

Final report on findings from federal award FNA16NMF4270257

Title: Improving stock structure estimates for west coast swordfish using Fishery Independent methods.

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The Pfleger Institute of Environmental Research (PIER) has been tagging swordfish since 2003, with studies focused on movement patterns, habitat utilization, physiology, and fishery development. More recently, PIER has combined NOAA-funded deep-set buoy gear trials (standard and linked) with tagging and genetic studies to assess regional movement patterns in the Eastern North Pacific (FNA16NMF4270257).

Study Design: All swordfish tagged under award # FNA16NMF4270257 were outfitted with at least two electronic tags to assess migratory behaviors in relation to current stock boundary designations used to manage swordfish in the north Pacific (ISC, 2014). Satellite-based tags were programmed with varying deployment regimes such that pop-off times aligned with the proposed regional spawning season.

Tags used in this study included data storage tags (DSTs), mark-recapture pop-up tags (mrPATs), pop-up archival tags (PSATs) and dorsal fin-mount SPOT tags. Tag deployments were performed aboard the PIER research vessel *Malolo* during deep-set buoy gear development trials.

Tissue samples (i.e., fin clips) were also collected from all tagged swordfish to assess genetic structure and compile a genomic database for individuals of known track history. Subsequent genetic analyses are proposed using single nucleotide polymorphisms (SNPs) in the Alvarado-Bremer Laboratory at Texas A&M at Galveston.

Results to Date: This work provides information from 70 electronic tags that reported location information following deployment off the California coast. The deployments ranged from southern California (n=56) to central California (n=14) and revealed extensive horizontal movements that ranged from the Equator (0.8°N/132.0°W) to out beyond the Hawaiian Islands (17.0°N/154.0°W).

Southern California deployments: Of the 56 swordfish tagged off southern California, 17 (30%) tags reported proximal to the tagging area (within the CA EEZ), providing limited information regarding migratory routes and stock affiliation. Of the 39 swordfish that moved outside of the CA EEZ, 30 individuals (77%) moved into the Eastern Pacific Ocean (EPO) Management Unit (Figure 1). An additional seven swordfish (18%) moved to the west or southwest into the Western and Central North Pacific (WCNP) management unit region (Figure 1). Lastly, two (5%) of the double-tagged swordfish showed affinity to both the EPO and WCNP management units during the deployment period, with pop-off locations spanning both sides of the stock boundary line.

In addition to traditional pop-off tag technology, this work also trialed the use of dorsal fin mounted SPOT tags that report fish location when basking at the surface (Figure 2). All three of the SPOT tagged swordfish entered into and spent significant time within the EPO management unit. A track from Swordfish #171954 (purple trace) includes recent 2018 location data which show a return visit to southern California after travelling around the tip of Baja California.

Figure 1. Deployment and reported locations for 54 swordfish tagged along southern California in 2016-2017 plotted over management unit boundary lines (ISC, 2014). Only one location was used to represent each tagged fish. An orange star is used to show locations from the two individuals that moved across the stock boundary line during the track.

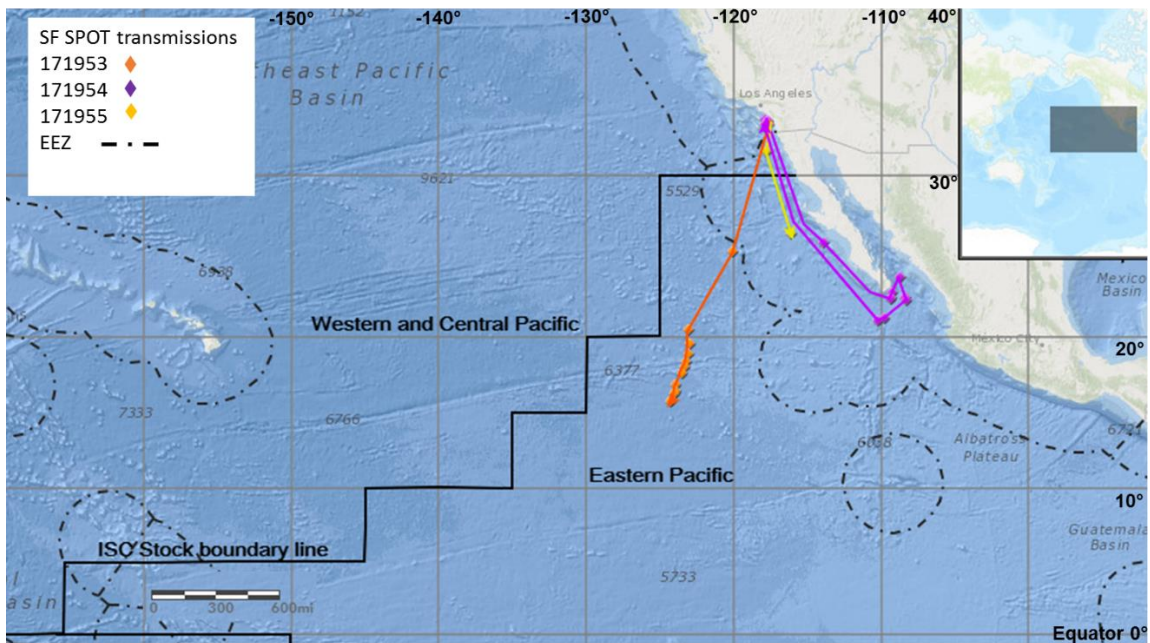
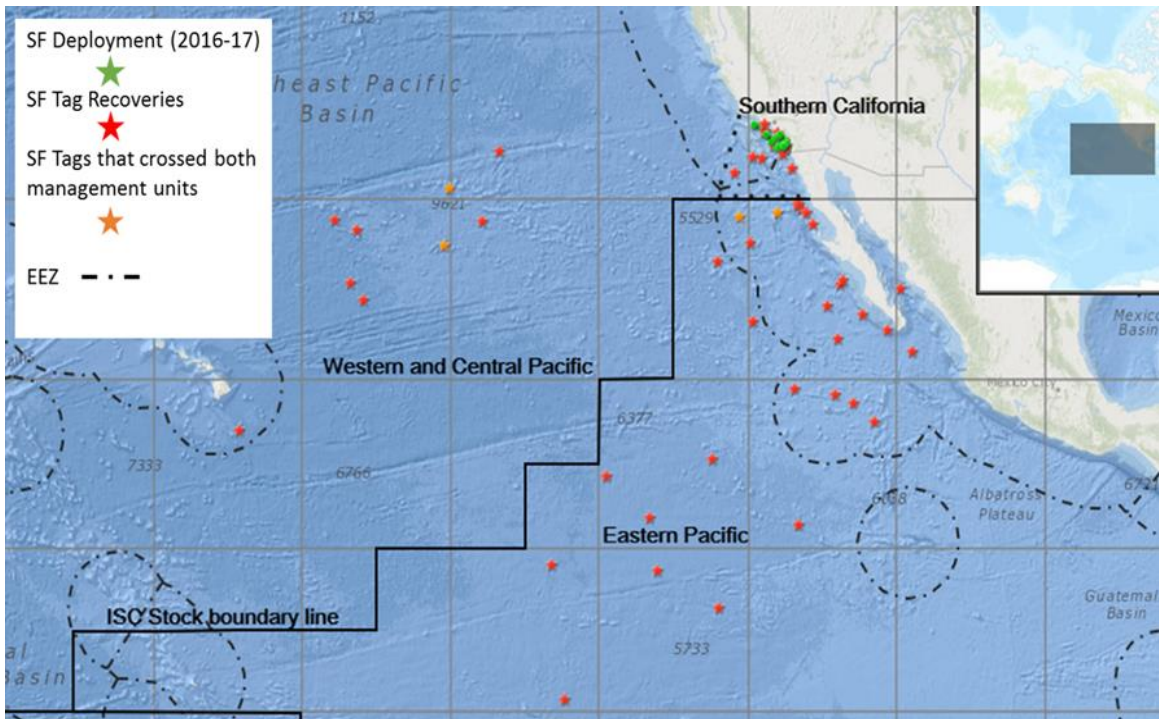


Figure 2, Dorsal-fin mounted SPOT tag transmissions for three swordfish tagged off southern California in 2017. Track from Swordfish #171954 includes recent 2018 location data exhibiting a return visit to southern California after travelling around the tip of Baja California, an area within the Eastern Pacific Ocean management unit.

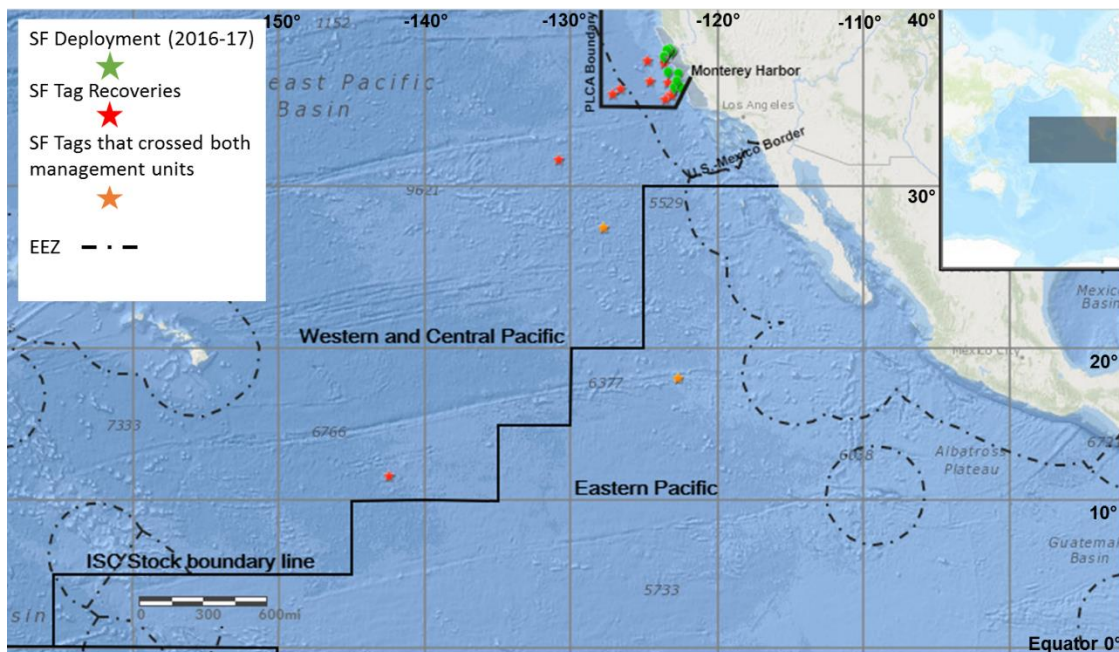


Figure 3 Tag deployment and recovery locations for swordfish tagged within the Pacific Leatherback Conservation Area (PLCA; n=14) plotted over current management unit boundaries. Orange stars represent multiple tag locations from a single fish that moved across the stock boundary line over the course of the track. Locations for 11 PSAT deployments within the PLCA were also included from a recently published swordfish tagging study (Sepulveda et al. 2018).

Central California Deployments: Swordfish were also tagged and released within the boundaries of the Pacific Leatherback Conservation Area (PLCA) off central California (n=14; Figure 3). Swordfish tagged within the PLCA boundaries primarily travelled in a west or southwest direction and exhibited a greater affinity for the WCNP management unit area. To date, only one of the 14 double-tagged swordfish has moved from the WCNP into the EPO management area (7%).

Tag Recaptures: From 2015-2017 this work has documented a relatively high recapture rate (13%). Six tagged swordfish (46%) were recaptured by Mexican flagged longline vessels operating within the EPO management unit, and one individual (8%) was recaptured by a U.S. flagged longline vessel fishing south of the Hawaiian Islands. The remaining recaptured individuals (46%) were reported by California drift gillnet (n=3) and deep-set buoy gear (n=3) fishers off southern California. Recovered data-storage tags will provide depth and temperature data that will be used to better characterize seasonal and regional movement patterns of swordfish in the north Pacific.

Findings from this NOAA-funded study are currently being compared with other data on swordfish movements in the Pacific, including previous tag deployments by PIER and NOAA collaborators dating back to 2003. Preliminary analyses of the earlier deployments suggest similar horizontal movement patterns to those presented in this study.

Findings from additional tag recoveries will be incorporated into a publication on swordfish horizontal movements in the north Pacific that will be prepared for submission in late 2018. In addition, genetic analyses and movement data will be collected and published in a subsequent manuscript. We hope to continue to better document swordfish movements and increase the information available for long term sustainable management of this valuable resource.