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SEI WHALE (*Balaenoptera borealis borealis*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognizes one stock of sei whales in the North Pacific (Donovan 1991, Wada and Numachi 1991), but some evidence exists for multiple populations (Masaki 1977; Mizroch *et al.* 1984; Horwood 1987). Kanda *et al*. (2006) reported there is likely a single population of sei whales in the western North Pacific, based on microsatellite analyses, for the region 37ºN-45ºN and 147ºE-166ºE. Sei whales are distributed far out to sea in temperate waters worldwide and do not appear to be associated with coastal features. Whaling effort for this species was distributed continuously across the North Pacific between 45-55ºN (Masaki 1977). Two sei whales tagged off California were later killed off Washington and British Columbia (Rice 1974). Sei whales are rare in the California Current (Dohl *et al.* 1983; Barlow 2016; Forney *et al.* 1995; Green *et al.* 1992), but were the fourth most common whale taken by California coastal whalers in the 1950s-1960s (Rice 1974). They are extremely rare south of California (Wade and Gerrodette 1993; Lee 1993). Lacking additional data on sei whale population structure, sei whales in the eastern North Pacific (east of longitude 180º) are considered as a separate stock. For the Marine Mammal Protection Act (MMPA) stock assessment reports, sei whales within the Pacific U.S. EEZ are divided into two discrete areas: (1) California, Oregon and Washington waters (this report) and (2) waters around Hawaii. The Eastern North Pacific stock includes animals found within the U.S. west coast EEZ and in adjacent high seas waters; however, because comprehensive data on abundance, distribution, and human-caused impacts are lacking for high seas regions, the status of this stock is evaluated based on data from U.S. EEZ waters of the California Current (NMFS 2005).

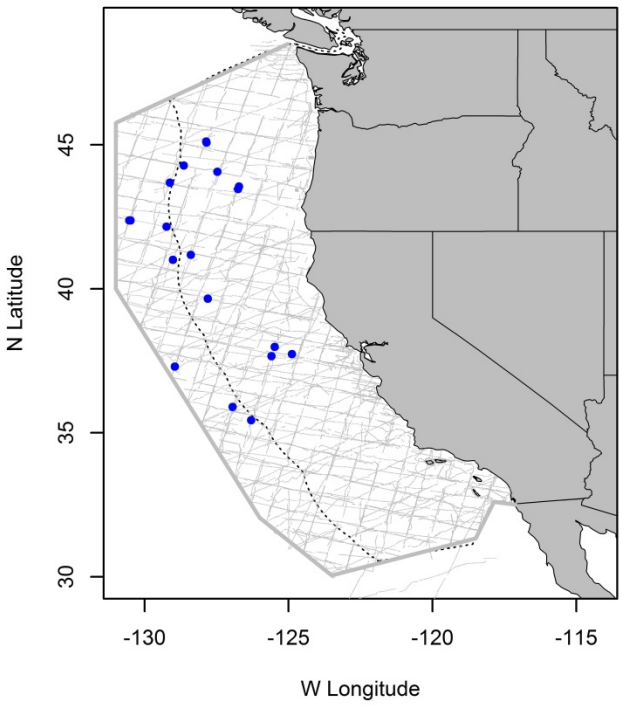

Figure 1. Sei whale sighting locations from shipboard surveys off California, Oregon, and Washington, 1991-2014. Dashed line represents the U.S. EEZ; thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

Ohsumi and Wada (1974) estimated the pre-whaling abundance of sei whales to be 58,000-62,000 in the North Pacific. Tillman (1977) estimated sei whale abundance in the North Pacific and revised this pre-whaling estimate to 42,000. His estimates for the year 1974 ranged from 7,260 to 12,620. These previous studies depended on using the history of catches and trends in CPUE or sighting rates. Hakamada *et al*. (2017) estimated sei whale abundance at 29,632 sei whales (CV = 0.242, 95% CI 18,576–47,267) in the central and eastern North Pacific based on visual line-transect surveys between 2010 and 2012. This estimate corresponds with the first systematic sighting survey abundance estimate for this species over a pelagic high-seas region. However, while the study area of Hakamada *et al*. (2017) included waters north of 40ºN latitude and west of 135ºW longitude, it excluded waters of the California Current. The estimated number of sei whales in the California Current is based on ship line-transect surveys between 1991-2014 within 300 nmi of the U.S. West

Coast, where sightings are relatively rare (Fig. 1, Barlow 2016). Abundance estimates for the two most recent line transect surveys of California, Oregon, and Washington waters in 2008 and 2014 are 311 (CV=0.76) and 864 (CV=0.40) sei whales, respectively (Barlow 2016). The best estimate of abundance for California, Oregon, and Washington waters is the unweighted geometric mean of the 2008 and 2014 estimates, or 519 (CV=0.40) sei whales (Barlow 2016).

Minimum Population Estimate

The minimum population estimate for sei whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from 2008 and 2014 vessel line-transect surveys, or 374 whales.

Current Population Trend

No data on trends in sei whale abundance exist for the eastern North Pacific. Although the population in the North Pacific is expected to have grown since being given protected status in 1976, the possible effects of continued unauthorized takes (Yablokov 1994), vessel strikes and gillnet mortality make this uncertain. Barlow (2016) noted that an increase in sei whale abundance observed in 2014 in the California Current is partly due to recovery of the population from commercial whaling, but may also involve distributional shifts in the population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of sei whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (374) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 0.75 whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The California swordfish drift gillnet fishery is the most likely U.S. fishery to interact with sei whales from this stock, but no entanglements have been observed from 8,845 monitored fishing sets from 1990-2016 (Carretta *et al.* 2018a, Table 1). Mean annual takes for this fishery (Table 1) are based on 2012-2016 data and are zero whales annually. However, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net.

Table 1. Summary of available information on the incidental mortality and injury of sei whales (eastern North Pacific stock) for commercial fisheries that might take this species. n/a indicates that data are not available. Mean annual takes are based on 2012-2016 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed mortality (and injury in parentheses)	Estimated mortality (CV in parentheses)	Mean annual takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	2012 2013 2014 2015 2016	observer	19% 37% 24% 20% 18%	0	0	0 (n/a)

Ship Strikes

One documented ship strike of a sei whale occurred in the most recent 5-year period, 2012-2016 (Carretta *et al.* 2018b), although uncertainty over whether the strike occurred pre- or post-mortem exists. For purposes of this stock assessment report, the ship strike is considered as the probable cause of death. During 2012-2016, there was one additional serious injury of an unidentified large whale attributed to a ship strike. Additional ship strike mortality probably goes unreported because the whales do not strand or, if they do, they may not have obvious signs of trauma. The average observed annual mortality due to ship strikes is 0.2 sei whales per year for the period 2012-2016.

STATUS OF STOCK

The NMFS sei whale recovery plan notes that basic data such as distribution, abundance, trends and stock structure is of poor quality or largely unknown, owing to the rarity of sightings of this species (NMFS 2011). Sei whales were estimated to have been reduced to 20% (8,600 out of 42,000) of their pre-whaling abundance in the North Pacific (Tillman 1977). The initial abundance has never been reported separately for the eastern North Pacific stock, but this stock was also depleted by whaling. Kanda *et al*. (2006) found a high level of genetic variation among sei whale samples in the western North Pacific and hypothesized that the population did not suffer from a genetic bottleneck due to commercial whaling. Sei whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the eastern North Pacific stock is automatically considered a "depleted" and "strategic" stock under the MMPA. Total observed fishery mortality is zero and therefore is considered to be approaching zero mortality and serious injury rate. The current known rate of ship strike deaths and serious injuries is 0.2 annually, but most sei whale ship strikes are likely unreported. Increasing levels of anthropogenic sound in the world's oceans is a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound (Croll *et al.* 2002). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen *et al.* 2013), but it is unknown if sei whales respond in the same manner to such sounds.

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