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PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata attenuata*): Hawaiian Islands Stock Complex – Oʻahu, Maui Nui, Hawaiʻi Island, and Hawaiʻi Pelagic Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pantropical spotted dolphins are primarily found in tropical and subtropical waters worldwide (Perrin *et al.* 2009). Much of what is known about the species in the North Pacific has been learned from specimens obtained in the large directed fishery in Japan and in the eastern tropical Pacific (ETP) tuna purse-seine fishery (Perrin *et al*. 2009). Spotted dolphins are common and abundant throughout the Hawaiian Islands, including nearshore where they are the second most frequently sighted species during nearshore surveys (Baird *et al*. 2013) and offshore where they are frequently observed during periodic shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands (Figure 1). Morphological differences and distribution patterns indicate that the spotted dolphins around the Hawaiian Islands belong to a stock that is distinct from those in the ETP (Perrin 1975; Dizon *et al.* 1994; Perrin *et al*. 1994b).

Pantropical spotted dolphins have been observed in all months of the year around the main Hawaiian Islands, and in areas ranging from shallow nearshore waters to depths of 5,000 m, although they peak in sighting rates in depths from 1,500 to 3,500 m (Baird *et al.* 2013). Although they represent from 22.9 to 26.5% of the odontocete sightings from Oʻahu, the Maui Nui (Molokaʻi, Lānaʻi, Maui, Kahoʻolawe), and Hawaiʻi Island, they are largely absent from the nearshore waters around Kauaʻi and Niʻihau, representing only 3.9% of sightings in that area (Baird *et al.* 2013). Genetic analyses of 176 unique samples of pantropical spotted dolphins collected during nearshore surveys off each of the main Hawaiian Islands from 2002 to 2003, and near Hawaiʻi Island from 2005 to 2008, suggest three island-associated stocks

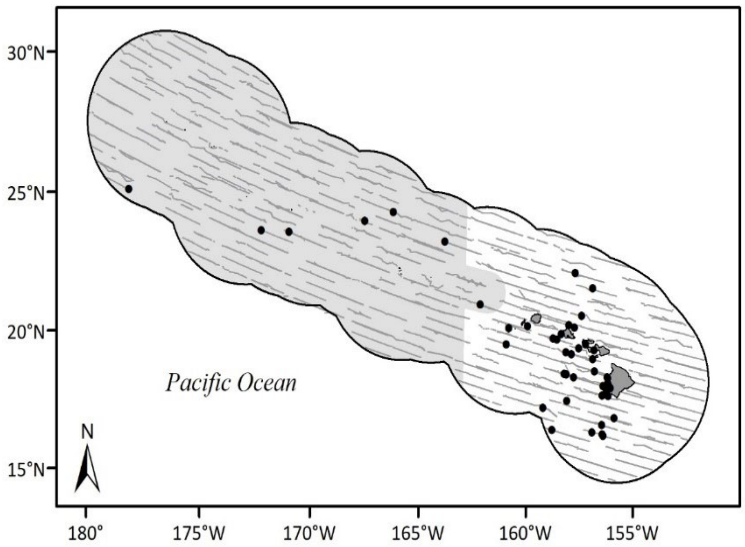

Figure 1. Pantropical spotted dolphin sighting locations (circles) and survey effort (gray lines) during the 2002 (Barlow 2006), 2010 (Bradford *et al.* 2017), and 2017 (Yano *et al.* 2018) shipboard surveys of the U.S. EEZ around the Hawaiian Islands (outer black line). The Papahānaumokuākea Marine National Monument in the western portion of the EEZ is shaded gray. Insular stock boundaries are shown in Figure 2.

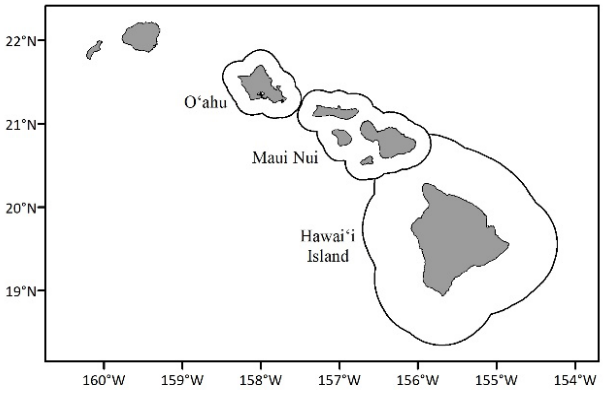

Figure 2. Main Hawaiian Islands insular stock boundaries (gray lines). Areas beyond the insular boundaries represent the pelagic stock range.

are evident (Courbis *et al*. 2014). The results of the Courbis *et al*. (2014) study indicate that pantropical spotted dolphins in Hawai'i's nearshore waters have low haplotypic diversity with haplotypes unique to each of the island areas. Courbis *et al*. (2014) conducted extensive tests on the relatedness of individuals among islands using the microsatellite dataset and found significant differences in haplotype frequencies between islands, suggesting genetic differentiation in spotted dolphins among islands. This suggestion is supported by the results of assignments tests, which indicate support for 3 island-associated populations: Hawai'i Island, the Mui Nui region, and O'ahu. Samples from Kaua'i and Ni'ihau did not cluster together, but instead were spread among the Hawai'i and O'ahu clusters. Analysis of migration rate further support the separation of pantropical spotted dolphins into three island-associated stocks, with migration between regions on the order of a few individuals per generation. Based on an overview of all available information on pantropical spotted dolphins in Hawaiian waters, and NMFS guidelines for assessing marine mammal stocks (NMFS 2023), Oleson *et al.* (2013) proposed designation of three new island associated stocks in Hawaiian waters, as well as recognition of a fourth broadly distributed spotted dolphin stock given the frequency of sightings in pelagic waters. Stock boundaries for main Hawaiian Islands spotted dolphin stocks are based on the furthest distance from shore of an insular sighting. Around O'ahu and Maui Nui the stock extends to 20km form shore and around Hawai'i Island to 65km. Fishery interactions with pantropical spotted dolphins and sightings near Palmyra and Johnston Atolls (NMFS PIRO unpublished data) demonstrate that this species also occurs in the U.S. EEZ of those locations, but it is not known whether these animals are part of the Hawai'i Pelagic population or are a separate stock or stocks of pantropical spotted dolphins.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, there are four Pacific management stocks within the Hawaiian Islands EEZ (Oleson *et al.* 2013): 1) the O'ahu stock, which includes spotted dolphins within 20 km of O'ahu, 2) the Maui Nui stock, which includes spotted dolphins within 20 km of Maui, Moloka'i, Lāna'i, and Kaho'olawe, collectively, 3) the Hawai'i Island stock, which includes spotted dolphins found within 65 km from Hawai'i Island, and 4) the Hawai'i Pelagic stock, which includes spotted dolphins inhabiting the waters throughout the Hawaiian Islands EEZ, outside of the insular stock areas, but including adjacent high seas waters. Because data on abundance, distribution, and human-caused impacts are largely lacking for high seas waters, the status of the Hawai'i pelagic stock is evaluated based on data from the U.S. EEZ around the Hawaiian Islands (NMFS 2023). Spotted dolphins involved in eastern tropical Pacific tuna purse-seine fisheries are managed separately under the MMPA.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Entanglement in gillnets and hooking or entanglement in various hook and line fisheries have been reported for small cetaceans in Hawai'i (Nitta and Henderson 1993). No estimates of human-caused mortality or serious injury are currently available for nearshore hook and line or gillnet fisheries because these fisheries are not observed or monitored for protected species bycatch. Commercial and recreational troll fisherman have been observed "fishing" dolphins off the islands of Hawai'i, Lāna'i, and O'ahu, including spotted dolphins, in order to catch tuna associated with the animals (Courbis *et al*. 2009, Rizzuto 2007, Shallenberger 1981). Anecdotal reports from fisherman indicate that spotted dolphins are sometimes hooked (Rizzuto 1997). An assessment of the incidence of potential fishing gear-associated scarring on pantropical spotted dolphins near Maui Nui revealed 13% of non-calf well-marked individuals photographed between 1996 and 2020 had one or more scars that may be attributed to fishing gear (Machernis *et al.* 2021). A study of the incidence of fishing vessels associated with spotted dolphins revealed that hundreds of boats appear to be engaging in this fishing method, including a high incidence of trolling through the group of dolphins or maneuvering through the group to drop hook and line gear ahead of the dolphin group (Baird and Webster 2020). In 2017, a spotted dolphin (Maui Nui stock) was seen near Lāna'i with a band of debris around its rostrum preventing it from opening its mouth, which was determined to be a serious injury (Bradford and Lyman 2019). Serious injuries from nearshore fishing gear have previously been observed in other insular stocks (Bradford and Lyman 2018).

There are currently two distinct longline fisheries based in Hawai'i: a deep-set longline (DSLL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSLL) that targets swordfish. Both fisheries operate within U.S. waters and on the high seas, but are prohibited from operating within the Papahānaumokuākea Marine National Monument (PMNM) and within the Longline Exclusion Zone around the main Hawaiian Islands and the Pacific Remote Islands and Atolls (PRIA) MNM around Johnston Atoll. The PMNM originally included the waters within a 50 nmi radius around the Northwestern Hawaiian Islands. In August, 2016, the PMNM area was expanded to extend

to the 200 nmi EEZ boundary west of 163° W. Between 2017 and 2021, no pantropical spotted dolphins were observed hooked or entangled in the SSLL fishery (100% observer coverage) or in the DSLL fishery (15-21% observer coverage) (McCracken and Cooper 2022).

O'AHU STOCK

POPULATION SIZE

The population size of the O'ahu stock of pantropical spotted dolphins has not been estimated. Model-based estimates using line-transect datasets have been explored for this stock (Becker *et al.* 2022), though the small sample size and an uneven distribution of survey effort resulted in unreliable estimates.

Minimum Population Estimate

There is no information on which to base a minimum population estimate of the O'ahu stock of pantropical spotted dolphins.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the O'ahu stock of pantropical spotted dolphins is calculated as the minimum population estimate times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the O'ahu stock area; Wade and Angliss 1997). Because there is no minimum population estimate available, the PBR for O'ahu stock of pantropical spotted dolphins is undetermined.

STATUS OF STOCK

The O'ahu stock of pantropical spotted dolphins is not considered a strategic stock under the MMPA. The status of O'ahu spotted dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for this stock. Spotted dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor designated as "depleted" under the MMPA. There have been no reports of recent mortality or serious injuries, though fishermen may target groups of spotted dolphins around O'ahu in order to catch associated tuna, increasing the likelihood of dolphins being hooked or entangled (Baird and Webster 2020). There is no systematic monitoring for interactions with protected species within nearshore fisheries that may take this species, thus mean annual takes are undetermined. Insufficient information is available to determine whether the total fishery mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate. *Morbillivirus* has been detected within other insular stocks of pantropical spotted dolphins in Hawai'i (Jacob *et al*. 2016). The presence of *morbillivirus* in 10 species of cetacean in Hawaiian waters raises concerns about the history and prevalence of this disease in Hawai'i and the potential population impacts, including the cumulative impacts of disease with other stressors.

MAUI NUI STOCK

POPULATION SIZE

The population size of Maui Nui stock of pantropical spotted dolphins has not been estimated. Model-based estimates using line-transect datasets have been explored for this stock (Becker *et al.* 2022), though the small sample size and an uneven distribution of survey effort resulted in unreliable estimates.

Minimum Population Estimate

There is no information on which to base a minimum population estimate of the Maui Nui stock of pantropical spotted dolphins.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Mui Nui stock of pantropical spotted dolphins is calculated as the minimum population estimate times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the Mui Nui stock area; Wade and Angliss 1997). Because there is no minimum population estimate available for this stock, the PBR for 4-Islands stock of pantropical spotted dolphins is undetermined.

STATUS OF STOCK

The Maui Nui stock of pantropical spotted dolphins is not considered a strategic stock under the MMPA. The status of Maui Nui spotted dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for this stock. Spotted dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor designated as "depleted" under the MMPA. Aside from the spotted dolphin entangled in marine debris in 2017 (Bradford and Lyman 2018), there are no other reports of recent mortality or serious injuries, though fishermen may target groups of spotted dolphins around the Maui Nui region to catch associated tuna, increasing the likelihood of dolphins being hooked or entangled (Baird and Webster 2020), with injuries potentially associated with fishing line observed in a portion of well-marked animals (Machernis *et al.* 2021). There is no systematic monitoring for interactions with protected species within nearshore fisheries that may take this species, thus mean annual takes are undetermined. Insufficient information is available to determine whether the total fishery mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate. *Morbillivirus* has been detected within other insular stocks of pantropical spotted dolphins in Hawai‘i (Jacob *et al.* 2016). The presence of *morbillivirus* in 10 species of cetacean in Hawaiian waters raises concerns about the history and prevalence of this disease in Hawai‘i and the potential population impacts, including the cumulative impacts of disease with other stressors.

HAWAI‘I ISLAND STOCK

POPULATION SIZE

The population size of the Hawai‘i Island stock of pantropical spotted dolphins has not been estimated. Design and model-based estimates using line-transect datasets have been explored for this stock (Becker *et al.* 2022, Bradford *et al.* 2022), though the small sample size and an uneven distribution of survey effort resulted in unreliable estimates.

Minimum Population Estimate

There is no information on which to base a minimum population estimate of the Hawai‘i Island stock of pantropical spotted dolphins.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawaii Island stock of pantropical spotted dolphins is calculated as the minimum population estimate times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious

injury within the Hawaii Island stock area; Wade and Angliss 1997). Because there is no minimum population estimate available for this stock, the PBR for Hawaii Island stock of pantropical spotted dolphins is undetermined.

STATUS OF STOCK

The Hawai‘i Island stock of pantropical spotted dolphins is not considered a strategic stock under the MMPA. The status of Hawai‘i Island spotted dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for this stock. Spotted dolphins are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor designated as “depleted” under the MMPA. There have been no reports of recent mortality or serious injuries, though fishermen target groups of spotted dolphins around Hawai‘i Island to catch associated tuna, increasing the likelihood of dolphins being hooked or entangled (Baird and Webster 2020). There is no systematic monitoring for interactions with protected species within nearshore fisheries that may take this species, thus mean annual takes are undetermined. Insufficient information is available to determine whether the total fishery mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate. One spotted dolphin found stranded on Hawai‘i Island has tested positive for *Morbillivirus* (Jacob *et al.* 2016). The presence of *morbillivirus* in 10 species of cetacean in Hawaiian waters (Jacob 2012) raises concerns about the history and prevalence of this disease in Hawaii and the potential population impacts, including the cumulative impacts of disease with other stressors.

HAWAI‘I PELAGIC STOCK

POPULATION SIZE

Encounter data from shipboard line-transect surveys of the Hawaiian Islands EEZ were recently reevaluated for each survey year, resulting in the following abundance estimates of pantropical spotted dolphins in the entirety of the Hawaiian Islands EEZ (Becker *et al.* 2022, Bradford *et al.* 2021; Table 1).

Table 1. Line-transect abundance estimates for Hawai‘i pelagic pantropical spotted dolphins in the Hawaiian Islands EEZ in 2002, 2010, 2017, and 2020, derived from NMFS surveys in the central Pacific since 1986 (Becker *et al.* 2022, Bradford *et al.* 2021).

Year	Design-based Abundance	CV	95% Confidence Limits	Model-based Abundance	CV	95% Confidence Limits
2020				67,313	0.27	40,096-113,005
2017	39,798	0.51	15,432-102,637	73,667	0.28	42,769-126,886
2010	49,488	0.39	23,551-103,992			
2002	16,931	0.65	5,289-54,202			

Sighting data from 2002 to 2020 within the Hawaiian Islands EEZ were used to derive stock-specific habitat-based models of animal density for the 2017 to 2020 period. The models were then used to predict density and abundance for each survey year based on the environmental conditions within that year (see Forney *et al.* 2015, Becker *et al.* 2016). The modeling framework incorporated Beaufort-specific trackline detection probabilities for spotted dolphins from Barlow *et al.* (2015). Although model-based estimates were previously derived for years 2002, 2010, and 2017 (Becker *et al.* 2021), those estimates were not pelagic stock specific and as such may have reflected both the habitat associations and abundance of the insular stocks within the main Hawaiian Islands. Stock-specific model-based estimates were derived only for the most recent years (2017-2020), such that direct comparison of model and design-based estimates for the full survey time series is not possible at this time. Bradford *et al.* (2021) produced design-based abundance estimates for spotted dolphins for each full EEZ survey year. Design-based estimates for spotted

dolphins are generally lower than model-based estimates, though the confidence limits broadly overlap with those produced from the model-based approach (Figure 3). Current model based-estimates are based on the implicit assumption that annual changes in abundance are attributed to environmental variability alone. Explicitly incorporating a trend term into the model is not possible due to the insufficient sample size to test for temporal effects. Despite not fully accounting for inter-annual variation in total abundance, the model-based estimates are considered the best available estimate for the most recent survey year. Becker *et al.* (2022) and Bradford *et al.* (2022) evaluated seasonal changes in the abundance of spotted dolphins within the main Hawaiian Islands using summer-fall data from 2017 and winter survey data from 2020 and found no significant difference, with no reliance on season within the model-based approach and largely similar design-based estimates for summer-fall 2017 versus winter 2020. Previously published design-based estimates for the Hawaiian Islands EEZ from 2002 and 2010 surveys (Barlow 2006, Bradford *et al.* 2017) used a subset of the dataset used by Becker *et al.* (2021, 2022) and Bradford *et al.* (2021, 2022) to derive line-transect parameters, such that these estimates have been superseded by the estimates presented here. The best estimate of abundance is based on the 2020 survey, or 67,313 (CV=0.27) pantropical spotted dolphins.

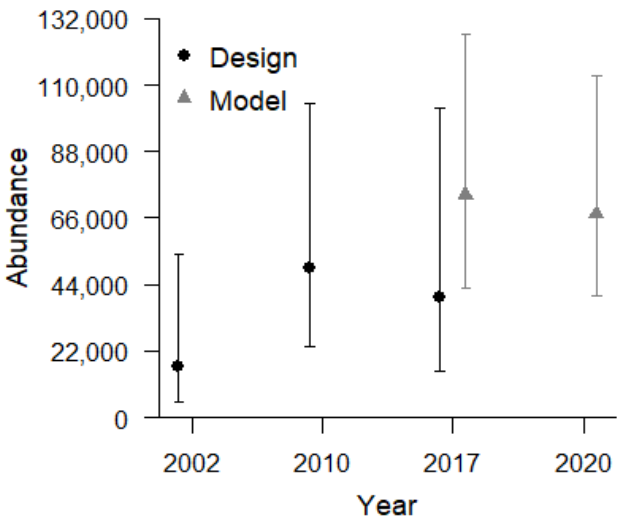

Figure 3. Comparison of design-based (black circles, Bradford *et al.* 2021) and model-based (gray triangles, Becker *et al.* 2021, 2022) estimates of abundance for hawai‘i pelagic pantropical spotted dolphins for each survey year (2002, 2010, 2017, 2020).

Population estimates are available for Japanese waters (Miyashita 1993), but it is not known whether any of these animals are part of the same population that occurs around the Hawaiian Islands.

Minimum Population Estimate

The minimum population estimate for the Hawai‘i pelagic stock of pantropical spotted dolphins is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2020 abundance estimate for the pelagic stock area (from Becker *et al.* 2022), or 53,839 pantropical spotted dolphins.

Current Population Trend

The available abundance estimates for this stock have very broad and overlapping confidence intervals, precluding robust evaluation of population trend for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawai‘i pelagic stock of pantropical spotted dolphins is calculated as the minimum population estimate within the U.S. EEZ of the Hawaiian Islands (53,839) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997), resulting in a PBR of 538 Hawai‘i pelagic pantropical spotted dolphins per year.

STATUS OF STOCK

The Hawai‘i pelagic stock of spotted dolphins is not considered strategic under the 1994 amendments to the MMPA. The status of Hawai‘i pelagic pantropical spotted dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Pantropical spotted dolphins are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor designated as “depleted” under the MMPA. Given the

absence of recent recorded fishery-related mortality or serious injuries within U.S. EEZ, the total fishery mortality and serious injury can be considered to be insignificant and approaching zero. *Morbillivirus* has been detected within other insular stocks of bottlenose dolphins in Hawai'i (Jacob *et al.* 2016). The presence of *morbillivirus* in 10 species of cetacean in Hawaiian waters raises concerns about the history and prevalence of this disease in Hawai'i and the potential population impacts, including the cumulative impacts of disease with other stressors.

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