National Marine Fisheries Service
NOAA

Fishery Bulletin
established in 1881

Spencer F. Baird
First U.S. Commissioner of Fisheries and founder of *Fishery Bulletin*

Assessing postrelease mortality in hook-and-line fishing of a large coastal sciaenid, the white seabass (*Atractoscion nobilis*)

Ruairi MacNamara (contact author)
Michael Shane
Victor Bach Muñoz
Mark Drawbridge

Email address for contact author: rmacnamara@hswri.org

Hubbs-SeaWorld Research Institute
2595 Ingraham Street
San Diego, California 92109

Abstract—White seabass (*Atractoscion nobilis*) are highly prized on the Pacific coast of North America. Size-based, seasonal, and spatial harvest regulations are in place for this species, leading to the release of live fish in hook-and-line fisheries. To better understand how releases may be affecting the population of this species in the Southern California Bight, 161 white seabass (420–1425 mm in total length [TL]) were captured by hook and line over a 4-year period (2021–2024). Biological, environmental, and fishing data were recorded for each capture event, and fish were subsequently released into a large (630-m^3) net pen. The short-term postrelease mortality of white seabass (i.e., within 24 h) was 14.9% overall. When assessed by using logistic regression, the best-supported model of mortality included *hooking location* and its interaction with *fish TL*. Model-predicted mortality was generally lower for fish hooked in the lip (0%–67%) than for fish hooked in the oral cavity or deeper (21%–63%), although mortality increased substantially in lip-hooked individuals >1000 mm TL (10%–67%). A small number of white seabass (11 individuals) had signs of barotrauma, with the results of a separate analysis indicating that these fish were significantly larger and captured at deeper sites than those without barotrauma. These findings can help improve fisheries management decision-making for a species that is heavily targeted by hook-and-line fishing.

Manuscript submitted 6 September 2024.
Manuscript accepted 25 February 2025.
Fish. Bull. 123:119–126 (2025).
Online publication date: 12 March 2025.
doi: 10.7755/FB.123.2.4

In fishery systems, captured fish may be voluntarily returned to the water alive (as in catch-and-release fishing) or may be returned as a result of regulations that limit harvest. The release (or discard) of fish is an important part of managing fisheries, but quantifying postrelease mortality can be challenging. Relative to net-based gears, capture by hook and line can have distinctive effects on fish that are released (e.g., Veldhuizen et al., 2018). Species-specific studies of hook-and-line fishing are therefore necessary to understand the effects on intentionally or incidentally captured fish that are released.

Along the west coasts of the United States (California) and Mexico (Baja California), the white seabass (*Atractoscion nobilis*) is targeted commercially with gears that include hook and line, and this sciaenid is also popular among recreational anglers (Valero and Waterhouse, 2016; MacNamara et al., 2022). According to logbook records, a sizeable proportion of the white seabass captured by anglers on commercial passenger fishing vessels is released (Valero and Waterhouse, 2016). Although some work has been undertaken to examine postrelease mortality of juvenile white seabass (Aalbers et al., 2004), little is known about this issue in larger individuals (>600 mm in total length [TL]).

In the Southern California Bight, white seabass are collected from the wild to be used as broodstock for a longstanding stock-enhancement program (Drawbridge et al., 2021; MacNamara et al., 2022). Fish are captured by hook and line under a scientific collecting permit (S-201600001-21118-001) from the California Department of Fish and Wildlife that waives many recreational harvest regulations for this species (CDFW[1]). White seabass are held and monitored in a large net pen at Santa Catalina Island, an offshore island in the Southern California Bight, before being brought to the hatchery of the Hubbs-SeaWorld Research Institute on the mainland. Using this net pen, we were able to assess the effects of fishing and the biological and environmental factors that influence postrelease mortality of white seabass. The results of this multiyear study will help improve

[1] CDFW (California Department of Fish and Wildlife). 2025. Scientific collecting permits. [Web page available from website, accessed February 2025.]

the harvest regulations and stock assessments required for management of this important species.

Material and methods

Harvest regulations

Although voluntary catch and release is likely low, various size-based, seasonal, and spatial harvest regulations lead to the release of white seabass captured by hook and line. Both recreational and commercial fisheries for white seabass in California are subject to the minimum legal length of 711 mm TL (California. . .2025). A daily bag limit of 3 white seabass per angler is in effect statewide for recreational fishing, decreasing to 1 fish between 15 March and 15 June from Point Conception to the border of the United States and Mexico (i.e., in the Southern California Bight). Lastly, California's extensive network of marine protected areas includes several state marine conservation areas (CDFW[2]) in the Southern California Bight in which white seabass cannot be harvested by hook and line but similar species can be. As a result, incidental capture of white seabass may occur in those areas.

Fishing

Fishing of white seabass for this study took place annually at Santa Catalina Island in late spring and early summer from 2021 to 2024. Boat-fishing tackle commonly used to catch white seabass (30- to 50-lb test) was fished by 5–10 experienced anglers each year. Large (4/0–8/0) non-offset circle hooks and J-hooks were used; the latter were a type called *jig head* that has a small lead weight affixed to the upper shank near the eye. Live California market squid (*Doryteuthis opalescens*) were used as bait close to the seabed while at anchor. The depth at each fishing site was recorded by using the boat's echo sounder (NavNet vx2[3], Furuno Electric Co. Ltd., Nishinomiya, Japan), as an indicator of capture depth, although it is possible that some fish were hooked higher up in the water column. Sea-surface temperatures at the times of capture were obtained from the NOAA National Data Buoy Center for station 46222, located between Santa Catalina Island and the mainland (33°37′5″N, 118°19′1″W; data available from website). This data buoy, which records temperature at a depth of 0.5 m, was selected as it is the closest to the fishing grounds (approximately 28–35 km away) and data from it were available across all 4 years of the study. During scientific gill-net surveys at Santa Catalina Island (Allen et al., 2007), sea-surface temperatures in summer were only 1°C warmer on average than bottom temperatures within the depth range at which angling for white seabass took place.

Once hooked, white seabass were brought to the boat as quickly as possible (fight time was not recorded) and were landed with a large, knotless mesh landing net. Fish were placed in a 0.36-m^3 transport tank (inside dimensions: 0.98 m long by 0.65 m wide by 0.57 m high) with a seawater flow rate of approximately 75 L/min. For each fish, hooking location was recorded as occurring in the lip, roof of the mouth, or deeper (i.e., in the gills, esophagus, or stomach) (Fig. 1). Bleeding was noted but was difficult to estimate quantitatively; therefore, hooking location was used as an index of injury. The hook was removed with long-nose pliers (except in 3 deep-hooked individuals for which the line had to be cut), TL was measured to the nearest millimeter, and each fish's cheek was scanned for the presence of a coded wire tag that indicates hatchery origin. Only fish of wild origin (i.e., without a coded wire tag) were used in this study. A passive integrated transponder was injected in the left dorsoposterior musculature of each fish for identification of individuals. Each fish was kept submerged during handling, which typically lasted <1.5 min and was performed by onboard scientists. A lid was then placed over the transport tank, and the boat was driven to the net pen. All fishing occurred within 10 km of the net pen to minimize transport time (i.e., the time from being placed in the transport tank to being transferred to the net pen). Fish that died immediately upon capture were assigned a transport time of 0 min.

Fish were transferred from the transport tank to the net pen in a landing net or in a vinyl fish sling. Most fish were able to descend unaided in the net pen within a few seconds. When a live fish floated at the surface, efforts were made to right the body position and gently submerge the fish to a depth of about 1 m. If the fish did not swim away after this effort was made several times, the swim bladder was deflated (hereafter referred to as *vented*) to allow the fish to descend. Venting involved carefully penetrating the body wall at a shallow angle (<45°) from the posterior direction by using a spinal needle (1.2 by 90.0 mm) with stylet (BD Medical, Franklin Lakes, NJ). Although generally discouraged among recreational anglers in California (CDFW[4]), venting was approved for this study because of the difficulty of using a descending device within the net pen, which was shallower than most of the fishing sites and posed a snagging risk at the bottom for descended fish. Loss of equilibrium and the need to deflate the swim bladder served as an indicator of barotrauma in this study, as other gross external signs, such as exophthalmia or protrusion of the organs from the body, were generally not present (note that 2 vented individuals did have mild stomach eversion in their oral cavity).

[2] CDFW (California Department of Fish and Wildlife). 2024. California marine protected areas (MPAs). [Web page available from website, accessed November 2024.]

[3] Mention of trade names or commercial companies is for identification purposes only and does not imply endorsement by the National Marine Fisheries Service, NOAA.

[4] CDFW (California Department of Fish and Wildlife). 2024. Rockfish barotrauma and descending devices. [Web page available from website, accessed November 2024.]

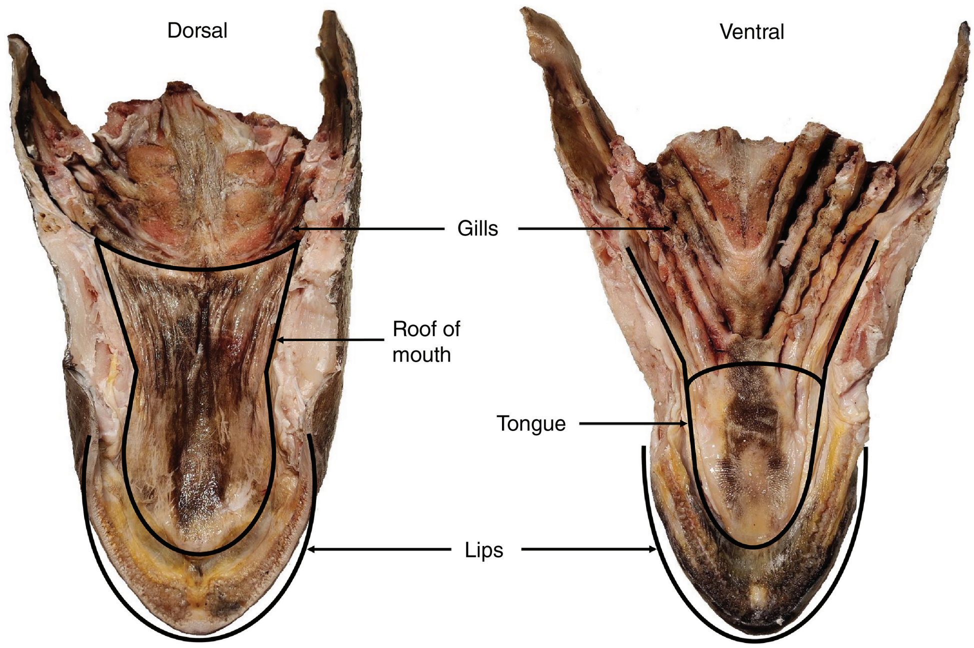

Figure 1

Horizontal plane view of the dorsal and ventral mouth parts of an adult white seabass (*Atractoscion nobilis*) caught in the Southern California Bight in 2024, showing the hooking locations for fish categorized as lip hooked and as internally hooked (roof of mouth and gills shown, esophagus and stomach not shown). Note that the tongue is shown on the ventral side for reference, although no fish were hooked in the tongue in this study.

Holding

The net pen is located in a protected cove in water with mean lower low water of 21.7 m. The pen consists of a floating frame measuring 9.7 m long by 9.7 m wide, with a containment net (3.2-cm square mesh) suspended to a depth of 6.7 m from the frame. The total volume of the containment net is 630 m^3. The containment net is surrounded by a predator net (10.0-cm square mesh). White seabass were monitored for 24 h after being placed in the net pen, and any dead fish were removed and identified by using their passive integrated transponder. White seabass that were not removed during this period were assumed to have survived short-term after release. Fish were held for several months before being transported to the hatchery of the Hubbs-SeaWorld Research Institute, but after the first 24 h, monitoring became less regular (i.e., occurring every 2–3 d, when fish were being fed). Therefore, only short-term postrelease mortality (i.e., within 24 h) could be quantitatively assessed.

Data analysis

Data for all 4 years were combined, and results from initial data exploration indicate collinearity between the variables *fish TL* and *fishing site depth*: smaller white seabass tended to be captured at shallower fishing sites and larger white seabass at deeper fishing sites (Suppl. Figure). *Fishing site depth*, therefore, was removed from the primary analysis, given that *fish TL* is more easily measured and commonly reported in fishing logs or by fishery samplers. Because depth is important in the context of fisheries management, analysis was also done with an alternative generalized linear model (GLM) in which *fish TL* is substituted for *fishing site depth* (the results of this alternative GLM are presented in Supplementary Tables 1 and 2). Generalized linear models with the binomial response *white seabass mortality within 24 h* (0 or 1) were fitted by using a logit link in R, vers. 4.3.1 (R Core Team, 2023). The R package brglm2 (vers. 0.9.2; Kosmidis, 2023) was used because it is better suited to dealing with quasi-complete separation and rare occurrence of events in small datasets than standard GLMs, giving more conservative model estimates.

The main variable of interest was *hooking location*, which was coded as a binary categorical variable of either lip hooked or internally hooked (i.e., any fish hooked in the roof of the mouth, gills, esophagus, or stomach). The continuous predictor variables *fish TL* and *water temperature at capture* were included as main effects or as interactive effects with *hooking location*. *Transport time* was also modeled to better estimate if it may have contributed to mortality, given that fish not harvested in typical hook-and-line fishing are immediately released following capture. Multicollinearity was checked (it was detected if the variance inflation factor was >2), and selection of candidate models was performed with Akaike information criterion corrected for small sample sizes (AICc). The model with the fewest parameters and a difference in AICc <2 between it and the best-fit model was selected. The R package ggeffects (vers. 1.7.0; Lüdecke, 2018) was used to plot values with 95% confidence intervals (CIs).

The study design limited the identification of barotrauma to individuals that survived long enough to be transported to, and placed in, the net pen. Furthermore, fish exhibiting barotrauma underwent venting to allow them to descend in the net pen; therefore, this handling step differed from the handling of fish without barotrauma. Although fish with barotrauma were included in the GLM analysis, barotrauma was not explicitly modeled as a predictor variable. Instead, a separate analysis compared *fish TL*, *fishing site depth*, *transport time*, and *water temperature at capture* among fish that had signs of barotrauma and those that did not. Mann–Whitney *U*-tests were used because of the non-normality of the data and the highly unequal group sizes.

Results

A total of 161 white seabass were captured, with sizes ranging between 420 and 1425 mm TL (mean: 837 mm TL [standard deviation (SD) 253]). Of those fish, 69 individuals had lengths less than and 92 individuals had lengths greater than the minimum legal length of 711 mm TL (Fig. 2A). White seabass were captured at fishing sites with depths of 4.6–21.3 m (mean: 10.6 m [SD 5.0]) (Fig. 2B), and more were lip hooked (number of fish [*n*]=135) than internally hooked (*n*=26) (Fig. 2C). Transport time ranged between 0 and 264 min (mean: 62 min [SD 39]) (Fig. 2D), and water temperature at the time of capture was 16.9°C–21.7°C (mean: 18.3°C [SD 1.0]) (Fig. 2E). Of the captured white seabass, 11 individuals had signs of barotrauma, 144 fish did not, and 6 individuals that died immediately upon capture could not be assessed for barotrauma (Fig. 2F). For an overall mortality of 24 white seabass (14.9%) in this study, 6 fish died immediately upon capture (all internally hooked), and an additional 18 individuals died within 24 h (Table 1).

For the GLMs, AICc values indicate clear support for the model in which the interaction of the variables *hooking location* and *fish TL* is used to examine mortality over the other candidate models (Table 2). The 95% CIs do not overlap with zero, indicating that short-term postrelease mortality of white seabass was statistically significant for hooking location and for the interaction between lip hooking and fish TL in the selected model (Table 3). Internally hooked white seabass were more likely to suffer postrelease mortality than lip-hooked white seabass (95% CI: 5.590–15.505). Mortality increased for lip-hooked white seabass as fish TL increased (95% CI: 0.003–0.011), but no statistically significant mortality trend occurred with fish TL for internally hooked white seabass (95% CI: –0.005–0.001) (Table 3).

Model-predicted mortality for a lip-hooked white seabass increased from 0% (95% CI: 0%–3%) for a 420-mm-TL fish to 67% (95% CI: 33%–89%) for a 1425-mm-TL fish; this trend was gradual up to about 1000 mm TL (mortality <10%) and much steeper between 1000 and 1425 mm TL (mortality increased from 10% to 67%) (Fig. 3A). Although not statistically significant, the estimated mortality for internally hooked white seabass decreased between 63% (95% CI: 32%–86%) for a 420-mm-TL fish and 21% (95%

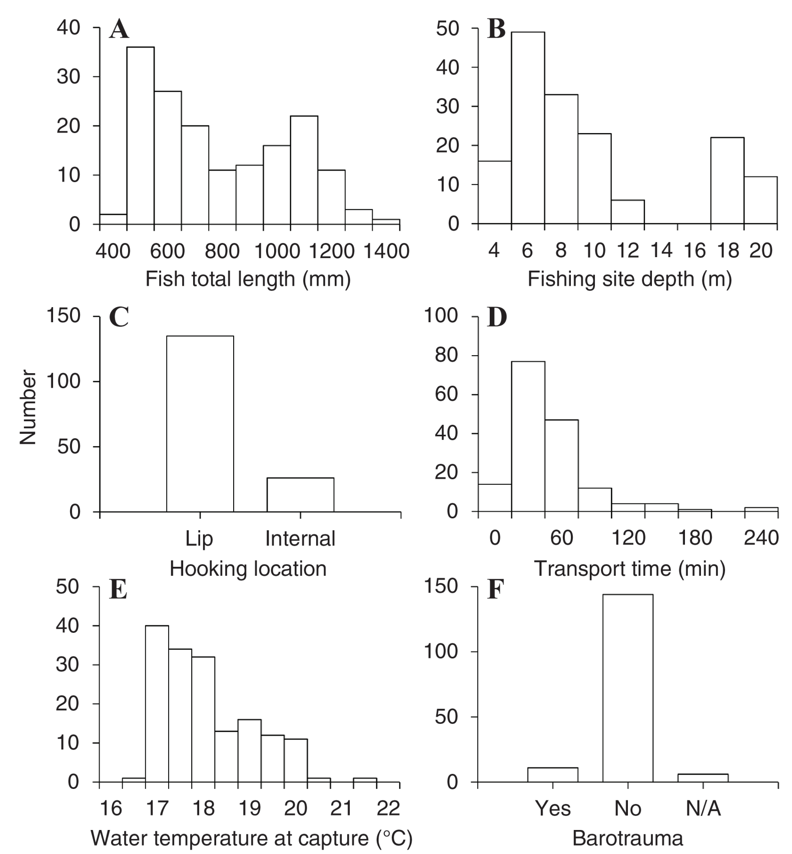

Figure 2

Frequencies of (**A**) fish total length, (**B**) fishing site depth, (**C**) hooking location, (**D**) transport time, (**E**) water temperature at capture, and (**F**) barotrauma for 161 white seabass (*Atractoscion nobilis*) captured by hook and line between 2021 and 2024 in the Southern California Bight. In panel F, *N/A* is the label for fish that died immediately upon capture and could not be assessed for barotrauma.

Table 1

Number of white seabass (*Atractoscion nobilis*) captured by hook and line in the Southern California Bight during each year of the study and all years combined. Also provided are the numbers of captured fish that died within 24 h of release and the associated rates of short-term postrelease mortality.

Year	Number captured	Postrelease mortalities	
		Number	Rate (%)
2021	33	8	24.2
2022	55	5	9.1
2023	41	4	9.8
2024	32	7	21.9
All years	161	24	14.9

CI: 3%–69%) for a 1425-mm-TL fish (Fig. 3B). Results from the use of the alternative GLM, with *fishing site depth* substituted for *fish TL*, indicate that postrelease mortality of white seabass was statistically significant for the main effects of *hooking location* and *fishing site depth* (Suppl. Tables 1 and 2).

For the subset of 155 white seabass that did not die immediately upon capture, 9 of the 11 individuals with barotrauma suffered postrelease mortality (81.8%). Fish TLs were significantly different between fish that had barotrauma and those that did not (P<0.001; Fig. 4A), as were the fishing site depths at which they were captured (P<0.001; Fig. 4B). White seabass with barotrauma were all large (850–1425 mm TL) and were captured at the deepest sites (9.1–21.3 m). In contrast, between fish that had barotrauma and those that did not, there were no differences in transport time (P=0.931; Fig. 4C) or water temperature at capture (P=0.895; Fig. 4D).

Table 2

Candidate generalized linear models used to describe short-term postrelease mortality (within 24 h) for white seabass (*Atractoscion nobilis*) captured by hook and line. The number of predictor variables in the model (K), Akaike information criterion corrected for small sample sizes (AICc), difference in AICc between the given model and the best-performing model (ΔAICc), individual model weight (AICc weight), and log-likelihood value (LL) are provided for each model. Predictor variables are *fish total length*, *hooking location*, *transport time*, and *water temperature at capture*. The selected model is the one in which the interaction of *hooking location* and *fish total length* is used. Models were fitted to data for fish caught from 2021 through 2024 in the Southern California Bight.

Model	K	AICc	ΔAICc	AICc weight	LL
Hook × length	4	100.36	0.00	1.00	−46.05
Hook + length	3	116.98	16.63	0.00	−55.41
Hook + length + temperature	4	119.10	18.74	0.00	−55.42
Hook	2	120.97	20.61	0.00	−58.45
Hook + temperature	3	122.81	22.45	0.00	−58.33
Hook × temperature	4	124.24	23.88	0.00	−57.99
Transport	2	131.31	30.96	0.00	−63.62
Null	1	137.62	37.27	0.00	−67.80

Discussion

In this study, we quantified the short-term postrelease mortality of white seabass captured by hook and line and found that hooking location is a key determinant, as has been documented for other marine fish species, including the related red drum (*Sciaenops ocellatus*) (e.g., Flaherty et al., 2013). Expanding the earlier findings of Aalbers et al. (2004) on juvenile white seabass, the results of our work indicate that mortality in larger individuals was generally low for fish hooked in the lip in comparison to mortality for those hooked in the oral cavity or deeper. The rate of internal hooking was relatively low (16.1%), but a larger sample size of fish captured using practices representative of the entire recreational fishery would allow for a better assessment of fine-scale hooking locations, as the severity of injury likely increases with proximity to sensitive areas (e.g., gills). Despite our having to create a single *internally hooked* category because of constraints on sample size, our findings highlight the need for managers to consider outreach on tactics like the use of circle hooks that have the potential to increase hooking in external mouth parts (Aalbers et al., 2004; Cooke and Suski, 2004). Any effort to change anglers' choice of hook type should be coupled with studies on how hook type might influence catch composition and size selectivity (Garner et al., 2017) and on how hook type, regardless of hooking location, might affect postrelease mortality (Vecchio and Wenner, 2007).

Fish size was another significant predictor of postrelease mortality and was examined across the size range typically captured by hook and line in California (Valero and Waterhouse, 2016). Mortality increased with size for lip-hooked white seabass, a result that has been found in some other hook-and-line capture studies (e.g., Grixti et al., 2008; Wegner et al., 2021). The increase in mortality was gradual up to a fish size of about 1000 mm TL, after which a more rapid increase occurred (albeit with fewer data points and wider CIs). This size effect could be driven by the inclusion of several large, lip-hooked individuals that were captured at the deepest fishing sites and that had barotrauma and died. Large fish (e.g., >1000 mm TL) may also have incurred disproportionately more stress due to handling, higher transport density, or longer fight times (the latter was not recorded but tends to be related to fish size in hook-and-line fishing; e.g., Zemeckis et al., 2020). The inverse size–mortality pattern for internally hooked white

Table 3

Model coefficients (estimates, standard errors, and 95% confidence intervals on a logit scale) for the selected generalized linear model fitted to data for short-term postrelease mortality (within 24 h) of white seabass (*Atractoscion nobilis*) captured by hook and line during 2021–2024 in the Southern California Bight. The selected model includes the interaction of *hooking location* and *fish total length*. *Hooking location* is coded either as lip hooked or as internally hooked (in the roof of the mouth, gills, esophagus, or stomach). The reference level for *hooking location* is lip hooked.

Parameter	Estimate	Standard error	95% confidence interval Lower value	95% confidence interval Upper value
Intercept	–9.235	2.217	–13.579	–4.890
Hooking location	10.548	2.530	5.590	15.505
Hooking location (internal) × fish total length	–0.002	0.002	–0.005	0.001
Hooking location (lip) × fish total length	0.007	0.002	0.003	0.011

seabass may be a result of this category including fewer individuals than the category for lip-hooked fish or of larger fish being more resilient than smaller fish to internal hooking damage or hook removal.

Neither short-term postrelease mortality nor the occurrence of barotrauma appear to be influenced by water temperature, but it remains to be seen if cumulative temperature effects over periods longer than 24 h lead to delayed mortality or behavioral impairment (e.g., Gale et al., 2013). The depths of fishing sites in this study (4.6–21.3 m) were similar to observed swimming depths of tagged adult white seabass during summer months (Aalbers and Sepulveda, 2015). Few white seabass had signs of barotrauma (7.1%), and the results of our analysis indicate that this condition was limited to large individuals captured at the deepest fishing sites. Venting, which may work in other species (e.g., Zemeckis et al., 2020), ultimately does not appear to be effective in white seabass (as evidenced by the deaths of 9 of the 11 vented individuals). The maximum depth of the net pen (6.7 m) may also have constrained the ability of vented individuals to remain submerged. Recompression with a descending device should be explored for reducing mortality in large white seabass that float on the surface after release.

Postrelease mortality has been assessed for recreationally targeted marine fish species in California by using electronic tags (e.g., Sepulveda et al., 2020; Wegner et al., 2021) and was documented in our study during captive monitoring of white seabass in a large enclosure. Regardless of their experimental approach, studies of postrelease mortality have limitations and potential biases. The net pen used in our study was large enough to hold white seabass at very low densities (<0.1 fish/m^3), but our use of it precluded replication because of the challenges of operating multiple pens. In addition, the net pen offered protection to compromised individuals that otherwise may have been susceptible to predation (Raby et al., 2014). Because white seabass are patchily distributed in space and time, the collection of a large number of fish from the wild for use as hatchery broodstock provided a valuable opportunity to quantify postrelease mortality. However, broodstock collection techniques differ from typical hook-and-line fishery

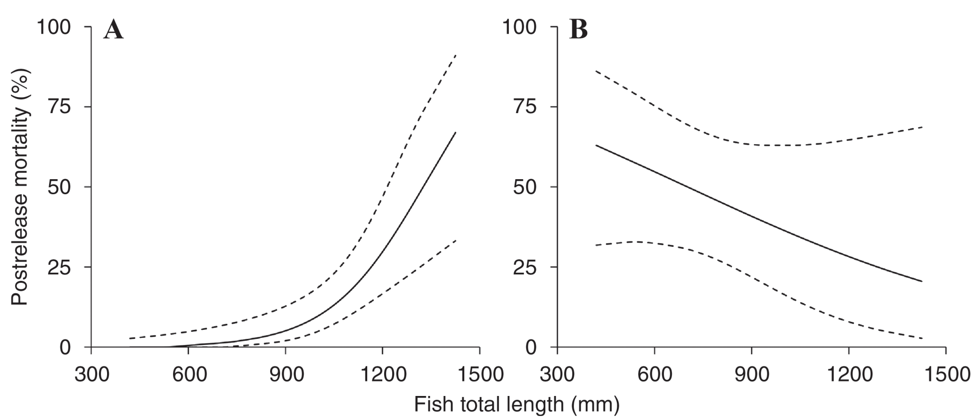

Figure 3

Model response curves showing the relationship between short-term postrelease mortality (within 24 h) and fish total length (**A**) when lip hooked or (**B**) when internally hooked for white seabass (*Atractoscion nobilis*) captured by hook and line during 2021–2024 in the Southern California Bight. Dashed lines indicate 95% confidence intervals.

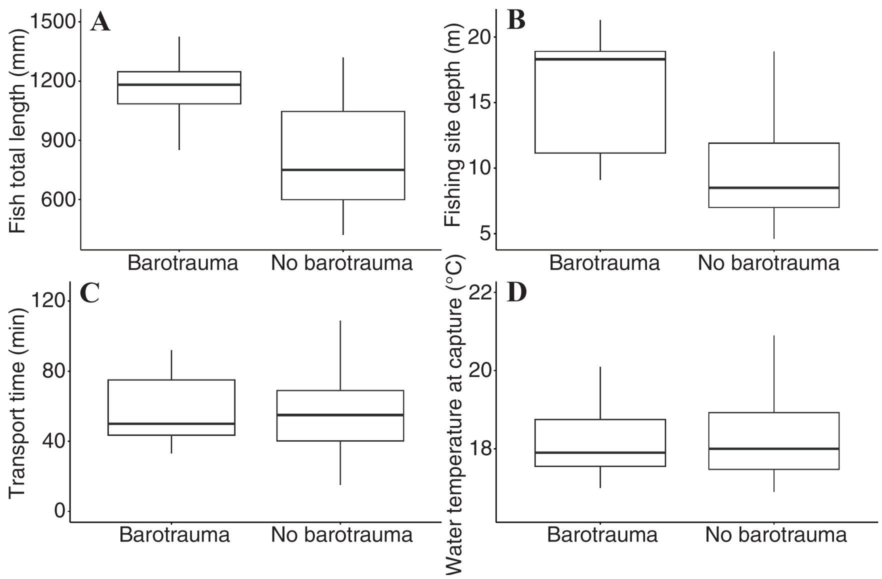

Figure 4

Box plots of (**A**) fish total length, (**B**) fishing site depth, (**C**) transport time, and (**D**) water temperature at capture for 2 groups of white seabass (*Atractoscion nobilis*) captured by hook and line from 2021 through 2024 in the Southern California Bight: fish with barotrauma (number of fish [*n*]=11) and without barotrauma (*n*=144). In each box plot, the horizontal line is the median. The upper and lower parts of each box represent the first and third quartiles (the 25th and 75th percentiles). The whiskers extend 1.5 times the interquartile range. Outliers have been removed for visual clarity.

practices; in particular, stress or trauma may be caused by transport to the net pen or by the handling process used for collections. This study also focused only on short-term mortality (within 24 h), but delayed effects are known to be important in some species (e.g., Wegner et al., 2021). Indeed, 15 white seabass died during long-term holding (1–8 months) in the 4 years of this study (Hubbs-SeaWorld Research Institute, unpubl. data), indicating that delayed or captivity effects can manifest in the net pen. Complementary techniques like blood chemistry analysis (e.g., Gallagher et al., 2014; Sepulveda et al., 2020) could allow the physiological effects of capture, handling, transport, and holding on white seabass to be better distinguished in the future.

Conclusions

Model-predicted mortality was low for lip-hooked white seabass of sublegal and legal sizes up to around 1000 mm TL, relative to those for internally hooked fish. Mortality was higher in larger fish, possibly because of barotrauma, a finding that warrants investigation of an appropriate technique for alleviation. Postrelease mortality estimates can help inform stock assessment models that were developed previously without such data being available (Valero and Waterhouse, 2016), allowing improvement of harvest regulations to better account for hook-and-line releases.

Resumen

La corvina blanca (*Atractoscion nobilis*) es muy apreciada en la costa del Pacífico de América del Norte. Existen regulaciones de captura basadas en el tamaño, la temporada y espacio para esta especie, lo que lleva a la liberación de peces vivos en las pesquerías con anzuelo y línea. Para comprender mejor cómo las liberaciones pueden estar afectando a la población de esta especie en la bahía del sur de California, se capturaron 161 corvinas blancas (420–1425 mm de longitud total [LT]) con anzuelo y línea durante un período de 4 años (2021–2024). Se registraron datos biológicos, ambientales y de pesca para cada evento de captura, y luego los peces fueron liberados en un corral de red grande (630 m^3). La mortalidad a corto plazo posterior a la liberación de la corvina blanca (es decir, dentro de las 24 h) fue del 14.9 % en total. Cuando se evaluó mediante regresión logística, el modelo de mortalidad mejor respaldado incluyó *el lugar del anzuelo* y su interacción con la *TL* del pez. La mortalidad predicha por el modelo fue, en general, menor para los peces enganchados en el labio (0%–67%) que para los peces enganchados en la cavidad oral o a mayor profundidad (21%–63%), aunque la mortalidad aumentó sustancialmente en los individuos enganchados en el labio >1000 mm TL (10%–67%). Un pequeño número de corvinas blancas (11 individuos) presentaban signos de barotrauma, y los resultados de un análisis separado indicaron que estos peces eran significativamente

más grandes y se capturaban en lugares más profundos que los que no presentaban barotrauma. Estos resultados pueden contribuir a mejorar la toma de decisiones de manejo pesquero para una especie que es objeto de una pesca intensiva con anzuelo y línea.

Acknowledgments

We thank J. Albright, C. Albright, D. Elm, and their crews for supporting the study. E. Hernandez, C. Brewer, C. Macherzak, J. Johnson, and members of the Coastal Conservation Association of California assisted in the field. Comments from 3 anonymous reviewers helped improve the manuscript. The work was funded by the Ocean Resources Enhancement and Hatchery Program of the California Department of Fish and Wildlife and supported in part by the Catalina Seabass Fund and SeaWorld Busch Gardens Conservation Fund.

Literature cited

Aalbers, S. A., and C. A. Sepulveda.
2015. Seasonal movement patterns and temperature profiles of adult white seabass (*Atractoscion nobilis*) off California. Fish. Bull. 113:1–14. Crossref

Aalbers, S. A., G. M. Stutzer, and M. A. Drawbridge.
2004. The effects of catch-and-release angling on the growth and survival of juvenile white seabass captured on offset circle and J-type hooks. N. Am. J. Fish. Manag. 24:793–800. Crossref

Allen, L. G., D. J. Pondella II, and M. A. Shane.
2007. Fisheries independent assessment of a returning fishery: abundance of juvenile white seabass (*Atractoscion nobilis*) in the shallow nearshore waters of the Southern California Bight, 1995–2005. Fish. Res. 88:24–32. Crossref

California Fish and Game Code §8383.5 (2025). [Available from website, accessed February 2025.]

Cooke, S. J., and C. D. Suski.
2004. Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? Aquat. Conserv. 14:299–326. Crossref

Drawbridge, M., M. Shane, and C. Silbernagel.
2021. The status of white seabass, *Atractoscion nobilis* as a commercially ready species for marine US aquaculture. J. World Aquac. Soc. 52:647–661. Crossref

Flaherty, K. E., B. L. Winner, J. L. Vecchio, and T. S. Switzer.
2013. Spatial and size distribution of red drum caught and released in Tampa Bay, Florida, and factors associated with post-release hooking mortality. Gulf Caribb. Res. 25:29–41. Crossref

Gale, M. K., S. G. Hinch, and M. R. Donaldson.
2013. The role of temperature in the capture and release of fish. Fish Fish. 14:1–33. Crossref

Gallagher, A. J., J. E. Serafy, S. J. Cooke, and N. Hammerschlag.
2014. Physiological stress response, reflex impairment, and survival of five sympatric shark species following experimental capture and release. Mar. Ecol. Prog. Ser. 496: 207–218. Crossref

Garner, S. B., W. F. Patterson III, and C. E. Porch.
2017. Experimental assessment of circle vs. J hook performance and selectivity in the northern Gulf of Mexico recreational reef fish fishery. ICES J. Mar. Sci. 74:1437–1447. Crossref

Grixti, D., S. D. Conron, A. Morison, and P. L. Jones.
2008. Estimating post-release survival and the influential factors for recreationally caught black bream (*Acanthopagrus butcheri*) in the Glenelg River, south eastern Australia. Fish. Res. 92:303–313. Crossref

Kosmidis, I.
2023. brglm2: bias reduction in generalized linear models. R package, vers. 0.9.2. [Available from website, accessed July 2024.]

Lüdecke, D.
2018. ggeffects: tidy data frames of marginal effects from regression models. J. Open Source Softw. 3(26):772. Crossref

MacNamara, R., M. Shane, and M. Drawbridge.
2022. Understanding the long-term movement patterns of hatchery-reared white seabass. Environ. Biol. Fishes 105:1797–1808. Crossref

R Core Team.
2023. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. [Available from website, accessed July 2024.]

Raby, G. D., J. R. Packer, A. J. Danylchuk, and S. J. Cooke.
2014. The understudied and underappreciated role of predation in the mortality of fish released from fishing gears. Fish Fish. 15:489–505. Crossref

Sepulveda, C. A., S. A. Aalbers, M. Wang, J. Kneebone, and D. Bernal.
2020. Post-release survivorship of Pacific bluefin tuna (*Thunnus orientalis*) captured in the California recreational fishery. Fish. Res. 223:105413. Crossref

Valero, J., and L. Waterhouse.
2016. California white seabass stock assessment in 2016, 191 p. Cent. Adv. Popul. Assess. Methodol., La Jolla, CA. [Available from website.]

Vecchio, J. L., and C. A. Wenner.
2007. Catch-and-release mortality in subadult and adult red drum captured with popular fishing hook types. N. Am. J. Fish. Manag. 27:891–899. Crossref

Veldhuizen, L. J. L., P. B. M. Berentsen, I. J. M. De Boer, J. W. van de Vis, and E. A. M. Bokkers.
2018. Fish welfare in capture fisheries: a review of injuries and mortality. Fish. Res. 204:41–48. Crossref

Wegner, N. C., E. J. Portner, D. T. Nguyen, L. Bellquist, A. P. Nosal, A. L. Pribyl, K. L. Stierhoff, P. Fischer, K. Franke, R. D. Vetter, et al.
2021. Post-release survival and prolonged sublethal effects of capture and barotrauma on deep-dwelling rockfishes (genus *Sebastes*): implications for fish management and conservation. ICES J. Mar. Sci. 78:3230–3244. Crossref

Zemeckis, D. R., J. Kneebone, C. W. Capizzano, E. A. Bochenek, W. S. Hoffman, T. M. Grothues, J. W. Mandelman, and O. P. Jensen.
2020. Discard mortality of black sea bass (*Centropristis striata*) in a deepwater recreational fishery off New Jersey: role of swim bladder venting in reducing mortality. Fish. Bull. 118:105–119. Crossref