Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Action Agency:	National Marine Fisheries Service, Pacific Islands Region, Sustainable Fisheries Division
Federal Action:	Supplement to the Authorization of the Hawaii Shallow-set Longline Fishery; Effects to North Pacific Loggerhead Sea Turtles
Consultation Conducted by:	National Marine Fisheries Service, Pacific Islands Region, Protected Resources Division
NMFS File No. (ECO):	PIRO-2023-02747
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Approved By:	MALLOY.SARAH.JOAN.1262526743 Digitally signed by MALLOY.SARAH.JOAN.1262526743 Date: 2024.03.12 09:02:09 -10'00' Sarah Malloy Acting Regional Administrator, Pacific Islands Region
Date Issued:	March 12, 2024

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1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each federal agency to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. The ESA requires federal action agencies to consult with National Marine Fisheries Service (NMFS) when the action may affect a listed species or its designated critical habitat under our jurisdiction (50 CFR 402.14(a)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, we provide a biological opinion (opinion) stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If we determine that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, in accordance with the ESA section 7(b)(3)(A), we provide a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If incidental take[1] is reasonably certain to occur, section 7(b)(4) requires us to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

We prepared this supplemental biological opinion and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR part 402. We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). Following signature and finalization, the document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome].

On July 5, 2022, in *Animal Legal Defense Fund v. Haaland, et al.*, 4:19-cv-06812-JST, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. On June 22, 2023, NMFS and the U.S. Fish and Wildlife Service issued a proposed rule amending portions of the ESA Section 7 regulations (88 FR 40753). For purposes of this consultation and

[1] Under the ESA, the term "take" is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. We further define "harass" as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Application and Interpretation of the Term Harass Pursuant to the Endangered Species Act: NMFS Guidance Memo May 2, 2016). NMFS defines harm as "an act which actually kills or injures fish or wildlife." 50 C.F.R. 222.102. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering.

in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations, the 2019 regulation, or the 2023 proposed regulations. We have determined that our analysis and conclusions would not be any different.

1.1 Consultation History

The proposed federal action addressed by this biological opinion is the authorization of the Hawaii shallow-set longline fishery (SSLL) fishery. Prior to 2008, NMFS consulted on the SSLL fishery as part of the Fisheries Management Plan for the Pelagic Fisheries (pelagic FMP). Consultations on the pelagic FMP were conducted in 1998, 2001 and 2004. Consultation histories for earlier consultations on the FMP and the SSLL fishery can be found in the 1998, 2001, 2004, 2008, 2012 and 2019 biological opinions.

On October 15, 2008, NMFS completed a biological opinion (2008 biological opinion; NMFS 2008a) evaluating management changes recommended under Amendment 18 to the Hawaii-based SSLL swordfish fishery. The 2008 biological opinion determined that the fishery was likely to adversely affect, but not jeopardize, humpback whales, loggerhead, leatherback, olive ridley, green, and hawksbill sea turtles. The 2008 biological opinion also provided incidental take authorization for these five species of sea turtle, but not for humpback whales (NMFS 2008a). Through an August 27, 2008 letter of concurrence, NMFS had previously determined that the fishery was not likely to adversely affect Hawaiian monk seals, or blue, fin, sei, sperm, and northern right whales (NMFS 2008b).

The SSLL fishery has been the subject of several court orders, and has operated under a restricted fishing regime to protect listed sea turtles when NMFS completed a new consultation on January 30, 2012. The 2012 biological opinion concluded that the continued operation of the SSLL fishery was not likely to jeopardize the continued existence of humpback whales[2], loggerhead, leatherback, olive ridley, and green sea turtles.

On November 2, 2012, Plaintiffs Turtle Island Restoration Network and Center for Biological Diversity filed a lawsuit against NMFS under the ESA, Magnuson–Stevens Fishery Conservation and Management Act, and their implementing regulations, challenging among other decisions NMFS's final rule approving the continued operation of the shallow-set fishery under sea turtle annual interaction limits of 34 loggerheads and 26 leatherbacks, based on a 2012 no-jeopardy biological opinion. After the parties moved for summary judgment, on August 23, 2013 the district court ruled in the agency's favor on all of Plaintiffs' claims, and Plaintiffs appealed.

On December 27, 2017, the U.S. Court of Appeals, Ninth Circuit, vacated the loggerhead decisions and on May 2018, a court-approved settlement agreement was completed that would shut down the SSLL fishery for the remainder of the 2018 year, and required implementation of the 2004 hard cap at 17 loggerhead sea turtles starting in January 2019.

On April 20, 2018, NMFS reinitiated ESA Section 7 consultation for the shallow-set fishery for all ESA-listed species under NMFS jurisdiction occurring in the action area due to three re-initiation triggers: ESA listing of the oceanic whitetip shark and giant manta ray; critical habitat

[2] The Humpback Whale global listing was divided into 14 distinct population segments (DPS) September 8, 2016; four DPSs were listed as endangered, one as threatened, and the remaining nine were not warranted (81 FR 62259). The Hawaii humpback whale was one of the nine species that was not warranted.

designation for MHI IFKW Distinct Population Segment (DPS); and taking of Guadalupe fur seals.

On January 19, 2019, the SSLL fishery reached its cap of 17 loggerhead sea turtles (a total of 20 loggerhead sea turtles were taken by March 20, 2019) and the fishery was closed for the remainder of the year.

On June 26, 2019, NMFS completed a biological opinion (NMFS 2019) which determined that the continued authorization of the Hawaii-based SSLL fishery may affect, but is not likely to jeopardize the continued existence of the leatherback sea turtle, North Pacific loggerhead sea turtle, green sea turtle (East Pacific, Central North Pacific, East Indian-West Pacific, Central West Pacific, Southwest Pacific and Central South Pacific DPSs), oceanic whitetip shark, giant manta ray, or Guadalupe fur seal. The 2019 biological opinion included not likely to adversely affect determinations for the hawksbill sea turtle; MHI IFKW DPS; humpback (Mexico DPS), fin, blue, sei, sperm, and North Pacific right whales; eastern Pacific scalloped hammerhead shark; as well as ESA-listed fish and invertebrate species off the coast of California[3]. The 2019 biological opinion also concluded that the Hawaii shallow-set fishery is not likely to adversely modify designated critical habitat for the leatherback sea turtle, the Hawaiian monk seal, the MHI IFKW DPS, the Steller sea lion, and the listed fish and invertebrate species common to transiting areas off the coast of California.

On April 7, 2023, NMFS Protected Resources Division (PRD) began providing technical assistance to NMFS Sustainable Fisheries Division (SFD) to start the process for re-initiation after the fishery exceeded the 2019 biological opinion's ITS for North Pacific loggerhead sea turtles.

On October 27, 2023, SFD requested reinitiation of the biological opinion due to the exceedance of the ITS for North Pacific loggerhead sea turtles in 2023. NMFS reinitiated ESA Section 7 consultation on the same day. No other re-initiation triggers have been met and therefore the current biological opinion will supplement the 2019 biological opinion with new information and analyses on North Pacific loggerhead sea turtles. The 2019 biological opinion remains valid for all other ESA-listed species under NMFS jurisdiction occurring in the action area.

1.2 Proposed Federal Action

Under the ESA (50 CFR 402.02), the term "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas (see 50 CFR 402.02). NMFS SFD proposes to authorize the operation of the SSLL fishery, as currently managed under the existing framework of the Pelagic FEP and other applicable laws. In this biological opinion we consider activities directly associated with the fishing operation (setting, soaking, and retrieving gear) as well as vessel operation and transit to ports.

[3] Central California coast coho salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central California coast steelhead, California coast steelhead, Southern North American green sturgeon, Black abalone, and White abalone.

1.2.1 Overview of Fishing Operation

Longline fishing uses gear consisting of a mainline that exceeds one nautical mile (6,076 ft.) in length suspended horizontally in the water column, from which branch lines with baited hooks are attached (NMFS 2008a). Longline fishing allows a vessel to distribute effort over a large area to harvest fish that are not concentrated in great numbers. Overall catch rates in relation to the number of hooks are generally low (less than 2%). Longline fishing involves setting (deploying) a mainline horizontally at a preferred depth in the water column using floats spaced at regular intervals. Crewmembers usually attach three to five radio buoys at regular intervals along the mainline so the line may be easily located for retrieving (hauling) the gear and retrieving line segments if the mainline breaks during fishing operations.

Crewmembers clip branch lines to the mainline at regular intervals, and each branch line has a single baited hook. Mainline lengths can be 30 to 100 km (18 to 60 nm) long. After deploying the mainline, the gear fishes (soaks) for several hours before being hauled. In longlining, a "set" is the deployment and retrieval of a discrete unbroken section of mainline, floats, and branch lines. Usually, crewmembers make one set per day. Shallow-set fishing trips are usually 4-5 weeks long, with about 17 days spent fishing. By comparison, deep-set trips are historically 3-4 weeks long, and about 13 days fishing (NMFS 2001, Beverly and Chapman 2007, Western Pacific Fishery Management Council [WPFMC] 2009, NMFS 2023b). Figure 1 illustrates the difference between shallow-set and deep-set gear configuration.

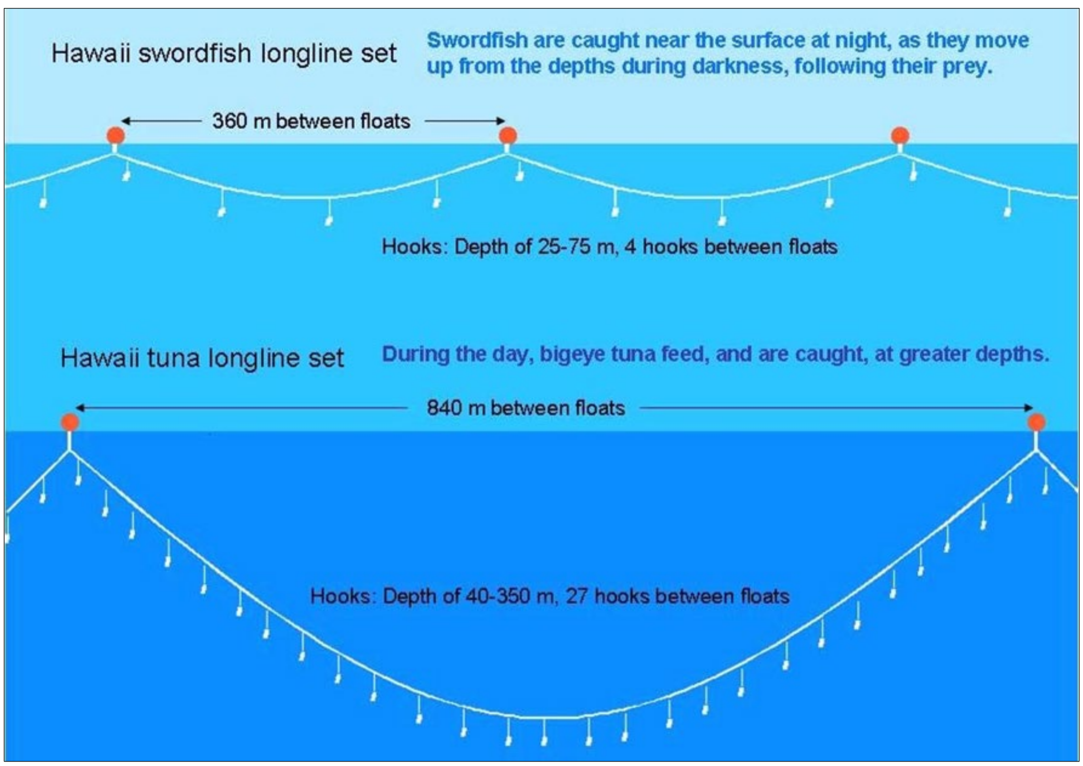

Figure 1. Generalized depiction of shallow-set and deep-set gear configuration

In SSLL fishing, the bait is set at depths of 30 to 90 m. The portion of the mainline with branch lines is suspended between floats at about 20 to 75 m deep, and the branch lines hang off the mainline another 10 to 15 m with luminescent light sticks attached. Fishermen clip four to six branch lines to the mainline between floats, and a typical set for swordfish uses about 800 to

1,000 hooks. Vessels are required to begin setting gear at least one hour after local sunset and to complete the deployment of gear no later than local sunrise. The most productive swordfish fishing areas for Hawaii longline fishing are north of Hawaii outside the EEZ on the high seas. Shallow-set longline vessels have displacement hulls and travel at speeds less than 10 kt. Vessel sizes range up to nearly the maximum 101-foot limit, but the average size is 65 to 70 ft. Since 2004, the fishery has consisted of 11-35 vessels.

In 2004, the fishery began operating under a suite of mitigation measures designed to reduce interactions with ESA-listed sea turtles. These included requirements to use large 18/0 or larger circle hooks and mackerel-type bait (saba), a set certificate program that limited the annual number of sets to 2,120, maximum annual interaction limits for loggerhead and leatherback sea turtles, and a requirement for owners and operators of longline vessels to attend a protected species education workshop.

In 2010, NMFS implemented Amendment 18, which intended to allow for the attainment of optimum yield in the swordfish fishery while mitigating impacts to listed species. Specifically, Pelagic FEP Amendment 18 removed the shallow-set effort limit and eliminated the set certificate program (74 FR 65460; January 10, 2010), but retained all other sea turtle mitigation measures.

In 2020, NMFS implemented Pelagic FEP Amendment 10, which established individual trip interaction limits for loggerhead and leatherback turtles and removed the annual interaction limit for loggerhead sea turtles (85 FR 57988; September 17, 2020). Amendment 10 intended to help ensure a continued supply of fresh swordfish to U.S. markets, consistent with the conservation needs of sea turtles. Fishery effort increased slightly in 2020 and again in 2021 in response to the amendments, but has remained below 2,000 sets annually since 2004 (Table 1), and well below the estimated 5,500 sets analyzed in Amendment 18. Effort in this fishery is described in more detail below.

1.2.2 Anticipated Fishing Effort

In the 2019 biological opinion, NMFS expected fishing effort to remain within the approximate range of effort (135-1,833 sets) observed from 2004-2016 and have a reasonable chance of reaching 2,000 sets annually. However, while remaining in the approximate range from the 2019 biological opinion, effort between 2018-2020 was low relative to averages from 2004-2018 (Table 1) due to a combination of events. A settlement agreement in 2018 closed the fishery in May and a subsequent reinstatement of a lower loggerhead sea turtle annual interaction limit closed the fishery in March in 2019. In 2020, there was associated low fishery participation until the implementation of Pelagic FEP Amendment 10, which modified sea turtle catch limits as described above. Since 2021, fishery participation has increased, and effort in 2022 and so 2023 has recovered closer to the pre-biological opinion average (Table 1). We assume effort will continue to remain within the approximate range of effort (135-1,872 sets) analyzed in the 2019 biological opinion, observed now from 2004-2023, and may still reasonably reach 2,000 sets annually for the following reasons:

1. 2,000 sets annually is within historical levels (prior to the 2001-2004 closure);
2. Global swordfish demand and demand for fresh swordfish from Hawaii fisheries can fluctuate, resulting in price changes that, in turn, are one driver of fishing effort; and
3. Annual bigeye tuna catch limits applicable to Hawaii longline vessels could change, making the targeting of swordfish a likely alternative in the event of a bigeye closure.

Table 1. Effort in the SSLL fishery, 2004-2023. New information since publication of the 2019 biological opinion is italicized.

Year	Active Vessels	Trips	Sets	Hooks
2004	7	11	135	115,718
2005	33	108	1,646	1,358,247
2006	35	57	850	676,716
2007	28	87	1,569	1,353,761
2008	27	92	1,597	1,460,042
2009	28	113	1,762	1,694,550
2010	28	115	1,872	1,835,182
2011	20	83	1,474	1,505,467
2012	18	82	1,364	1,476,969
2013	15	58	962	1,074,909
2014	20	81	1,338	1,470,683
2015	23	70	1,156	1,274,805
2016	13	46	727	796,165
2017	21	72	1005	1,083,216
2018	11	30	420	486,013
2019	*15*	*28*	*312*	*374,487*
2020	*15*	*37*	*479*	*624,579*
2021	*18*	*60*	*804*	*1,026,373*
2022	*21*	*75*	*971*	*1,242,997*
2023	*24*	*65*	*810*	*1,012,699*
2004-2023 avg.	**21.0**	**68.5**	**1,063**	**1,097,179**
2018-2023 avg.	**17.3**	**49.2**	**633**	**794,525**

Source: NMFS unpublished observer data based on begin haul timing.

1.2.3 Regulatory Requirements for the Fishery

Under the proposed action, NMFS would retain the following requirements for the SSLL fishery. A summary of these requirements related to loggerhead turtles that are part of the proposed action follows:

Fishing Permits and Certificates on board the vessel

- Hawaii Longline Limited Entry Permit (50 CFR 665.801).
- Marine Mammal Authorization Program Certificate (50 CFR 229.4).
- High Seas Fishing Compliance Act Permit (if fishing on the high seas (50 CFR 300.212).
- Western and Central Pacific Fisheries Convention (WCPFC) Area Endorsement (if fishing on the high seas in the convention area; 50 CFR 300.212 (a)).

- Protected Species Workshop (PSW) Certificate (50 CFR 665.814).
- Western Pacific Receiving Vessel Permit, if applicable (50 CFR 665.801(e)).
- State of Hawaii Commercial Marine License (HRS 189-2,3).

Reporting, Monitoring, and Gear Identification

- Logbook for recording effort, catch, and other data (50 CFR 665.14 (b)).
- Transshipping Logbook, if applicable (50 CFR 665.14 (c)).
- Vessel monitoring system (50 CFR 635.69).
- Vessel and fishing gear identification (50 CFR 665.16 (a-e); 50 CFR 665.128 (a)).

Notification Requirement and Observer Placement

- Notify NMFS before departure of a shallow-set trip (50 CFR 665.803).
- NMFS places observers on every SSLL trip, resulting in 100% observer coverage (50 CFR 600.746; 50 CFR 665.808).

Areas in Hawaii

- Northwestern Hawaiian Islands (NWHI) Longline Protected Species Zone (50 CFR 665.806 (a1))
- Main Hawaiian Islands (MHI) Longline Fishing Prohibited Area (50 CFR 665.806 (a2)).
- Papahanaumokuakea Marine National Monument: Prohibited commercial fishing in the Monument, which has boundaries that align with the NWHI Longline Protected Species Zone (50 CFR 665.806 (a1)).

Protected Species Workshop (PSW)

- Each year, longline vessel owners and operators must complete a PSW and receive a certificate (50 CFR 665.814 (a)).
- The vessel owner must have a valid PSW certificate to renew a Hawaii longline limited entry permit (50 CFR 665.814 (c)).
- The vessel operator must have a valid PSW certificate on board the vessel while fishing (50 CFR 665.814 (d)).

Sea Turtle Handling and Mitigation Measures

- Vessel owners and operators must have on board the vessel all required turtle handling/dehooking gear specified in regulations (50 CFR 665.812(a)), including:
    - Line clippers
    - Extended reach handle dip nets
    - Dehookers (five types)
    - Tire
    - Long-nose or needle-nose pliers
    - Wire or bolt cutters
    - mouth openers and gags (14 items)
    - line cutters
- There is a maximum annual fleet-wide interaction limit (hard cap) of 16 leatherback sea turtles. If the fleet reaches the annual hard cap of 16 leatherback turtles, all shallow-set vessels must immediately stop fishing, retrieve fishing gear, return to port, and the fishery is closed for the remainder of the calendar year (50 CFR 665.813(b)).

- There is also an interaction limit of two leatherback and five loggerhead sea turtles for each fishing trip. If an individual vessel reaches a trip limit of either two leatherback or five loggerhead sea turtles, that vessel must immediately stop fishing, retrieve fishing gear, and return to port. That vessel may not engage in SSLL fishing during the 5 days immediately following the vessel's return to port. If a vessel reaches a trip limit for the same sea turtle species twice in a calendar year, it will be prohibited from shallow-set fishing for the remainder of that calendar year. In the subsequent calendar year, that vessel will be limited to an annual interaction limit for that species (either two leatherback or five loggerhead sea turtles). If that subsequent annual interaction limit is also reached, that vessel will be prohibited from shallow-set fishing for the remainder of that subsequent calendar year (50 CFR 665.813(b)).
- Vessel owners and operators are required to adhere to regulations for safe handling and release of sea turtles specified in regulations (50 CFR 665.812(b)).
    - Actions for turtles too large to be brought aboard the vessel
    - Resuscitation and release actions for turtles able to be brought aboard.
- When SSLL fishing north of the Equator:
    - Use 18/0 or larger circle hooks with no more than 10° offset (50 CFR 665.813(b)).
    - Use mackerel-type bait (50 CFR 665.813(b)).
    - Set at night for stern set vessels (50 CFR 665.815(a)).

A summary of regulations for Hawaii longline fisheries (shallow-set and deep-set combined), including requirements specific to sea turtles, is provided in NMFS (2022).

1.2.4 Sampling Captured Sea Turtles

Incidental captures in commercial fisheries are addressed as a threat in the marine environment in the Pacific Sea Turtle Recovery Plan and Status Review for loggerhead sea turtles. Gathering scientific data from incidentally captured turtles helps NMFS to better meet the goals of sea turtle recovery and protection outlined in those documents. The collection of these data will contribute to the objectives identified in the North Pacific Loggerhead Recovery Plan (NMFS and U.S. Fish and Wildlife Service [USFWS] 1998), specifically objective 2.1.2, determine distribution, abundance and status in the marine environment; and Objective 2.1.4, monitor and reduce incidental mortality in the commercial and recreations fisheries. Therefore, NMFS considers the collection of these data as a part of the proposed action. The scientific data collected from captured turtles will be applied to methods used to mitigate incidental take. This research is designed to provide information to aid in the development of methods to reduce sea turtle interactions with longline fishing gear. Steps taken to reduce sea turtle interactions with fishing gear will help mitigate this threat to current populations. Data collection will be conducted by trained observers on all captured and landed turtles for which it is practicable, will follow the best management practices in Appendix A, and will include:

- Measuring carapace length
- Photographing
- Applying flipper tags
- Taking skin biopsies
- Applying satellite tags

Carapace lengths provide information on the size/age classes interacting with the fishery which is critical to understanding the population-level impacts of the fishery. Photographs help to confirm species and identify extents of injury, which influence post-interaction survival. Passive flipper tags provide invaluable information on individual growth, survival and movements for recaptured turtles. Genetic analysis of skin biopsies helps to identify which source populations are interacting with longline fishing activity. Identifying source populations will help determine the pelagic distribution of these turtles. Incidental takes of certain source populations may represent a greater threat towards long term goals for species recovery.

Utilization of satellite transmitters will also help provide critical information on post-hooking mortality of turtles, diving behavior, and determining individual migratory routes on turtles that have interacted with longline gear. Satellite tracking of individual loggerheads in the North Pacific waters has already proven useful for investigating migratory pathways of mature turtles (Sakamoto et al. 1997). Post-release mortality of incidentally captured animals has been analyzed in various studies. The satellite tracking of 40 loggerheads released alive in the Hawaii-based longline fishery suggests that there is a difference between the survival functions of transmitters attached to deep and light hooked turtles (Chaloupka 2004). Additional studies by Parker et al. (2001) have examined the post-hooking survival of sea turtles taken by the pelagic longline fishing in the North Pacific. Satellite transmitters are available in small quantities and deployment opportunities are limited, therefore it is not anticipated that all captured and landed loggerheads will be tagged, however efforts will be made to tag as many as practicable given the availability of tags and time restrictions for observers' ability to deploy the tags.

1.3 Action Area

The action area is defined by regulation as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). The action area for the proposed activities encompasses the full extent of the action's modifications to land, water, and air. For this action, the full extent of direct and indirect effects is the area where SSLL vessels actively fish as well as where they transit to and from fishing areas to ports.

The SSLL fishery operates almost entirely north of Hawaii. In some years, depending on seawater temperature, this fishery may operate mostly north of 30° N. Fishing from 2012-2021 has occurred between 180°- 124° W and 10°- 46° N (Figure 2), and more recent fishing (2022) has not exceeded these boundaries (Figure 3). Longline fishing is prohibited year-round by Federal regulations in several areas, including the EEZ seaward of California (50 CFR 660) and the MHI Longline Fishing Prohibited Area (50 CFR 665); thus active fishing does not occur in these areas, but vessels do transit through them to and from ports. Hawaii SSLL vessels transit to ports of Honolulu, Long Beach, San Francisco, and San Diego.

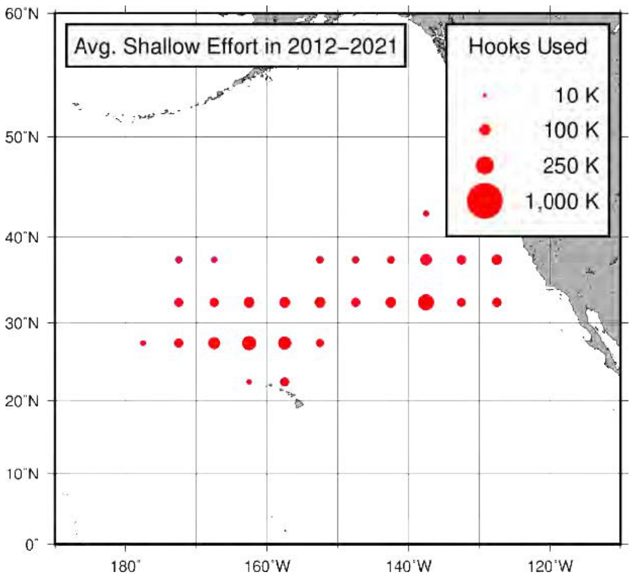

Figure 2. Spatial distribution of the average number of shallow-set hooks set by longline vessels based in Hawaii and California fishing within the North Pacific Ocean, 2012-2021 (NMFS 2023a).

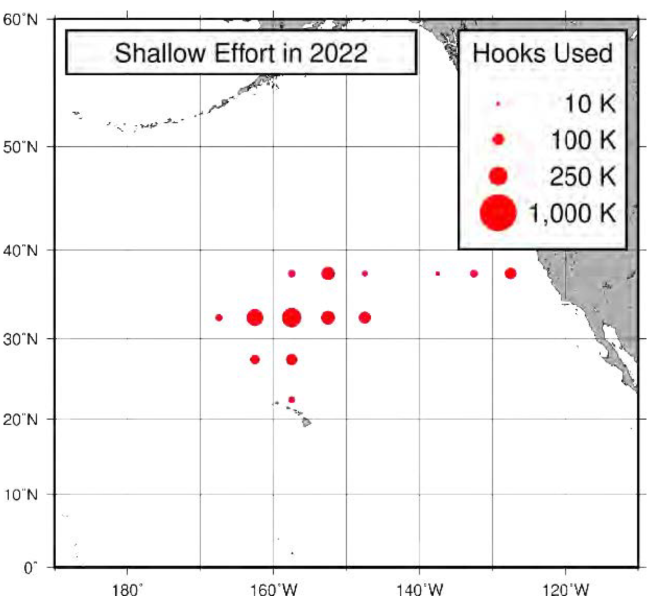

Figure 3. Spatial distribution of the number of shallow-set hooks set by longline vessels based in Hawaii and California fishing within the North Pacific Ocean, 2022 (NMFS 2023a).

1.4 Analytical Approach

NMFS has previously determined the proposed action may affect but is not likely to adversely affect those species and critical habitat listed in Table 4 of the 2019 biological opinion (NMFS 2019) with the exception of the leatherback sea turtle, the North Pacific loggerhead sea turtle, the olive ridley sea turtle (both threatened and endangered populations), the green sea turtle (six specified DPSs), the oceanic whitetip shark, the giant manta ray, and the Guadalupe fur sea; that not likely to adversely affect determination is still valid. The operation of the SSLL fishery is likely to adversely affect the remaining species/DPSs specified in the preceding sentence, and with the exception of the North Pacific loggerhead sea turtle, the ITS for these species specified in the 2019 biological opinion (NMFS 2019) remains valid. As noted previously, the SSLL fishery exceeded the North Pacific loggerhead sea turtle ITS of the 2019 biological opinion (NMFS 2019) on April 2, 2023 and we focus this supplemental biological opinion on that DPS.

This biological opinion includes a jeopardy analysis, the jeopardy analysis relies upon the regulatory definition of jeopardize the continued existence of a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species:

- Evaluate the range wide status of the species expected to be adversely affected by the proposed action
- Evaluate the environmental baseline of the species
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach
- Evaluate cumulative effects
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species, analyze whether the proposed action is likely to directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action

We used available data to describe the Hawaii SSLL fishery location and its stressors. Interactions by hooking, entanglements, and landings represent the best data available on the Hawaii SSLL fishery because it has been collected under 100% observer coverage since 2004.

The stressors associated with the SSLL fishery produce responses that range from exposed but not adversely affected (such as opportunistic successful depredation of bait or catch), to accidentally being hooked and released alive unharmed, hooked and released injured, and death (immediate, or later in time following injury). Survival from injury is a function of an individual's prior health condition, environmental conditions, severity of injury, indicators of the severity of stress and injury (such as manner of capture, handling and release), and other variables (Swimmer and Gilman 2012; Hall and Roman 2013).

We analyzed historic interactions rates, including the severity of those interactions, to inform our estimation of probable future interactions. The Hawaii-based longline fishery was split up to become the SSLL and DSLL fisheries in 2004 following a three year closure of the shallow-set portion of the fishery. Therefore, the analysis presented in the biological evaluation (NMFS 2023a) used data from 2005 to 2023 to analyze effects of the action as 2005 was the first complete fishing year with 100% observer coverage following the 2001 to 2004 SSLL fishery closure. We have observed incidental captures in the SSLL through 2023, hence our analysis of the demographic, spatial and temporal effects of the fishery in this biological opinion focus on observed incidental captures from 2003 to 2022 and the partial year of 2023. The SSLL operated under hard caps for loggerhead and leatherback sea turtle until 2019, and continues to operate under a hard cap for leatherback sea turtles. The hardcaps were reached and the fishery was shut down in 2006, 2011, and 2019. The fishery also closed in May 2018 pursuant to a settlement agreement; therefore, the captures in 2006, 2011, 2018 and 2019 are not representative of a full year of fishing. In their BE, NMFS (2023a) applied linear regressions to estimate what the full captures would have been in those years and we apply that approach in our Effects Analysis. In conducting our calculations, for the maximum 5-year running average and running sum, we used the observed capture numbers from 2004, 2005, 2007 – 2010, 2012-2017, and 2023, and extrapolated capture numbers for 2006, 2011, 2018, and 2019.

Our risk analysis assesses how changes in the viability of populations of threatened or endangered species affect the viability of the species those populations comprise (measured using probability of demographic, ecological, or genetic extinction in 10, 25, 50 or 100 years). For the analysis in the biological opinion, we used 40 years because we have adequate information about population trends, interaction rates, and effects from interactions to reasonably predict the action's effects over that timeframe.

2 STATUS OF THE LISTED RESOURCES

This opinion examines the status of the North Pacific loggerhead sea turtle. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' reproduction, numbers, or distribution for the jeopardy analysis.

2.1 Climate Change

Future climate will depend on warming caused by past anthropogenic emissions, future anthropogenic emissions and natural climate variability. NMFS' policy (NMFS 2016a) is to use climate indicator values projected under the Intergovernmental Panel on Climate Change (IPCC)'s Representative Concentration Pathway (RCP) 8.5 when data are available or best available science that is as consistent as possible with RCP 8.5. RCP 8.5, like the other RCPs, were produced from integrated assessment models and the published literature; RCP 8.5 is a high pathway for which radiative forcing reaches >8.5 W/m^2 by 2100 (relative to pre-industrial values) and continues to rise for some amount of time. A few projected global values under RCP 8.5 are noted in Table 2. Presently, the IPCC predicts that climate-related risks for natural and humans systems are higher for global warming of 1.5 ºC but lower than the 2 ºC presented in Table 2 (IPCC 2018, 2022). Changes in parameters will not be uniform, and IPCC projects that areas like the equatorial Pacific will likely experience an increase in annual mean precipitation under scenario 8.5, whereas other mid-latitude and subtropical dry regions will likely experience decreases in mean precipitation. Sea level rise is expected to continue to rise well beyond 2100 and while the magnitude and rate depends upon emissions pathways, low-lying coastal areas, deltas, and small islands will be at greater risk (IPCC 2018, 2022).

Table 2. Projections for certain climate parameters under Representative Concentration Pathway 8.5 (values from Table 2.1 IPCC 2014; see Figure 3.4 in IPCC 2022). Shown are the results for two scenarios (2046 to 2065 and 2081 to 2100) with the mean and likely range for temperature and sea level rise.

Projections	Years 2046-2065	Years 2081-2100
Global mean surface temperature change (ºC)	2.0 (1.4-2.6)	3.7 (2.6-4.8)
Global mean sea level increase (m)	0.30 (0.22-0.38)	0.63 (0.45-0.82)

In this assessment we rely on systematic assessments of available and relevant information to incorporate climate change in a number of ways. We address the effects of climate, including changes in climate, in multiple sections of this assessment: Status of the Listed Resources (Section 2), Environmental Baseline (Section 3), and Integration and Synthesis (Section 6). In the Status of Listed Resources and the Environmental Baseline we present an extensive review of the best scientific and commercial data available to describe how the listed species and its designated critical habitat is affected by climate change—the status of individuals, and its demographically independent units (subpopulations, populations), and critical habitat in the action area and range wide.

We do this by identifying species sensitivities to climate parameters and variability, and focusing on specific parameters that influence a species health and fitness, and the conservation value of their habitat. We examine habitat variables that are affected by climate change such as sea level rise, temperatures (water and air), and changes in weather patterns (precipitation), and we try to assess how species have coped with these stressors to date, and how they are likely to cope in a changing environment. We look for information to evaluate whether climate changes effects the species' ability to feed, reproduce, and carry out normal life functions, including movements and migrations.

We review existing studies and information on climate change and the local patterns of change to characterize the Environmental Baseline and Action Area changes to environmental conditions that would likely occur under RCP 8.5, and where available we use changing climatic parameters (magnitude, distribution, and rate of changes) information to inform our assessment. In our exposure analyses, we try to examine whether changes in climate related phenomena will alter the timing, location, or intensity of exposure to the action. In our response analyses we ask, whether and to what degree a species' responses to anthropogenic stressors would change as they are forced to cope with higher background levels of stress cause by climate-related phenomena.

2.2 Status of the Species

This section consists of a narrative for the North Pacific loggerhead sea turtle which may be adversely affected by the proposed action. This status summary provides the point of reference for our analysis of whether or not the action's direct and indirect effects are likely to appreciably reduce a species' probability of surviving and recovering in the wild. The narrative presents a summary of:

1. The species' distribution and population structure (which are relevant to the distribution criterion of the jeopardy standard)

2. The status and trend in abundance of the species and affected population(s) (which are relevant to the numbers criterion of the jeopardy standard)
3. Information on the reproduction of the species and affected population(s) (which is a representation of the reproduction criterion of the jeopardy standard)
4. Natural and anthropogenic threats to the species and/or affected population(s) (which helps explain our assessment of a species' likelihood of surviving and recovering in the wild)
5. Recent conservation activities for the species and/or affected population(s) (which also helps explain our assessment of a species' likelihood of surviving and recovering in the wild)

More detailed background information on the general biology and ecology of North Pacific loggerhead sea turtles can be found in the recovery plan (NMFS and USFWS 1998) and 5-year status review (NMFS and USFWS 2020). We incorporate this information by reference and provide an overview in the sections below. In the sections below, we note new studies that have occurred since the last status review or that were not included in the status review.

2.2.1 North Pacific Loggerhead Sea Turtle

We listed loggerhead sea turtles as threatened on July 28, 1978 (43 FR 32800). On 9/22/2011, NMFS and the USFWS replaced the global loggerhead sea turtle listing with DPSs (76 FR 58868). These 9 DPSs are demographically, spatially, and genetically independent. As a result, they have been listed as separate "species" for the purposes of the ESA. Four of these DPSs are listed as threatened and five are listed as endangered. Of these nine DPSs, only one, the endangered North Pacific loggerhead sea turtle, is expected to interact with the SSLL fishery. The last 5-year review for the North Pacific loggerhead sea turtles (NMFS and USFWS 2020) reaffirmed the endangered listing. A DPS-specific recovery plan had not yet been drafted and therefore we rely on the original 1998 recovery plan (NMFS and USFWS 1998).

<u>Distribution and Population Structure</u>

North Pacific loggerhead sea turtles occur north of the equator in the Pacific Ocean (Figure 4). We incorporate by reference pages 11 through 14 and 24 through 26 of the status review (NMFS and USFWS 2020) and briefly summarize it here along with information not included in the status review.

Like all sea turtles, North Pacific loggerhead sea turtles exhibit a complex life cycle that contains several life stages (i.e., hatchling, pelagic juvenile, neritic juvenile, and adult) occurring across wide-spread and diverse habitats. Almost all nesting occurs in Japan (NMFS and USFWS 2020, page 11); some nesting may occur at low levels outside of Japan in areas surrounding the South China Sea (Chan et al. 2007; Wang and Li 2008; Conant et al. 2009) although this has not been confirmed recently (Jia et al. 2019). Hatchlings emerge between July and September, and will eventually migrate to forage in parts of the central and eastern North Pacific Ocean using the North Pacific Gyre, including the Kuroshio Extension and the Kiroshio Current to assist their movements (NMFS and USFWS 2020, page 12). Foraging North Pacific loggerhead sea turtles occur in the eastern Pacific as far south as Baja California Sur, Mexico and in the Western Pacific in the South and East China Seas and as far south as the Philippines and Malaysia (NMFS and USFWS 2020, pages 12 through 14; Kim et al. 2023). After years spent foraging and maturing in oceanic habitats, some juveniles recruit to neritic habitats in either the West or East

Pacific while others remain in oceanic habitats until reaching maturity (NMFS and USFWS 2020, pages 12 through 14). Briscoe et al. (2021) suggest that intermittent thermal corridors between the Central North Pacific and the eastern North Pacific enable pulsed recruitment to neritic habitats in the eastern North Pacific. Once mature, North Pacific loggerheads return to waters off their natal beaches to mate. Adults display two main foraging strategies that imply differential distribution, feeding on planktonic prey in oceanic waters of the Northwest Pacific or on benthic prey in neritic waters of Japan and the East China Sea (NMFS and USFWS 2020, pages14 through 15; Okuyama et al. 2022; Fujita et al. 2023). Okuyama et al. (2022) stress the importance of the East China Sea for adult North Pacific loggerheads and the need to elevate conservation efforts in this area. Fujita et al. (2023) used satellite tags to confirm these foraging strategies and make inferences regarding time spent foraging in each habitat.

There appears to be a meaningful substructure in the North Pacific loggerhead sea turtle such that it is comprised of at least three subpopulations[4] (NMFS and USFWS 2020, pages 24 through 26):

- Mainland (Chiba, Shizuoka, Minabe/Ise Bay, Shikoku, Miyazaki/Shibushi Bay)
- Yakushima
- Ryukyu (Amami, Okinoerabu, and Okinawa Islands).

The genetic data that define the three subpopulations are characterized by at least two common mtDNA haplotypes that occur at different frequencies but have too much overlap to differentiate in the fishery using a mixed stock analysis from the sample size from the Hawaii SSLL fishery (P. Dutton pers. comm. July 24, 2018) and we therefore assume loggerhead sea turtles captured in the SSLL may come from any of these subpopulations.

[4] Note that we use subpopulation here for clarity and to be consistent with the status review (NMFS and USFWS 2020). Based on the analytical approach outlined in Section 1.4, our analysis assesses how changes in the viability of *populations* of listed species affect the viability of the species. In this case, the North Pacific loggerhead sea turtle DPS is the species, and the subpopulations discussed in this section would represent the *populations* in our analysis.

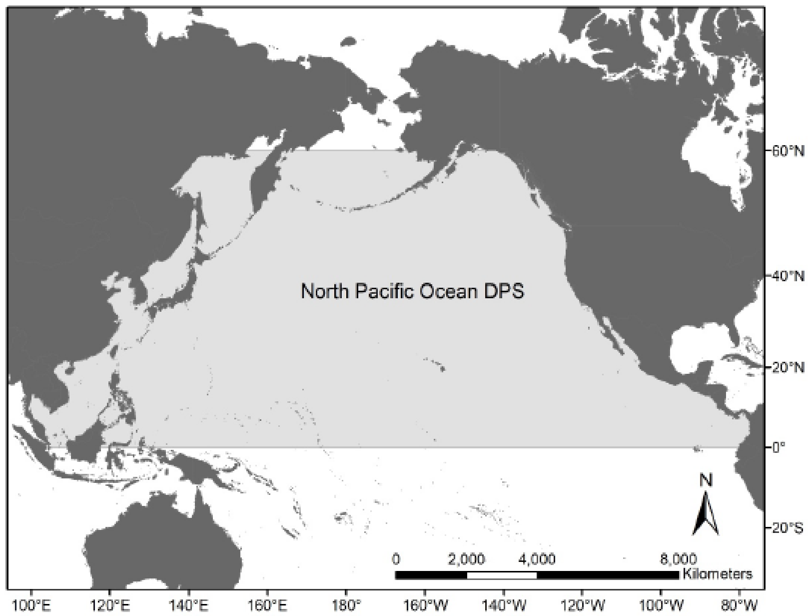

Figure 4. Range of the North Pacific loggerhead sea turtle.

Status and Trends of Abundance

NMFS and USFWS (2020) rely on the assessment conducted by Martin et al (2020) to assess status and trends of the North Pacific loggerhead turtle and we summarize the key findings of Martin et al. (2020) here. Martin et al. (2020) used a Bayesian state-space model to estimate a long-term trend from nest count data for North Pacific loggerhead sea turtles. They used data from three index beaches in Japan, Maehama, Inakahama, and Yotsusehama, from 1985 to 2015. We note that as of 2023, no additional nesting beach data are available from Japan to update this assessment. The nest count data was converted to nester count data by dividing the number of nests each year by the mean clutch frequency (4.6 nests per female; Hatase et al. 2013). Based on estimates derived from their trend analysis, Martin et al. (2020) calculated an abundance "snapshot" of 4,541 nesting females (95 % CI: 4,074 to 5,063) using those three beaches. Because these beaches comprise approximately 52 percent of the total nesting population, the extrapolated 2015 total nesting abundance for the entire DPS is approximately 8,733 nesting females (95 % CI: 7,834 to 9,736 nesting females). Using a sex ratio of 65% female (Martin et al. 2020) suggests the DPS is comprised of approximately 13,435 (8,733*100/65) adults.

Results of the model suggest that the adult female portion of the North Pacific loggerhead sea turtle population is increasing at a rate of 2.3% per year (95% CI: -11.1 to 15.6%; Figure 5). These trends will not necessarily represent the true growth rate of the population because annual nester counts, which represent the bulk of data on turtles, only represent a portion of the population, specifically, adult females. However, as this is the only estimate of population growth available for this DPS, we consider it the best available scientific information to describe trends.

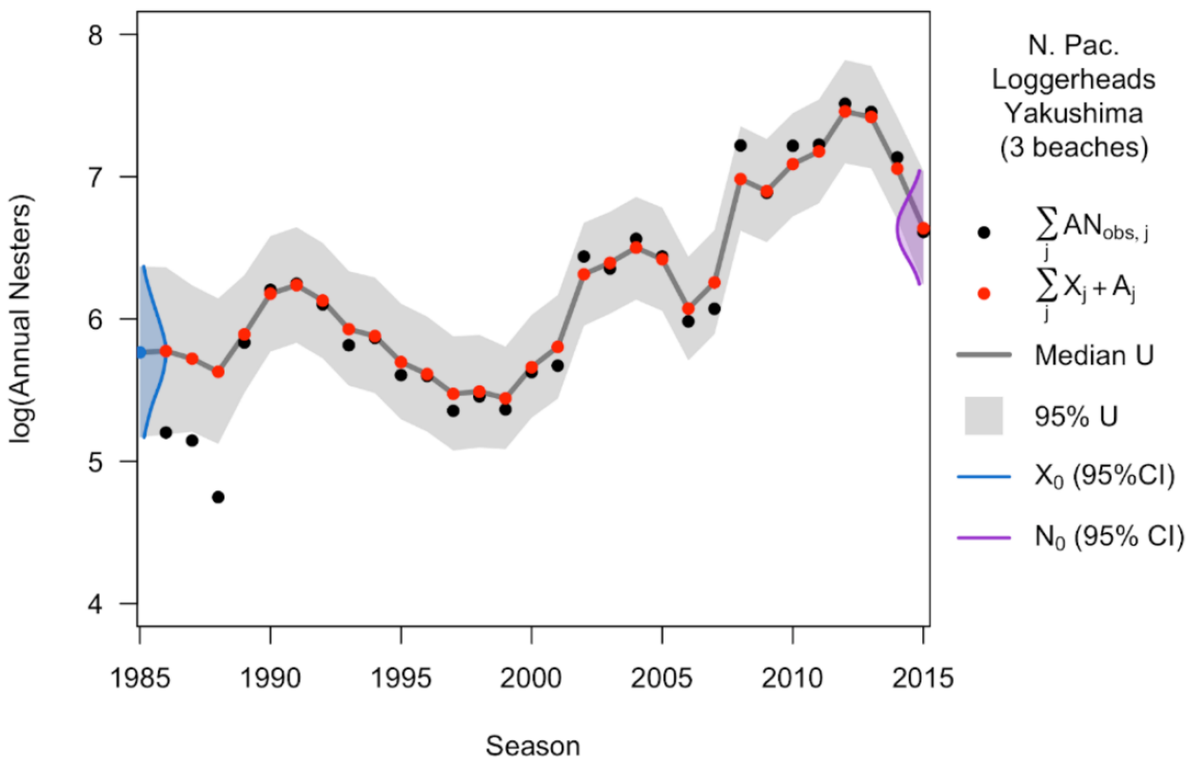

Figure 5. Model of nesting trends from 1985 to 2015 (Figure 7 from Martin et al. 2020). The gray line (median U) depicts the median long-term trend. The gray shading depicts the 95 percent credible interval of the model fit. Observed data are shown in black and model-predicted data are shown in red. The purple line (N0) depicts the distribution around 2015 model-predicted data.

As noted previously, there are no updated nesting data available for the primary nesting beaches in Japan that are more recent than 2015, or about eight years ago, and the trend in the intervening years is not known. Okuyama et al. (2020) present loggerhead, green, and hawksbill sea turtle nesting data from 1993 to 2018 for a small island, Ishigakijima, within the Yaeyama Islands in the southern Japanese EEZ. While the nesting trends for green and hawksbill sea turtles were relatively stable over this timeframe, loggerhead nesting generally declined and no nests or false crawls (adult female emergences on nesting beaches that do not result in a nest) were observed in 2018 (Figure 6). Without effort data we cannot assess trends for these data, however the relatively stable trends for green and hawksbill sea turtles indicate that since beach monitoring was continuing with sufficient effort to detect those species, it seems reasonable that loggerheads would have been observed if they were present. Okuyama et al. (2020) suggest that increasing water temperatures around the islands have pushed temperate loggerheads to more northern beaches, which is possible. However, given the lack of data for the primary nesting beaches and the observation of a more recent declining trend through 2018 for Ishigakijima, we use caution in our assessment of trends for the North Pacific loggerhead sea turtle. As noted above, we consider the mean and 95% CI for nesting beach trends from Martin et al. (2020) to be the best available information, however we will analyze the range of possibilities that the population has only remained stable (0% per year population growth since 2015) to the mean (2.3% per year increase) in our assessment to account for the possibility that the trend in the DPS has not continued to increase.

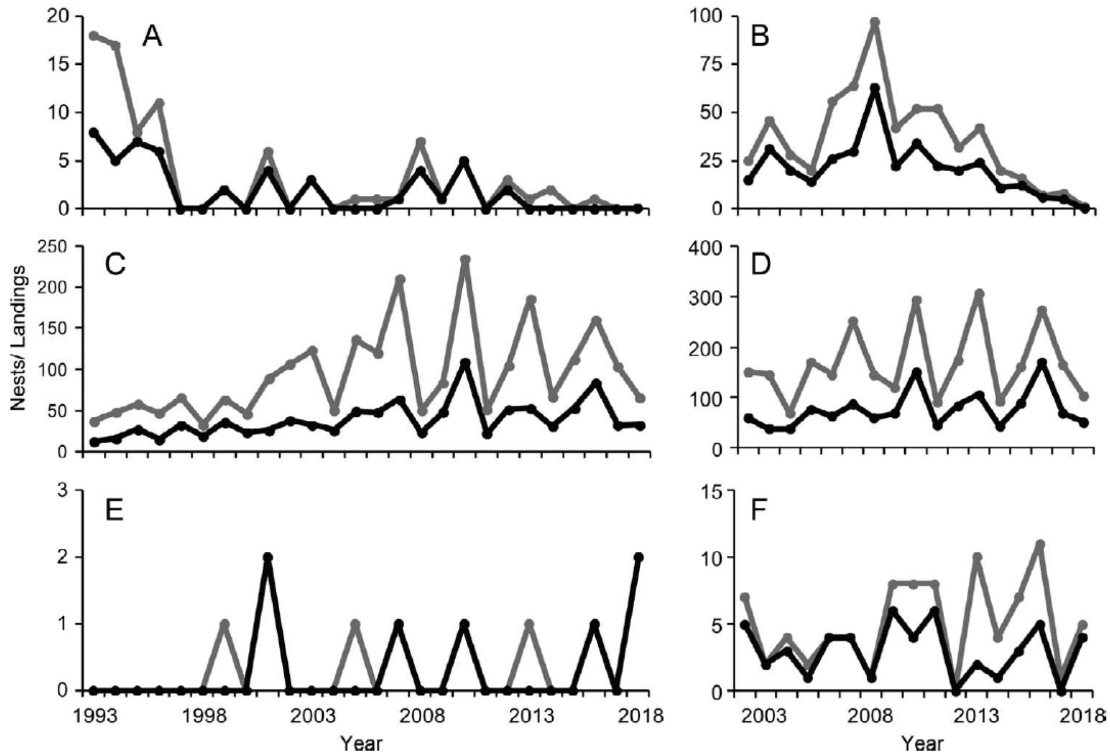

Figure 6. Nesting (black lines) and false crawls (gray lines) for loggerhead (A, B), green (C, D), and hawksbill (E, F) sea turtles on Ishigakijima Island, Japan. A, C and E show data from 1993 to 2018 for Ibaruma beach only; B, D and F show data from 2002 to 2018 collected at 6 nesting beaches around the island (data from Figure 2 of Okuyama et al. 2020).

<u>Reproduction</u>

We incorporate by reference pages 15 through 16 and 21 through 22 of the status review (NMFS and USFWS 2020) and briefly summarize it. Males enter the waters off nesting beaches starting in January before females arrive in April or May. Mating likely occurs at foraging areas, in migratory corridors, or off nesting beaches. Peak nesting occurs in June.

Females make reproductive migrations every 3.3 years, laying 4.6 nests per year, with an average of 122 eggs per nest. Age to maturity is uncertain. Martin et al. (2020) analyzed the data of Turner-Tomaszewicz et al. (2015) along with nesting female sizes from Hatase et al. (2002) to estimate 37.9 years to maturity.

<u>Threats to Species</u>

We incorporate by reference pages 28 through 52 of the status review (NMFS and USFWS 2020). Below we list the impacts identified as threats to North Pacific loggerheads and provide specific page numbers in NMFS and USFWS (2020) where details, references and justifications may be found:

- Loss of marine and terrestrial habitat (NMFS and USFWS 2020 concluded a moderate level of threat to DPS that may rise to major with rising sea levels)

    - Beach erosion resulting from typhoons, storm surges, high tides, waves, changes in shoreline geology, and sea level rise (pages 28 through 30)
    - Shoreline structures and coastal development (pages 28 through 30)
    - Artificial lighting from coastal structures and vehicles (pages 30 through 31)
    - Beach use (page 31)
        - Sand compaction from trampling
        - Ruts from vehicles impede hatchlings from reaching the ocean
    - Beach debris (page 31)
    - Marine debris (page 32)
    - Direct or indirect disposal of contaminants (i.e. herbicides, pesticides, and oil; pages 32 through 33)
- Direct harvest (NMFS and USFWS 2020 concluded a moderate level of threat to DPS)
    - Historic egg collection in Japan; recent laws now prohibit collection (page 33)
    - In-water harvest of loggerheads currently legal in Japan with a permit (page 33)
    - Historic wide-spread harvest of juveniles in Mexico, in spite of a ban on directed take, poaching is likely continuing but the extent is unknown (pages 33 through 34)
    - Relocation of nests for educational purposes, results in lower hatchling emergence rates (page 34)
    - Retention of hatchlings for tourism release events, likely results in lower survival rates (page 34)
- Disease or predation (NMFS and USFWS 2020 concluded a low level of threat to DPS)
    - Little information on North Pacific loggerheads but other loggerhead populations are known to be impacted from bacterial and viral diseases and endoparasite loads (page 35)
    - Fibropapillomatosis has not been observed in North Pacific loggerheads (page 35)
    - Algal blooms may be an issue in the Gulf of Ulloa, Mexico (page 35)
    - Known predators of loggerhead nests in Japan include raccoon dogs, weasels, Japanese fox, wild boar, and the Ryuku odd-tooth snake. Where predation is known to occur at index beaches, nests are often protected with wire cages (page 35)
    - Tiger sharks are known predators of hatchling and juvenile loggerheads (page 35)
- Fisheries bycatch; NMFS and USFWS (2020) concluded that fisheries bycatch is the greatest present threat to the DPS. We include NMFS and USFWS (2020) threat assessment levels for the individual fisheries below:
    - Western North Pacific

        - Japanese pound net fishery – high threat (page 41)
        - Japanese longline fishery – moderate threat (page 42)
        - Japanese gillnet fishery – threat but level undefined (pages 42 through 43)
        - Japanese trawling fishery - threat but level undefined (page 43)
        - Japanese purse seine fishery - threat but level undefined (page 44)
        - Japanese pole and line fishery - threat but level undefined (page 44)
        - Japanese troll fishery - threat but level undefined (page 44)
    - Central North Pacific
        - Illegal, unreported, and unregulated (IUU) fishing - moderate threat (page 45)
        - U.S. deep-set longline fishery – low threat (pages 44 through 45)
        - International longline fisheries – low threat (page 45)
    - Eastern North Pacific
        - Mexican gillnet fishery – high threat (page 46)
        - Mexican longline fishery – high threat (pages 46 through 47)
        - Other Mexican fisheries – low to moderate threat (page 47)
        - U.S. drift gillnet fishery – low threat (page 47; the Driftnet Modernization and Bycatch Reduction Act became law in January 2023 and this will phase out the use of large-mesh drift gillnets in federal waters off of California by 2027; California state law will terminate their use in state waters in 2024)
- Climate change, storm events, and ocean features; NMFS and USFWS (2020) conclude that climate change is currently a major threat to the DPS and that, in the near future, it may rival fisheries bycatch as the greatest threat to the DPS.
    - Sea level rise and increased storm events (pages 49 through 50)
    - Temperature increases and changes in ocean circulation patterns (pages 50 through 51)
    - Ocean acidification and reduced prey availability (pages 51 through 52)

In addition to the fisheries noted in NMFS and USFWS (2020), we also note that North Pacific loggerheads are likely captured in the Eastern Pacific purse seine fisheries. Thirty interactions with loggerhead sea turtles are estimated to occur in the U.S. Eastern Tropical Pacific purse seine fishery, with one mortality expected every seven years (NMFS 1999, 2004). Given the location of the fishery, these are likely to be North Pacific loggerhead sea turtles.

<u>Recent Conservation Activities</u>

Considerable effort has been made since the 1980s to document and reduce loggerhead bycatch in Pacific Ocean fisheries which is the highest conservation priority for the DPS. Information on these efforts was summarized by NMFS and USFWS (2020) and we incorporate by reference the following information from that status review: pages 36 through 38, which details existing laws, regulations, and international conventions designed to protect loggerhead sea turtles; and pages 39 to 47, which details national (Japan, Mexico and the U.S.) and international efforts to reduce sea turtle bycatch in fisheries.

In addition to conservation measures discussed in NMFS and USFWS (2020), the WCPFC adopted Conservation and Management Measure (CMM) 2018-04, which became effective in January 2020 and specifies measures to minimize sea turtle bycatch in the WCPO purse seine and longline fisheries, and includes safe handling and release protocols for captured sea turtles.

As a result of these designations and agreements, many of the intentional impacts on sea turtles have been reduced: harvest of eggs and adults have been slowed at several nesting areas through nesting beach conservation efforts and an increasing number of community-based initiatives are in place to slow the take of turtles in foraging areas. Moreover, while, as discussed in the Threats section, bycatch in some of the coastal fisheries in Mexico and Japan continue to be an issue, there are increasing international efforts to reduce sea turtle interactions and mortality in artisanal and industrial fishing practices (Gilman et al. 2007b; Peckham et al. 2007; Ishihara et al. 2014).

3 ENVIRONMENTAL BASELINE

The environmental baseline is defined by regulation (50 CFR 402.02). It refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

North Pacific loggerhead sea turtles within the Action Area are primarily juveniles or subadults using pelagic foraging habitats; there is no nesting or near-shore foraging within the Action Area. However, recruitment of hatchlings from the nesting beaches in Japan to the North Pacific foraging habitats is the key driver of the status and trend of this segment of the population and therefore, nest trends and the threats to nesting females, nesting beaches, eggs and hatchlings discussed in the Species Status section are relevant to the status of loggerhead turtles in the Action Area. Aside from recruitment of juveniles to the North Pacific foraging areas, the greatest impacts to the status and trends of loggerhead sea turtles in the Action Area are from past and present fishery bycatch and climate change, with minor impacts from vessel traffic (vessel strike and noise), other anthropogenic noise sources, marine pollution and marine debris. We detail each of these categories below.

3.1 Climate Change

For climate change impacts within the Action Area, we incorporate by reference pages 50 to 52 of the status review and the references therein (NMFS and USFWS 2000). We also include new information or information not covered in the status review. Briefly, the primary impacts from climate change with the Action Area are changes in turtle and prey distributions driven by changes in sea surface temperatures (SST), nutrient concentrations and currents (NMFS and USFWS 2020). Increasing SST may result in changes to large-scale and periodic climate patterns, such as the Pacific Decadal Oscillation (PDO) and El Niño Southern Oscillation (ENSO). Loggerhead prey availability varies greatly between the phases, as does loggerhead population abundance and productivity. For example, the strong Kuroshio Extension Current during negative phases of the PDO prohibits hatchlings from reaching the Transition Zone Chlorophyll Front (TZCF) and pushes post-hatchlings into more southern and less productive forage habitat (Ascani et al. 2016). This can both lower recruitment and increase potential overlap with fisheries (Kobayashi et al. 2008, Ascani et al. 2016). During positive phases of the PDO, the Kuroshio Extension Current weakens and post-hatchlings are able to reach more productive habitats (Ascani et al. 2016; see Figure 7 for an overview of the primary North Pacific Currents).

It is anticipated that negative phases of the PDO are likely to increase with climate change (Polovina et al. 2011; Navarra and Di Lorenzo 2021) which may make it more difficult for post-hatchlings to reach highly productive waters, reducing future juvenile recruitment rates into the Central North Pacific foraging area. Figure 8 shows the PDO since 1985 with the loggerhead nesting trend from Martin et al. (2020). If the loggerheads that interact with the SSLL average about 13 yrs old (see Section 4.2.1 and Figure 19), the majority of juvenile turtles captured in 2023 would be from about the 2010 nesting cohort and would have experienced negative phases of the PDO as post-hatchlings migrating into the North Pacific (Figure 8), with strong Kuroshio Currents pushing them into more southern latitudes and potentially higher overlap with the SSLL fishery (Ascani et al. 2016).

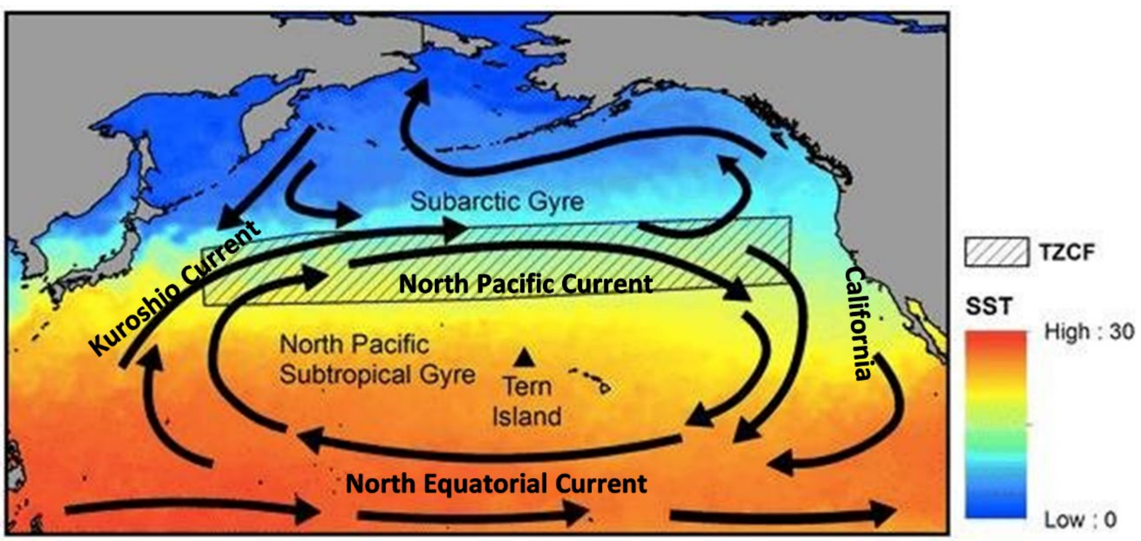

Figure 7. Diagram of the main currents forming the North Pacific Subtropical Gyre and the location of the Transition Zone Chlorophyll Front (TZCF) shown as the hatched area. Map adapted from Daviot (2017).

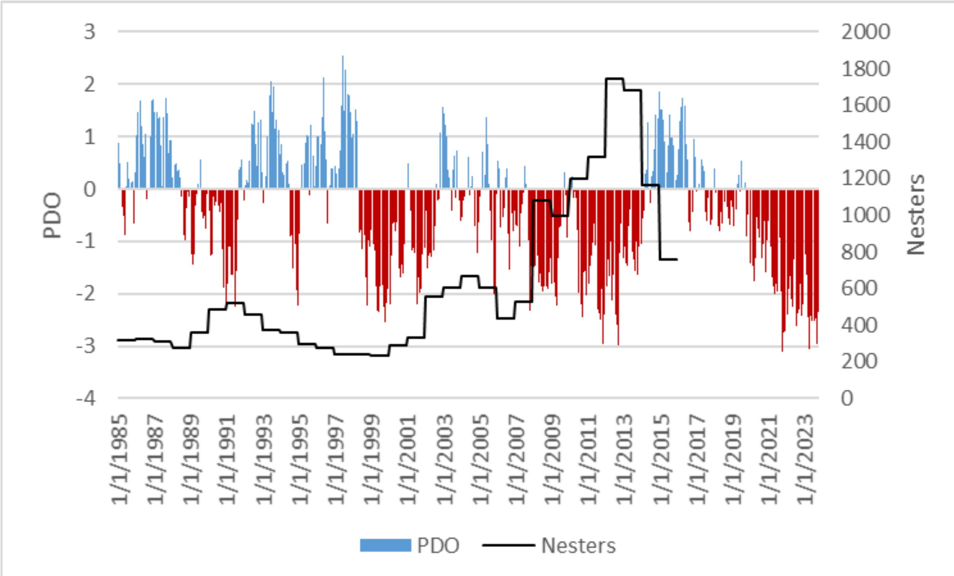

Figure 8. Monthly PDO measures from January 1985 to October 2003, with blue bars indicating positive PDO and red bars indicating negative PDO (left axis). The black line are the estimates of annual nesting North Pacific loggerhead females numbers from Martin et al. (2000; right axis).

Climate change may also impact loggerhead prey resources. It is very likely that the ocean has taken up 20 to 30 percent of total anthropogenic carbon dioxide emissions since the 1980s, leading to ocean acidification rates of 0.017 to 0.027 per decade since the late 1980s (IPCC 2022). There is high confidence that increasing ocean acidification and oxygen loss have negatively impacted two of the most productive ocean ecosystems: the California and Humboldt Currents (IPCC 2022). Loggerhead turtles often prey on shell-forming (i.e., calcifying) organisms, therefore ocean acidification may reduce the abundance of calcifying organisms and available prey. Other aspects of climate change may also influence the availability of prey for the DPS. For example pelagic red crabs, which are a key forage species for loggerheads in the southern California Current, have undergone substantive changes in distribution and abundance due to ENSO events, reducing their availability to loggerheads (NMFS and USFWS 2020).

Environmental changes associated with climate change are occurring within the Action Area and are expected to continue into the future. Negative affects currently occurring and likely to continue to occur include ocean current patterns that do not allow access to favorable forage habitats and overall reduced prey availability. Environmental changes associated with climate change outside of the Action Area will also affect the abundance and trend of North Pacific loggerheads in the action area by impacting nesting habitat, nest success rates and sex ratios. North Pacific loggerhead turtles are already at risk due fishery threats and these threats will be increased by the direct and indirect effects of climate change.

3.2 Fishery Interactions

The main fisheries that occur in the Action Area and that have measurable effect on North Pacific loggerhead sea turtles are fisheries for highly migratory species using longline and purse seine gear. Key target species for these fisheries are tuna (albacore, bigeye, skipjack, and yellowfin), swordfish, and marlin. Fisheries that use both types of gear have occurred in the western and central Pacific Ocean since the 1950s (for longline fisheries; 1980s for purse seine fisheries), and fisheries managers have, since 2004, been collecting robust data that can be used to assess the impacts of these fisheries on endangered and threatened species in the North Pacific Ocean generally, and in the Action Area specifically.

3.2.1 International Fisheries

The Action Area overlaps with the management areas of two Regional Fishery Management Organizations (Figure 9): in the western portion of the Action Area, the WCPFC manages fisheries for highly migratory species targeted by 26 nations, 7 territories, and 7 cooperating non-member nations. In the eastern portion of the Action Area, the Inter-American Tropical Tuna Commission (IATTC) manages fisheries for highly migratory species targeted by 21 nations and 5 cooperating non-member nations. We highlight data from the WCPFC and IATTC to provide insights into the impacts of fisheries for highly migratory species on North Pacific loggerhead sea turtles in the Action Area. Longline fisheries operating in the Action Area, such as the Taiwan and China tuna fisheries, likely have bycatch rates several times higher than the U.S. fisheries (Kaneko and Bartram 2008; Chan and Pan 2016). Lewison et al. (2004) estimated 2,600–6,000 loggerhead sea turtle juvenile and adult mortalities occurred from pelagic longlining in 2000. However, important international CMMs have likely reduced bycatch in international fleets in recent years. Using effort data from Lewison et al. (2004) and bycatch data from Molony (2005), Beverly and Chapman (2007) estimated loggerhead sea turtle and leatherback longline bycatch to be approximately 20% of that estimated by Lewison et al. (2004), or 520–1,200 juvenile and adult loggerhead sea turtles annually.

In 2015 a workshop was convened to analyze the effectiveness of sea turtle mitigation measures in the tuna regional fisheries management organizations and 16 countries provided data on observed sea turtle interactions and gear configurations (Common Oceans Tuna Project 2017). From 1989 -2015 those sixteen countries reported there were 549 observed loggerhead sea turtle captures with a total estimate of 10,980 loggerheads caught in the region from 1989-2016 from 16 countries. The U.S. reported 27% of those observed interactions, which we will describe in detail in the U.S. fisheries section below. We note the disproportionate number of U.S. fishery captures are due to the higher observer coverage rates in U.S. fisheries (100% for SSLL and 20% in the DSLL) compared to the WCPFC standard of 5%.

Peatman (2019) estimated that a total of 16,263 loggerheads were captured by WCPO longline fisheries between 2003 and 2017 north of 10°N, with an annual average of 1,084 (95% CI: 676 – 1493). Based on the observer data provided by WCPFC (WCPFC 2023), between 2013 and 2022 north of 10°N, an average of 51 (95% CI: 22-79) loggerheads were observed captured annually with an estimated 1,217 (95% CI: 636 – 1,855) annually when expanded for observer coverage. Of those, an average 74 (95% CI: 29-119) were dead at capture each year.

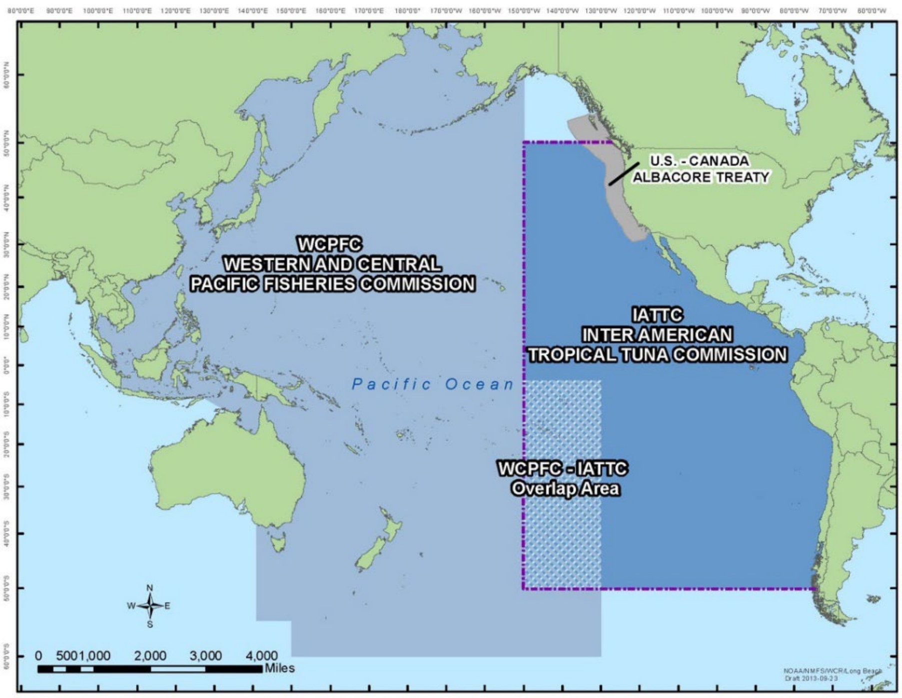

Figure 9. The boundaries of the WCPFC (west of the line) and the IATTC (east of the line).

3.2.2 Domestic Fisheries

In addition to the Hawaii SSLL fishery, the domestic federal Hawaii DSLL, West Coast DSLL and West Coast large mesh drift gillnet fisheries also occur in the Action Area. The Hawaii DSLL fishery overlaps partially on the north side of the MHI. The West Coast DSLL and large mesh drift gillnet fisheries partially overlap near the California EEZ.

In April 2004, the SSLL fishery reopened with new sea turtles mitigation requirements under a regulatory amendment, following a court-ordered closure between 2001-2004. Since 2004, the Hawaii SSLL fishery has had 100% observer coverage, which provides a robust data set of the number of interactions (i.e. hooking and entanglement) between that fishery and threatened and endangered species over 15 years. Data on interactions with listed species are available for a longer period; however, numbers of sea turtle interactions dropped considerably following the implementation of gear changes adopted with the reopening of the Hawaii SSLL fishery in 2004. Since then, interactions have declined by 95% for loggerhead sea turtles (Swimmer et al. 2017). Table 3 specifies the number of loggerhead sea turtles captured in the SSLL and DSLL from 2004 to 2022. NMFS (2023b) estimates that up to 43 loggerhead sea turtles will be captured by the DSLL over 5 years.

NMFS (2016b) estimates that the West Coast DSLL fishery will capture up to one loggerhead sea turtle every 10 years with one mortality. From 2005 to 2022, one loggerhead turtle was observed captured and was released alive. Observer coverage was 100% from 2005 to 2015 and has varied since then with coverage as low as 30%. Observer coverage was 30% in 2019, the year the loggerhead was observed captured. The West Coast large mesh drift gillnet fishery is estimated to capture up to 3 loggerhead sea turtles over 5 year, with one mortality (NMFS 2023c).

Table 3. Number of loggerhead sea turtles interacting with the Hawaii SSLL and DSLL fisheries between 2004 and 2022, inclusive of both dead and live releases. For the DSLL we report the number observed with the number estimated based on observer coverage in parentheses.

Observed turtle status	SSLL	DSLL
Hooked or entangled; released injured	248	10 (52)
Dead	3	9 (46)
Grand Total	251	19 (98)

3.2.3 Summary Fishery Interactions

As noted in the Status of Listed Resources section, coastal fisheries in Japan and Mexico present the primary threat from fisheries to the North Pacific loggerhead. Within the Action Area, the domestic and international longline and purse seine fisheries have resulted in interactions with the North Pacific loggerhead sea turtle in the Action Area. These activities are reasonably likely to continue and may increase over time due to the effects of increased human population, and increased human consumption of fish products.

3.3 Surface Vessel Traffic

The propensity of vessel strikes to go unnoticed or unreported by vessel operators impedes an accurate assessment of the magnitude this threat poses to ESA-listed species. Large container vessels represent a known threat to sea turtles. Vessel operated by the United States Navy and other governments are also a known threat to sea turtles. Within the Action Area, North Pacific loggerheads occur mainly in pelagic waters where vessel density is sparse. Therefore, we do not expect vessel strikes to significantly contribute to the extinction risk of this DPS.

3.4 Anthropogenic Noise

In addition to creating a risk of ship strike, much of the increase in sound in the ocean environment over the past several decades is due to increased shipping, as vessels become more numerous and of larger tonnage (NRC 2003; Hildebrand 2009; Mckenna et al. 2012). Shipping constitutes a major source of low-frequency (5 to 500 Hz) sound in the ocean (Hildebrand 2004), particularly in the Northern Hemisphere where the majority of vessel traffic occurs. While commercial shipping appears to be a primary source of anthropogenic noise pollution in the ocean, other sources of maritime traffic can also impact the marine environment. These include recreational boats, whale-watching boats, research vessels, and ships associated with oil and gas activities.

Seismic surveys, primarily for scientific research, have been conducted in the Action Area over the past several decades (NMFS 2018). These surveys use high energy sound sources operated in the water column to probe below the seafloor with acoustic energy. Endangered and threatened sea turtles have been reported to exhibit a variety of responses when exposed to sound fields associated with seismic airguns and echosounders. Avoidance behavior and physiological responses from airgun exposure may affect the natural behaviors of sea turtles (McCauley et al. 2000). McCauley et al. (2000) conducted trials with caged sea turtles and an approachingdeparting single air gun to gauge behavioral responses of green and loggerhead sea turtles. Their findings showed behavioral responses to an approaching airgun array at around two kilometers with avoidance occurring around one kilometer.

In 2018 NMFS completed a section 7 consultation on seismic surveys funded by the National Science Foundation in 2018 and 2019. They concluded that 61 North Pacific Ocean loggerhead sea turtles were expected to be harassed during the survey which was conducted within the US EEZ around Hawaii, outside of territorial waters, as well as the Emperor Seamounts in the North Pacific (NMFS 2018).

Although anthropogenic sounds may have adversely affected loggerhead sea turtles, within the Action Area, North Pacific loggerheads occur mainly in pelagic waters where vessel density and other sources of anthropogenic noise is sparse. Therefore, we do not expect anthropogenic noise within the Action Area to significantly contribute to the extinction risk of this DPS.

3.5 Pollution and Marine Debris

Many different types of pollution can adversely affect loggerhead sea turtles within the Action Area. There are three main categories of marine pollution: oil pollution, contaminants and pesticides, and marine debris. In this section, we describe these three pollution categories, the, exposure pathways and anticipated effects on endangered and threatened resources.

3.5.1 Oil Pollution

Hawaii's geographic isolation results in more energy requirements than it produces. More than four-fifths of Hawaii's energy comes from imported petroleum, making it the most petroleum-dependent state in the nation (U.S. EIA 2019; EPA 2022). Imported crude oil is refined at the PAR Pacific’s refinery on Oahu for distribution and use. Total petroleum imports ranged from 53 million barrels in 2006 to approximately 47 million barrels in 2019 (State of Hawaii 2022) with significant increases in domestic petroleum sources attributed to this rate of decline in use (EPA 2022).

Past oil and other spills that impacted the offshore marine environment of Hawaii within the Action Area are listed in as reported by the EPA (2022). Where available, information on the impacts to natural resources is summarized.

Table 4. Important recent spills in the Action Area. From the Hawaii Area Plan Section 9000-9 (October 2015) except where otherwise noted (EPA 2022).

Date	Spill Name/Location	Oil Type and Volume	Natural Resource Impacts
09/10/13	Molasses Spill Oahu: Honolulu Harbor	233,000 gallons molasses	Various coral species, fish kills, other bottom crustaceans/creatures
01/16/15	Tug *Nalani* Oahu: Barbers Point	75,000 gallons diesel	Not reported
05/24/16	*USS HOPPER* 50 miles southwest of Barbers Point	2,000 gallons fuel oil 1D	Not reported
10/11/17	F/V *Pacific Paradise* Oahu: Kaimana Beach in Waikiki	1,500 gallons of fuel and oily water mix	Not reported

3.5.2 Contaminants and Pesticides

Persistent organic pollutants (POPs) are man-made chemicals that remain in the environment for years or even decades. They can have negative effects on sea turtles including inhibiting sex hormone binding, reduced hatchling survival and impaired immune function (Barraza et al. 2020). The uses of POPs include pesticides, flame retardants, and other household and industrial purposes (United Nations Environmental Programme, 2023). Because of their persistence, POPs can be transported locally by agricultural runoff and globally by atmospheric and oceanic currents (Jones and de Voogt 1999; Wania and Mackay 1995), biomagnifying up food chains. Clukey et al. (2018) assessed the levels of POPs in the fat of sea turtles captures in the Hawaii longline fisheries. Loggerhead sea turtles generally had the highest concentrations of dichlorodiphenyltrichloroethanes (DDT), polychlorinated biphenyls (PCBs) and chlordanes relative to olive ridley and green sea turtles (Figure 10). Clukey et al. (2018) indicate that the likely exposure pathway for these sea turtle was consumption of contaminated prey. The individual and population-level impacts of these contaminant concentrations are unclear for sea turtles (Clukey et al. 2018). Clukey et al. (2018) do note that these concentrations were less than have been measured in near-shore sea turtles.

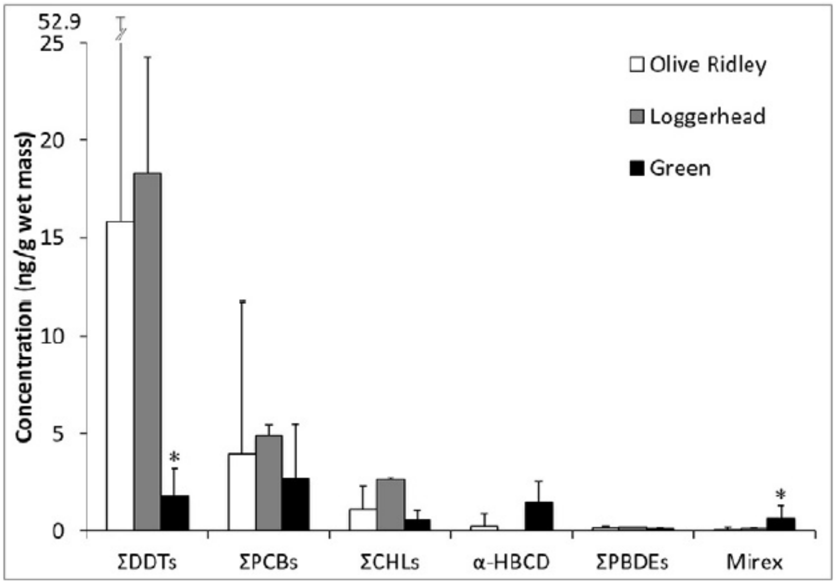

Figure 10. Mean and standard deviation of POP concentrations in the fat of pelagic Pacific sea turtles (Clukey et al. 2018).

3.5.3 Marine Debris

Of the different types of pollution that can adversely affect the sea turtles, ingestion and entanglement risk of marine debris may pose the most serious threat. The sub-tropical convergence zone (STCZ), a known area of marine debris aggregation (Kubota 2004; Pichel et al. 2007; Maximenko et al. 2012), is within the Action Area. The STCZ marks the boundary between the TZCF to the north and the oligotrophic waters to the south (Pichel et al. 2007). Due to increased biological productivity in the STCZ, it has become a significant foraging and migration corridor for swordfish (*Xiphias gladius*) (Seki et al. 2002) and sea turtles (Polovina et al. 2004; Howell et al. 2008, 2010). The early developmental stages of all turtle species are spent in the open sea. During this time both juvenile turtles and their buoyant food are drawn by advection into fronts (convergences, rips, and drift lines). The same process accumulates large volumes of marine debris, such as plastics and lost fishing gear, in ocean gyres (Carr 1987). An estimated four to twelve million metric tons of plastic enter the oceans annually (Jambeck et al. 2015). It is thought that some sea turtles eat plastic because it closely resembles jellyfish, a common natural prey item (Schuyler 2016). Ingestion of plastic debris can block the digestive tract which can cause turtle mortality as well as sub-lethal effects including dietary dilution, reduced fitness, and absorption of toxic compounds (Lutcavage et al. 1997; Laist et al. 1999).

In a recent study focused on plastic debris in the North Pacific, Savoca et al. (2022) found that the North Pacific Ocean is among the most polluted ocean region globally. The number of ingested plastic particles per individual for sea turtles was more than twice that of other ocean regions (Figure 11). They assessed 352 species for their potential to serve as bioindicators for the prevalence of plastic debris in the North Pacific; of those they identified 12 candidate species. Loggerhead sea turtles were one of these 12 candidate species due in part to the number of plastic items ingested per individual and their residency time in the area (Savoca et al. 2022).

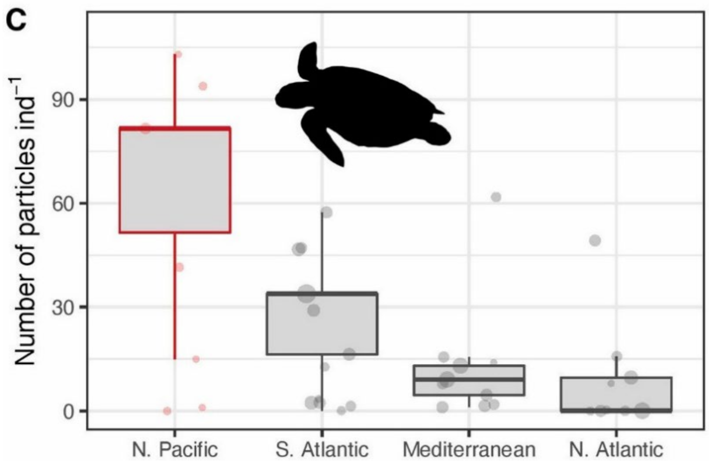

Figure 11. The number of ingested plastic particles per individual sea turtle across four ocean regions (Savoca et al. 2022).

Similarly, Clukey et al. (2017) analyzed the gastrointestinal tracks of green and loggerhead turtles captured in the Hawaii and American Samoa pelagic longline fisheries in the Pacific. They found these turtles have high plastic ingestion frequencies (35% to 100%) compared to more neritic aggregations across the Pacific Ocean, however, no adverse effect of the debris ingestion was observed (Clukey et al. 2017).

Santos et al. (2015) found that a small amount of plastic debris was sufficient to block the digestive tract and cause death in sea turtles. They reported that 10.7% of green turtles in Brazilian waters were killed by plastic ingestion, while 39.4% had ingested enough plastic to have killed them. These results suggest that debris ingestion is a potentially important source of turtle mortality, one that may be masked by other causes of death. Ingestion of marine plastics are a risk to North Pacific loggerheads in the Action Area but we do not have enough information to assess the population-level risks.

In addition to ingestion risks, sea turtles can also become entangled in marine debris such as fishing nets, monofilament line, and fish-aggregating devices or FADs (NRC 1990a, 1990b; Lutcavage et al. 1997; Laist et al. 1999). Turtles are particularly vulnerable to ghost nets due to their tendency to use floating objects for shelter and as foraging stations (Kiessling 2003; Dagorn et al. 2013).

4 Effects of the Action on North Pacific Loggerhead Sea Turtles

Under the ESA regulations (50 CFR 402.02), effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. We are also required to include the consequences of other activities caused by the proposed action. In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b). For this proposed action, research activities on captured and landed turtles are consequences of the proposed action and are reasonably certain to occur. These research activities include handling, measuring, skin biopsying, applying flipper tags, and ―as they are available— the application of satellite tags.

The 2019 SSLL biological opinion (NMFS 2019) presented an analysis of the possibility that the number of turtles captured and killed—globally or, at least, Pacific wide—in commercial fisheries would be higher but for the continued operation of the HI SSLL fishery at current effort based in part on an analysis by Chan and Pan (2016). The rational is because: (1) reduced landings in the HI SSLL fishery—resulting from closing or reducing fishing effort—would create market demands ("market transfer" or "spillover effect") that would be satisfied by non-domestic fisheries; (2) to meet the consumer demand in the United States that would no longer be filled by the domestic fisheries, specifically the HI SSLL fishery, non-domestic fisheries would increase their fishing effort; (3) increasing effort in non-domestic fisheries would increase the number of interactions between those fisheries and threatened and endangered sea turtles; and (4) more of those sea turtles would be killed because non-domestic fleets do not abide by the same turtle-friendly protective measures as the HI SSLL fishery. NMFS (2019) concluded that the evidence available do not suggest that the continued operation of the HI SSLL fishery is reasonably certain to cause a change in the number of sea turtles captured and killed in foreign fisheries. We are not aware of any new information since NMFS (2019) that would change this conclusion and therefore we do not consider the numbers of North Pacific loggerhead sea turtles captured in foreign longline fleets to be an "indirect effect" of the proposed action. We therefore determined that the proposed action will not cause any other activities.

We use a stepwise approach to analyze effects to species and critical habitats:

1. Identify those physical, chemical, or biotic effects of the proposed action that directly or indirectly affect the action area (hereafter using the term stressors).
2. Identify the species and/or critical habitats likely to co-occur with these stressors in space and time (exposure).
    a. For species, estimate the number, age or life stage, and other pertinent characteristics (e.g. gender) of the individuals and the populations or subpopulations those individuals represent.
        i. If estimating the number is not possible, use a habitat-based analysis.
    b. For critical habitat, if applicable, identify the physical or biological features exposed.
3. Determine if/how exposed species and critical habitats will likely respond to the exposure.
    a. For species, determine the individual's probable response and if it is likely to have consequences on its fitness (growth, survival, annual reproductive success, etc.).
        i. If using a habitat-based analysis, explain the changes in habitat and the consequences to individuals.
        ii. Determine what consequences the effects on individuals have on the populations those individuals represent (changes in the population' abundance, reproduction, spatial structure and connectivity, growth rates, etc.).

b. For critical habitat, if applicable, examine the relationships between the habitat changes and physical and biological features and overall value of the affected area.

4.1 Potential Stressors

Potential stressors associated with the proposed action related to fishery operations include:

1. Interaction with gear including capture of non-target species, such as listed species or their prey
2. Interaction with derelict gear resulting from the proposed activities
3. Introduction of oily discharges, cardboard, plastics, and other waste into marine waters
4. Collisions with vessels
5. Vessel noise
6. Vessel emissions

Potential stressors associated with NMFS requirements for handling, data collection and tagging captured sea turtles include:

1. Capture and landing of turtles including the use of a dipnet
2. Holding and handling of turtles for measurements and vital rate monitoring
3. Measuring turtles
4. Piercing skin for attachment of flipper tag
5. Collection of skin biopsy (tissue sampling)
6. Attachment of satellite transmitter to carapace using adhesive

Collectively, we refer to the six stressors detailed above as handling and data collection stressors.

4.1.1 Insignificant or Discountable Stressors

We determined that vessel noise, collisions with vessels, introduction of discharges and other wastes, derelict gear, and vessel emissions have effects on North Pacific loggerhead sea turtles that are either discountable or insignificant. Discountable effects are those extremely unlikely to occur. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. The rationale for these determinations is documented below.

While individually we found these stressors to have discountable or insignificant effects on North Pacific loggerhead sea turtle, we consider the effects of the action as a whole, inclusive of the insignificant or discountable stressors, interaction with gear and data collection stressors in Section 6 Integration and Synthesis.

<u>Vessel Noise</u>

The proposed action would expose North Pacific loggerhead sea turtles to noise from the vessels. Vessel sizes range up to nearly the maximum 100-ft limit, but the average size is 65 to 70 ft. SSLL vessels have displacement hulls and travel at speeds less than 10 knots. Man-made sounds can affect animals exposed to them in several ways such as: non-auditory damage to gas-filled organs, hearing loss expressed in permanent threshold shift (PTS) or temporary threshold shift (TTS), and behavioral responses. They may also experience reduced hearing by masking (i.e., the presence of one sound affecting the perception of another sound). Masking and behavioral avoidance are the most likely responses of animals in the vicinity of the SSLL fishing vessels.

Given the size of the SSLL fishery (the small number of vessels in the fishery and the wide area they cover), the fact that the sound field produced by the vessels in the fishery is relatively small and would move with the vessel, the animals would be moving as well, vessel transit vectors would be predictable, sudden or loud noises would be unlikely or infrequent, and, we would expect that any exposure to noises generated by this fishery would be short-term and transient. Numerous studies demonstrate that sea turtles are unlikely to change their behavior when confronted with stimuli with these attributes. Although hydraulics may have the potential to create loud noises; due to the expected above water operations, frequency and duration of time these species spend at the surface, dissipation of sound from the source, and the poor transference of airborne generated sounds from the vessel to ocean water through the hull, it is highly unlikely noises generated from vessel operations would rise to the level of harming North Pacific loggerhead sea turtles. Thus, we are reasonable certain this stressor would have insignificant effects on the North Pacific loggerhead sea turtle.

Collision with vessels

The proposed action would expose North Pacific loggerhead sea turtles to the risk of collision with vessels. Vessel sizes range up to nearly the maximum 100-ft limit, but the average size is 65 to 70 ft. SSLL vessels have displacement hulls and travel at speeds less than 10 knots. Vessel speed is an important component of the risk for a collision between a vessel and an individual from a listed species.

Kelly (2020) documented vessel collisions with sea turtles resulting in lethal and sub-lethal injuries. Sea turtles could potentially be struck by the transiting vessel during the proposed activities. NMFS (2008c) estimated 37.5 vessel strikes of sea turtles per year from an estimated 577,872 trips per year from vessels of all sizes in Hawaii. More recently, as many as 200 green sea turtle strikes are estimated to occur annually in Hawaii (Kelly 2020), however loggerhead sea turtles do not occur in nearshore areas around Hawaii, they are primarily found in offshore pelagic habitats around Hawaii. We have no documentation of vessel strikes on loggerhead sea turtles in Hawaii.

Increased vessel speed decreases the ability of sea turtles to recognize a moving vessel in time to dive and escape being hit, as well as the vessel operator's ability to recognize the turtle in time to avoid it. Because the probability of a vessel striking a loggerhead sea turtle is even lower than that of a green sea turtle, we are reasonably certain the likelihood of exposure of any individual is extremely unlikely, and therefore discountable.

Introduction of Vessel Wastes and Discharges, Gear Loss, and Vessel Emissions

The diffuse stressors associated with the longline fisheries: vessel waste discharge, gear loss, and carbon emissions and greenhouse gasses, can affect both pelagic and coastal areas. North Pacific loggerhead sea turtles could be exposed to discharges, and run-off from vessels that contain chemicals such as fuel oils, gasoline, lubricants, hydraulic fluids and other toxicants. Although leakage, wastes, and gear loss would occur as a result of the SSLL fishery, given the small number of vessels participating in the fishery, the small number of anticipated vessel trips, the expectation that ESA-listed marine species would be widely scattered throughout the proposed Action Area, the small chance that a North Pacific loggerhead sea turtle would be exposed, NMFS is reasonably certain the probability of exposure to measurable or detectable amounts of leakage, wastes, or gear from this fishery is extremely unlikely, and therefore discountable for North Pacific loggerhead sea turtles.

United States SSLL fishery vessels burn fuel and emit carbon into the atmosphere during fishing operations and transiting. Parker et al. (2018), estimates that in 2011, the world's fishing fleets burned 40 billion liters of fuel and emitted 179 million tons of carbon dioxide greenhouse gasses into the atmosphere. Between 1990 and 2011, emissions grew by 28% primarily due to increased harvests of crustaceans, a fuel intensive fishery (Parker et al. 2018). While we don't have an accurate estimate of the carbon footprint of the United States SSLL fishery, we are reasonably certain the contribution to global greenhouse gases would not rise to the level of harm or harassment of any ESA-listed individuals based on the low number of participants in the fishery and is therefore insignificant.

4.2 Exposure

4.2.1 Fishery Interactions

Loggerhead sea turtles have been captured in the SSLL fishery in 19 of the 20 years between 2004 and 2023. During this 20-year time interval, fishery observers reported that 298 loggerhead sea turtles were captured in the SSLL fishery. As this fishery has historically had 100% observer coverage, the observed captures are equivalent to total captures. An additional six unidentified hardshell sea turtles were captured over that timeframe, some of which were likely to have been loggerheads. To estimate how many were likely loggerheads, we calculated the proportions of the three hardshell sea turtle species (loggerhead, green, and olive ridley sea turtles) observed captured from 2004 to 2023 and used the Wilson Score method without continuity correction (Newcombe 1998) to estimate the 95% confidence interval around the proportion of loggerheads (Table 5). We multiplied that upper 95% CI by the number of unidentified hardshell sea turtles captured each year from 2004 to 2023 to estimate the proportions of each unidentified category that were likely to have been loggerheads (6*0.94 = 5.6 rounded to 6). In total, from 2004-2023, the SSLL fishery had 304 observed interactions with loggerheads (298 observed loggerheads plus 6 unidentified hardshell sea turtles).

Table 5. The proportion of estimated captures identified as loggerhead, green, or olive ridley sea turtles from 2004 to 2023 and the lower (LCI) and upper (UCE) 95% confidence intervals for the probability (p) of assigned an unidentified turtle to each species.

Species	Number Assigned to Species	Number Not Assigned to Species	Sample Size	p (Species Proportions)	1-p (Not Species)	Wilson LCI (Species)	Wilson UCI (Species)
Loggerhead	298	29	327	0.91	0.09	0.88	0.94
Green	11	316	327	0.03	0.97	0.02	0.06
Olive Ridley	18	309	327	0.06	0.94	0.04	0.09

All of the loggerhead turtles captured in this fishery are North Pacific loggerhead sea turtles, which nest at one or more of the nesting beaches in Japan. Of the 304 captured loggerheads, 262 had carapace length recorded. Based on these 262 turtles, sizes of loggerhead sea turtles captured by the SSLL fishery ranged from 28 to 122 cm Straight Carapace Length [SCL] (Figure 12).

The average size of nesting North Pacific loggerhead sea turtles is 85 cm SCL (Hatase et al. 2002) and this is the size cutoff used to define maturity in the Martin et al. (2020) PVA and for consistency with that analysis we use it here. The minimum size of these nesters is about 75 cm SCL (Hatase et al. 2004) and we acknowledge that some of the captured turtles between 75 and 85 cm SCL may be mature, however the same is true of turtles larger than 85 cm SCL, these will be a mix of mature and immature individuals. Of the 262 measured turtles, 250 had lengths less than 85 cm SCL. Therefore 82.2% ([250/304]*100) of the loggerhead sea turtles interacting with the fishery are estimated to be juveniles, with 3.9 % ([(262-250)/304]*100) adults and 13.8 % ([(304-262)/304]*100) unknown. Focusing only on measured turtles, 95% ([250/262]*100) are estimated to be juveniles and 5% ([(262-250)/262]*100) are adults.

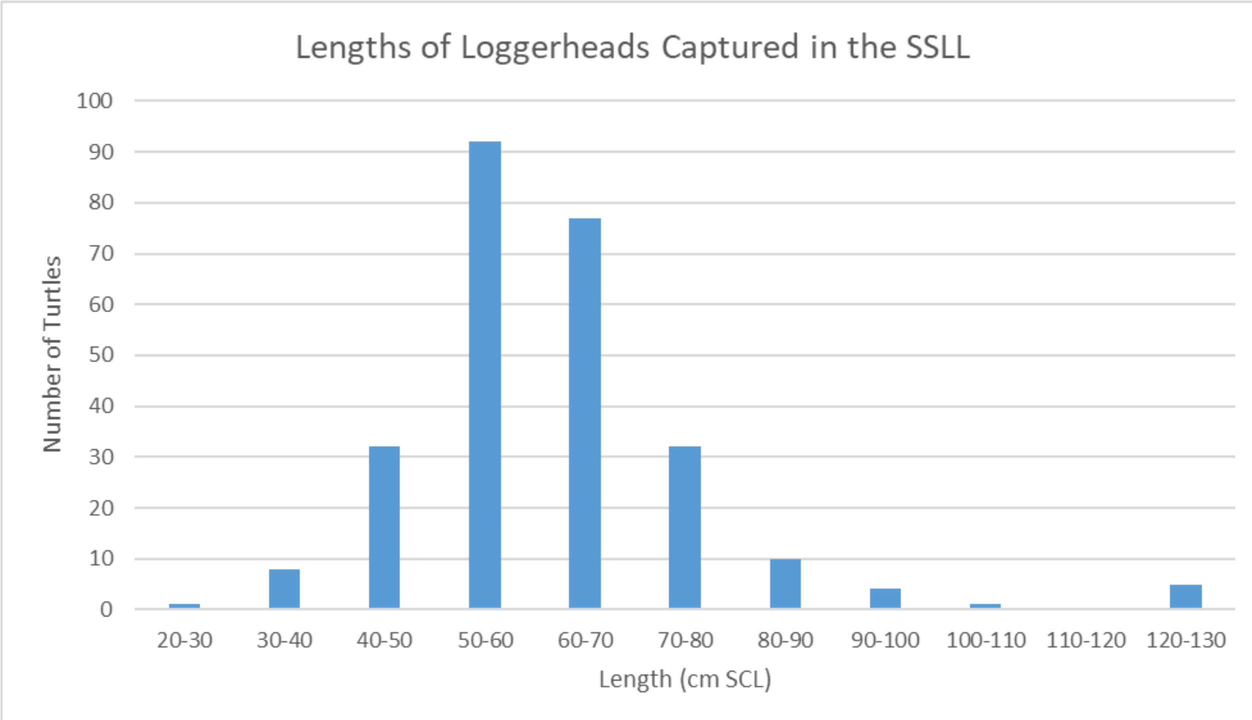

Figure 12. Lengths of observed North Pacific loggerhead sea turtles interacting with the SSLL fishery from 2004 to 2023 (*n*= 262).

One of the most important oceanic features that affects loggerhead sea turtle habitat use is sea surface temperatures (Howell et al. 2008, 2015). NMFS issues a composite image of remotely-sensed SST data (the average of the most recent 3-day period) and ocean current vectors (see www.pifsc.noaa.gov/eod/turtlewatch.php) to illustrate the preferred thermal habitat of loggerhead sea turtles and the area where more than 50% of loggerhead sea turtle interactions have occurred during the first quarter of the year (Figure 13). The map is meant to help fishermen reduce interaction with loggerhead sea turtles and is based, in part, on research that indicates that most loggerhead turtles stay in water colder than 18.5º C (Polovina et al. 2000, 2001, 2004, 2006; Howell et al. 2008).

Swimmer et al. (2017) examined the potential impact of restricting fishing from this thermal band and determined that interactions between the SSLL and loggerhead sea turtles between 2004 and 2015 could have been reduced by 42%. Recently, Siders et al. (2023) assessed the effectiveness of TurtleWatch using telemetry from satellite-tagging loggerheads that were either captured in the SSLL fishery or were captive-raised. They found that the location of loggerhead captures overlapped the TurtleWatch SST band in the first and fourth quarters, however in the second and third quarters they found that both turtles and the fishery shifted to warmer waters resulting in minimal overlap with the SST band in the second quarter and no overlap in the third quarter. Siders et al. (2023) further assessed that TurtleWatch, while useful to fishery managers for the purpose of understanding population dynamics and habitat use, has not discouraged fishing in the SST band and that TurtleWatch has not decreased loggerhead captures in the SSLL.

In November 2022, the WPFMC, PIFSC and the University of Florida convened a workshop with representatives from the HLA, SSLL fishery, and PIRO to discuss a case study evaluating the effects of spatial decision making by fishery participants on the protected species interactions and catch of target species WPFMC 2022). The case study focused on scenarios of SSLL fishers avoiding loggerhead sea turtles in the first or fourth quarter of the year either by using the TurtleWatch product or areas identified by the Protected Species Ensemble Random Forests (PSERF) model based on the probability of loggerhead interactions. The spatial tool developed for the evaluation identified that no matter how the avoidance area was defined, there was a strong chance that avoiding loggerhead interactions by the SSLL fishery would result in increasing the leatherback interactions in at least one of the months in quarters 1 and 4. Workshop discussions also indicated that there can be 1-2 ºC differences between the satellite products and onboard sensors, which is equivalent to the range of SST used to define the TurtleWatch band. This highlighted the difficulty of implementing spatial management using SST for this fishery, and the need to ensure that any spatial tool is consistent with data captains have access to in real time at sea.

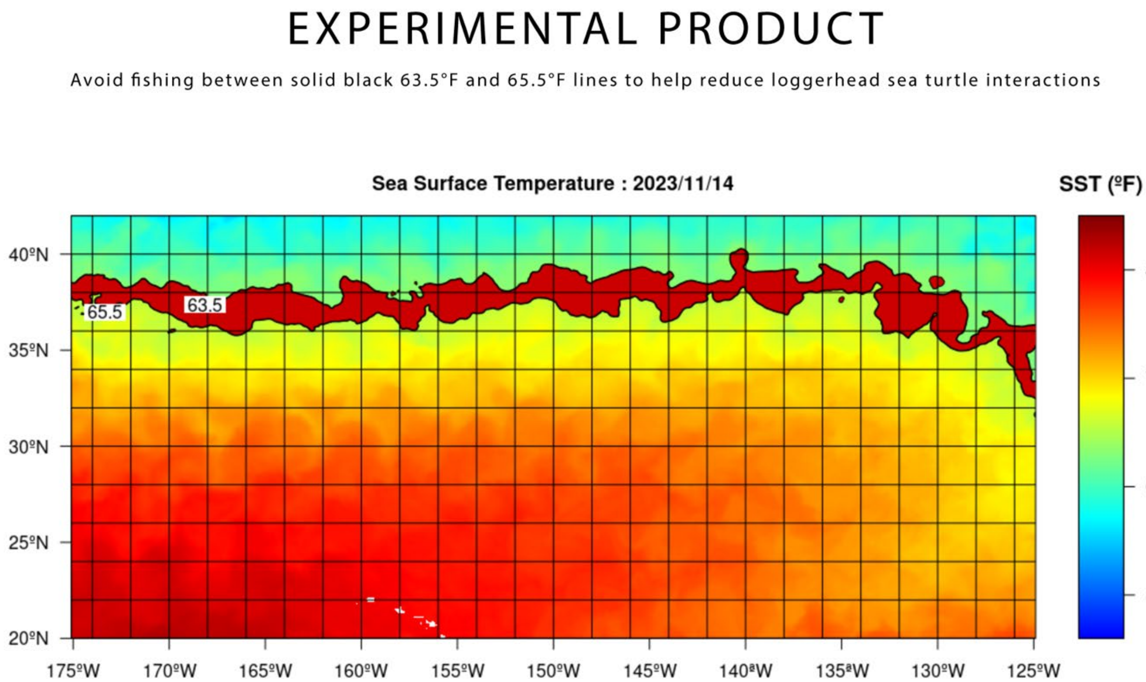

Figure 13. TurtleWatch map, November 14, 2023 (https://oceanwatch.pifsc.noaa.gov/img/today.png)

Overall, most loggerhead captures in the SSLL occur between 25° to 40°N latitude and 130° to 170°W longitude.

About 55% of loggerhead turtles captured between 2004 and 2023 were captured in January and February (Figure 14). The monthly trend of loggerhead captures largely follows the seasonal pattern of the fishery, however the highest number of hooks are set in March while the greatest number of loggerhead captures occurs in January (Figure 14). Looking at the catch per unit effort (CPUE), in terms of loggerheads captured per 1,000 hooks, confirms that January has the highest rate of capture (Figure 15).

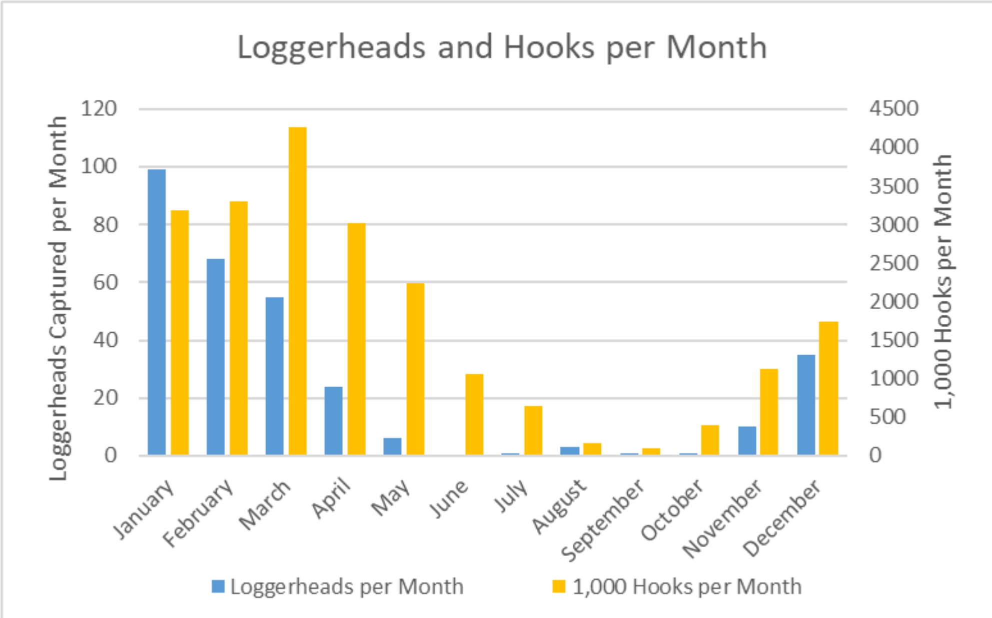

Figure 14. Number of loggerhead turtle interactions in the SSLL fishery per month from 2004 to 2023 (blue bars and left axis). Also shown is the number of hooks (x1,000) set by the SSLL fishery per month over the same time period (yellow bars and right axis).

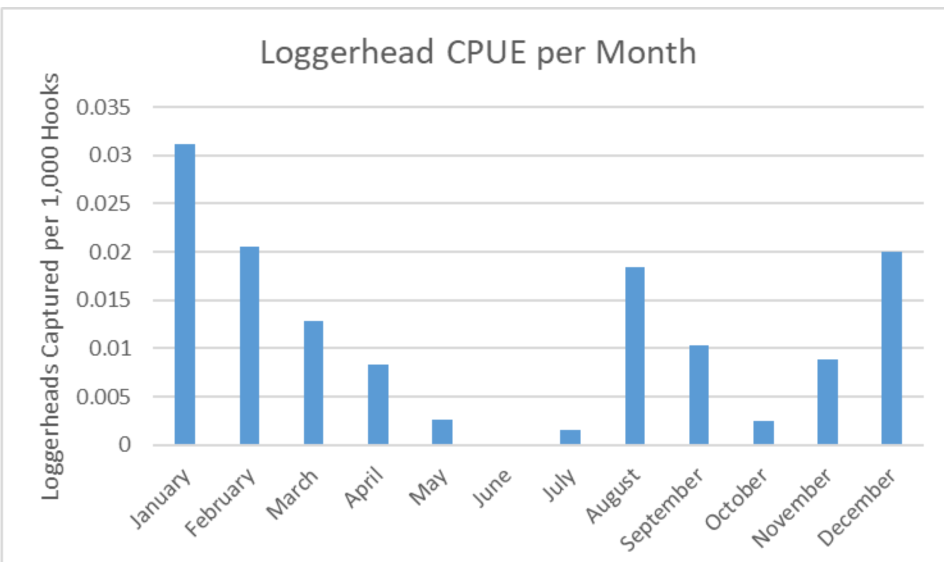

Figure 15. Catch per unit effort (CPUE) measured as captures per 1,000 hooks by month for the SSLL fishery from 2004 to 2023.

The captures in 2023 represent the highest annual captures since 2004 (Figure 16). In terms of CPUE, 2023 represents the third highest CPUE since 2004, with the highest and second highest occurring in 2018 and 2019 respectively (Figure 17). We also note three discrepancies for captures per year from that of the biological evaluation in 2006, 2014, and 2021(NMFS 2023a). In each of these years, unidentified hardshell sea turtles were captured and we consider them to have likely been loggerhead sea turtles, increasing capture counts by two in 2006, and one each in 2014 and 2021 from that considered in the biological evaluation (NMFS 2023a).

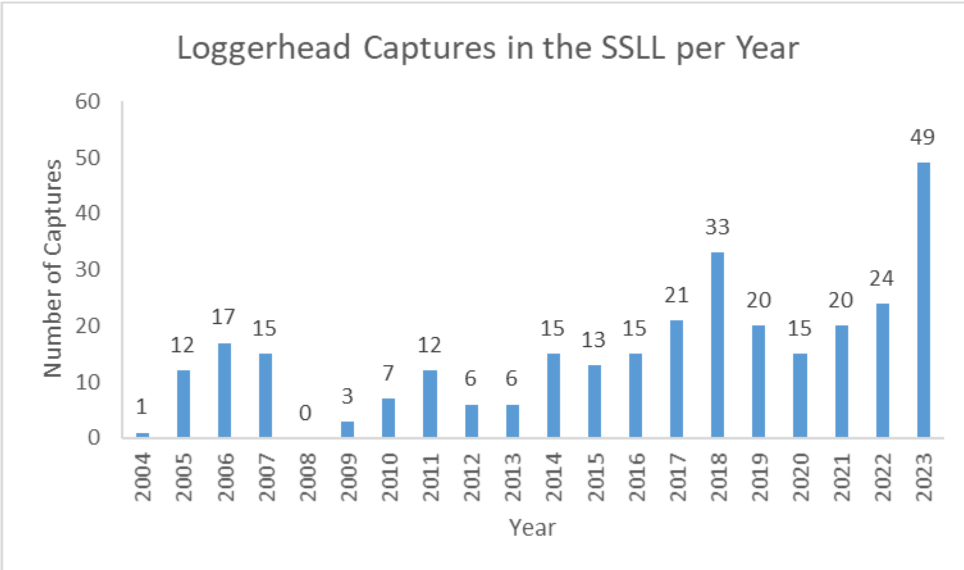

Figure 16. North Pacific loggerhead sea turtle interactions per year in the SSLL fishery between 2004 and 2023.

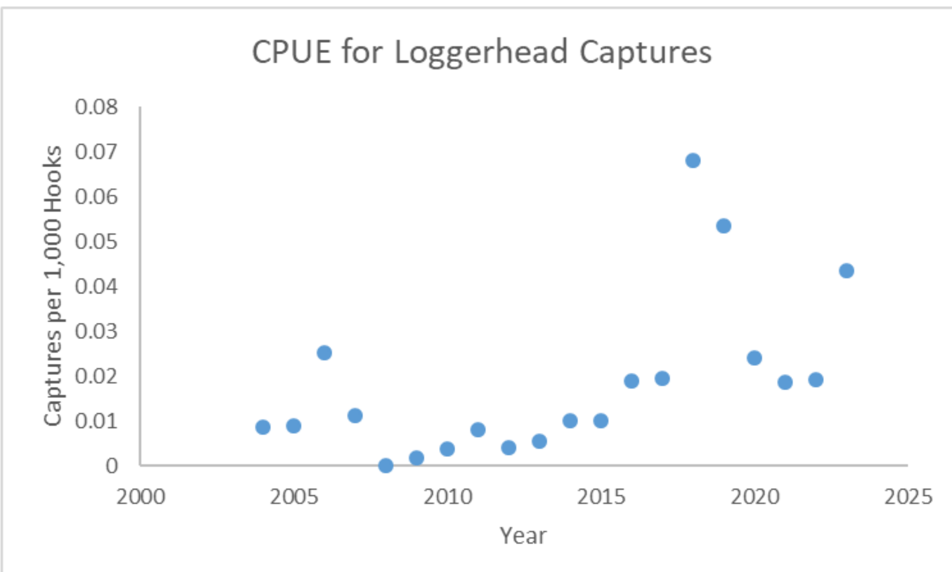

Figure 17. Annual CPUE (loggerheads per 1,000 hooks) in the SSLL fishery between 2004 and 2023.

With 100% observer coverage in the shallow-set fishery since 2004, we know the number of interactions that occurred in the fishery from 2004 to 2023 (Table 6). However, in 2006, 2011, 2018, and 2019, the fishery did not extend through the full year because a loggerhead (2006, 2018, and 2019) or leatherback (2011) sea turtle hard cap was reached or a court order (2018) closed the fishery. Given the current management regime of individual trip interaction limits and no loggerhead hard cap, estimating the number of interactions that would have occurred if the fishery had continued for the full year in those years would provide a more robust historical baseline for estimated anticipated future captures.

To predict the anticipated number of loggerhead sea turtle interactions that would have occurred in years where the fishery closed before the end of the year, the biological evaluation (NMFS 2023a) presented an analysis using linear regressions between first and second quarter loggerhead captures and total loggerhead captures for years when the fishery remained open for the entire calendar year. We adopt that analysis here, updating it to include the third and fourth quarter for 2023, and increasing the number of captures in 2006 to 17, 2014 to 15, and 2021 to 20 as noted earlier.

Following NMFS (2023a), we generated linear regression models between loggerhead interactions during the first quarter (Q1; January through March) and Q1 and the second and third quarters (Q2, Q3; January through September) against total annual interactions using data from 2005 to 2023 (Table 6). We excluded those years where the fishery closed early in these regressions. We used the Q1 regression and observed Q1 interactions to estimate the 2006, 2018, and 2019 total year interactions. For 2006 and 2019, which closed several days prior to the end of Q1 (March 20, 2006 and March 27, 2019), we assumed that the number of interactions observed to the closure date was equal to the Q1 interactions, despite being several days short of the end of Q1. We used the Q1+Q2+Q3 regression to estimate total year interactions for 2011 where the fishery remained open until November. All of the estimated full year interaction estimates are presented in Table 6.

Table 6. Observed loggerhead sea turtle interactions and mortalities in the SSLL fishery, 2005-2023[a], including estimates of what total annual interactions would have been in years where the fishery closed prematurely. Observed loggerhead interactions are inclusive of unidentified hardshell turtles that were likely to be loggerheads.

Year	Observed loggerhead interactions (mortalities)	Closure date	Full year interactions (observed or estimated)
2005	12		12
2006	17	March 20	24.4 [95% C.I. 21.7– 27.1]
2007	15		15
2008	0		0
2009	3		3
2010	7		7
2011	12	November 18	15.0 [95% C.I. 13.1 – 17.0]
2012	6		6
2013	6		6
2014	15		15
2015	13		13
2016	15		15
2017	21 (1)		21
2018	33 (1)	May 8	44.8 [95% C.I. 38.9 – 50.7]
2019	20	March 27	28.2 [95% C.I. 25.0 – 31.4]
2020	15 (1)		15
2021	20		20
2022	24		24
2023	49 (1)		49

[a]In this table, interactions by year are based on actual interaction dates and thus annual totals may differ from accounting based on vessel arrival date.

Using interaction data up to 2017, McCracken (2018) estimated that we would expect the fishery, on average, to interact with 15.6 (95% CI: 36) North Pacific loggerhead sea turtles. An analysis of 40 loggerhead captures (the capture number at the time the data was analyzed) using the coefficients from McCracken (2018) to parameterize a Conway-Maxwell-Poisson (CMP) distribution describing historical anticipated take levels indicated that 40 interactions falls on the 97.6% quantile of the distribution and would not be unexpected given that distribution (pers comm, T. Jones to J. Makaiau; May 26, 2023; Figure 18). However, given that the number of captures in the SSLL have exceeded the mean of McCracken (2018) in seven of the last eight years, we consider it likely that the mean of McCracken (2018) is no longer representative of anticipated levels of capture. Therefore, we focus on the maximum 5-year running sum and running average from 2005 to 2023 (eliminating 2004 as it was a partial year) using either the observed or estimated mean (whichever value is greater) value from Table 6 to estimate anticipated interactions (Table 7). The maximum 5-year running average and running sum over the time series from 2005 to 2023 occurred in the most recent 5-year span from 2019-2023.

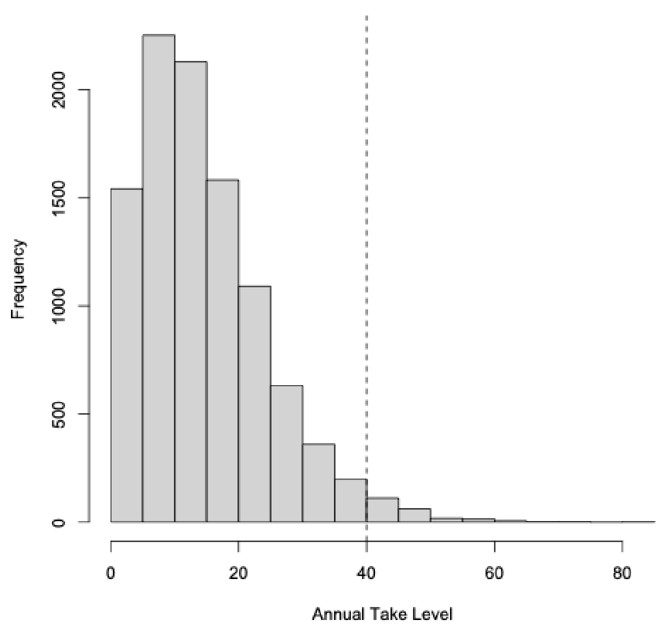

Figure 18. Distribution of 10,000 simulated take levels from the statistical distribution established in McCracken (2018) describing historical anticipated take, or interaction, levels. The vertical dashed line indicates 40 takes at the 97.6% quantile.

Table 7. The maximum 5-yr running average and running sum from 2005 to 2023 using observed captures in the SSLL. For years when the fishery did not operate for the entire year, as well as for the current 2023 year, we used the mean values from Table 6 for the estimated numbers of captures that would have occurred if the fishery remained open for the full year.

Rate	Value
Maximum 5-Yr Running Average	27.0
Maximum 5-Yr Running Sum	135

To further analyze the dynamics of SSLL loggerhead captures, we looked at the juvenile portion of captures, because those represent the majority of the captures and, as described in the Environmental Baseline section, the abundance and trends of this segment of the population are driven by productivity from the nesting beaches and large-scale climatic conditions such as the PDO which drive currents in the North Pacific. We use the relationship between size (measured as SCL in cm) and age in years from Martin et al. (2020) to estimate the age of juveniles captures in the SSLL for which carapace measurements were available (see the Response section below for details on the calculation of age). We found that the mean age of juvenile captures each year are relatively consistent and average about 13.5 yr (Figure 19). Using these ages, we can estimate the hatch year for each loggerhead captured in the SSLL by subtracting age from year of capture (Figure 20). A linear regression between mean hatch year and capture year results in a slope of almost 1 (1.08; Figure 20) indicating a nearly one-to-one relationship between hatch year and capture year. In other words, juvenile loggerheads captured in the SSLL in one year are roughly one year older than the juvenile loggerheads captured in the previous year, suggesting a strong cohort link for juvenile loggerhead captures from year to year and further suggesting that cohort strength in terms of hatchling production may influence SSLL captures. While loggerhead turtle captures have been increasing in the SSLL, we estimate that the 2023 captures were primarily from the 2009 or 2010 nesting beach cohort based on the mean age of 13.5 years and 2012 had the highest recorded number of nests from 1985 to 2015 (Figure 5). If this trend holds, we may expect increased captures in the SSLL over the next two to three years, however, as the trend in the nesting beach following 2015 is uncertain, and we anticipate a link between nesting numbers and SSLL captures, it is not clear if we can expect continued increases in SSLL loggerhead captures into the future.

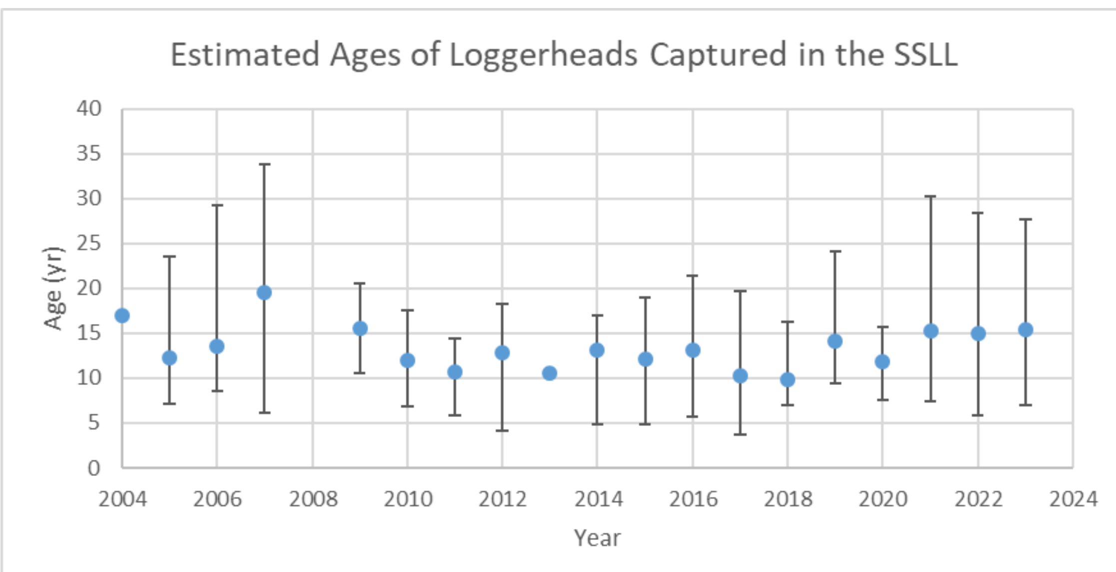

Figure 19. Mean age of juvenile loggerheads captured in the SSLL (blue dots) estimated from carapace length. Bars indicate the minimum and maximum age each year. No bars indicate there was only one capture in that year.

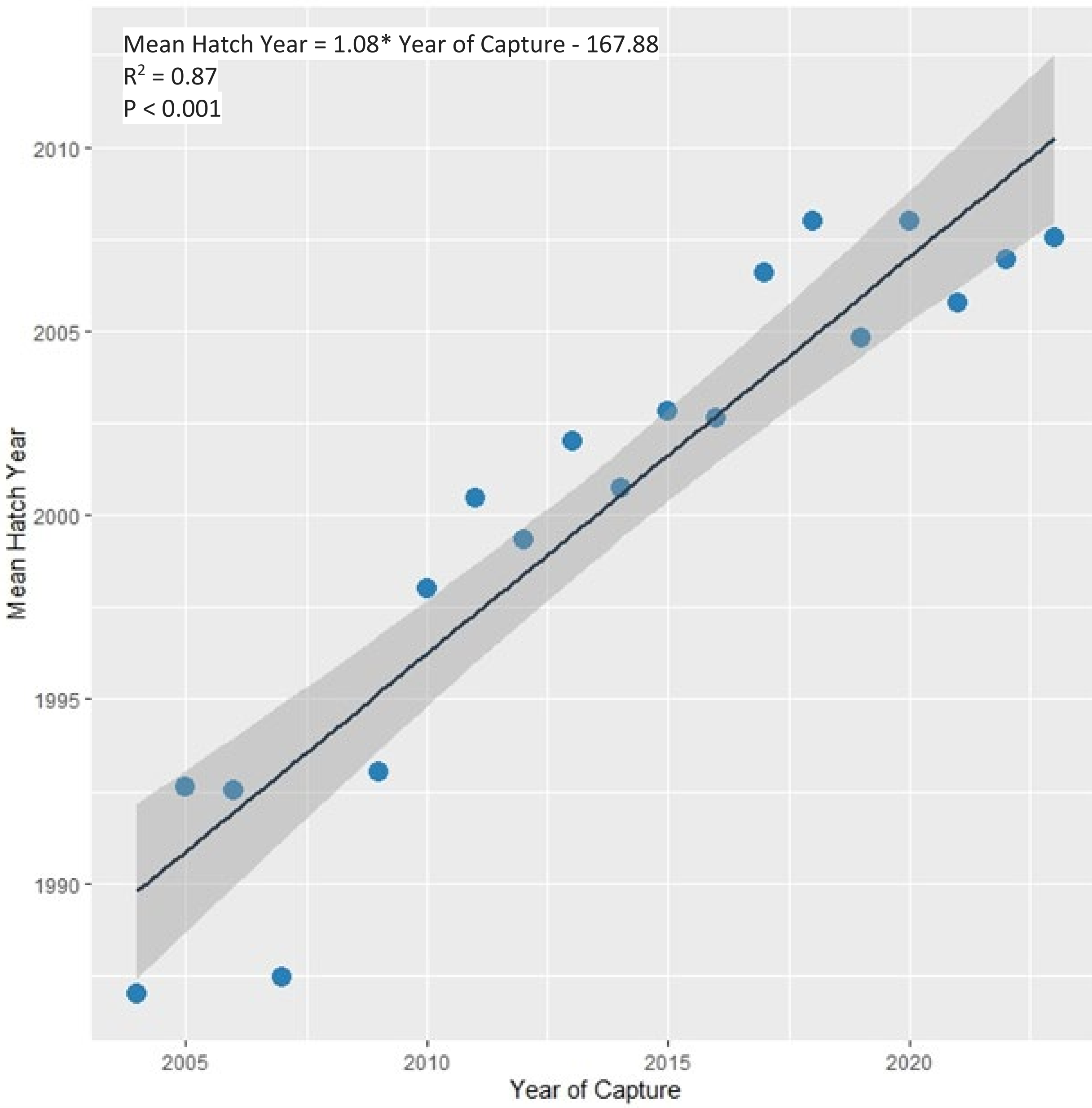

Figure 20. Mean hatch year of loggerhead sea turtles captured in the SSLL estimated by subtracting the mean age (Figure 19) from the year of capture plotted against year (blue dots). Solid black line represents a linear regression fit to the data; shaded area is the 95% CI. The equation describing this fit, the coefficient of determination (R^2), and significance level (P) are provided in the plot.

4.2.2 Handling and Data Collection

The annual number and size distribution of loggerhead sea turtles exposed to the handling and data collection stressors will be directly linked to the captures in the fishery. Not all captured loggerheads can be landed due to size or breaking free of the line, but all of those that are landed, to the greatest extent practicable, will be measured, tissue sampled and flipper tagged, therefore we anticipate up to 136 turtles (i.e. the maximum 5-year running sum described in Table 7) over any five year period to be exposed to these stressors.

Satellite tagging will be conducted at the direction of NMFS Pacific Islands Fisheries Science Center (PIFSC) and only as tags are available and ongoing data collection is needed for survival and habitat use studies. Therefore we anticipate up to 136 turtles will be satellite tagged over any 5 year period, but recognize the actual number is likely to be less.

4.3 Response

4.3.1 Fishery Interactions

The most significant hazard the SSLL fishery presents to listed species results from hooking and entanglement by gear which can injure or kill sea turtles. If hooked or entangled, air-breathing species such as sea turtles can drown after being prevented from surfacing for air; alternatively, sea turtles that are hooked or entangled, may not immediately die from their wounds but can suffer impaired swimming or foraging abilities, altered migratory behavior, and altered breeding or reproductive patterns, and latent mortality from their interactions.

Sea turtles are particularly prone to being entangled in fishing gear because of their body configuration and behavior. Records of stranded or entangled sea turtles reveal that fishing debris can wrap around the neck, flippers, or body of a sea turtle and severely restrict swimming or feeding. Over time, if the sea turtle is entangled around its flipper, the fishing line will become tighter and more constricting as the sea turtle grows or as it moves/swims, cutting off blood flow, causing deep gashes, some severe enough to remove an appendage. Sea turtles have also been found with trailing gear that has been snagged on the bottom, thus causing them to be anchored in place (Balazs 1985).

Sea turtles have been found entangled in branch lines, mainlines and float lines. Longline gear is fluid and can move according to oceanographic conditions determined by wind and waves, surface, and subsurface currents, etc.; therefore, depending on both sea turtle behavior, environmental conditions, and location of the set, turtles could be entangled in longline gear. Entanglement in monofilament line or polypropylene (float line) could result in substantial wounds, including cuts, constriction, or bleeding on any body part. In addition, entanglement could directly or indirectly interfere with mobility, causing impairment in feeding, breeding, or migration. Sea turtles entangled by longline gear are most often entangled around their neck and fore flippers.

In addition to being entangled in a longline, sea turtles are also injured and killed by being hooked. Sea turtles are either hooked externally - generally in the flippers, head, beak, or mouth - or internally, where the animal has attempted to forage on the bait, and the hook is ingested into the gastrointestinal tract, often a major site of hooking (E. Jacobson in Balazs et al. 1995a). Hooking can occur as a result of a variety of scenarios, some of which will depend on foraging strategies and diving and swimming behavior of the various species of sea turtles. For example, necropsied olive ridleys have been found with bait in their stomachs after being hooked; therefore, they most likely were attracted to the bait and attacked the hook. Similarly, a turtle could concurrently be foraging in or migrating through an area where the longline is set and could be hooked at any time during the setting, hauling, or soaking process.

When a sea turtle is hooked and the hook is removed, which is often possible with a lightly hooked turtle, the hooking interaction is likely to result in injuries that can, in some cases, lead to death (Ryder et al. 2006). The risk of mortality from hooking increases if the hook is lodged internally. Like all vertebrates, the digestive tract of the sea turtle begins in the mouth, through the esophagus, and then dilates into the stomach. The esophagus is lined by strong conical papillae, which are directed caudally towards the stomach (White 1994). The existence of these papillae, coupled with the fact that the esophagus snakes into an S-shaped bend further towards the tail make it difficult to see hooks, especially when deeply ingested. Not surprisingly, and for those same reasons, a deeply ingested hook is also very difficult to remove without significant injury to the animal. The esophagus is attached firmly to underlying tissue; therefore, when a hook is ingested, the process of movement, either by the turtle's attempt to get free of the hook or by being hauled in by the vessel, can traumatize the internal organs of the turtle, either by piercing the esophagus, stomach, or other organs, or by pulling the organs from their connective tissue. Once the hook is set and pierces an organ, infection may ensue, which may result in the death of the animal (Ryder et al. 2006).

If a hook does not become lodged or pierce an organ, it can pass through to the colon, or even be expelled through the turtle (E. Jacobson in Balazs et al. 1995a). In such cases, sea turtles can pass hooks through the digestive tract with little damage (Work 2000). Of 38 loggerheads deeply hooked by the Spanish Mediterranean longline fleet and subsequently held in captivity, six loggerheads expelled hooks after 53 to 285 days (average 118 days; Aguilar et al. 1995). If a hook passes through a turtle's digestive tract without getting lodged, the chances are good that less damage has been done. Tissue necrosis that may have developed around the hook may also get passed along through the turtle as a foreign body (E. Jacobson in Balazs et al. 1995a).

If the patterns found in the observer data from 2004 to 2023 are representative, most of the loggerhead turtles captured in the fishery would be hooked rather than entangled. About 88% of the observed loggerhead captures were hooked, 6% were both hooked and entangled, 4% were entangled, for 2% it was unknown if the animal was hooked or entangled.

Of the hooked loggerheads, 50% were hooked externally, primarily in the flipper, 19% were hooked in the jaw/beak, and 31% were hooked in the soft tissues of the mouth or in the esophagus. Of these, 82.7% were released with no gear attached, 16.0% had the hook and some amount of line still attached and 1.4 % were dead at capture. Of the entangled turtles, 100% were released with no gear attached. Of the turtles that were both hooked and entangled, 81.3% were released with no gear attached.

Of the 304 observed captures, four were dead when they were hauled back to the fishing vessel, or 1.3%. For the remaining 300 turtles, we used the post-interaction mortality rates of Ryder et al. (2006; Table 8) for hard-shell sea turtles to estimate post-interaction mortality of loggerhead sea turtles that were alive when they were captured. Table 9 shows the number of loggerhead sea turtles in each injury category and the corresponding post-interaction mortality rate for the 300 observed loggerhead sea turtles released alive. In some instances the observer records did not allow us to precisely assign a post-interaction mortality rate. In these cases we assigned a likely range of post-interaction mortality rates. In Table 9 we assigned half of each turtle to the upper and lower end of this range which is why partial turtles appear in this table. We used the mean of this range to calculate post-interaction mortality rates for these turtles. When at-vessel mortality and post-release mortality are combined, the effective mortality rate for loggerhead sea turtles captured in this fishery is 16.8% (95% CI = 13.0% to 21.4%).

Table 8. Post-interaction mortality rates for sea turtles interacting with longline fisheries from Ryder et al. (2006)*.

Nature of Interaction	Released with hook and with line greater than or equal to half the length of the carapace	Released with hook and with line less half the length of the carapace	Released with hook and entangled (line is not trailing, turtle is entangled)	Released with all gear removed
Category	Hardshell (Leatherback)	Hardshell (Leatherback)	Hardshell (Leatherback)	Hardshell (Leatherback)
I Hooked externally with or without entanglement	20 (30)	10 (15)	55 (65)	5 (10)
II Hooked in upper or lower jaw with or without entanglement. Includes ramphotheca, but not any other jaw/mouth tissue parts (see Category III)	30 (40)	20 (30)	65 (75)	10 (15)
III Hooked in cervical esophagus, glottis, jaw joint, soft palate, tongue, and/or other jaw/mouth tissue parts not categorized elsewhere, with or without entanglement. Includes all events where the insertion point of the hook is visible when viewed through the mouth	45 (55)	35 (45)	75 (85)	25 (35)
IV Hooked in esophagus at or below level of the heart (includes all hooks where the insertion point of the hook is not visible when viewed through the mouth) with or without entanglement	60 (70)	50 (60)	85 (95)	N/A
V Entangled only	50 (60)			1 (2)
I Comatose/resuscitated	N/A	70 (80)	N/A	60 (70)

*Numbers in the table are the percent of turtles with the corresponding injury and release condition expected to die. For example, a loggerhead sea turtle is a hardshell turtle, and if one is hooked in a flipper (externally hooked) and released with the hook and an amount of line equivalent to less than half of its carapace length, there is a 10% chance that it will die from its injury. A leatherback sea turtle with the same injury and release condition would have a 15% chance of dying.

At this mortality rate, if an average of 27.0 loggerhead turtles are captured in the fishery in any given year, we would expect an average of 4.5 (95% CI = 3.5 to 5.8) of them to die as a result of being captured. Over a 5-year period we would expect 23 (95% CI = 18 to 29) loggerhead turtles to die (Table 10).

Table 9. Number of North Pacific loggerhead sea turtles released alive in the SSLL fishery between 2004 and 2023 by their injury and release condition (N = 299). Numbers in parentheses are the corresponding post-interaction mortality rates from Ryder et al. (2006; Table 8). See the text for an explanation of fractions of individuals.

Injury Category	Released with **Line < 1/2 SCL**	Released with **Line ≥ 1/2 SCL**	Released **Entangled**	Released with **No Gear**	**Grand Total**
Entangled	-	-	-	9 (0.01)	9
External	2 (0.10)	3 (0.20)	1 (0.55)	141(0.05)	147
Insertion Not Visible	21.5 (0.50)	3.5 (0.60)	2 (0.85)	-	27
Insertion Visible	11 (0.45)	1.5 (0.55)		49 (0.25)	62
Jaw	2 (0.20)	-		53 (0.10)	55

Table 10. Number of North Pacific loggerhead sea turtles that are likely to die as a result of being captured in the SSLL each year based on mean estimated mortality rate (16.7%).

Rate	**Anticipated mortalities based on the mean (16.7%) mortality rates**
5-year Running Average	4.5
5-year Running Sum	23

Martin et al. (2020) present a population viability analysis (PVA) for North Pacific loggerhead sea turtles, considering the effect of the SSLL fishery on DPS based on their estimates of nesting trends. They ‘removed’ the historic impact of the fishery by adding back to the population observed and estimated loggerhead sea turtle mortalities caused by the fishery. Because the PVA is based on nesting females, for juvenile-sized captured sea turtles, an Adult Nester Equivalent (ANE) was estimated, and the ANE mortality was added back into the year when it would have first nested. The PVA was then conducted with and without the fishery mortalities by projecting numbers of nesting females into the future, removing ANE mortalities in the same way they were added back in to remove fishery effects. The results of this analysis suggest that without the fishery, the North Pacific loggerhead sea turtle is still increasing at an average of 2.3% per year (95% CI: -11.1% to 15.6%), equivalent to the trend with the fishery. They found no difference in the probabilities of reaching 50%, 25%, and 12.5% of current abundance in the population projections with and without the fishery (Table 11). The results of the Martin et al. (2020) PVA indicate that the SSLL fishery is not altering the trajectory of the North Pacific loggerhead sea turtle.

Table 11. Median and 95% CI (lower [LCI], upper [UCI]) of North Pacific loggerhead sea turtles reaching abundance thresholds equal to 50%, 25%, and 12.5% of 2015 abundance at 5, 10, 25, 50, and 100 years from the end of the nesting data time series or 2015 (Martin et al. 2020). "No Fishery" indicates the probabilities without the SSLL fishery mortalities and "Fishery" is with the fishery at historic interaction rates.

Threshold and Scenario	5 yr	10 yr	25 yr	50 yr	100 yr
50% No Fishery	0.01	0.08	0.21	0.29	0.33
50% Fishery	0.01	0.08	0.22	0.29	0.33
50% LCI No Fishery	0.01	0.08	0.21	0.28	0.32
50% LCI Fishery	0.01	0.08	0.21	0.28	0.32
50% UCI No Fishery	0.01	0.08	0.22	0.29	0.33
50% UCI Fishery	0.01	0.08	0.22	0.29	0.33
25% No Fishery	0	0.01	0.11	0.21	0.29
25% Fishery	0	0.01	0.11	0.22	0.29
25% LCI No Fishery	0	0.01	0.11	0.21	0.28
25% LCI Fishery	0	0.01	0.11	0.21	0.28
25% UCI No Fishery	0	0.01	0.12	0.22	0.29
25% UCI Fishery	0	0.01	0.12	0.22	0.29
12.5% No Fishery	0	0	0.05	0.16	0.25
12.5% Fishery	0	0	0.05	0.16	0.25
12.5% LCI No Fishery	0	0	0.05	0.15	0.24
12.5% LCI Fishery	0	0	0.05	0.16	0.24
12.5% UCI No Fishery	0	0	0.06	0.16	0.25
12.5% UCI Fishery	0	0	0.06	0.16	0.25

For the 2023 captures, NMFS (pers comm T. Jones to J. Makaiau, May 26, 2023) used a Monte Carlo approach generating 10,000 samples for each individual using observed straight carapace length (SCL) and derived release mortality estimates from Ryder et al. (2006). SCL was imputed from a multivariate normal distribution based on observed measurements if no length was recorded for an individual. Given the observed or imputed SCL, age was imputed for each individual for each sample using the von Bertalanffy growth model coefficient and residual variability of Martin et al. (2020).

In the PVA, Martin et al. (2020) divided the resulting ANE by the remigration interval to account for only a portion of maturing individual nesting in a given year. Therefore in this analysis, NMFS randomly assigned a remigration interval to each sample. This analysis includes 40 of the 44 2023 interactions that had occurred at the time the data were submitted for analysis in April 2023.

Results indicated the 50% quantile of ANE summed over the 40 individuals is 0.081 turtles, with a 97.5% quantile of 0.413 turtles (Figure 21). Furthermore, as described above, NMFS (pers comm T. Jones to J. Makaiau, May 26, 2023) indicated that the 40 observed captures were still within the Conway-Maxwell-Poisson distribution estimated for SSLL loggerhead sea turtle captures by McCracken (2018) and would be in the 97.6% quantile of the distribution. The total of 49 captures for 2023 would be in a higher quantile but are still within the distribution analyzed in the PVA (Figure 18). The purpose of these analyses was to demonstrate that the 2023 captures, while the highest observed to date, are still within the range of variability assessed in the Martin et al. (2020) PVA and the results of that PVA are still valid for the range of annual captures that have been observed to date when the full variability of the output of the PVA are considered. While the mean captures of McCracken (2018) used in the PVA are likely no longer valid, the observed capture numbers in recent years would have been assessed in the Martin et al. (2020) PVA as they drew values for annual captures from the full distribution of McCracken (2018). Therefore, the upper 95% CI for probabilities of reaching population thresholds (Table 11) would be inclusive of declining populations and high fishery captures and these probabilities indicate essentially no difference in the probabilities of reaching thresholds with and without the fishery.

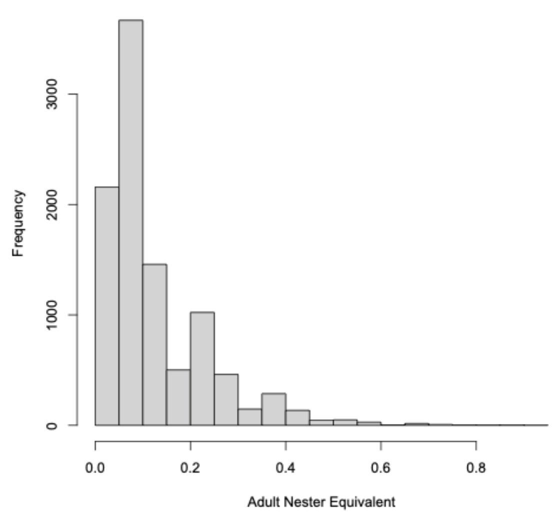

Figure 21. Distribution of 10,000 ANE samples based on lengths and estimated post-interaction mortality rates for 40 observed SSLL captures in 2023 (pers comm T. Jones to J. Makaiau, May 26, 2023).

The current median abundance of adult female North Pacific loggerheads has been estimated at about 4,541 (95% CI: 4,074 to 5,063) from Martin et al.'s (2020) PVA model results. This model used nesting data from three index beaches on Yakushima Island, Japan (Inakahama, Maehama, and Yotsusehama); which represent approximately 52% of loggerhead nesting in Japan. Applying the 52%, we estimate a total of 8,733 (95% CI: 7,835 to 9,737) adult females for the population as of 2015. Assuming a 65% female to male sex ratio, this implies a total of 13,435 adults in the population. Martin et al. (2020) estimate an increasing trend of 2.3% (95% CI: -11.1% to 15.6%) per year for these index beaches. We do not have data to ascertain trends in the remaining portion of the DPS and assume these trends apply to the remaining portion. As noted in the Status of Listed Resources section, we are not confident that the measured mean increasing trend of 2.3% per year has continued since 2015, the last year for which we have data, and we therefore use the range of a stable population (0% per year) to a 2.3% per year increase in our risk analysis.

Martin et al. (2020), together with the additional analyses presented above support that the level of captures observed in the SSLL, inclusive of 2023, are unlikely to appreciably impact the population trend or extinction risk of the North Pacific loggerhead sea turtle. As noted in Table 7, we anticipate a 5-year maximum running average of 27.0 loggerhead captures per year with 4.5 (95% CI: 3.5 to 5.8) mortalities per year. Over 5 years we anticipate 135 captures with 23 (95% CI: 18 to 29) mortalities. We next assess the impact of that specific level of captures on the DPS.

Similar to Martin et al. (2020), we focus our population impact analysis on the adult female portion of the population as this is the portion where we have the highest confidence in the abundance estimate because it is based on counts of nests. To assess the impact of mortalities from the SSLL on the North Pacific loggerhead sea turtle, we need to determine reproductive equivalents for the primarily juvenile captures. To do this we estimate the ANE for each captured individual following Martin et al. (2020). In this case, rather than using Monte-Carlo simulations as described above, we use the median estimates for age (based on length and using the von Bertalanffy growth function [VBGF] of Martin et al. [2020]), age at maturity and juveniles survival rates of Martin et al. (2020) and the assigned post-interaction mortality rate based on Ryder et al. (2006). In this case we do not divide ANE by remigration interval as we want to know the reproductive value of a given turtle irrespective of the actual year it may nest. Using this approach we can only assign ANE values to measured turtles and we assume these mean values will apply to unmeasured turtles.

As an example of our calculations, we assume a 55 cm SCL loggerhead is hooked in the esophagus with the insertion point of the hook visible and the hook and line are removed prior to release. Based on Ryder et al. (2006), this turtle would have a post-interaction mortality rate of 25% (Table 8; category III interaction released with no gear attached). The VBGF for loggerhead sea turtles in Martin et al. (2020) is:

$$L_t = L_\infty - (L_\infty - L_0)e^{-kt}$$

Where L_t is the length of the turtle at time t, L_∞ is the asymptotic size (86.9 cm SCL), L_0 is the length at hatching (4.73 cm SCL), k is the Brody growth coefficient (0.09) and t is age at L_t. To estimate age from length this equation is rearranged to:

$$t = -\left(\frac{\ln\left(\frac{L_\infty - L_t}{L_\infty - L_0}\right)}{k}\right)$$

From this equation, a 55 cm SCL turtle is 10.5 years old. Age at maturity from Martin et al. (2020) is 37.9 years, therefore this turtle has 37.9-10.5 = 27.4 years until maturity. The juvenile annual survival rate and sex ratio in terms of percent female from Martin et al. (2020) is 0.8 and 65% respectively. The ANE is essentially the turtle's probability of surviving to maturity times the probability of it being female. The probability of surviving to maturity is calculated as:

$$AE = \varphi_J{}^{Y}$$

Where AE is adult equivalent (or probability of surviving to maturity irrespective of sex), φ_J is the juvenile survival rate and Y is the time to maturity. A 55 cm SCL turtle therefore has a 0.8^27.4 = 0.0022 or 0.22% probability of surviving to maturity and represents 0.22% of an adult. Furthermore the turtle has a 65% chance of being female, therefore the ANE is 0.0022*0.65=0.0014, or the juvenile turtle represents the reproductive equivalent of 0.14% of an adult female. As noted above, based on hooking location and release condition, there is a 25% chance that this turtle will die as a result of its interaction. This would equate to the mortality of 0.0014*0.25=0.00036 adult nesting females. The ANE results for all measured turtles are summarized in Table 12. We present means for all measured turtles as well as separate means for juveniles (less than 85 cm SCL) and adults (greater than 85 cm SCL). Note that the AE of an adult-sized turtle is one as it has zero years until maturity. Therefore the ANE is equal to the sex ratio in terms of proportion of females, or 0.65. For comparison with the results described above for 2023 captures using Monte Carlo simulations, using the average ANE mortalities for all captures (0.0065; Table 12), 40 captures would have an ANE of 0.0064*40 = 0.26. We did not divide ANE by remigration intervals as was done above, if we had the value would be 0.26/3.3 = 0.079 (where 3.3 yrs is the mean remigration interval from Martin et al. [2020]). This value is consistent with the 50% quantile value of 0.081 reported from that analysis.

Table 12. Average and 95% CI of the ANE per captured turtle using all loggerhead sea turtles captured in the SSLL from 2004 to 2023 that were measured (n=261). Both the ANE of the captures exclusive of post-interaction mortality (ANE) and the ANE with the post-interaction mortality (ANE Mortalities) are presented.

Metric	Mean	LCI	UCI
All Captures - ANE	0.038	0.022	0.055
All Captures – ANE Mortalities	0.0064	0.0030	0.0099
Juveniles - ANE	0.0091	0.0057	0.013
Juveniles – ANE Mortalities	0.0021	0.0012	0.0031
Adults - ANE	0.650	0.650	0.650
Adults – ANE Mortalities	0.096	0.043	0.15

As noted previously, we anticipated 95% of captures to be juveniles with 5 % adults. Therefore we expect an average of 1.2 adults and 25.8 juveniles to be captured in a given year (Table 13). Using the adult- and juvenile-specific ANE from Table 12, we anticipate an average of 1.0 ANE captures per year with 0.2 mortalities (Table 13). Over five years, we anticipate a total of 5.2 ANE captures with 0.9 mortalities (Table 13).

Table 13. Anticipated ANE captures and mortalities for the maximum 5-yr running sum and running average in Table 7 and Table 10.

Capture Units	Capture Metric	Adults	Juveniles	Total
Total Captures	Maximum 5-yr RA	1.2	25.8	27.0
Total Captures	Maximum 5-yr RS	6.2	128.8	135
Total Captures - ANE	Maximum 5-yr RA	0.8	0.2	1.0
Total Captures - ANE	Maximum 5-yr RS	4.0	1.2	5.2
Total Mortalities - ANE	Maximum 5-yr RA	0.1	0.1	0.2
Total Mortalities - ANE	Maximum 5-yr RS	0.6	0.3	0.9

We next looked at the percent of the adult female portion of the population that would be captured or killed by the fishery over the next 40 years assuming average annual numbers of captures in the SSLL remain stable and under assumptions of the population increasing at 2.3% per year (Table 14) or remaining stable at 0% per year (Table 15). The greatest impact we computed is the mortality of 0.002% of adult females in year 40 with a stable population (Table 15).

We assume that these population growth rates are inclusive of mortalities in the SSLL as the fishery has been operating since 2004. Therefore to estimate the population trends without the impact of the fishery, we added back in the number of ANE mortalities to the number of adult females each year for 40 years into the future and recalculated the population growth rates with these additions. Given that the 95% credible interval for the population growth rate estimated by Martin et al. (2020) is -11.1% to 15.6% with a standard deviation of 0.0679, our analysis shows that the impact of fishery mortalities on population growth rates are much smaller than our confidence in the underlying data informing population trends (Table 14 and Table 15).

If the population has only remained stable since 2015, the difference between the scenarios with and without the fishery is an improvement in the population growth rate to 0.002%. Based on a power analysis and assuming the same standard deviation of 0.0679, over 100,000 years of data would be required to detect a statistically significant difference between 0% and 0.002%. This difference cannot be statistically detected when the 95% CI around the estimate of a value ranges 26.6%. Even if the most conservative reasonable scenario happens, it would not be statistically detectable. These results are consistent with the PVA of Martin et al. (2020). Therefore, we are reasonably certain the consequences of the proposed action will not be biologically appreciable to the numbers, reproduction, or distribution of the North Pacific loggerhead sea turtle population.

Table 14. Impact of SSLL incidental captures and mortalities on adult female portion of the North Pacific loggerhead sea turtle assuming captures remain constant over time and that the population is increasing. Capture numbers are based on ANE and the 5-year running average (Table 7). Population growth rates without SSLL mortalities are calculated as baseline population growth rate (2.3% per year) adding back the SSLL mortalities each year and calculating population growth rates based on the exponential growth equation.

Year	Abundance	Captures	Mortalities	% of Abundance Captured	% of Abundance Killed	Population Growth Rate With SSLL ANE Mortalities (Without SSLL ANE Mortalities)
2015	8733	1.0	0.2	0.012	0.002	2.3 (2.3016)
2024	10742	1.0	0.2	0.010	0.002	2.3 (2.3016)
2034	13520	1.0	0.2	0.008	0.001	2.3 (2.3014)
2044	17017	1.0	0.2	0.006	0.001	2.3 (2.3013)
2054	21418	1.0	0.2	0.005	0.001	2.3 (2.3011)
2064	26956	1.0	0.2	0.004	0.001	2.3 (2.3010)

Table 15. Impact of SSLL incidental captures and mortalities on adult female portion of the North Pacific loggerhead sea turtle assuming captures remain constant over time and that the population is stable. Capture numbers are based on ANE and the 5-year running average (Table 7). Population growth rates without SSLL mortalities are calculated as baseline population growth rate (0% per year), adding back the SSLL mortalities each year and calculating population growth rates based on the exponential growth equation.

Year	Abundance	Captures	Mortalities	% of Abundance Captured	% of Abundance Killed	Population Growth Rate With SSLL ANE Mortalities (Without SSLL ANE Mortalities)
2015	8733	1.0	0.2	0.012	0.002	0.0 (0.0020)
2024	7912	1.0	0.2	0.012	0.002	0.0 (0.0020)
2034	7087	1.0	0.2	0.012	0.002	0.0 (0.0020)
2044	6348	1.0	0.2	0.012	0.002	0.0 (0.0020)
2054	5687	1.0	0.2	0.012	0.002	0.0 (0.0020)

Year	Abundance	Captures	Mortalities	% of Abundance Captured	% of Abundance Killed	Population Growth Rate With SSLL ANE Mortalities (Without SSLL ANE Mortalities)
2064	5094	1.0	0.2	0.012	0.002	0.0 (0.0020)

4.3.2 Handling and Data Collection

We anticipate that live sea turtles captured and handled as a result of the proposed action would be released alive and in a condition that is similar to or better than its initial capture condition. We note that by regulation (50 CFR 665.812(b)), vessel owners and operators are required to adhere to regulations for safe handling and release of sea turtles including the resuscitation of comatose sea turtles and these actions have an overall positive affect on the post-interaction survival of captured sea turtles. Here we detail the anticipated responses to the handling and data collection that are part of the proposed action.

Capture and Handling

Capture can cause stress responses in sea turtles (Gregory and Schmid 2001; Hoopes et al. 1998; Jessop et al. 2003; Jessop et al. 2004; Thomson and Heithaus 2014). The physiological response of releasing stress hormones has been documented by multiple researchers (Gregory et al. 1996; Gregory and Schmid 2001; Harms et al. 2003; Hoopes et al. 2000; Stabenau et al. 1991). This stress is similar to the stress of evading a predator and may incur a metabolic cost of energy expected during evasive behavior as well as forgone foraging opportunities. The mitigation measures outlined in Appendix A are designed to minimize the stress on turtles while they are retained for data collection.

Capture and handling activities may markedly affect metabolic rate (St. Aubin and Geraci 1988), reproduction (Mahmoud and Licht 1997), and hormone levels (Gregory et al. 1996). Handling has been shown to result in progressive changes in blood chemistry indicative of a continued stress response (Gregory and Schmid 2001; Hoopes et al. 2000). The additional on-board holding time imposes an additional stressor on these already acidotic turtles (Hoopes et al. 2000). It has been suggested that the muscles used by sea turtles for swimming might also be used during lung ventilation (Butler et al. 1984). Thus, an increase in breathing effort in negatively buoyant animals may have heightened lactate production. Understanding the physiological effects of capture methodology is essential to conducting research on endangered sea turtles, since safe return to their natural habitat is required. However, literature pertaining to the physiological effects of capture on sea turtles is scarce. As a mitigation, turtles would be returned to the water as quickly as possible to minimize stresses resulting from their capture.

Measuring

Measuring turtles with the use of a flexible tape measure and calipers and the additional handling involved can result in raised levels of stress hormones in sea turtles. As noted above, the muscles used by sea turtles for swimming might also be used during lung ventilation (Butler et al. 1984), which may cause heightened lactate production.

That said, the measuring procedure is simple, non-invasive, with a relatively short time period and NMFS does not expect that individual turtles would normally experience more than short-term stresses as a result of these activities. No injury is expected from these activities, and the sampling process will be completed as quickly as possible to minimize stresses to the turtle.

Flipper tagging

Flipper tagging involves the implantation of tags in or through skin of the flippers. Flipper tags have both internal and external components, and the internal tag parts are expected to be biologically inert. In addition to the stress sea turtles are expected to experience by handling and restraint associated with inspection and tagging, we expect an additional stress response associated with the short-term pain experienced during tag implantation (Balazs 1999). We expect disinfection methods should mitigate infection risks at the tagging site. Researchers have not reported evidence of infection resulting from tagging when turtles are recaptured. Tags are designed to be small, physiologically inert, and not hinder movement or cause chafing; we do not expect the tags themselves to negatively impact sea turtles in any appreciable way (Balazs 1999). The proposed methods are standard worldwide and not known to result in decreased survival, reproduction, or prolonged health effects (Balazs 1999; NMFS SEFSC 2008; Stapleton and Eckert 2008). The proposed tagging methods have been regularly employed in sea turtle research with little lasting impact on the individuals tagged and handled (Balazs 1999). Given the precautions that would be taken by observers to ensure the safety of the turtles and the permit conditions relating to handling and tagging and using aseptic techniques, we expect that the activities would have minimal effects on the animals. We do not expect mortality or long-term adverse effects to the turtle due to attachment of the flipper tags.

Tissue Sampling

During skin biopsy, it is not expected that individual turtles will experience more than short-term stresses during tissue sampling (for genetic and stable isotope analyses). Sterile techniques will be utilized to minimize the possibility of infection at the biopsy site (Appendix A). It is not expected that the collection of a tissue sample will cause any additional significant stress or discomfort to the turtle beyond what was experienced during the other data collection activities.

No adverse effects have been noted when tissue sampling animals in central California by the NMFS Southwest Fisheries Science Center (NMFS 2017). Researchers who examined hard-shelled turtles re-captured two to three weeks after initial capture and sample collection noted that the sample collection site was almost completely healed (NMFS 2017). Sampling sites on turtles re-captured in San Diego Bay after several months to years have completely healed and have shown no signs of infection. In areas such as San Diego Bay, California, and St. Croix, U.S. Virgin Islands, animals remain in the study area long term, indicating that sampling does not produce any adverse effects on their behavior (NMFS 2017).

Satellite Tagging

All external tag units would result in increased drag forces while the unit is attached; this varies widely from days to weeks or months based on the method of attachment. The standard mitigation measures for transmitters set forth by NMFS are designed to minimize impacts from drag forces, harm and injury to the animal and risk of entanglement. Satellite tags will only be placed on loggerhead turtles that are 40 cm SCL or larger and that are alive and conscious. The weight of the tags will not exceed 5% of the body mass. The duration of the tagging is anticipated to be approximately one year.

Attachment of satellite tags with epoxy is a technique commonly used by NMFS (NMFS 2017). Satellite tags, as well as biofouling of the tag, attached to the carapace of turtles have the potential to increase hydrodynamic drag and affect lift and pitch. Watson and Granger (1998) performed wind tunnel tests on a full-scale juvenile green turtle and found that at small flow angles representative of straight-line swimming, a transmitter mounted at the peak of the carapace increased drag by 27 to 30 percent, reduced lift by less than 10 percent and increased pitch moment by 11 to 42 percent. More recently, tests by Jones et al. (2011) determined that drag forces can be high depending on the shape, size and placement of the tag; however, drag can be substantially reduced to 17 percent or lower if the tag is shifted off the peak of the carapace (Jones et al. 2011). Standard mitigation measures for transmitters are in line with the recommendations of Jones et al. (2011) and include requirements to make attachments as hydrodynamic as possible, reduce risk of entanglement, and attach tags off the peak of the carapace whenever possible (Appendix A).

Researchers have successfully tracked turtles from nesting to foraging grounds (Hart et al. 2012; Hart et al. 2013; Shaver et al. 2005; Van Dam et al. 2008). Shaver et al. (2017) has recorded females returning to nest after having a transmitter attached across inter-nesting seasons. Others have documented tagged animals using the same foraging areas, inter-nesting habitat, or home range after tagging (Hawkes et al. 2011; MacDonald et al. 2012; MacDonald et al. 2013; Madrak et al. 2016; Olson et al. 2012; Shaver et al. 2017). This information suggests that having a transmitter attached using adhesive methods does not impact a sea turtle's migration, feeding, and mating behavior. Hatchlings, post-hatchlings, and juveniles grow much faster than subadult or adult individuals do. The attachment mechanism can impair growth if not flexible enough to either grow with the individual or break away as its base expands. Mansfield et al. (2012) evaluated potential impacts to tagging neonates by comparing tagged with non-tagged turtles and found no significant differences in growth, condition, swimming behavior and feeding, suggesting that the attachment does not pose more than minimal energetic costs. The authors also noted that because neonates are not continuously actively swimming, energetic costs may be further reduced to this age class. Taking information on turtle movements into account with standard mitigation measures for transmitters, we do not anticipate that the proposed methods pose any long-term risks to the turtle. The transmitters would not result in any serious injury. We expect that the proposed materials or methods would not significantly interfere with the turtles' normal activities, growth, movement, feeding, or other critical life functions after they are released.

Summary of Response to Handling and Data Collection Stressors

The anticipated effects of the proposed data collection from captured sea turtles (e.g., biopsy, flipper tagging, satellite tagging, restraining, and measuring) are expected to be minimal, and are not likely to manifest in long-term adverse effects, reduced fitness, or mortality (NMFS 2017). No mortalities or serious injuries are known to have occurred as a result of sampling during similar research projects. Only minor short-term stress, discomfort, pain, and a chance of infection are expected during skin biopsy sampling and tagging. External flipper tags are small and not likely to result in a significant increased drag force while the tag is attached. No long-term detrimental effects are expected based on many years of NMFS conducting tagging and biopsy procedures on sea turtles. Risk of infection will be minimized by employing the standard measures described Appendix A requiring the use of aseptic practices.

In past studies, reactions of sea turtles to sampling has ranged from no reaction to a mild reaction, including the turtle pulling away its flipper or minor bleeding at the site. Satellite tag type and placement are designed to minimize drag and no impact on movement, foraging, migration, growth or reproduction is anticipated for turtles outfitted with transmitters. Overall, such impacts from handling and sampling are anticipated to be nominal, and will be managed with measures designed to keep animals as calm as possible until released (see Appendix A). Mitigation measures and research protocols detailed in Appendix A further reduce the risk and severity of sub-lethal effects from authorized research activities. Consequently, handling and data collection procedures are not expected to result in additional mortality, or long-term fitness consequences beyond those caused by capture in the fishery (NMFS 2017); therefore, no population level effects are anticipated as a result of these activities.

5 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). A conclusion of reasonably certain to occur must be based on clear and substantial information, using the best scientific and commercial data available (50 CFR 402.17). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

NMFS searched for information on future State, tribal, local, or private actions that were reasonably certain to occur in the Action Area. Most of the Action Area is outside of territorial waters of the United States of America, which would preclude the possibility of future state, tribal, or local action that would not require some form of federal funding or authorization.

While we considered various state managed vessel-based fisheries which exist in Hawaiian waters, we do not believe they will overlap in geographical space for fishing activities and would only overlap the vessel paths from this fishery when they transit to Hawaiian ports, and we consider the probability of exposure to impacts from transiting vessels by the ESA-listed resources considered in this biological opinion to be discountable. The same could be said for recreational boating around the MHI as well. The primary effects we would expect from State fisheries and recreational boating, would include injury and mortality from ship strikes and fishing, as well possibly changes in local prey numbers and distribution. NMFS is not aware of any other actions that are likely to occur in the Action Area during the foreseeable future.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline (Section 3.1).

6 INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the Effects of the Action (Section 4) and the Cumulative Effects (Section 5) to the Environmental Baseline (Section 3), and in light of the Status of the Listed Resources (Section 2), formulate our opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of North Pacific loggerhead sea turtles in the wild by reducing its numbers, reproduction, or distribution.

6.1 North Pacific Loggerhead Sea Turtles

As discussed in the Status of Listed Resources section, all loggerhead sea turtles caught in this fishery are North Pacific loggerhead sea turtles; which is comprised of at least three subpopulations (NMFS and USFWS 2020). We do not know with certainty what portion of the loggerhead sea turtles that the fishery interacts with would be from the three different subpopulations but it is likely the fishery interacts with all three.

The recent PVA indicates that the adult female portion of the Yakushima subpopulation was increasing at a rate of approximately 2.3% per year (95% CI -11.1% to 15.6%) and was comprised of 4,538 (95% CI: 4,077-5,064) adult females as of 2015 (Martin et al. 2020) at the index beaches or 8,726 adult females for the DPS assuming the index beaches represent 52% of all nesting for the DPS. This analysis found essentially no difference in the probabilities of the subpopulation reaching 50%, 25% and 12.5% of current abundance in population projections conducted with and without the fishery, even at the upper 95% CI where the simulations would have included declining populations and higher fishery captures (Table 11; Martin et al. 2020). The PVA is based only on data up to 2015 as more recent data are not available. Monitoring at minor nesting beaches in Japan indicated declines of loggerheads through 2018 (Okuyama et al. 2020). Okuyama et al (2020) attribute this to water temperature and temperate loggerhead moving to more northward nesting areas. Given the uncertainty in current trends, our analysis focused on the mean population growth rates estimated by Martin et al. (2020) and the possibility that the population has not continued to increase but has remained stable.

Fisheries bycatch from pelagic longlining and artisanal coastal fisheries in Japan and Mexico are the greatest threat to individual fitness and the DPS as described in the Status of Listed Species section. As described in the Environmental Baseline, effects from international and United States fisheries have resulted in interactions with the North Pacific loggerhead sea turtle in the Action Area. These activities are reasonably likely to continue and may increase over time due to the effects of increased human population, and increased human consumption of fish products. The DSLL ITS authorized 43 captures over five years with an anticipated 24 mortalities for North Pacific loggerhead sea turtles

Climate change is likely affecting the DPS already and is expected to increase in the future. The primary impacts from climate change with the Action Area are changes in turtle and prey distributions driven by changes in SST, nutrient concentrations and currents (NMFS and USFWS 2020). Increasing SST may result in changes to large-scale and periodic climate patterns, such as the PDO and ENSO. This likely affects migrations and feeding patterns by changing ocean circulation. Projected increases in sea level will likely reduce beach access for nesting due to significant beach armoring in Japan. Increased sand temperatures can also cause decreased egg survival and an increase in female turtle production, skewing sex ratios and affecting the reproductive capacity of the population.

Loggerhead sea turtles are exposed to the stressors of hooking and entanglement in the Action Area. Since 2004, 298 loggerhead sea turtles were observed captured in the SSLL fishery, with an additional six unidentified hardshell sea turtles that we attribute to loggerheads, for a total of

304 captures. As the fishery has been observed at 100% coverage over that time, this represents the actual number of captures by the fishery. Based on the maximum 5-yr running sum, which occurred over the most recent 5 years (2019-2023) we anticipate that over 10 years, up to 270 North Pacific loggerhead sea turtles will be captured and of those 45 will be killed. As described in the Effects of the Action section, the maximum 5-year running average is 27.0 turtles with 4.5 mortalities. Converting these numbers to ANE, we anticipate the capture of one ANE per year on average with the mortality of 0.2 ANE per year. About 95% of these captures are juveniles with a mean of 0.0091 ANE captured or 0.0021 ANE killed per captured juvenile. The remaining 5% are adults with a mean of 0.65 ANE captured or 0.096 ANE killed. As described in the Effects of the Action section, we considered adult female population trends from 0% per year (stable) to +2.3% per year (the mean from Martin et al. 2020). If the adult female portion of the population is stable, and that includes mortalities from the historic operation of the SSLL, removing the mortalities each year for the next 40 year would only improve the growth rate to 0.002% per year. This difference is not statistically detectable given the uncertainty in the trend estimates. This result is consistent with the PVA of Martin et al. (2020) which indicated that captures and mortalities of loggerhead sea turtles in the SSLL do not alter the trends or extinction risks of North Pacific loggerhead sea turtles.

Because North Pacific loggerhead sea turtle abundance will not be appreciably impacted by the proposed action, we are reasonably certain the proposed action will not cause appreciable material changes having biological consequences to the DPS' numbers, reproduction, or distribution. NMFS does not anticipate the SSLL fishery will reduce appreciably the likelihood of the survival or recovery of North Pacific loggerhead sea turtles in the wild by reducing their reproduction, numbers, or distribution.

Part of the action includes handling of and data collection from captured and landed sea turtles. As specified in the Effects of the Action section, we do not anticipate that these activities will reduce the fitness of any captured turtle beyond that caused by injuries associated with capture by the fishery. The insignificant or discountable stressors discussed in Section 4.1.1, considered together or separately, will not have adverse effects on an individual that is captured in the fishery. Therefore we do not anticipate any population-level effects from these activities.

Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the North Pacific loggerhead sea turtle.

7 Incidental Take Statement

Section 9(a) of the ESA prohibits taking of endangered species. In the case of threatened species, section 4(d) of the ESA leaves it to the Secretary's discretion whether and to what extent to extend the statutory 9(a) take prohibitions, and directs the agency to issue regulations it considers necessary and advisable for the conservation of the species. As the North Pacific loggerhead sea turtle is listed as endangered, section 9(a) take prohibitions apply.

The term "incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). The proposed action results in the incidental take of North Pacific loggerhead sea turtles. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of this incidental take statement (ITS). In order to monitor the impact of incidental take, 50 CFR 402.14(i)(3) provides that "the Federal agency or any applicant must report the progress of the action and its impact on the species to the Service as specified in the ITS."

7.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions.

The number of takes occurring annually is highly variable due to fluctuations in fishery target-species distribution, ESA-listed species distribution and abundance, fishing effort, sea surface temperatures, ocean currents, and other factors that are difficult to predict. As a result, using the estimated mean annual take levels as reinitiation triggers is not reasonable or practical. Warden et al. (2015) state "when the population is large compared to the incidental mortality, frequent (e.g., annual) monitoring is not likely to produce results that are substantially different from the previous assessment. Less frequent but more comprehensive assessments, which explicitly address uncertainty, may provide more reliable information." For these reasons, and based on our experience monitoring fisheries, we believe that the maximum 5-year running sum is most appropriate metric for meaningful tracking of take with respect to the ITS. Year to year variation in capture numbers is expected, and managing the incidental take by the 5-year running sum accounts for this annual variation, allowing for years with higher than average captures and years with lower than average captures. Exceeding the maximum 5-year running sum over any five consecutive years is a reinitiation trigger. This does not imply we will wait five years to assess take. Observed interactions are documented in real time and are continually monitored by NMFS SFD and PRD. Therefore, we will know of any exceedance of the numbers regardless of when it happens during the 5-year period. As an example, reinitiation will be triggered if 136 North Pacific loggerhead sea turtles are captured within a 2 or 3-year period rather than waiting until 5 years has elapsed.

In the biological opinion, NMFS determined that the incidental take of up to 135 North Pacific loggerhead sea turtles over five consecutive years is reasonably certain to occur. This value will serve as the ITS for loggerhead sea turtles in this fishery as a check on our no jeopardy finding. We will use all 2024 captures as year one for tracking this ITS, acknowledging that any captures prior to implementation of this biological opinion are not exempted by this ITS. Therefore, to determine if reinitiation is warranted, the first five year term of the ITS will include captures from January 1, 2024 to December 31, 2028.

7.2 Reasonable and Prudent Measures

Reasonable and prudent measures are actions necessary or appropriate to minimize the impacts, i.e., amount or extent, of incidental take (50 CFR 402.02). We determine that the following reasonable and prudent measures, as implemented by the terms and conditions that follow, are necessary and appropriate to minimize the impacts of the proposed action on threatened and endangered species and to monitor the level and nature of any incidental takes.

1. NMFS shall implement and evaluate minimization measures designed to reduce the incidental capture of loggerhead sea turtles in the Hawaii SSLL fishery and for those that are incidentally caught alive, to maximize survival by being released from fishing gear in a manner that minimizes injury and the likelihood of further gear entanglement or entrapment to increase their post-release survivorship.
2. NMFS shall ensure that the Hawaii SSLL fishery has a monitoring and reporting program sufficient to confirm that extent of take is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.

7.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action may lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. NMFS SFD shall conduct an analysis of fleet-wide interactions with loggerhead sea turtles to evaluate patterns of interactions between this DPS and vessel owners and operators. Within 18 months of receiving a signed biological opinion, NMFS SFD shall provide a report on their findings to NMFS PRD with an action plan for working with the fleet to reduce impact of individual vessels on loggerhead sea turtles and provide fleet-wide guidance on how to avoid reaching limits established in regulation based on Terms and Condition in NMFS (2019; 50 CFR 665.813).
    b. NMFS SFD shall implement measures to minimize the amount of trailing gear left on ESA-listed species to the maximum extent practicable to reduce the amount of injury and harm, the likelihood of further gear entanglement or entrapment, and improve the post-release mortality of loggerhead sea turtles. This may include using new technologies once developed and proven.
    c. To reduce post-release mortality, within two years NMFS SFD shall require species handling training for crew members and at a minimum have one trained person on deck who directs and oversees activities of the vessel when retrieving fishing gear. Training shall include best practices for minimizing trailing gear identified in 1.b above.
2. The following terms and conditions implement reasonable and prudent measure 2:
    a. NMFS SFD shall maintain observer coverage at levels reliable for estimating protected species interaction rates onboard Hawaii SSLL vessels. This may include electronic monitoring.
        i. NMFS SFD shall collect standardized information regarding the incidental capture, injury, and mortality of ESA-listed marine species for each interaction by species, gear, and set information, as well as the presence or absence of tags on these species.

ii. NMFS SFD shall disseminate quarterly summaries of the data collected by observers on all ESA-listed marine species. These summaries shall be based on the date the interactions occurred.

iii. The observers shall document the method or technology used to release all ESA-listed species.

b. NMFS shall conduct studies to better understand post-interaction mortality, distribution and movement patterns of loggerhead sea turtles.

c. On at least an annual basis, NMFS SFD shall evaluate the effectiveness of adopted measures for reducing incidental captures and minimizing gear, and report findings to NMFS PRD.

d. NMFS SFD shall collaborate with NMFS PRD to develop annual data products to be provided to NMFS PRD detailing numbers of captures, updates to interaction mortality rates and locations of fishing effort as it relates to numbers of captures. These reports will be provided to NMFS PRD once all data from the previous year have been finalized but not later than July of the following year. The report from the first year will include all data for calendar year 2024, as well as the period from the date this opinion was signed to the end of the year. Only the take that occurs post-signature is exempted by this opinion, but the calendar year data will be used to ensure incidental captures are within the expectations of our analysis.

e. Every five years after signing of this opinion, NMFS SFD shall collaborate with NMFS PRD to evaluate the data:

i. Use the data from Term and Condition 2.a.i to explore ecosystem and area based management techniques with potential to reduce interactions with ESA-listed species in the future. Examples include time area closures, rotational zone management, dynamic closures, hotspot analyses, and move-on methods.

ii. Evaluate the effectiveness of methods designed to reduce post release mortality in ESA-listed species and make improvements or incorporate changes as warranted.

7.4 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

In order to keep NMFS PRD informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS SFD should notify NMFS PRD in writing upon initiating any of these conservation recommendations in their final action.

1. NMFS should promote studies on ecology, habitat use, fecundity, genetics, and post interaction survivability of North Pacific loggerhead sea turtles.
2. NMFS should explore how climate change, including ocean warming, may affect habitat quality, prey abundance and distribution, and the physiological ecology (e.g., thermal tolerance) of North Pacific loggerhead sea turtles.
3. NMFS should enhance bilateral cooperation and engagement with key countries that have large international longline fleets to promote conservation and recovery of North Pacific loggerhead sea turtles.
4. NMFS should enhance capacity building among the international fishing community for increasing data collection and information sharing.
5. NMFS should develop an outreach and education campaign for the public to increase awareness of the status and importance of North Pacific loggerhead sea turtles, while incorporating cultural insights and perspectives from various regions/locations of the species' range.

7.5 Reinitiation of Consultation

This concludes formal consultation for the continued authorization of the Hawaii shallow set longline fishery. Under 50 CFR 402.16(a), reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

1. If the amount or extent of taking specified in the incidental take statement is exceeded;
2. If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
3. If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or
4. If a new species is listed or critical habitat designated that may be affected by the identified action.

8 References

Aguilar, R., J. Mas, and X. Pastor. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. In: Richardson, J. I., T. H. Richardson, editors. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation, 1995. p. 1-6. NOAA Tech Memo NMFS-SEFSC-361.

Ascani, F., K.S. Van Houtan, E. Di Lorenzo, J.J. Polovina, and T.T. Jones. 2016. Juvenile recruitment in loggerhead sea turtles linked to decadal changes in ocean circulation. Global Change Biology. *22*(11):3529-3538.

Balazs, G. H. 1985. Impact of ocean debris on marine turtles: Entanglement and Ingestion. Honolulu Hawaii: U.S. Department of Commerce. p. 387-429.

Balazs, G.H. 1999. Factors to consider in the tagging of sea turtles. Pages 101-109 *in* K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly editors. Research and Management Techniques for the Conservation of Sea Turtles. International Union for Conservation of Nature and Natural Resources, Survival Service Commission, Marine Turtle Specialist Group Publication No. 4.

Barraza, A. D., L. M. Komoroske, C. D. Allen, T. Eguchi, R. Gossett, E. Holland, D. D. Lawson, R. A. LeRoux, V. Lorenzi, J. A. Seminoff, and C.G. Lowe. 2020. Persistent organic pollutants in green sea turtles (*Chelonia mydas*) inhabiting two urbanized Southern California habitats. 153:110979.

Beverly, S., and L. Chapman. 2007. Interactions between sea turtles and pelagic longline fisheries. WCPFC-SC3-EB SWG/IP-01. Western and Central Pacific Fisheries Commission, 76 p.

Briscoe, D.K., Turner Tomaszewicz, C.N., Seminoff, J.A., Parker, D.M., Balazs, G.H., Polovina, J.J., Kurita, M., Okamoto, H., Saito, T., Rice, M.R. and Crowder, L.B., 2021. Dynamic thermal corridor may connect endangered loggerhead sea turtles across the Pacific Ocean. Frontiers in Marine Science. 8:630590.

Butler, P.J., W.K Milsom, and A.J. Woakes. 1984. Respiratory, cardiovascular and metabolic adjustments during steady state swimming in the green turtle, *Chelonia mydas*. Journal of comparative Physiology B. 154:167-174.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology. 1(2):103-121.

Chaloupka, M., D. Parker and G. Balazs. 2004. Modelling post-release mortality of loggerhead sea turtles exposed to the Hawaii-based pelagic longline fishery. Marine Ecology Progress Series. 280:285-293.

Chan, S.K.-F., I.-J. Cheng, T. Zhou, H.-J. Wang, H.-X. Gu, and X. J. Song. 2007. A comprehensive overview of the population and conservation status of sea turtles in China. Chelonian Conservation and Biology. 6(2):185-198.

Chan, H.L., and M. Pan. 2016. Spillover effects of environmental regulations for sea turtle protection in the Hawaii longline swordfish fishery. Marine Resource Economics. 31(3):259-279.

Clukey, K.E., C.A. Lepczyk, G.H. Balazs, T.M. Work, and J.M. Lynch. 2017. Investigation of plastic debris ingestion by four species of sea turtles collected as bycatch in pelagic Pacific longline fisheries. Marine Pollution Bulletin. 120(1-2):117-125.

Clukey, K.E., C.A. Lepczyk, G.H. Balazs, T.M. Work, Q.X. Li, M.J. Bachman, and J.M. Lynch. 2018. Persistent organic pollutants in fat of three species of Pacific pelagic longline caught sea turtles: accumulation in relation to ingested plastic marine debris. Science of the Total Environment. 610:402-411.

Common Oceans Tuna Project. 2017. Joint Analysis of Sea Turtle Mitigation Effectiveness Final Report. Scientific Committee Thirteenth Regular Session. Rarotonga, Cook Islands 9-17 August 2017. WCPFC-SC13-2017/EB-WP-10. 139 p.

Conant, T. A., P. H. Dutton, T. Eguchi, E. P. Epperly, C.C. Fahy, M. H. Godfrey, S. L. MacPherson, E. E. Possardt, B. A. Schroeder, J. A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pages.

Dagorn, L., K. N. Holland, V. Restrepo, and G. Moreno. 2013. Is it good or bad to fish with FADs? What are the real impacts of the use of drifting FADs on pelagic marine ecosystems? Fish and Fisheries. 14(3):391-415.

Daviot, J. 2017. The potential for Baited Remote Underwater Video to detect changes in fish communities caused by natural and human-induced events in Cockburn Sound. Master’s Thesis, Murdoch University, November 2017

EPA (Environmental Protection Agency). 2022. EPA Biological Evaluation for the Hawaii Dispersant Preauthorization Plan (July 2019). 256 p.

Fujita, K., H. Nishizawa, J. Okuyama, M. Arita, S. Takuma, T. Narazaki and A. Watabe. 2023. Polymorphic foraging tactics in a marine reptile: insight from horizontal movement and dive behavior analyses. Marine Ecology Progress Series. 707:115-129.

Gilman E., D. Kobayashi, T. Swenarton, N. Brothers, P. Dalzell, I. Kinan-Kelly. 2007. Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. Biological Conservation 139:19-28.

Gregory, L.F. and J.R. Schmid. 2001. Stress responses and sexing of wild Kemp's ridley sea turtles (*Lepidochelys kempii*) in the northeastern Gulf of Mexico. General and Comparative Endocrinology, 124(1):66-74.

Gregory, L.F., T.S. Gross, A.B. Bolten, K.A. Bjorndal, and L.J. Guillette Jr. 1996. Plasma corticosterone concentrations associated with acute captivity stress in wild loggerhead sea turtles (Caretta caretta). General and comparative endocrinology. 104(3):312-320.

Hall, M., and M. Roman. 2017. The fishery on fish-aggregating devices (FADs) in the Eastern Pacific Ocean–Update. Inter-American Tropical Tuna Commission Scientific Advisory Committee Seventh Meeting La Jolla, California (USA). 19 p.

Harms, C.A., K.M. Mallo, P.M. Ross, and A.L. Segars. 2003. Venous blood gases and lactates of wild loggerhead sea turtles (Caretta caretta) following two capture techniques. Journal of Wildlife Diseases, 39(2):366-374.

Hart, K.M., M.M. Lamont, I. Fujisaki, A.D. Tucker, and R. Carthy. 2012. Common coastal foraging areas for loggerheads in the Gulf of Mexico: Opportunities for marine conservation. Biological Conservation. 145:185-194.

Hart, K.M., M.M. Lamont, A.R. Sartain, I. Fujisaki, and B. Stephens. 2013. Movements and habitat-use of loggerhead sea turtles in the northern Gulf of Mexico during the reproductive period. PLoS ONE. 8(7):e66921.

Hatase, H., K. Goto, K. Sato, T. Bando, Y. Matsuzawa, and W. Sakamoto. 2002. Using annual body size fluctuations to explore potential causes for the decline in a nesting population of the loggerhead turtle *Caretta caretta* at Senri Beach, Japan. Marine Ecology Progress Series. 245:299-304.

Hatase, H., Y. Matsuzawa, K. Sato, T. Bando, and K. Goto. 2004. Remigration and growth of loggerhead turtles (Caretta caretta) nesting on Senri Beach in Minabe, Japan: life-history polymorphism in a sea turtle population. Marine Biology. 144:807-811.

Hatase, H., K. Omuta, and K. Tsukamoto. 2013. A mechanism that maintains alternative life histories in a loggerhead sea turtle population. Ecology. 94(11):2583-2594.

Hawkes, L.A., M.J. Witt, A.C. Broderick, J.W. Coker, M.S. Coyne, M. Dodd, M.G. Frick, M.H. Godfrey, D.B. Griffin, S.R. Murphy, T.M. Murphy, K.L. Williams, and B.J. Godley. 2011. Home on the range: spatial ecology of loggerhead turtles in Atlantic waters of the USA. Diversity and Distributions. 17:624-640.

Hildebrand, J. A. 2004. Impacts of anthropogenic sound on cetaceans. Unpublished paper submitted to the International Whaling Commission Scientific Committee SC/56 E. p. 13.

Hildebrand, J. A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series. 395:5-20.

Hoopes, L.A., A.M. Landry Jr., and E.K. Stabenau. 1998. Preliminary assessment of stress and recovery in Kemp's ridleys captured by entanglement netting. Pages 201 *in* S.P. Epperly, and J. Braun, editors. Seventeenth Annual Sea Turtle Symposium.

Hoopes, L.A., A.M. Landry Jr., and E.K. Stabenau. 2000. Physiological effects of capturing Kemp's ridley sea turtles, *Lepidochelys kempii*, in entanglement nets. Canadian Journal of Zoology. 78(11):1941-1947.

Howell, E. A., D. R. Kobayashi, D. M. Parker, G. H. Balazs, and A. Polovina. 2008. TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery. Endangered Species Research. 5:267-278.

Howell, E. A., P. H. Dutton, J. J. Polovina, H. Bailey, D. M. Parker, and G. H. Balazs. 2010. Oceanographic influences on the dive behavior of juvenile loggerhead turtles (*Caretta caretta*) in the North Pacific Ocean. Marine Biology. 157(5):1011-1026.

Howell, E. A., A. Hoover, S. R. Benson, H. Bailey, J. J. Polovina, J. A. Seminoff, and P. H. Dutton. 2015. Enhancing the TurtleWatch product for leatherback sea turtles, a dynamic habitat model for ecosystem-based management. Fisheries Oceanography. 24(1):57-68.

Ishihara T., N. Kamezaki, Y. Matsuzawa, A. Ishizaki. 2014. Assessing the status of Japanese coastal fisheries and sea turtle bycatch. Wildlife and Human Society. 2:23-35.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland. p. 151.

IPCC. 2018. Summary for Policymakers. In: Masson-Delmotte V, Zhai P, Portner H-O, Roberts D, Skea J, Shukla PR, Pirani A, Moufouma-Okia W, Pean C, Pidcock R *et al.* editors. Global Warm.ing. of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland: 32

IPCC. 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

Jambeck, J. R., R. Geyer, C. Wilcox, T. R. Siegler, M. Perryman, A. Andrady, R. Narayan, and K. L. Law. 2015. Plastic waste inputs from land into the ocean. Science. 347(6223):768-771.

Jessop, T.S., A.D. Tucker, C.J Limpus and J.M. Whittier. 2003. Interactions between ecology, demography, capture stress, and profiles of corticosterone and glucose in a free-living population of Australian freshwater crocodiles. General and comparative endocrinology. 132(1):161-170.

Jessop, T.S., J.M. Sumner, C.J Limpus, and J.M.Whittier. 2004. Interplay between plasma hormone profiles, sex and body condition in immature hawksbill turtles (*Eretmochelys imbricata*) subjected to a capture stress protocol. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology. 137(1):197-204.

Jia, Y., J. Wang, G.H. Balazs and M. Liu. 2019. Nest productivity for green turtles (Chelonia mydas) at Qilianyu of Xuande Islands, South China Sea, PR China: preliminary findings. Chelonian Conservation and Biology. 18(1):116-120.

Jones, K.C. and P. De Voogt. 1999. Persistent organic pollutants (POPs): state of the science. Environmental pollution. 100(1-3):209-221.

Jones, T.T., B. Bostrom, M. Carey, B. Imlach, J. Mikkelsen, P. Ostafichuk, S. Eckert, P. Opay, Y. Swimmer, J.A. Seminoff, and D.R. Jones. 2011. Determining transmitter drag and best-practice attachment procedures for sea turtle biotelemetry. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-480.

Kaneko, J.J. and P.K. Bartram. 2008. What if you don't speak "CPUE-ese"? Pelagic Fisheries Research Program 13(2):1-8.

Kelly, I. K. 2020. A Review of vessel collision threat to sea turtles in Hawaii. NOAA-NMFS-PIRO Report, 18 pp.

Kiessling, I. 2003. Finding solutions: derelict fishing gear and other marine debris in northern Australia. National Oceans Office. p. 58.

Kim, I.H., I.K. Park, D.J. Han, M.S. Kim, D. Park, D.Y.Moon, I.Y. Cho, J.E. Im, J. Park, and Y.R. An. 2022. Movement Patterns of Juvenile Loggerhead Turtles (*Caretta caretta* L. 1758) and Green Turtles (*Chelonia mydas* L. 1758) Hatched in Captivity and Released in the Korean Waters. Animals. 12(16):2157.

Kobayashi, D. R., J. J. Polovina, D. M. Parker, N. Kamezaki, I. J. Cheng, I. Uchida, P. H. Dutton, and G. H. Balazs. 2008. Pelagic habitat characterization of loggerhead sea turtles, *Caretta caretta*, in the North Pacific Ocean (1997–2006): Insights from satellite tag tracking and remotely sensed data. Journal of Experimental Marine Biology and Ecology. 356(1-2):96-114.

Kubota, M. 2004. A Mechanism for the Accumulation of Floating Marine Debris North of Hawaii. Journal of Physical Oceanography. 24(5):1059-1064.

Laist, D. W., J. M. Coe, and K. O'Hara. 1999. Marine Debris Pollution. In: Twiss JR, Reeves RR, editors. Conservation and Management of Marine Mammals. Washington and London: Smithsonian Institution Press. p. 342-366.

Lewison, R. L., S. A. Freeman, and L. B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters. 7(3):221-231.

Lutcavage, M. E., P. Plotkin, P. Witherington, and P. L. Lutz. 1997. Human impacts on sea turtle survival. In: Lutz, P., J. Musick, editors. The Biology of Sea Turtles. p. 387-409. Boca Raton, Florida: CRC Press.

MacDonald, B.D., R.L. Lewison, S.V. Madrak, J.A. Seminoff, and T. Eguchi. 2012. Home ranges of East Pacific green turtles *Chelonia mydas* in a highly urbanized temperate foraging ground. Marine Ecology Progress Series. 461:211-212.

MacDonald, B.D., S.V. Madrak, R.L. Lewison, J.A. Seminoff, and T. Eguchi. 2013. Fine scale diel movement of the east Pacific green turtle, *Chelonia mydas*, in a highly urbanized foraging environment. Journal of Experimental Biology and Ecology. 443:56-64.

Madrak, S.V., R.L. Lewison, J.A. Seminoff, and T. Eguchi. 2016. Characterizing response of East Pacific green turtles to changing temperatures: using acoustic telemetry in a highly urbanized environment. Animal Biotelemetry. 4:22.

Mahmoud, I.Y. and P. Licht. 1997. Seasonal changes in gonadal activity and the effects of stress on reproductive hormones in the common snapping turtle, *Chelydra serpentina*. General and Comparative Endocrinology. 107(3):359-372.

Mansfield, K.L., J. Wyneken, D. Rittschoff, M. Walsh, C.W. Lim, and P.M. Richards. 2012. Satellite tag attachment methods for tracking neonate sea turtles. Marine Ecology Progress Series. 457:181-192.

Martin, S.L., Siders, Z., Eguchi, T., Langseth. B., Ahrens, R., and T. T. Jones. 2020. Assessing the population-level impacts of North Pacific loggerhead and western Pacific leatherback turtle interactions in the Hawaii-based shallow-set longline fishery. NOAA-TM-NMFS-PIFSC-95, 183 p. https://repository.library.noaa.gov/view/noaa/23037

Maximenko, N., J. Hafner, and P. Niiler. 2012. Pathways of marine debris derived from trajectories of Lagrangian drifters. Marine Pollution Bulletin. 65(1-3):51-62.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M. N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys—a study of environmental implications. The APPEA Journal. 40(1):692-708.

McCracken, M.L. 2018. Hawaii Permitted Shallow-set Longline Fishery Estimated Anticipated Take Level for Endangered Species Act Listed Species. PIFSC Data report DR-18-014. 18 p.

Molony, B. 2005. Estimates of the mortality of non-target species with an initial emphasis on seabirds, turtles and sharks. Oceanic Fisheries Program, Secretariat of the Pacific Community WCPFC-SC1; EB WP-1.

NMFS (National Marine Fisheries Service). 1999. Interim final rule for the continued authorization of the United States tuna purse seine fishery in the eastern tropical Pacific Ocean under the Marine Mammal Protection Act and the Tuna Conventions Act as revised by the International Dolphin Conservation Program Act. NMFS Southwest Region, Long Beach, CA. 60 p.

NMFS. 1999. Interim final rule for the continued authorization of the United States tuna purse seine fishery in the eastern tropical Pacific Ocean under the Marine Mammal Protection Act and the Tuna Conventions Act as revised by the International Dolphin Conservation Program Act. National Marine Fisheries Service – West Coast Region. 8 December 1999.

NMFS. 2001. Final Environmental Impact Statement for the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region. March 30, 2001.

NMFS. 2004. Biological Opinion on Proposed Regulatory Amendments to the Fisheries Management Plan for the Pelagic Fisheries of the Western Pacific Region. NMFS Southwest Region, Long Beach, CA. 281 p.

NMFS. 2008a. Biological Opinion on Proposed Management Modifications for the Hawaii-based Shallow-set Longline Swordfish Fishery-Implementation of Amendment 18 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region. NMFS Pacific Islands Regional Office. Honolulu, HI. 91 p.

NMFS. 2008b. Letter of concurrence that recommended changes under Amendment 18 to the Hawaii-based shallow-set longline swordfish fishery are not likely to adversely affect Hawaiian monk seals, or blue, fin, sei, sperm, and Northern right whales. August 27, 2008. NMFS Pacific Islands Regional Office, Honolulu, HI.

NMFS. 2008c. Programmatic biological opinion on the effects of the activities associated with the Navy's Hawaii Range Complex. Office of Protected Resources. 314 p.

NMFS. 2012. Biological Opinion on the Continued Operation of the Hawaii-based Shallow-set Longline Swordfish Fishery – under Amendment 18 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region. January 30, 2012. NMFS Pacific Islands Regional Office. Honolulu, HI.

NMFS 2015a. Letter of concurrence that the continued authorization of the Hawaii shallow-set longline fishery under the FEP for the Pelagics is not likely to adversely affect the MHI

IFKW DPS and the Eastern Pacific scalloped hammerhead shark DPS. March 2, 2015. NMFS Pacific Islands Regional Office, Honolulu, HI.

NMFS 2015b. Letter of concurrence that the continued authorization of the Hawaii-based shallow-set and deep-set longline fisheries is not likely to adversely affect Hawaiian monk seal critical habitat and fin whales. September 16, 2015. NMFS Pacific Islands Regional Office, Honolulu, HI.

NMFS. 2016a. Revised guidance for treatment of climate change in NMFS Endangered Species Act decisions. 8 p.

NMFS. 2016b. Endangered Species Act Section 7(a)(2) Biological Opinion for the Continued Operation of the West Coast-based Deep-set Longline Fishery managed under the Fishery Management Plan for U.S. West Coast Highly Migratory Species. National Marine Fisheries Service, West Coast Regional Office. August 18, 2016.

NMFS. 2017. Biological and conference opinion on the proposed implementation of a program for the issuance of permits for research and enhancement activities on threatened and endangered sea turtles pursuant to Section 10(a) of the Endangered Species Act. National Marine Fisheries Service, Office of Protected Resources. December 21, 2017.

NMFS. 2018. Biological Opinion on the National Science Foundation-funded seismic survey in the North Pacific Ocean, and issuance of an Incidental Harassment Authorization pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA). Office of Protected Resources. Silver Spring, MD.

NMFS. 2019. Endangered Species Action Section 7(a)(2) Consultation on the Continued Operation of the Hawaii Pelagic Shallow-set Longline Fishery. National Marine Fisheries Service, Pacific Island Regional Office. June 26, 2019.

NMFS. 2022. Regulation Summary–Hawaii Pelagic Longline Fishing. Revised July 2022. https://www.fisheries.noaa.gov/resource/document/hawaii-pelagic-longline-regulation-summary

NMFS. 2023a. Biological Evaluation: Potential effects of the Hawaii shallow-set pelagic longline fishery on loggerhead sea turtles. October 27, 2023.

NMFS. 2023b. Endangered Species Act Section 7(a)(2) Consultation for the Authorization of the Hawaii Deep-Set Longline Fishery. May 18, 2023. NMFS Pacific Islands Regional Office, Honolulu, HI. 414 p.

NMFS. 2023c. Endangered Species Act Section 7(a)(2) Consultation for the Continued Operation of the Large Mesh Drift Gillnet Fishery under the U.S. West Coast Fishery Management Plan for Highly Migratory Species. July 7, 2023. NMFS West Coast Region, Seattle, WA. 201 p.

NMFS and USFWS (NMFS and U.S. Fish and Wildlife Service). 1998. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Office of Protected Resources, Silver Spring MD and U.S. Fish and Wildlife Service, Southeast Region Jacksonville Ecological Services Office, Jacksonville, FL. p. 71.

NMFS and USFWS. 2020. Loggerhead Sea Turtle (*Caretta caretta*) North Pacific Ocean DPS 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southeast Region Jacksonville Ecological Services Office, Jacksonville, FL. p. 84.

National Marine Fisheries Service Southeast Fisheries Science Center (NMFS SEFSC). 2008. Sea Turtle Research Techniques Manual. NOAA Technical Memorandum NMFS-SEFSC-579, 92 p.

Navarra, G.G. and E. Di Lorenzo. 2021. Poleward shift and intensified variability of Kuroshio-Oyashio extension and North Pacific Transition Zone under climate change. Climate Dynamics. 56(7-8):2469-2486.

National Research Council (NRC). 2003. National Research Council (US) Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. Ocean Noise and Marine Mammals. Washington (DC): National Academies Press (US).

NRC. 1990a. Decline of the sea turtles: causes and prevention. Washington, D.C.: National Academies Press. p. 259.

NRC. 1990b. Sea Turtle Mortality Associated with Human Activities. Decline of the Sea Turtles: Causes and Prevention. National Academies Press. p. 74-117.

Okuyama, J., H. Ishii, S. Tanizaki, T. Suzuki, O. Abe, H. Nishizawa, A. Yano, M. Tsujimura, T. Ishigaki, T. Ishigaki, and M. Kobayashi. 2020. Quarter-century (1993–2018) nesting trends in the peripheral populations of three sea turtle species at Ishigakijima Island, Japan. Chelonian Conservation and Biology: Celebrating 25 Years as the World's Turtle and Tortoise Journal. 19(1):101-110.

Okuyama, J., A. Watabe, S. Takuma, K. Tanaka, K. Shirai, N. Murakami-Sugihara, M. Arita, K. Fujita, H. Nishizawa, T. Narazaki and Y. Yamashita. 2022. Latitudinal cline in the foraging dichotomy of loggerhead sea turtles reveals the importance of East China Sea for priority conservation. Diversity and Distributions. 28(8):1568-1581.

Olson, E.L., A.K. Salomon, A.J. Wirsing, and M.R. Heithaus. 2012. Large-scale movement patterns of male loggerhead sea turtles (*Caretta caretta*) in Shark Bay, Australia. Marine and Freshwater Research. 63:1108-1116.

Parker D.M., G.H. Balazs, S.K.K. Murakawa, and J.J. Polovina. 2001. Post-hooking survival of sea turtles taken by pelagic longline fishing in the North Pacific. In: Coyne M (ed) Proceedings of the 21st annual symposium on sea turtle biology and conservation. NOAA Tech Mem NMFS-SEFSC.

Parker, R. W., J. L. Blanchard, C. Gardner, B. S. Green, K. Hartmann, P. H. Tyedmers, and R. A. Watson. 2018. Fuel use and greenhouse gas emissions of world fisheries. Nature Climate Change. 8(4):333.

Peatman, T., L. Bell, V. Allain, P. Caillot, S. Williams, I. Tuiloma, A. Panizza, L. Tremblay-Boyer, S. Fukofuka, and N. Smith. 2019. Summary of longline fishery bycatch at a regional scale, 2003-2017 Rev 3 (15 April 2019). Busan, Republic of Korea 8-16 August 2018. p. 61.

Peckham, S.H., D.M. Diaz, A. Walli, G. Ruiz, L.B. Crowder, W.J. Nichols. 2007. Small-scale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. PLoS ONE. 2(10):e1041.

Pichel, W. G., J. H. Churnside, T. S. Veenstra, D. G. Foley, K. S. Friedman, R. E. Brainard, J. B. Nicoll, Q. Zheng, and P. Clemente-Colon. 2007. Marine debris collects within the North Pacific Subtropical Convergence Zone. Marine Pollution Bulletin. 54(8):1207-1211.

Polovina, J. J., G. H. Balazs, E. A. Howell, D. M. Parker, M. P. Seki, and P. H. Dutton. 2004. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. Fisheries Oceanography. 13(1):36-51.

Polovina, J.J., J.P. Dunne, P.A. Woodworth, and E.A. Howell. 2011. Projected expansion of the subtropical biome and contraction of the temperate and equatorial upwelling biomes in the North Pacific under global warming. ICES Journal of Marine Science. 68(6):986-995.

Polovina, J. J., E. A. Howell, D. R. Kobayashi, and M. P. Seki. 2001. The transition zone chlorophyll front, a dynamic global feature defining migration and forage habitat for marine resources. Progress in Oceanography. 49(1-4):469-483.

Polovina, J. J., D. R. Kobayashi, D. M. Parker, M. P. Seki, and G. H. Balazs. 2000. Turtles on the edge: movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997–1998. Fisheries Oceanography. 9(1):71-82.

Polovina, J. J., I. Uchida, G. H. Balazs, E. A. Howell, D. Parker, and P. Dutton. 2006. The Kuroshio Extension Bifurcation Region: A pelagic hotspot for juvenile loggerhead sea turtles. Deep Sea Research Part II: Topical Studies in Oceanography. 53(3-4):326-339.

Ryder, C. E., T. A. Conant, and B. A. Schroeder. 2006. Report of the Workshop on Marine Turtle Longline Post-Interaction Mortality. U.S. Dep. Commerce, NOAA Technical Memorandum NMFS-F/OPR-29. 36 p. https://repository.library.noaa.gov /view/noaa/23893

Sakamoto, W., T. Bando, N. Arai, and N. Baba. 1997. Migration paths of the adult female and male loggerhead turtles *Caretta caretta* determined through satellite telemetry. Fisheries Science. 63(4):547-552.

Santos, R. G., R. Andrades, M. A. Boldrini, and A. S. Martins. 2015. Debris ingestion by juvenile marine turtles: an underestimated problem. Marine Pollution Bulletin. 93(1-2):37-43.

Savoca, M.S., S. Kühn, C. Sun, S. Avery-Gomm, C.A. Choy, S. Dudas, S.H. Hong, K.D. Hyrenbach, T.H. Li, C.K.Y. Ng, and J.F. Provencher. 2022. Towards a North Pacific Ocean long-term monitoring program for plastic pollution: A review and recommendations for plastic ingestion bioindicators. Environmental Pollution. 310: 119861.

Schuyler, Q. A., C. Wilcox, K. A. Townsend, K. R. Wedemeyer-Strombel, G. Balazs, E. van Sebille, and B. D. Hardesty. 2016. Risk analysis reveals global hotspots for marine debris ingestion by sea turtles. Global Change Biology. 22(2):567-576.

Seki, M. P., J. J. Polovina, D. R. Kobayashi, R. R. Bidigare, and G. T. Mitchum. 2002. An oceanographic characterization of swordfish (*Xiphias gladius*) longline fishing grounds in the springtime subtropical North Pacific. Fisheries Oceanography. 11(5):251-266.

Siders, Z.A., R.N.Ahrens, S.Martin, E.V.Camp, A.R.Gaos, J.H.Wang, J. Marchetti, and T.T. Jones. 2023. Evaluation of a long-term information tool reveals continued suitability for identifying bycatch hotspots but little effect on fisher location choice. Biological Conservation. 279:109912.

Shaver, D.J., K.M. Hart, I. Fujisaki, D. Bucklin, A.R. Iverson, C. Rubio, T.F. Backof, P.M. Burchfield, R.d.G.D. Miron, P.H. Dutton, A. Frey, J. Peña, D.G. Gamez, H.J. Martinez, and J. Ortiz. 2017. Inter-nesting movements and habitat-use of adult female Kemp's ridley turtles in the Gulf of Mexico. PLoS ONE 12(3):e0174248.

Shaver, D.J., B.A. Schroeder, R.A. Byles, P.M. Burchfield, J. Pena, R. Marquez, and H.J. Martinez. 2005. Movements and home ranges of adult male Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Gulf of Mexico investigated by satellite telemetry. Chelonia Conservation and Biology 4:817-827.

Stabenau, E.K., T.A. Heming, and J.F. Mitchell. 1991. Respiratory, acid-base and ionic status of Kemp's ridley sea turtles (*Lepidochelys kempi*) subjected to trawling. Comparative Biochemistry and Physiology Part A: Physiology. 99(1-2):107-111.

St. Aubin, D.J. and J.R. Geraci. 1988. Capture and handling stress suppresses circulating levels of thyroxine (T4) and triiodothyronine (T3) in beluga whales *Delphinapterus leucas*. Physiological Zoology, 61(2):170-175.

Stapleton, S.P., and K.L. Eckert. 2008. Community-Based Sea Turtle Research and Conservation in Dominica: A Manual of Recommended Practices.

State of Hawaii Department of Business, Economic Development and Tourism; Research Economic Analysis Division. 2022. Hawaii Economic Issues Data Report 2022 – State of Hawaii Energy Data and Trends. April 2022. Available at: https://files.hawaii.gov/dbedt/economic/data_reports/reports-studies/Energy%20Data%20Report%202022%20Final.pdf.

Swimmer, Y., and E. Gilman. 2012. Report of the Sea Turtle Longline Fishery Post-release Mortality Workshop, November 15−16, 2011. NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-34. 31 p.

Swimmer, Y., A. Gutierrez, K. Bigelow, C. Barceló, B. Schroeder, K. Keene, K. Shattenkirk, and D. G. Foster. 2017. Sea Turtle Bycatch Mitigation in U.S. Longline Fisheries. Frontiers in Marine Science. 4:260.

Thomson, J.A. and M.R. Heithaus M.R. 2014. Animal-borne video reveals seasonal activity patterns of green sea turtles and the importance of accounting for capture stress in short-term biologging. Journal of Experimental Marine Biology and Ecology. 450:15-20.

Turner Tomaszewicz C.N., J.A. Seminoff, L. Avens, L.R. Goshe, S.H. Peckham, J.M. Rguez-Baron, K. Bickerman, C.M. Kurle. 2015. Age and residency duration of loggerhead turtles at a north Pacific bycatch hotspot using skeletochronology. Biological Conservation. 186:134-142.

United Nations Environmental Programme. 2023. Listing of POPs in the Stockholm convention. https://www.pops.int/TheConvention/ThePOPs/AllPOPs/tabid/2509/Default.aspx, Accessed date: 11 December 2023.

U.S. Energy Information Administration (EIA). 2019. U.S. EIA, Petroleum & Other Liquids, Imports by Area of Entry. U.S.EIA, Editor: Washington, DC. Available from: https://www.eia.gov/petroleum/data.php.

USFWS and NMFS. 1998. Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act. p. 315.

Van Dam, R.P., C.E. Diez, G.H. Balazs, L.A.C. Colon, W.O. McMillan, and B. Schroeder. 2008. Sex-specific migration patterns of hawksbill turtles breeding at Mona Island, Puerto Rico. Endangered Species Research 4:85-94.

Wang, Y and W. Li. 2008. Sea turtle survey, monitoring and awareness promotion programme in Mainland China. Final Report to U.S. Fish and Wildlife Service.

Wania, F. and D. Mackay. 1995. A global distribution model for persistent organic chemicals. Science of the Total Environment. 160:211-232.

White, F. N. 1994. Swallowing dynamics of sea turtles. P. 89-95. In: Balazs GH, Pooley SG, editors. Research plan to assess marine turtle hooking mortality: results of an expert workshop held in Honolulu, Hawaii, November 16-18, 1993. NOAA-TM-NMFS-SWFSC-201. 172 p. https://repository.library.noaa.gov/view/noaa/6181

WCPFC (Western and Central Pacific Fisheries Commission). 2023. Science and Scientific Data Functions. Available at: https://www.wcpfc.int/node/29966 Accessed last on: February 6, 2023.

Work, T. M. 2000. Manual de Necropsia de Tortugas Marinas para Biologos en Refugios o Areas Remotas. Hawaii, U.S. Geological Survey National Wildlife Health Center, Hawaii Field Station. p. 25.

WPFMC (West Pacific Fisheries Management Council). 2009. Management Modifications for the Hawaii-based Shallow-set Longline Swordfish Fishery: Proposal to Remove Effort Limit, Eliminate Set Certificate Program, and Implement New Sea Turtle Interaction Caps. Amendment 18 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region, including a Final Supplemental Environmental Impact Statement. March 10, 2009. Honolulu, HI.

WPFMC. 2022. Report of the ecosystem based fishery management workshop: Exploring the effect of spatial decision making by fishers in the Hawaii shallow-set longline fishery. Available here: https://www.wpcouncil.org/wpcontent/ uploads/2021/10/09.A1-EBFM-SSLL-Turtle- Model-Workshop-Report.pdf

9 APPENDICES

9.1 Appendix A: Best Management Practices for Sea Turtle Handling and Data Collection

- No harm should occur from photographing, measuring and general handling of the animal. All fisheries observers collecting scientific data in the field related to sea turtles will complete training by NMS/PIFSC/Marine Turtle Research Program (MTRP) and the Pacific Islands Regional Office (PIRO) Observer Program in all procedures for handling and data collections specified in the biological opinion. The sampling and obtaining of scientific information is minimally invasive in regards to this permit. After sampling, to ensure that they can be released safely, all turtles will be released as close to the water's surface as possible.
- Animals will only be brought on board the fishing vessel (boarded) if they are able to fit into the required dip net (see 50 CFR 665.812(a)(6)). Animals too large to fit into this net will not be boarded, to prevent further injury from potential boarding and handling. Once on board, animals will be kept in a shaded area and placed on a small tire to limit movement. This will hold the turtle upright and prevent the animal from freely moving around the vessel and incurring further injuries. Following these guidelines should minimize the likelihood of injuries from boarding and handling.
- For flipper tagging and biopsy sampling, any negative effects of these activities are addressed as follows:
    - Equipment used for tagging will be disinfected before and after use, reducing the likelihood of disease transmission between animals and reducing the chance of a post tagging infection. When tagging the animal's flippers, the small puncture wound resulting from a tag properly applied to the flipper should heal completely in a short time. There is no data indicating that the tagging experience or presence of tags will cause lasting harm or alter a turtle's long term behavior (Balazs, 1999).
    - Biopsy sampling will be conducted using sterilize single-use to prevent disease transmission between animals. Treatment of the sampling site with Betadine swabs will further minimize the potential for infection at the sampling site. After biopsy sampling, following the removal of the sample, the defect can be left to heal by granulation (Jacobson 1999).
- For satellite tagging, any negative effects of these activities are addressed as follows:
    - Satellite Tags will not exceed 5% of a turtle's body weight. No tag will be place on sea turtles smaller than 40 cm SCL.
    - To reduce drag, tags will not be attached to the highest point on the carapace, but rather slightly posterior or anterior to this area. These tags will be applied in a series and close together to further reduce drag potential. The satellite tags employed are designed to minimize drag on the animal and have a negligible effect on swimming and diving ability. These tags will be designed to have a low profile frontal area, a teardrop shape, a minimized antenna.

- Tags will be applied using a minimal amount of adhesive. Adequate ventilation around the turtles' heads will be provided during each instance of a satellite tag attachment.