

Absence of leopard sharks in catch surveys in Puget Sound, Washington

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The leopard shark (*Triakis semifasciata*) is an inshore species that is a prominent member of the elasmobranch fauna along the Pacific coast from Mazatlan, Mexico including the Gulf of California, to Oregon, USA (Ebert 2003). Within its historic range, this species is particularly common in California bays and estuaries including Elkhorn Slough, San Francisco Bay, Tomales Bay, and Humboldt Bay. Until 2009, this shark had not been officially known to occur north of Oregon. However, Farrer (2009) reported the capture of a single male specimen (133.4 cm TL) in Samish Bay in northeastern Puget Sound, Washington on 6 September 2007 by a commercial fisherman as a range extension. The range extension reported by Farrer (2009), while not confirmed through subsequent captures, has been cited in Nosal et al. (2014) and Barker et al. (2015).

As of 1 January 1994, the California Fish and Game Commission imposed a minimum size limit of 91.4 cm TL on commercial sale of leopard sharks (California Fish and Game Code, 1993, Ch. 2, Article 9, section 8388.5a,b). However, in 2006 and 2013, several individuals were charged with violating the federal Lacey Act (16 U.S.C. 3372a), which incorporates California law, for attempting to sell thousands of undersized leopard sharks (TL range: 21.6–44.4 cm), in some cases for hundreds of dollars each, from San Francisco Bay, California (Flaherty 2007, Haag 2013). Leopard shark pups were quite popular among aquarists as I witnessed throughout from the 1970s to the 1990s in several aquarium shops in the San Francisco Bay Area with prices ranging from \$35 to \$80 per pup. Given the historic popularity and availability of this species, at least up to 2013, it is possible that some leopard sharks remain in private aquariums (Smith and Horeczko 2008).

Since 2008, the Washington Department of Fish and Wildlife has conducted annual April to June bottom trawl surveys using a 400-mesh eastern bottom trawl net with a 3.2 cm cod-end liner, 10 cm cookie gear on the footrope and a mouth that opens 9.1 m to 13.7 m, depending on depth, in 51 locations spread throughout state waters of Puget Sound. Altogether from 2008 to 2016, 731 tows have been made at depths ranging from 5 to 125 fa. Based on 2014 data, tows averaged about 11.0 minutes per trawl at a depth range from 6 to 115 fa with an average of 49.0 fa per trawl, and representing hundreds of hours of field time and analysis. More recently, elasmobranchs appeared in 40 (70.2%) out of 57 tows

made in 2014, 42 (76.4%) of the 55 tows made in 2015, and 46 (83.6%) of the 55 tows made in 2016 (J. Blaine, Washington Department Fish and Wildlife, unpublished data). The elasmobranchs captured during these three trawl seasons ($n=958$) included: 295 (30.8%) big skate (*Raja binoculata*), 303 (31.6%) longnose skate (*R. rhina*), 14 (1.5%) sandpaper skate (*Bathyraja kincaidii*), 345 (36.0%) spiny dogfish (*Squalus suckleyi*) (Ebert et al. 2010), and 1 (0.1%) brown catshark (*Apristurus brunneus*). The three species of skates and spiny dogfish have appeared regularly each trawl season. Sixgill sharks (*Hexanchus griseus*) have been caught prior to 2014, but not during this three-year period. During the nine-year period these data represent, no leopard sharks have been caught in Puget Sound by this method. (D. Lowry and J. Blaine, Washington Department Fish and Wildlife, personal communication).

Concurrently, I conducted a separate long-line study during the summer of 2014 to collect gill and heart parasites from elasmobranchs in Bellingham Bay within a 3–5 km radius of the coordinates 48° 41' N, 120° 30' W immediately to the north of Samish Bay, the area for the original, single leopard shark capture. In keeping with permit conditions, I used a 100 m long-line with 14/0 tuna hooks baited with squid set for 1 h to 1.5 h in water ranging from 18.3 m to 27.4 m deep, but with the long-line kept off the bottom by at least 3 m by interline floats. Six long-line events from May through September resulted in the capture of 49 spiny dogfish and no other elasmobranchs. By late September most spiny dogfish had migrated out of the area, as is typical in this region (McMillan 1999).

The extensive trawl data from the WDFW as well as data from the six long-line sets do not support the suggestion that leopard sharks have extended their range as proposed by Farrer (2009). There are possible explanations for the appearance of this lone leopard shark in eastern Puget Sound. While it is beyond the scope of this paper to prove the source, it is possible that a lone individual swam north from Oregon (Bates et al. 2014, Hight and Lowe 2007, Smith 2001) or this individual was the result of an aquarium release and not a range extension constituting a significant demographic unit shift for the species.

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