species. (3) Some Wasatch Front spotted frog populations are notably small in size and vulnerable to risks of detrimental genetic processes (inbreeding, loss of genetic diversity) and demographic uncertainty. Springville Hatchery/T-Bone Bottom population is particularly vulnerable based on its current size and decreasing trend. Actions should be taken to augment or, through some other process, increase the size of this population. Furthermore, the current trend should be evaluated to determine if specific land or water use activities are exacerbating the decrease. If specific threats are identified, priority should be placed on reducing these threats such that the population would remain secure into the future.

State conservation and management needs

Prevent habitat loss in known breeding areas. This species is disappearing from many areas of its range, but still considered common in British Columbia. The current population trend should be evaluated, and threats to populations identified. If specific threats are identified, priority should be placed on reducing these threats such that the population will remain secure into the future.

LITERATURE CITED

- Blaustein, Andrew R.; Hays, John B.; Hoffman, Peter D.; Chivers, Douglas P.; Kiesecker, Joseph M.; Leonard, William P.; Marco, Adolfo; Olson, Deanna H.; Reaser, Jamie K.; Anthony, Robert G. DNA repair and resistance to UV-B radiation in western spotted frogs. *Ecological Applications*, 9(3): 1100-1105.
- Blomquist, S.M., and J.C. Tull. 2002. *Rana luteiventris*: burrow use. *Herpetological Review* 33:131.
- Bos, D.H. and J.W. Sites. 2001. Phylogeography and conservation genetics of the Columbia spotted frog (*Rana luteiventris*; Amphibia, Ranidae). *Molecular Ecol* 10: 1499-1513.

- Bull, E.L., and M.P. Hayes. 2001. Post-breeding season movements of Columbia spotted frogs (*Rana luteiventris*) in northeastern Oregon. *Western North American Naturalist* 61:119-123.
- Bull, E.L., and J.F. Shepherd. 2003. Water temperature at oviposition sites of *Rana luteiventris* in northeastern Oregon. *Western North American Naturalist* 63:108-113.
- Carstensen, R., M. Willson and R. Armstrong. 2003. Habitat use of amphibians in northern southeast Alaska. Unpublished report to Alaska Department of Fish and Game. Juneau, AK: Discovery Southeast.
- Corn, P. S., and F. A. Vertucci. 1992. Descriptive risk assessment of the effects of acidic deposition on Rocky Mountain amphibians. *J. Herpetol.* 26:361-369.
- Engle, J.C. 2000. Columbia spotted frog Great Basin population (Owyhee Mountains subpopulation) long-term monitoring plan. Year 200 Results. (draft). Boise, ID.
- Engle, J.C. 2001. Population biology and natural history of Columbia spotted frogs (*Rana luteiventris*) in the Owyhee Uplands of southwest Idaho: implications for monitoring and management. M.Sc. Boise State University, Boise, ID.
- Green, D.M., T.F. Sharbel, J. Kearsley, and H. Kaiser. 1996. Postglacial range fluctuation, genetic subdivision and speciation in the western North American spotted frog complex, *Rana pretiosa*. *Evolution* 50:374-390.
- Green, D.M., H. Kaiser, T.F. Sharbel, J. Kearsley, and K.R. McAllister. 1997. Cryptic species of spotted frogs, *Rana pretiosa* complex, in western North America. *Copeia* 1997:1-8.
- Groves, Craig. 1992. Phone call regarding the status of the spotted frog. Idaho Natural Heritage Program, Dept. of Fish and Game, 600 S. Walnut St., Box 25, Boise, ID 83707. (208) 334-3402.
- Hayes, M.P. and M.R. Jennings. 1986. Decline of Ranid frog species in western North America: are bullfrogs (*Rana catesbeiana*) responsible? *J. Herpetol.* 20(4):490-509.
- Hodge, R.P. 1976. Amphibians & reptiles in Alaska, the Yukon, & Northwest Territories. Alaska Northwest Publishing Company, Anchorage, AK. 89 pp.
- Hollenbeck, R.R. 1974. Growth rates and movements within a population of *Rana pretiosa pretiosa* Baird and Girard in south central Montana. M.A. thesis, Montana State University, Bozeman.
- Hovingh, P. 1993. Aquatic habitats, life history observations and zoogeographic considerations of the spotted frog (*Rana pretiosa*) in Tule Valley, Utah. *Great Basin Naturalist.* 53:168-179.
- James, J.D. 1998. Status of the Columbia spotted frog (*Rana luteiventris*) in Alberta. Wildlife Status Report No. 17. Edmonton, AB: Alberta Environmental Protection, Fisheries & Wildlife Management Division, and Alberta Conservation Association.
- Koch, E.D., G. Williams, C.R. Peterson, and P.S. Corn. 1997. A summary of the conference on declining and sensitive amphibians in the Rocky Mountains and Pacific Northwest. November 7-8, 1996, Boise Idaho. Meeting sponsored by U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Bureau of Land Management, Idaho Herpetological Society, Declining Amphibian Population Task Force Rocky Mountain Working Group, U.S. Geological Survey - Biological Resources Division, Idaho Museum of Natural History, Idaho State University.
- Licht, L.E. 1986. Food and feeding behavior of sympatric red-legged frogs, *Rana aurora*, and spotted frogs, *Rana pretiosa*, in southwestern British Columbia. *Canad. Field-Naturalist* 100:22-31.
- Lindell, J.R. and E.M. Grossman. 1998. Columbia spotted frog (*Rana luteiventris*) distribution and local abundance in southeast Alaska: Juneau, Alaska: U.S. Fish and Wildlife Service, Southeast Alaska Ecological Services.
- MacDonald, S.O. 2003. The amphibians and reptiles of Alaska. A Field Handbook.

- Unpublished report to U.S. Fish and Wildlife Service, Juneau, AK.
- Mullen, C. 1999. Community-based stewardship in Nevada. *Endangered Species Bulletin* 24:9.
- Munger, J.C., M. Gerber, K. Madrid, M.-A. Carroll, W. Petersen, and L. Heberger. 1998. U.S. National Wetland Inventory classifications as predictors of the occurrence of Columbia spotted frogs (*Rana luteiventris*) and Pacific tree frogs (*Hyla regilla*). *Conservation Biology* 12:320-330.
- Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. *Amphibians and reptiles of the Pacific Northwest*. Univ. Press of Idaho. 332 pp.
- Phillips, K. 1990. Where have all the frogs and toads gone? *BioScience* 40:422-424.
- Pilliod, D.S., C.R. Peterson, and P.I. Ritson. 2002. Seasonal migration of Columbia spotted frogs (*Rana luteiventris*) among complementary resources in a high mountain basin. *Canadian Journal of Zoology* 80:1849-1862.
- Reaser, J.K. 2000. Demographic analysis of the Columbia spotted frog (*Rana luteiventris*): case study in spatiotemporal variation. *Canadian Journal of Zoology* 78:1158-1167.
- Slough, B.G. 2002. Geographic distribution: *Rana luteiventris*. *Herpetological Review* 33:146.
- Stebbins, R.C. 1985. *A Field Guide to Western Reptiles and Amphibians*. Second Edition. Houghton Mifflin Company, Boston, Massachusetts. xiv + 336 pp.
- Toline, C.A. and A.M. Seitz. 1999. Mitochondrial and nuclear DNA variation within and among populations of Columbia spotted frog (*Rana luteiventris*) in Utah. Unpublished report prepared for the Utah Division of Wildlife Resources. Salt Lake City, UT.
- Turner, F.B. 1960. Population structure and dynamics of the western spotted frog, *Rana p. pretiosa* Aaird and Girard, in Yellowstone Park, Wyoming. *Ecol. Monogr.* 30:251-178.
- U.S. Fish and Wildlife Service. 1993. *Endangered and threatened wildlife and plants: finding on petition to list the spotted frog*. Fed. Register 58:27260-27263.
- U.S. Fish and Wildlife Service. 1998. *Endangered and threatened wildlife and plants: new 12-month finding for a petition to list the Utah Wasatch Front and west desert populations of spotted frog*. 30 April 2, 1998. Federal Register 63:16218-16220.
- U.S. Fish and Wildlife Service. 2002. *12-month finding for a petition To list the Wasatch Front Columbia spotted frog as threatened throughout its range*. 30 August 2002 Federal Register 67(169):55758-55767.
- Waters, D.L. 1992. *Habitat associations, phenology, and biogeography of amphibians in the Stikine River basin and southeast Alaska*. Unpubl. rep. of the 1991 pilot project. U.S. Dept. Interior, Fish and Wildlife Service, California Cooperative Fishery Research Unit, Humboldt State University, Arcata, CA. 61 pp.

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Reviewer(s): Stephen MacDonald, University of New Mexico; Blain Anderson, National Park Service.

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Author(s): Hammerson, G.
