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Scientific Note: Cowsharks (*Hexanchidae*) as Predators on the Harbor Seals (*Phoca vitulina richardsi*) in San Francisco Bay, California

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In California waters, cowsharks are known to feed on harbor seals (*Phoca vitulina richardsi*), as indicated by pinniped remains from the stomachs of broadnose sevengill sharks (*Notorynchus cepedianus*) and blunt-nose sixgill sharks (*Hexanchus griseus*) collected from several localities along the California coast (Ebert, 1986, 1989). However, seal remains in the diet of cowsharks do not necessarily indicate predation. It was previously assumed that scavenging may have accounted for the presence of seals in the diet of these sharks. Recently, we gathered evidence that confirms cowsharks as occasional predators on adult harbor seals in San Francisco Bay (central California).



Population surveys were conducted at three seal haul-out sites in San Francisco Bay once per week for a two year period (20 December 1990 to 20 December 1992). A total of 285 harbor seals were documented, photographed and examined for markings, injuries and scars (Spencer, 1993). Of these, 19 animals showed punctures and scars attributable to the bites of cowsharks. Identification of scars and bite marks were based on comparison with the jaws and dental patterns of extant sixgill and sevengill sharks housed in museum collections. The unique tooth morphology of cowsharks with strong dignathic heterodonty (differences in morphology between upper and lower teeth, with large comblike lower teeth and smaller, long-cusped uppers) produces bite patterns that are readily separable from other sharks in San Francisco Bay that are potential seal-predators (see Long et al., in press). However, since both species of cowsharks in the Bay show somewhat similar tooth morphologies, it was difficult to identify bites from sevengill versus those from sixgill sharks. So all bites were listed as inflicted by "cowsharks." Measurements of the bite areas showed that bites were made by relatively large (> 250 cm) sharks. All of the seals were alive when first noted, and most survived for many months after the injuries were inflicted.

Dietary analysis of sixgill shark stomachs showed harbor seals to be an infrequent food item, but one

that contributed a high volume when present. Seals were more common in the diets of large (>278 cm total length) sevengill sharks (Ebert, 1989). Pinniped remains were relatively infrequent in the stomachs of sixgill sharks off California (Ebert, 1986). The ability of cowsharks to prey on marine mammals was unknown, but observations by Ebert (1991) showed that the sevengill shark actively attacked and fed on Cape fur seals (*Arctocephalus pusillus pusillus*) and possibly other marine mammals. Our evidence also confirms cowsharks to be significant predators on harbor seals in San Francisco Bay, with some 6.5% of seals showing signs of attempted predation. The more active broadnose sevengill shark is likely to be the more common predator on harbor seals, considering its relative abundance in the Bay and the comparative rarity of the primarily offshore, deep-water sixgill shark there. However, the sixgill cannot be entirely discounted as a possible seal predator in the Bay (Ebert, 1986, 1989).

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