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OCCURRENCE OF THE WHALE SHARK, *RHINCODON TYPUS* SMITH 1828, IN CALIFORNIA WATERS

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Key words: occurrence, whale sharks, *Rhincodon typus,* California

The whale shark, *Rhincodon typus* Smith 1828, is the world's largest living fish, reportedly growing to a total length (TL) of about 17 or 18 m (Compagno 2001). It can be distinguished from other large shark species by its slightly flattened head, terminal mouth, long straight gill openings, prominent lateral ridges on its flanks, and a prominent pattern of white spots between vertical and horizontal stripes, reminiscent of a checkerboard pattern. This unique color pattern is offset by a dorsal background color ranging from dark gray to bluish or brown (Compagno 2001).

Whale sharks have a global distribution, occurring in most tropical to warm temperate waters (Compagno 2001). They are common in the eastern Pacific from southern Baja California to northern Chile and the Galapagos Islands, with a few scattered reports extending their range into southern California (Miller and Lea 1972). Although they are abundant seasonally in the Gulf of California (Clark and Nelson 1997; Eckert and Stewart 2001), whale sharks are considered rare along the northern Baja and California coast. Fitch (1951) reported a whale shark 30 mi south of the United States–Mexico border near the South Island of Los Coronados in January 1951. It was estimated to be about 6.1 m TL and appeared to be feeding on sardines. The only reported California record is of a single individual sighted several times between San Diego and Torrey Pines near La Jolla, San Diego County (Miller and Lea 1972).

Increased knowledge on whale shark population structure can be gained from tracking studies and from observations on their occurrence. Tracking studies conducted off of southern Baja have revealed adult whale sharks to be wide ranging in the North Pacific (Eckert and Stewart 2001). However, despite the high profile of the whale shark as the largest living fish and increasing concern over its conservation status, virtually nothing is known about its distribution in the eastern North Pacific. Here we report on at least 10 previously unpublished records of the whale shark occurring along the California coast (Fig. 1). These records, which span a time period of over 70 y, were compiled from personal observations, recorded notes by observant biologists, and from records kept during marine mammal surveys.

While reviewing notes written by the late JB Phillips, a biologist with the California Department of Fish and Game (CDFG), on the basking shark (*Cetorhinus maximus*) fishery in Monterey Bay, we came across several entries that document the occurrence of whale sharks in Monterey Bay (36°45′N, 121°58′W). These handwritten notes that were used to prepare a publication on the basking shark fishery (Phillips 1948) mention that on ≥3 occasions between 1928 and 1944 whale sharks were sighted in Monterey Bay. Phillips' notes on whale sharks were never published and are now archived at the Monterey Maritime Museum. This prompted us to further investigate the Monterey Bay sightings and look for other unreported observations of whale sharks elsewhere in California waters.

The following 3 observations are taken from handwritten notes made by Phillips between 10 February and 6 May 1947. In August or September 1929, Herman Korf, local basking shark fisherman, observed at least 2 whale sharks mixing with a school of basking sharks. He distinguished the whale sharks by their larger size, distinct light-colored spots, and somewhat more rounded snout as compared with the basking sharks. Between 1828 and 1930, Henry J Leppert, a local basking shark fisherman and blacksmith, observed 3 whale sharks that he identified by their light colored spots and extremely large size. Phil-

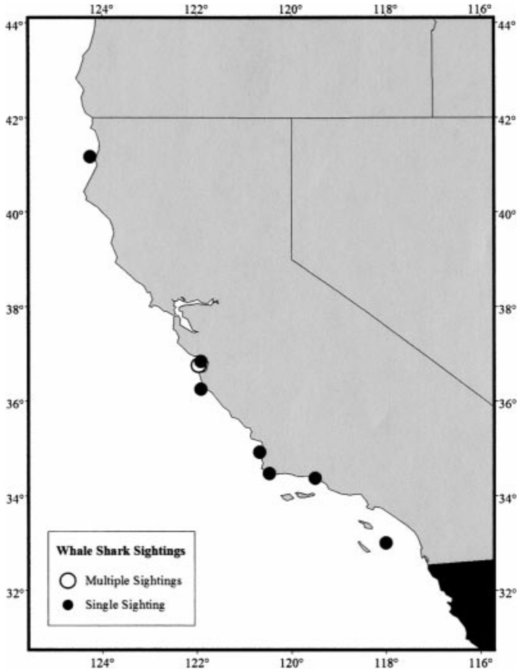

FIGURE 1. Location of whale shark (*Rhincodon typus*) sightings along the California coast.

lips wrote that Leppert was with an experienced former Navy seaman (anonymous) who had seen them before while conducting seal and basking shark surveys up and down the California coast. In the fall of 1944, Korf once again observed several whale sharks mixing together with basking sharks in Monterey Bay. To our knowledge these are the 1st observations of whale and basking sharks co-mingling. Known faunal associates of whale sharks include anchovies (Engraulidae), sardines (Clupeidae), scombrid fishes, manta rays (*Manta birostris*), tiger sharks (*Galeocerdo cuvier*), and hammerhead sharks (*Sphyrna lewini*) (Colman 1997).

Phillips wrote in his notes that Monterey Bay is several hundred miles north of the reported range of the whale shark. However, Phillips further commented that autumn is when the water is warmest in Monterey Bay and the warm Davidson Current is closest to shore. He wrote that other warm-water species such as albacore (*Thunnus alalunga*) were close to shore during this time of year. Phillips' notes commenting on the occurrence of albacore near the California coast are significant as Iwasaki (1970) found that whale sharks would gather with skipjack tuna (*Katsuwonus pelamis*) as they follow the warm Kuroshio Current as far north as the main Japanese island of Honshu (36°N, 141°W). Iwasaki (1970) observed a relationship between the abundance of skipjack tuna and whale sharks.

In 1943, during the height of the soupfin shark fishery, 1 of us (WER, retired CDFG biologist) observed a whale shark about 1 km off Carpinteria, Santa Barbara County (34°22′N, 119°30′W). WER recalled that he approached it close enough to touch, observed the large distinctive spots, and estimated the shark to be about 20 m TL.

Tom Dohl, former leader of the Mineral Management Service (MMS) flight surveys for marine mammals along the California coast between 1972 and 1984, observed whale sharks off the coast on ≥4 occasions. The 4 sightings, starting with the southernmost record, were from off San Clemente Island (33°00′N, 118°00′W), just south of Point Conception (34°28′N, 120°28′W), just north of Vandenberg Air Force Base off Santa Maria, Santa Barbara County (34°55′N, 120°40′W), and most surprisingly off Patrick's Point, Humboldt County, in northern California (41°10′N, 124°15′W). All 4 sightings by Dohl occurred on the continental shelf and not offshore in deepwater. These sharks are often seen in areas close to the continental shelf break where cool, nutrient-rich, upwelled waters mix with warmer surface waters (Iwasaki 1970; Beckley and others 1997). Cool subsurface waters do not appear to restrict their behavior or movements, as whale sharks in the Gulf of California will spend significant time at temperatures as low as 10°C (Eckert and Stewart 2001). These mixing areas of high biological productivity are optimal for nektonic organisms such as copepods that are a primary prey item for whale sharks in the Gulf of California (Clark and Nelson 1997). Large whale sharks, >6 m TL, often feed subsurface which may preclude their being observed more frequently (Compagno 2001).

The most recently reported sighting of whale sharks off California was made during marine mammal surveys conducted along the central California coast, Monterey County, in 1989. While flying in a fixed-wing aircraft at about 213 m altitude on 6 September 1989, 1 of us (KAF) observed a single whale shark off the Big Sur coast (36°15′N, 121°55′W). The shark was about 9 to 10 m TL with a broad, squared head, bluish-gray coloration, and many distinct light spots on the dorsal surface. This initial sighting was followed moments later by a 2nd whale shark, seen by biologist Doyle Hanan (CDFG). Two days later (8 September), during continued aerial surveys, 1 or 2 whale sharks were seen off Santa Cruz (36°50′N, 121°55′W). It is possible that the animals moved northward and these sightings represented the same individuals seen on 6 September.

Interestingly, all whale shark sightings reported here, where the season and year were recorded, were found to occur during the late summer or autumn, and during La Niña years. This finding is consistent with Wilson and others (2001), whose analysis of whale shark abundance in Western Australia found that their numbers increased during La Niña years.

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Literature Cited

BECKLEY LE, CLIFF G, SMALE MJ, COMPAGNO LJV. 1997. Recent strandings and sightings of whale sharks in South Africa. Environmental Biology of Fishes 50:343–348.

CLARK E, NELSON DR. 1997. Young whale sharks, *Rhincodon typus,* feeding on a copepod bloom near La Paz, Mexico. Environmental Biology of Fishes 50:63–73.

COLMAN JG. 1997. A review of the biology and ecology of the whale shark. Journal of Fish Biology 51: 1219–1234.

COMPAGNO LJV. 2001. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Vol 2. Bullhead, mackerel, and carpet sharks (Heterodontiformes, Lamniformes, and Orectolobiformes). Rome, Italy: FAO Species Catalogue for Fishery Purposes. No. 1, Vol 2. 2001. 269 p.

ECKERT SA, STEWART, BS. 2001. Telemetry and satellite tracking of whale sharks, *Rhincodon typus,* in the Sea of Cortez, Mexico. In: Tricas TC, Gruber SH, editors. The behavior and sensory biology of elasmobranch fishes: an anthology in memory of Donald Richard Nelson. Environmental Biology of Fishes, 60:299–308.

FITCH JE. 1951. The whale shark, *Rhineodon typus,* off northern Baja California. California Fish and Game 37:351.

IWASAKI Y. 1970. On the distribution and environment of the whale shark, *Rhincodon typus,* in skipjack fishing grounds in the western Pacific Ocean. Journal of the College of Marine Science and Technology, Tokai University, 4:37–51.

MILLER DJ, LEA RN. 1972. Guide to the coastal marine fishes of California. Sacramento, CA: California Department of Fish Game, Fish Bulletin 157. 235 p.

PHILLIPS JB. 1948. Basking shark fishery revived in California. California Fish and Game 34:11–23.

WILSON SG, TAYLOR JG, PEARCE AF. 2001. The seasonal aggregation of whale sharks at Ningaloo Reef, Western Australia: currents, migrations and the El Niño/southern oscillation. Environmental Biology of Fishes 61:1–11.

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RED BAT (*LASIURUS BOREALIS*) CAPTURED IN NORTHEASTERN ALBERTA

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Key words: red bat, *Lasiurus borealis,* capture, diet, Fort McMurray, Alberta

Within Canada, *Lasiurus borealis* (red bat) generally occupies forested regions throughout its summer range and migrates south in the fall to overwintering habitat (van Zyll de Jong 1985). However, when migrating, *L. borealis* may also be found in prairie regions in areas with trees (Shump and Shump 1982). In Alberta, *L. borealis* is considered an 'accidental' species due to its infrequent and unpredictable occurrence in the province (ASRD 2001).

On 11 August 2001, I captured and released a female red bat in boreal mixedwood forest during a bat survey conducted adjacent to the Athabasca River approximately 60 km N of Fort McMurray, Alberta. The bat was captured in a mist-net placed in a seismic cutline in the h1 ecosite phase (Beckingham and Archibald 1996), where the dominant herb layer was comprised of horsetails (*Equisetum arvense*), the dominant shrub was Labrador tea (*Ledum groenlandicum*), and the dominant tree species were white (*Picea glauca*) and black spruce (*P. mariana*).

I identified the bat as an adult based on the presence of a fully calcified epiphyseal plate in the fourth metacarpal (Anthony 1988). No milk could be expressed from the nipples and the fur around the nipples was not worn, suggesting that the bat was neither lactating nor postlactating (Racey 1988). The bat weighed 14.5 g and had a forearm length of 39.6 mm. These measurements are similar to the averages reported for mass (12.5 g, $s = 3.34$) and forearm length (39.7 mm, $s = 1.96$) of *L. borealis* in Canada (van Zyll de Jong 1985). There was no evidence of ectoparasites on the bat. Typical of larger, faster flying bat species like the red bat, which tend to fly high off the ground, this red bat was captured roughly 4.5 m high in the mist-net, which is similar to capture heights recorded elsewhere (Caire and others 1988).

In addition to typical morphological measurements, I collected and analyzed a 0.026 g fecal sample from the red bat to determine what it had consumed that evening. The bat was captured at 0100 and held for 17 h in a breathable cloth bag where it deposited its feces, which were then transferred to a plastic vial until analysed. I identified insect remains in the sample to order or family, where possible, by identifying known diagnostic features in the remains (Whitaker 1988). I then estimated the percent composition of the sample. The sample consisted primarily of caddisflies (Trichoptera; 48.1%) and moths (Lepidoptera; 39.3%). The red bat also consumed small quantities of Hymenoptera (6.7%), green lacewings (Chrysopidae; 2.0%) and beetles (Coleoptera; 2.0%). A small part (1.7%) of the sample contained remains that were unidentifiable. This variable diet is similar to that observed by others who have studied *L. borealis* (Whitaker 1972; Hickey and Fenton 1990; Whitaker and others 1997).

This capture near Fort McMurray represents the 1st record of *L. borealis* in northern Alberta and the 5th confirmed record in the entire province. The other 4 records occurred >600 km S of Fort McMurray in southern Alberta, including Calgary (1), Enchant (2), and Milk River (1) (Saunders 1990; Hill 1993). Times of year for these captures are not available (Hill 1993). However, it is likely they were captured during migration to their summer habitat, as observed at Delta Marsh, Manitoba (Barclay 1984), because habitat in southern Alberta is not consistent with the open forests preferred by red bats (Hill 1993).

Lasiurus borealis roosts in mixedwood and deciduous forests where it tends to select tall trees with dense overstory and an open understory (Menzel and others 1998; Hutchinson and Lacki 2000). Canopy height and cover at the capture site and in areas surrounding the site were consistent with known *L. borealis* roosting habitat, suggesting that suitable roosting habitat may be available in northern Alberta. Although many bat species are flexible in their use of foraging habitat (Furlonger and others 1987), larger bats, such as *L. borealis,* tend to forage in more open habitat such as canopy gaps, cutblocks, and wooded or open streams (Hart and others 1993; Hutchinson and Lacki 2000). Many bats use the edge of cutblocks for commuting and foraging (for example, Grindal and Brigham 1999; Verboom and Spoelstra 1999). The upland habitat in which the red bat was captured was surrounded by several cutblocks ranging from 25 to 75 ha. The Athabasca River, several small streams, and an abandoned beaver pond were located near the capture site. This suggests that suitable foraging habitat for *L. borealis* may also be available in the boreal forest of northern Alberta.

Until recently, few bat surveys have been conducted in Alberta's boreal forest located in the northern part of the province, an area in which *L. borealis* may occur based on its known habitat use within its range. Given the lack of surveys and difficulty in capturing red bats due to their high and fast flight (van Zyll de Jong 1985), it is perhaps not surprising that this species has not previously been recorded in northern Alberta.

The distribution of *L. borealis* within Canada extends west from New Brunswick to the Saskatchewan-Alberta border where it extends as far north as the Northwest Territories (Shump and Shump 1982). Records outside this range have been considered accidental. However, as discussed above, the capture reported here occurred in habitat consistent with that occupied by *L. borealis* across its current distribution, and the capture location was <175 km beyond the western edge of its distribution within Canada. The information presented here suggests that more extensive surveys with taller nets are needed in the boreal forest of Alberta to determine whether the range of *L. borealis* should be extended to include northeastern Alberta.

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LITERATURE CITED

[ASRD] ALBERTA SUSTAINABLE RESOURCE DEVELOPMENT. 2001. The general status of Alberta wild species 2000. Edmonton, AB: Alberta Sustainable Resource Development, Fish and Wildlife Service. 46p.

ANTHONY ELP. 1988. Age determination in bats. In: Kunz TH, editor. Ecological and behavioral methods for the study of bats. Washington, DC: Smithsonian Institution. p 47–58.

BARCLAY RMR. 1984. Observations on the migration, ecology and behaviour of bats at Delta Marsh, Manitoba. Canadian Field-Naturalist 98:331–336.

BECKINGHAM JD, ARCHIBALD JH. 1996. Field guide to ecosites of northern Alberta. Edmonton, AB: Northern Forestry Centre, Forestry Canada, Northwest Region. Variable pagination.

CAIRE W, HARDISTY RM, LACY KE. 1988. Capture heights and times of *Lasiurus borealis* (Chiroptera: Vespertilionidae) in southeastern Oklahoma USA. Proceedings of the Oklahoma Academy of Science 68:51–54.

FURLONGER CL, DEWAR HJ, FENTON MB. 1987. Habitat use by foraging insectivorous bats. Canadian Journal of Zoology 65:284–288.

GRINDAL SD, BRIGHAM MB. 1999. Impacts of forest harvesting on habitat use by foraging insectivorous bats at different spatial scales. Ecoscience 6: 25–34.

HART JA, KIRKLAND GL, GROSSMAN SC. 1993. Relative abundance and habitat use by tree bats, *Lasiurus* spp., in southcentral Pennsylvania. Canadian Field-Naturalist 107:208–212.

HICKEY MBC, FENTON MB. 1990. Foraging by red bats (*Lasiurus borealis*): do intraspecific chases mean territoriality? Canadian Journal of Zoology 68:2477–2482.

HILL HC. 1993. Alberta mammals: an atlas and guide. Edmonton, AB: Provincial Museum of Alberta. 238p.

HUTCHINSON JT, LACKI MJ. 2000. Selection of day roosts by red bats in mixed mesophytic forests. Journal of Wildlife Management 64:87–94.

MENZEL MA, CARTER TC, CHAPMAN BR, LAERM J. 1998. Quantitative comparison of tree roosts used by red bats (*Lasiurus borealis*) and Seminole bats (*L. seminolus*). Canadian Journal of Zoology 76: 630–634.

RACEY PA. 1988. Reproductive assessment in bats. In: Kunz TH, editor. Ecological and behavioral methods for the study of bats. Washington, DC: Smithsonian Institution. p 31–46.

SAUNDERS MB. 1990. Fourth red bat found in Alberta. Blue Jay 48:57–58.

SHUMP KA JR, SHUMP AU. 1982. Lasiurus borealis. Mammalian Species 183:1–6.

VAN ZYLL DE JONG CG. 1985. Handbook of Canadian mammals. Ottawa, ON: National Museum of Natural Science. 212p.

VERBOOM B, SPOELSTRA K. 1999. Effects of food abundance and wind on the occurrence of pipistrelle bats *Pipistrellus pipistrellus* and serotines *Eptesicus serotinus* near treelines. Canadian Journal of Zoology 77:1393–1401.

WHITAKER JO JR. 1972. Food habits of bats from Indiana. Canadian Journal of Zoology 50:877–883.

WHITAKER JO JR. 1988. Food habits analysis of insectivorous bats. In: Kunz TH, editor. Ecological and behavioral methods for the study of bats. Washington, DC: Smithsonian Institution. p 171–189.

WHITAKER JO JR, ROSE RK, PADGETT TM. 1997. Food of the red bat *Lasiurus borealis* in winter in the Great Dismal Swamp, North Carolina and Virginia. American Midland Naturalist 137:408–411.

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HARBOR SEAL (*PHOCA VITULINA*) PREDATION ON A MALE HARLEQUIN DUCK (*HISTRIONICUS HISTRIONICUS*)

JESSICA TALLMAN AND CONSTANCE SULLIVAN

On 23 November 2002, in the near-shore waters of San Juan Island, Washington, we watched a harbor seal (*Phoca vitulina*) capture and apparently eat a male harlequin duck (*Histrionicus histrionicus*). This sighting is the 1st record of harbor seal predation on a duck and 1 of the few records of harbor seals preying on seabirds of any kind (Riedman ML. 1990. The pinnipeds: seals, sea lions and walruses. Berkeley, CA: University of California Press. 439 pages).

On a calm, sunny afternoon, we were observing marine birds from Cattle Point Observation Station on San Juan Island. This site is on the east side of Cattle Pass where San Juan Channel meets George's Strait. Tidal flow through the narrow pass is quite strong and creates strong surface currents and eddies near islands and rocky points. Large numbers of seabirds and pinnipeds commonly forage in these tidal currents (Zamon JE. 2001. Seal predation on salmon and forage fish schools as a function of tidal currents in the San Juan Islands, Washington, USA. Fisheries Oceanography 10:353–366). At the time of this observation, however, the tide was high and currents were relatively weak. This is the ideal situation in which to observe *H. histrionicus* feeding (Fischer JB, Griffin C. 2000. Feeding behavior and food habits of wintering harlequin ducks at Shemya Island, Alaska. The Wilson Bulletin. 112:318–325). Our attention was focused on a small (approximately 300 m × 200 m), protected cove on the west side of Cattle Point.

Using 10 × 25 binoculars, we watched 4 *H. histrionicus* diving near the rocky point at the south end of the cove where a small surface eddy was visible. This was a typical feeding aggregation size for *H. histrionicus* (Fischer and Griffin 2000). The ducks dove and rested in male-female pairs throughout much of our hour-long observation period. At 15:30 all 4 of the ducks were resting; a moment later, we noticed 1 of the males was absent. His female companion hurriedly scuttled 15 m away and repeatedly dipped her head below the surface. The other pair of ducks continued to rest quietly about 15 m away. Moments later a solitary *P. vitulina* surfaced about 20 m away, farther off shore, with the male *H. histrionicus* in its mouth. We could clearly make out the male duck's distinct plumage. After almost a minute of holding the bird at the surface, the seal dove and emerged from the water 10 m from its original surface point, wrestling with another individual *P. vitulina* over the duck. They tussled with the catch for a couple minutes and then both disappeared. We did not see them again. Meanwhile, the female *H. histrionicus* continued to duck her head under the surface of the water every few seconds. The other pair of ducks moved at a normal pace to perch themselves on nearby rocks.

The seal's behavior struck us as unusual, as we had never known *P. vitulina* to capture birds, but a review of the literature demonstrated just how remarkable this event was. There is only 1 record of a *P. vitulina* preying on a bird in the wild. Riedman (1990) includes a 2nd-hand report of an individual *P. vitulina* attacking but not catching a brown pelican (*Pelecanus occidentalis*) in Monterey Bay, California.

There are a number of records of other pinniped species catching seabirds. In the Southern Hemisphere, leopard seals (*Hydrurga leptonyx*) and 6 species of eared seals are known to prey on penguins (Riedman 1990). Northern fur seals (*Callorhinus ursinus*) occasionally prey on seabirds (Niggol K and others. 1959. Pelagic fur seal investigations: California Oregon and Washington. Seattle, WA. US Fish and Wildlife Service. 92 pages).

This predation event is difficult to interpret as *P. vitulina* are known only to eat fish, cephalopods, krill, and other invertebrates (Riedman 1990). It may well have been an opportunistic act of predation by a generalist predator. Another possible explanation is that the seals were juveniles and were merely experimenting with their capturing abilities.

In San Juan Island waters, we have often made personal observations of *H. histrionicus* looking below the water's surface even when resting from diving. We assumed this was search for prey but it may be vigilance for predators, suggesting that perhaps *P. vitulina* predation of birds is not so rare.

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SMALL BOATS DISTURB FISH-HOLDING MARBLED MURRELETS

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Key words: marbled murrelet, *Brachyramphus marmoratus,* at-sea behavior, chick feeding, boat disturbance, southeast Alaska

Disturbance of seabirds by people at nesting colonies can reduce reproductive success and alter population demographics (Vermeer and Rankin 1984). In response to disturbance, adult seabirds may increase the incidence of alarm postures and alarm calling (Burger and Gochfeld 1993), increase heart and breathing rates (Culik and others 1990; Wilson and others 1991), reduce attendance of nest sites (Olsson and Gabrielsen 1990; Wilson and others 1991), and completely abandon nests and chicks (Boellstorff and others 1988; Evans and Kampp 1991). Daily or frequent handling of chicks can reduce their growth rates and survival (Harris and Wanless 1984; Pierce and Simons 1986; Piatt and others 1990).

While effects of human disturbance on nesting colonial waterbirds are fairly well described (Carney and Sydeman 1999), we are aware of only 1 study that measured effects of human disturbance of seabirds on the water, such as that caused by vessel traffic. Kuletz (1996) found that the number of marbled murrelets (*Brachyramphus marmoratus*) at sea was negatively correlated with the number of boats in Kachemak Bay, Alaska, and with both boats and low-flying aircraft in Prince William Sound, Alaska. Presumably, murrelets were moving away from areas with human disturbance. Ecotourism is a rapidly growing industry all over the world, and many seabird colonies are visited regularly by cruise ships, tour boats, and pleasure craft (Chardine and Mendenhall 1998). Therefore, it is worth considering further the possible impacts of vessel disturbance on seabirds as they occupy marine waters in the vicinity of their breeding grounds.

In 1992 and 1993, we studied marbled murrelets in Auke Bay and Fritz Cove, located 20 km NW of Juneau, Alaska (Speckman 1996; Speckman and others 2000; Speckman and others 2003). We counted murrelets daily from early May through mid-August in both years, spanning the period of courtship to chick fledging. Boat surveys were conducted from open skiffs with outboard motors. All skiffs were between 4 and 5 m in length.

In general, marbled murrelets in Auke Bay and Fritz Cove appeared to be habituated to boat traffic, perhaps more so than murrelets in other parts of Alaska (Kuletz 1996; SGS, pers. obs.). Both motor and sailing vessels comprising a wide range of sizes frequently pass through Auke Bay and Fritz Cove, including 130-m ferries of the Alaska Marine Highway system, commercial fishing vessels, numerous sport fishing charter boats, transient pleasure boats, and hundreds of resident vessels. Of the hundreds of murrelets we encountered with the skiff each day, only a few birds reacted to the moving skiff by flying away; the vast majority merely paddled away, and a few dove briefly before surfacing to paddle away.

However, like a few other alcids (Gaston and Jones 1998), adult murrelets may often be observed on the water with fish in their bills that are being held for later delivery to chicks (Carter and Sealy 1987; Strachan and others 1995). Murrelets that were holding fish for chicks appeared threatened by our skiff when we approached them during surveys. On 8 separate occasions in 1993, murrelets that were holding fish crosswise in their bills, presumably for chicks, swallowed those fish when approached closely by the skiff. Judging from their behavior, birds that swallowed fish did so because of the approaching skiff.

On 1 occasion on 7 June 1993, we slowly approached within 10 m of an adult murrelet holding a fish, in order to identify the fish to species. The murrelet dove twice to evade the boat, and after surfacing for the 3rd time at a distance of 15 to 20 m, it swallowed the fish, a Pacific sand lance (*Ammodytes hexapterus*), head-first. On 28 June 1993, we were surveying murrelets along a transect line and happened to head straight for a murrelet that was holding another Pacific sand lance. We moved forward at a slow, constant speed of <8 km/hr, and when we approached within about 15 m of the murrelet, it promptly swallowed the fish. On the other 6 occasions, fish-holding murrelets swallowed their fish as the skiff approached within 5 to 40 m.

Such disturbance could be detrimental to murrelets in areas where prey are relatively scarce, where birds must fly great distances inland to nesting sites, or where boat traffic is concentrated in waters immediately adjacent to nesting areas.

Marbled murrelets, like other alcids, are not known to hold fish that they themselves intend to consume at a later time. Birds on the water holding fish are presumed to be parents about to make food deliveries to their chicks (Carter and Sealy 1987; Strachan and others 1995). Indeed, fish-holding behavior is used by biologists to demarcate the timing of the chick-rearing period (Kuletz and Kendall 1998; Speckman and others 2003).

Adult murrelets usually deliver prey to chicks before dawn or after dusk (Naslund and O'Donnell 1995), and adults sitting on the water with prey in their bills are typically waiting for sunset to carry those prey to chicks at nearby inland nest sites. The majority of fish-holding murrelets in Auke Bay were observed during evening hours (Speckman and others 2003). Furthermore, the source of those fish may be quite distant. For example, marbled murrelets that breed in forests adjacent to Auke Bay, and that may stage on waters there in the evening, may travel up to 250 km round trip to get food for chicks (Whitworth and others 2000). Therefore, the loss of prey from boat disturbance can represent a substantial energetic cost to adults if they have to repeat this foraging trip in order to capture another fish for a chick. If it is too late in the evening, then it may be too late to get another prey item for delivery to the chick, and presumably the cost to chicks is even greater than for adults. It is not known whether adult murrelets can make up for these losses. If not, boat disturbance could result in a decrease in food delivery to chicks by adults that forage or nest near busy boating areas.

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LITERATURE CITED

BOELLSTORFF DE, ANDERSON DW, OHLENDORF HM, O'NEILL EJ. 1988. Reproductive effects of nest-marking studies in an American White Pelican colony. Colonial Waterbirds 11:215–219.

BURGER J, GOCHFELD M. 1993. Tourism and short-term behavioural responses of nesting masked, red-footed, and blue-footed boobies in the Galapagos. Environmental Conservation 20:255–259.

CARNEY KM, SYDEMAN WJ. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68–79.

CARTER, HR, SEALY, SG. 1987. Fish-holding behavior of marbled murrelets. Wilson Bulletin 99:289–291.

CHARDINE J, MENDENHALL V. 1998. Human disturbance at Arctic seabird colonies. Akureyri, Iceland: Conservation of Arctic Flora and Fauna International Secretariat. Circumpolar Seabird Working Group Technical Report No. 2. 27 p.

CULIK B, ADELUNG D, WOAKES AJ. 1990. The effect of disturbance on the heart rate and behavior of Adélie penguins (*Pygoscelis adeliae*) during the breeding season. In: Kerry KR, Hempel G, editors. Antarctic ecosystems: ecological change and conservation. Berlin, Germany: Springer-Verlag. p 177–182.

EVANS, PGH, KAMPP K. 1991. Recent changes in thick-billed murre populations in West Greenland. In: Gaston AJ, Elliot RD, editors. Studies of high latitude seabirds. 2. Conservation biology of thick-billed murres in the northwest Atlantic. Canadian Wildlife Service Occasional Paper no. 69: 7–14.

GASTON AJ, JONES IL. 1998. The Auks: Alcidae. Oxford University Press, Oxford, England. 349 p.

HARRIS MP, WANLESS S. 1984. The effects of disturbance on survival, age, and weight of young guillemots *Uria aalge.* Seabird 7:42–46.

KULETZ KJ. 1996. Marbled murrelet abundance and breeding activity at Naked Island, Prince William Sound, and Kachemak Bay, Alaska, before and after the *Exxon Valdez* Oil Spill. American Fisheries Society Symposium 18:770–784.

KULETZ KJ, KENDALL SJ. 1998. A productivity index for marbled murrelets in Alaska based on surveys at sea. Journal of Wildlife Management 62:446–460.

NASLUND NL, O'DONNELL BP. 1995. Daily patterns of marbled murrelet activity at inland sites. In: Ralph CJ, Hunt GL Jr, Raphael MG, Piatt JF, editors. Ecology and conservation of the marbled murrelet. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. General Technical Report PSW-152. p 129–134.

OLSSON O, GABRIELSEN GW. 1990. Effects of helicopters on a large and remote colony of Brünnich's guillemots (*Uria lomvia*) in Svalbard. Norsk Polar Institute Report Series no. 64. 36 p.

PIATT JF, ROBERTS BD, LIDSTER WW, WELLS JL, HATCH SA. 1990. Effects of human disturbance on breeding success of least and crested auklets at St. Lawrence Island, Alaska. Auk 107:342–350.

PIERCE DJ, SIMONS TR. 1986. The influence of human disturbance on Tufted Puffin breeding success. Auk 103:214–216.

SPECKMAN, SG. 1996. Marbled murrelet distribution and abundance in relation to the marine environment [thesis]. Fairbanks, AK: University of Alaska Fairbanks. 89 p.

SPECKMAN SG, PIATT JF, SPRINGER AM. 2003. Deciphering the social structure of marbled murrelets from behavioral observations at sea. Waterbirds 26:266–274.

SPECKMAN SG, SPRINGER AM, PIATT JF, THOMAS DL. 2000. Temporal variability in abundance of marbled murrelets at sea in southeast Alaska. Waterbirds 23:364–377.

STRACHAN G, MCALLISTER M, RALPH CJ. 1995. Marbled murrelet at-sea and foraging behavior. In: Ralph CJ, Hunt GL Jr, Raphael MG, Piatt JF, editors. Ecology and conservation of the marbled murrelet. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. General Technical Report PSW-152. p 247–253.

VERMEER K, RANKIN L. 1984. Influence of habitat destruction and disturbance on nesting seabirds. In: Croxall JP, Evans PGH, Schreiber RW, editors. Status and conservation of the world's seabirds. Cambridge, England: International Council for Bird Preservation. ICBP Technical Publication no. 2. p 723–736.

WHITWORTH DL, NELSON SK, NEWMAN SH, VAN VLIET GB, SMITH WP. 2000. Foraging distances of radio-marked marbled murrelets from inland areas in southeast Alaska. The Condor 102:452–456.

WILSON RP, CULIK P, DANFIELD R, ADELUNG D. 1991. People in Antarctica—how much do Adélie penguins *Pygoscelis adeliae* care? Polar Biology 11: 363–370.

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SURVEYS FOR TERRESTRIAL AMPHIBIANS IN SHASTA COUNTY, CALIFORNIA, WITH NOTES ON THE DISTRIBUTION OF SHASTA SALAMANDERS (*HYDROMANTES SHASTAE*)

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Key words: Shasta salamander, *Hydromantes shastae,* tailed frog, *Ascaphus truei,* Ensatina, *Ensatina eschscholtzii,* black salamander, *Aneides flavipunctatus,* plethodontidae, conservation, distribution, Shasta County, California

As part of a larger effort to manage rare, forest-associated species on United States Forest Service [USFS] lands, we conducted surveys to examine the terrestrial amphibian fauna in the region north of Shasta Lake in Shasta County, California. Our goal was to assess species diversity of terrestrial amphibians in this area and attempt to identify new localities of the Shasta salamander (*Hydromantes shastae*). We chose our survey area based on the distribution of USFS lands, the known range of *H. shastae,* and past survey efforts (Fig. 1). We selected 40 Public Land Survey Sections from USGS 7.5′ topographic maps for sampling. Sections within the study area were selected for survey based on the presence of a road or trail that allowed sufficient access for travel to and from the site and for sampling to occur in a single day. In each selected section, the largest stream crossing the primary access road or trail was chosen as the initiation point for surveys. Two surveyors searched 5-m wide meandering belts roughly parallel to the stream, 1 that began approximately 5 m and the other approximately 50 m from the stream edge. At the conclusion of 2 h search time or 0.8 km stream length the crew crossed the stream and repeated the procedure working in the opposite direction. An additional 1 person-hour opportunistic search (30 min/surveyor) was conducted in areas adjacent to the transects that the surveyors deemed most likely to harbor terrestrial salamanders. Searches were conducted by turning cover objects such as rocks and down wood. All surveyors had previous experience surveying for terrestrial amphibians.

Surveys were conducted from January to March 2002, when air temperatures were between 1 and 19°C and substrates beneath cover objects were moist. Because a main target of our surveys was *H. shastae,* a known population was visited weekly as a reference site. All *H. shastae* captured at newly discovered sites were deposited in the Museum of Vertebrate Zoology, University of California at Berkeley, for use in assays of genetic diversity. All *H. shastae* captured at the reference site were released at the point of capture. All other captured reptiles and amphibians were identified to species, measured, and released.

A map of historic *H. shastae* sites was compiled from museum collection records (American Museum of Natural History, California Academy of Sciences, Carnegie Museum of Natural History, Field Museum of Natural History, Humboldt State University, Los Angeles County Museum, Louisiana State University Museum of Natural Sciences, Milwaukee Public Museum, Texas Cooperative Wildlife Collection, University of California Berkeley Museum of Vertebrate Zoology, University of Texas Arlington, University of Michigan Museum of Zoology), observational reports from the Shasta-Trinity National Forest, and unpublished observations (P Lewendal, Environmental Planner, State of California, Eureka, CA; L Lindstrand III, Fisheries/Wildlife Biologist, North State Resources, Inc., Redding, CA). We combined records that appeared to be from the same locality. If the precision of the observation was not sufficient to differentiate the location of 2 sites, they were considered 1 site. The known site information contains localities ranging from the recent detection of a single individual

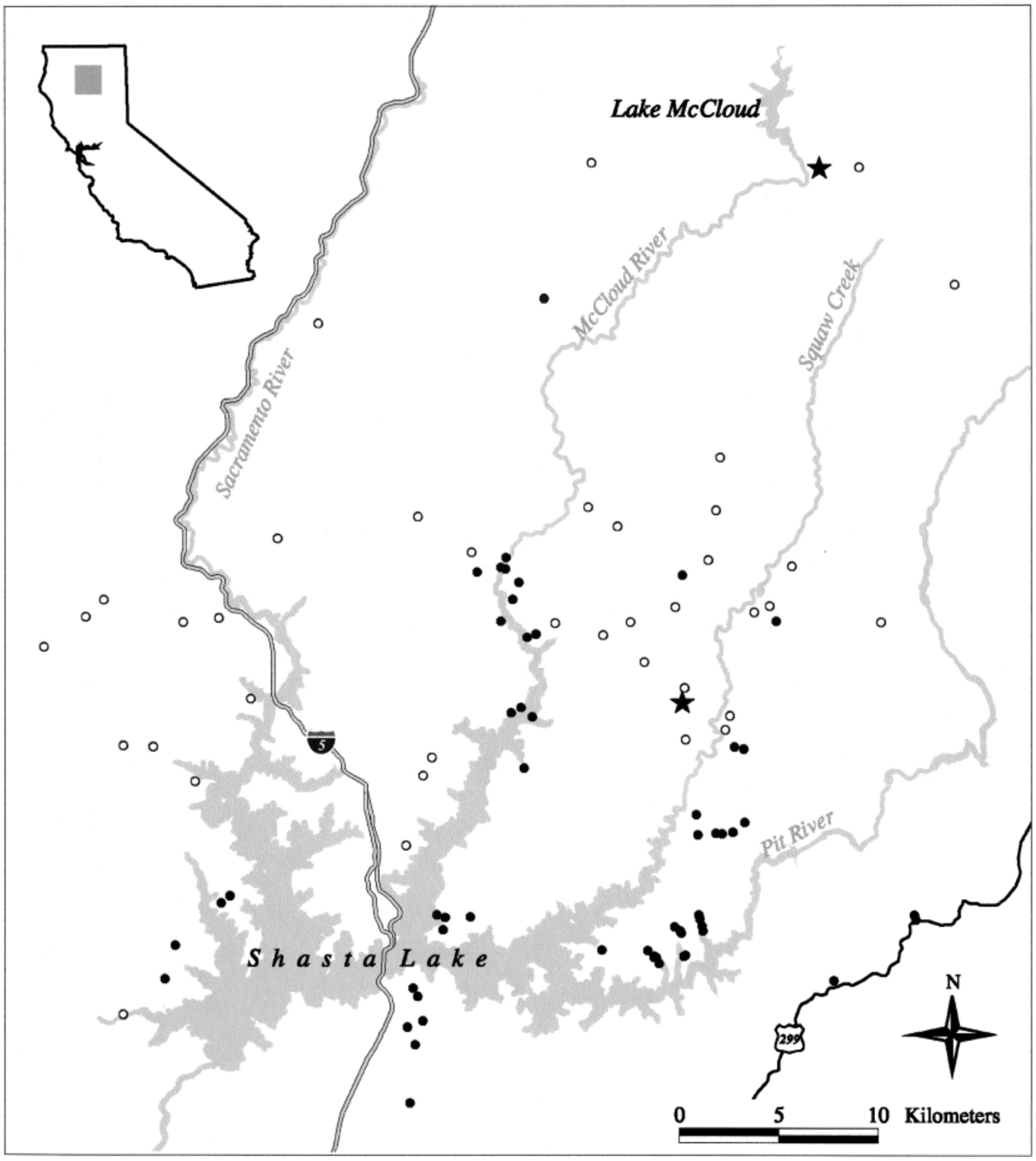

FIGURE 1. Locations surveyed in this project (open circles), with historical localities of *Hydromantes shastae* (solid circles), and 2 newly discovered sites from this study (stars).

to sites that extend over large areas and have had many observations and collections.

Three species of reptiles and 9 species of amphibians were found during 360 person-hours of survey in the 40 selected sections (Table 1). Few reptiles were detected, likely because of cool temperatures.

Ensatinas (*Ensatina eschscholtzii*; n = 348) were captured at 39 of 40 sites surveyed. *Ensatina eschscholtzii* was found in all habitats surveyed, including areas burned by wildfires, brush fields, and mature forests, and were most commonly found in upland transects (n = 189). At the 2 burned sites (burned during the summer of 1999), 5 and 13 *E. eschscholtzii* were captured.

Black salamanders (*Aneides flavipunctatus*; n = 352) were only slightly more abundant than

TABLE 1. Captures and capture rates of reptiles and amphibians by species at 40 sites in Shasta County, California.

Species	Total captures	Number of sites with species	Mean captures per person-hour	Maximum captures per person-hour
Aneides flavipunctatus	352	30	0.978	4.33
Ensatina eschscholtzii	348	39	0.967	2.89
Hydromantes shastae	2	2	0.006	0.11
Taricha granulosa	15	4	0.011	0.67
Dicamptodon tenebrosus	3	3	0.008	0.11
Ascaphus truei	2	1	0.006	0.22
Pseudacris regilla	3	2	0.008	0.22
Rana catesbeiana	3	1	0.008	0.33
Rana boylii	1	1	0.003	0.11
Sceloporus occidentalis	5	5	0.014	0.11
Eumeces skiltonianus	2	4	0.011	0.22
Contia tenuis	2	2	0.008	0.11

E. eschscholtzii, yet were captured at fewer sites (30 of 40 sites surveyed). *Aneides flavipunctatus* was detected in both sites burned in the 1999 fire season ($n = 12$ at each site). In our surveys *A. flavipunctatus* was consistently ($n = 313$) found along the edge of streams and seeps or in other moist areas. Lynch (1981) reported that most populations of *A. flavipunctatus* were found below 600 m. We surveyed 22 sites >600 m in elevation and captured 131 *A. flavipunctatus* at 14 of these sites, suggesting that in this area they are not constrained to elevations below 600 m.

Although our study did not target stream-dwelling amphibians, 2 sub-adult tailed frogs (*Ascaphus truei*) were found along Beartrap Creek, Shasta Co., CA (UTM Zone 10, 4552523N, 568045E). This site is approximately 23 km N of the Nosoni Creek site reported by Bury and others (1969) and extends the range of *A. truei* north and east in Shasta County. Vegetation at the survey area was dominated by old-growth Douglas-fir (*Pseudotsuga menziesii*) with Pacific yew (*Taxus brevifolia*) along the stream banks.

Hydromantes shastae was detected at only 2 survey sites (Fig. 1), but was detected at the reference site during all weeks that we conducted surveys. The northernmost site where *H. shastae* was detected was in the Centipede Creek drainage (UTM Zone 10, 4552300N, 579500E), 14.5 km SE of McCloud, California. This locality extends the known range approximately 16 km NE of the previous northernmost site at Dutch Creek. This site is also a new elevation record (975 m), exceeding the previous published maximum of 910 m (Petranka 1998). One individual was found on the side slope of a rocky, steep-sided, high-gradient-stream canyon with extensive areas of shale and gravel talus and bedrock cliffs composed of meta-sedimentary materials. Vegetation was dominated by an open overstory (canopy closure visual estimate = 40%) of large, old-growth Douglas-fir and canyon live oak (*Quercus chrysolepis*) with lesser amounts of white fir (*Abies concolor*) and big leaf maple (*Acer macrophyllum*). Understory vegetation consisted of dense stands of canyon live oak, California hazel (*Corylus cornuta*), Pacific yew, boxwood (*Pachistima myrsinites*), Douglas maple (*A. glabrum*), and *Alnus* spp. The *H. shastae* was captured approximately 75 m from the stream. An area 40 m in diameter surrounding the capture point was extensively searched with no additional captures of this species. Six *Aneides flavipunctatus* and 16 *E. eschscholtzii* were also captured at this site.

Two *H. shastae* were captured at a 2nd site in the Salt Creek drainage (UTM Zone 10, 4525500N, 572600E), 2 km NW of Chirpchatter Mountain at 500 m elevation in piles of meta-sedimentary rock along a road cut. The site had an open overstory (canopy closure visual estimate = 30%) dominated by canyon live oak with limited amounts of Douglas-fir, knobcone pine (*Pinus attenuatta*), and big leaf maple. A thick shrub layer including poison oak (*Toxicodendron diversilobum*), canyon live oak, Douglas maple, California hazel, and *Ceanothus* spp. dominated the understory. One *H. shastae* was approximately 20 m from a stream, while the other was approximately 70 m from a stream;

they were 95 m apart. We captured 2 *Pseudacris regilla,* 6 *A. flavipunctatus,* and 16 *E. eschscholtzii* at this site in addition to the 2 *H. shastae.*

Including the 2 sites discovered in this study, our compilation of *H. shastae* site records resulted in 61 known sites (29 from museum records and 30 from observational records; Fig. 1). We reviewed an additional 420 records but did not include them in this compilation because either the locality data were insufficient to map the record (n = 23), the locality information was insufficient to differentiate it from another record (n = 374), or the information was a secondary report of an observation that was already included (n = 23).

Historically *H. shastae* has been associated with limestone outcrops and forested areas adjacent to limestone outcrops (Gorman and Camp 1953; Bury and others 1969; Lewendal 1995), but it has been found in association with a volcanic rock outcrop (Papenfuss and Cross 1980) and in areas with scattered rocks and colluvium pockets but no extensive talus slopes or other rock outcrops (Lindstrand 2000). Our field crew did not observe limestone outcrops in the areas surveyed at either newly discovered *H. shastae* sites. Of 40 surveys conducted, only 2 had minor amounts of limestone visible at the surface. Mature forest conditions at both new sites are similar to non-limestone localities recently discovered on Green Mountain (Lindstrand 2000).

The observation of *H. shastae* at the northern Centipede Creek site indicates that the range of this species may be larger than currently recognized. However, future discoveries of range extensions likely will require significant effort given that our effort (360 person-hours of search time) yielded only 3 animals. Rugged landscapes, limited road access, and unpredictable weather conditions further constrain survey opportunities for *H. shastae.* Areas to consider for additional distributional surveys include the Sacramento River canyon and Upper Squaw Creek, where our surveys were limited due to access issues. Searches in the McCloud River drainage may yield more occupied *H. shastae* sites.

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LITERATURE CITED

BURY RB, FELLERS GM, RUTH SB. 1969. First records of *Plethodon dunni* in California, and new distributional data on *Ascaphus truei, Rhyacotriton olympicus,* and *Hydromantes shastae.* Journal of Herpetology 3:157–161.

GORMAN J, CAMP CL. 1953. A new cave species of salamander of the genus *Hydromantes* from California, with notes on habits and habitat. Copeia 1953:39–43.

*LEWENDAL P. 1995. Habitat-use by the Shasta salamander *Hydromantes shastae.* Unpublished report prepared for the California Department of Fish and Game. 32 p. Available from: California Department of Fish and Game, 601 Locust Street, Redding, CA, 96001.

LINDSTRAND L III. 2000. Discovery of Shasta salamanders in atypical habitat. California Fish and Game 86:259–261.

LYNCH JF. 1981. Patterns of ontogenetic and geographic variation in the black salamander, *Aneides flavipunctatus* (Caudata: Plethodontidae). Smithsonian Contributions to Zoology 324:1–53.

*PAPENFUSS T, CROSS D. 1980. The status of the Shasta salamander *Hydromantes shastae* in the Mountain Gate and Cedar Creek areas of Shasta County. Unpublished report to the USDA Forest Service. 9 p. Available from: US Forest Service, Shasta-Trinity National Forest, 2400 Washington Avenue, Redding, CA 96001.

PETRANKA JW. 1998. Salamanders of the United States and Canada. Washington, DC: Smithsonian Institution Press. 587 p.

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