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The Effects of Catch-and-Release Angling on the Growth and Survival of Juvenile White Seabass Captured on Offset Circle and J-Type Hooks

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Abstract.—Despite the growing number of recreational anglers targeting white seabass *Atractoscion nobilis* in California, no information is available on the mortality rates of juveniles following catch and release. We captured juvenile white seabass (430–577 mm total length) with 4/0 offset circle hooks ($n = 113$) or 4/0 J-type hooks ($n = 108$) or with a net (control, $n = 30$) to investigate the effect of hook type on anatomical hook location. We also examined how hook location affected growth and survival for 90 d following release. Offset circle hooks penetrated the lip region significantly more frequently (73%) than did J-type hooks (41%). Hook location was directly correlated with mortality; all mortalities involved hook damage to the visceral region. A 10% postrelease mortality rate was observed for fish caught on both offset circle and J-type hooks. All mortalities occurred within 5 d postrelease. Survival was enhanced when deeply embedded hooks were left in place rather than removed from the visceral tissue. Hook-caught fish showed no reduction in growth when compared with control fish, but deeply hooked fish grew at a significantly lower rate than did fish hooked in the mouth. Angler success rates did not differ significantly between hook types. We recommend that catch-and-release mortality be incorporated into the management plan for white seabass.

White seabass *Atractoscion nobilis* (Sciaenidae) historically supported important commercial and recreational fisheries throughout California prior to a sharp decline in landings between 1959 and 1965 (Vojkovich and Crooke 2001; CDFG 2002). The decline has been attributed largely to overfishing (Vojkovich and Reed 1983). Recreational landings sharply increased in conjunction with a threefold increase in fishing effort between 1999 and 2002, and now exceed commercial landings (CDFG 2002). Elevated recreational fishing effort and catch rates can negatively impact juvenile recruitment into the fishery through increased incidental hooking mortality following catch-and-release angling (Waters and Huntsman 1986).

The effectiveness of traditional white seabass management strategies, which include bag-limit reductions and a 71-cm minimum size limit, is directly influenced by the rate of hooking mortality in undersized fish after release (Meador and Green 1986). The current white seabass fishery management plan recognizes that postrelease mortality information is both essential and lacking (CDFG 2002). Because hooking mortality is an important component of overall fishing mortality, the Atlantic States Marine Fisheries Commission allocated 8% of the total striped bass *Morone saxatilis* catch to compensate for incidental mortality rates estimated from catch-and-release studies (Lukacovic 2000).

Catch-and-release studies typically address factors that affect immediate mortality rates in fish, but rarely evaluate reduced growth or delayed mortality that may result from hooking injury, disease, or osmoregulatory dysfunction (Muoneke and Childress 1994). Although Muoneke and Childress (1994) identified many factors that affect catch-and-release mortality, anatomical location of hook penetration is clearly the most significant factor affecting mortality in many species (Murphy et al.

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1995; Diodati and Richards 1996; Taylor et al. 2001). Schill (1996) recommended that new hook designs, including circle hooks, should be investigated to reduce the incidence of deeply hooking fish. The circle hook is designed to roll or pivot around the bend of the hook and potentially reduces the likelihood for the point of the hook to penetrate the soft visceral tissue (Cooke et al. 2003), a feature that appeals to the growing number of catch-and-release anglers (Barnhart and Roelofs 1988). Recent studies provide evidence that circle hooks reduce hook damage and subsequent mortality rates (Caruso 2000; Lukacovic 2000; Prince et al. 2002; Skomal et al. 2002).

We sought to determine whether hooking location and subsequent mortality in juvenile white seabass were dependent on hook type and to estimate the catch-and-release mortality rate. We investigated how the fate of deeply embedded hooks (removed or left embedded by the angler) affected fish growth and mortality after release, and recorded data on hook degradation and shedding rates. We also determined the angler success rate for each hook type. Results will contribute to the management of white seabass stocks.

Methods

Research location.—This study was conducted from July 1 to November 14, 2000, at an aquaculture net-pen facility moored in Catalina Harbor, Santa Catalina Island, California. The system consisted of four 9-m × 9-m pens with 1.2-cm-mesh nylon containment nets suspended to a depth of 6.5 m (526-m^3 volume). Individual pens were enclosed within a 10-cm-mesh nylon predator net. Water depth at the site was approximately 17.0 m. Ambient water temperature at a depth of 5 m ranged from 15.0°C to 22.6°C over the study period.

Experimental design.—White seabass used in the experiment were hatchery spawned in September 1997, transported to the net pens in February 1998, and raised on a formulated dry diet for 18 months prior to the study. Three hundred white seabass were transferred to a net pen 30 d before the experiment and were fasted for 48 h prior to all hooking events. Between July 1 and 3, 2000, a total of 120 white seabass were caught on offset circle hooks (n = 60) and J-type hooks (n = 60) from within the containment net. Hook types were alternated to minimize biases associated with differences in feeding behavior. Fish were caught on duplicate medium-weight baitcasting rods and reels spooled with 15-lb-test monofilament line; one line was rigged with an Owner SSW 4/0 J-type hook and the other with an Owner 4/0 Super Mutu-lite offset circle hook. Hooks were baited with market squid *Loligo opalescens* (mean mantle length = 127 mm). Fish were allowed to hold the bait for 5 s before the hook was set. Offset circle hooks were set by winding the line tightly and applying steady pressure, whereas J-type hooks were set by firmly lifting the rod tip. All fish were angled for 30 s and netted with a Duraframe nylon net.

Thirty fish were netted on July 3, 2000, to form a control group. Control fish were subjected to the same mean (±1 SD) handling time as hook-caught fish (76 ± 18 s). All fish were measured to the nearest millimeter total length (TL) and tagged with a passive integrated transponder (PIT) inserted into the musculature at the base of the second dorsal fin. Tagged fish were weighed to the nearest 10 g on an electronic hanging scale and released into an adjacent containment net. Fish were fed a daily ration (3% of initial biomass) of Silver Cup 8.5-mm formulated dry pellets. A diver inspected the bottom of the net pen for mortalities several times each day. We identified mortalities with a PIT scanner and recorded the elapsed time from release to mortality. The extent of hook damage and the probable cause of death were determined by necropsy.

For each fish caught, we recorded hook location, hook fate (removed or left embedded), the degree of visible damage, and whether the fish was bleeding. The location of hook penetration was scored based on the convention illustrated in Figure 1. Fish receiving a score of 1–4 were considered shallowly hooked, whereas fish scoring 5–8 were considered deeply hooked. By use of needle-nose pliers, we removed all hooks from shallowly hooked fish, whereas hooks were alternately removed or left embedded in deeply hooked fish. An angler success rate for each hook type was calculated as the number of fish successfully landed divided by the number of hook sets.

After 90 d, we recaptured all fish to record growth and to obtain additional data on hook location and subsequent mortality. We used rod and reel to recapture 101 of the original experimental fish (48 J-type; 53 offset circle), whereas the remaining individuals were netted. A total of 221 hooking events (108 J-type; 113 offset circle) were recorded during the study, and no individuals were deeply hooked twice. We assumed that fish had completely recovered from the initial hooking event, and that any mortality observed after re-

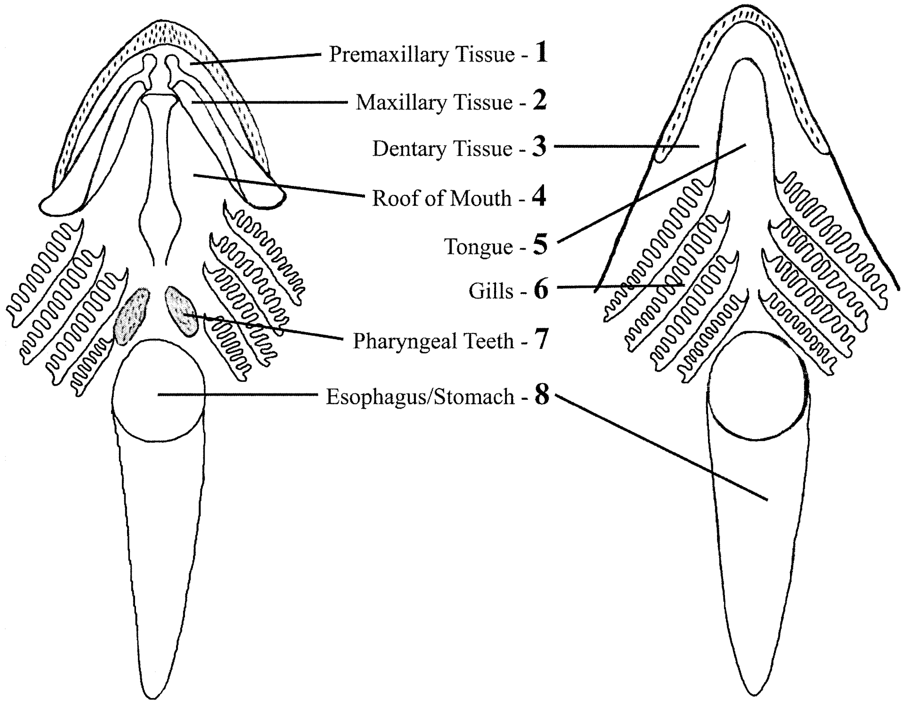

FIGURE 1.—Dorsal (left) and ventral (right) views of a juvenile white seabass, illustrating the eight regions used to score anatomical hook location. Locations 1–4 represent shallow regions, while locations 5–8 represent deep regions.

capture was due to the second hooking event. Upon recapture, fish were identified and re-measured. We monitored the fish for an additional 40 d, then euthanatized and examined them to determine the extent of hook damage and the rate of hook degradation in fish with deeply embedded hooks. The amount of hook degradation in fish was compared to the degradation of 10 hooks that were submerged in ambient seawater.

We used chi-square tests of independence and goodness-of-fit, analysis of variance (ANOVA), a two-sample *t*-test, a sampled randomization test, and a Mann–Whitney *U*-test to analyze the results. Data were examined for violations of underlying assumptions prior to analysis (Sokal and Rohlf 1995). Nonparametric procedures were used to analyze growth of shallowly hooked and deeply hooked fish because underlying assumptions of homogeneous variance were violated (Levene's test, $P = 0.044$), differences between sample sizes greatly exceeded 10%, and the smaller variance was associated with the larger sample (Zar 1998). Randomization tests were run with 10,000 iterations and were used to confirm the results of the Mann–Whitney *U*-test. For all statistical comparisons, the significance level α was equal to 0.05. All growth values are reported in TL because of the high variance in weight values recorded on the floating platform.

Results

Hook Location

Offset circle and J-type hooks differed significantly in the anatomical location of hook penetration ($\chi^2 = 28.8$, df = 7, $P = 0.0005$) (Figure 2). A greater percentage of fish was hooked in the lip region on offset circle hooks ($n = 82$; 73%) than on J-type hooks ($n = 44$; 41%). The frequency of deeply hooked fish was 14% ($n = 16$) on offset circle hooks and 24% ($n = 26$) on J-type hooks. The frequency of hook penetration of the esophagus and stomach was similar between offset circle hooks ($n = 15$; 13%) and J-type hooks ($n = 18$; 17%).

Postrelease Mortality

All postrelease mortality resulted from hook penetration in and subsequent injury to the esophagus or stomach (region 8 in Figure 1); no mortality was observed for fish hooked in anatomical

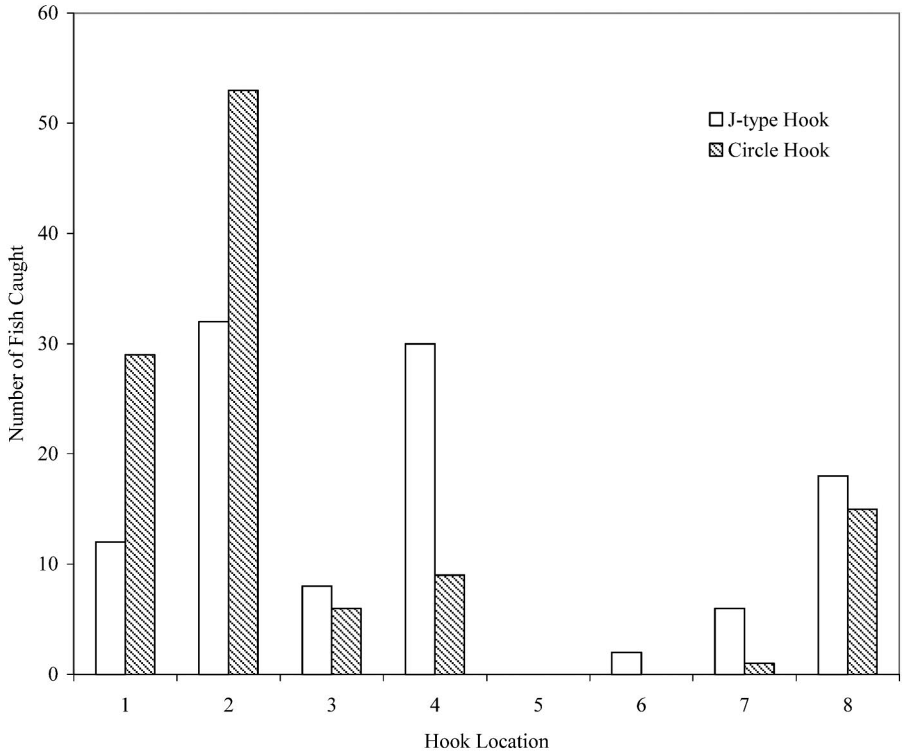

FIGURE 2.—Number of white seabass hooked on offset circle and J-type hooks within eight anatomical locations (see Figure 1).

regions 1–7 or for control fish. Regardless of hook type, mortality occurred in 67% (22/33) of fish exhibiting hook damage to the esophagus and stomach. Of the 22 fish that died, equal numbers were caught on offset circle and J-type hooks. The catch-and-release mortality rate was 10% for both hook types. Eighty percent of the postrelease mortality occurred within 24 h, 91% occurred within 3 d, and 100% occurred within 5 d.

Necropsies of deeply hooked fish with hooks left embedded frequently revealed hook points penetrating the esophagus or stomach tissue and adjacent vital organs, including the liver, kidney, and heart. Necropsies revealed the presence of seawater within the coelomic cavity in 69% of mortalities. Forty-one percent of mortalities exhibited moderate to heavy bleeding upon capture. Thirty-two percent (7/22) of the total mortalities appeared to be shallowly hooked upon landing; however, necropsies revealed that the hook initially penetrated the esophagus and tore out before lodging in a shallow region of the mouth during the fight.

Hook Fate, Shedding, and Degradation

Regardless of hook type, deeply hooked fish died in 65% (13/20) of cases when hooks were removed, compared with a 41% (9/22) mortality rate when hooks were left embedded (χ^2 = 2.44, df = 1, P = 0.125). Thirty-nine percent (5/13) of fish released with deeply embedded hooks were successful in shedding the hooks during the study period. Deeply embedded hooks showed minimal degradation in seven fish over the study period, but one hook degraded 50% after 130 d. Hook degradation was apparent only on the region of the hook that was exposed to seawater, not on parts embedded in the visceral tissue. The embedded portions of three hooks were encased in a hardened tissue. Hooks suspended in seawater degraded approximately 50% after 90 d and 90–100% after 150 d. Hooks typically corroded first at the point and barb, and then gradually corroded down to the bend and into the shank.

White Seabass Growth

The initial mean (±1 SD) TL and weight of white seabass were 513 mm (28.6) and 1.1 kg (0.12), respectively. Active feeding in some fish resumed within 24 h of release. There was no significant difference in initial mean TL among the three treatment groups (ANOVA, F = 1.02, P =

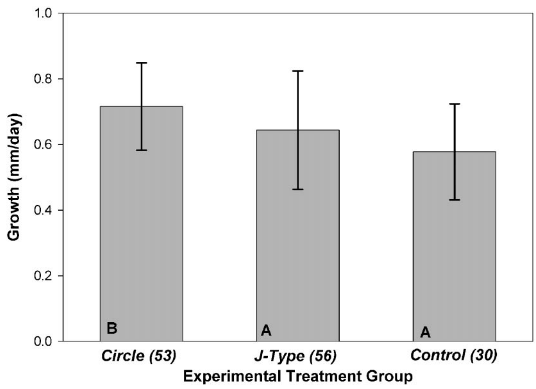

FIGURE 3.—Rate of growth in total length (mm/d) over a 90-d postrelease period for net-pen-reared juvenile white seabass captured with offset circle hooks, J-type hooks, or nets (control). Bars represent means (±SD). Bars without a letter in common are significantly different (analysis of variance, $P = 0.001$).

0.362). Analysis of growth rates after 90 d revealed a significant difference among the three groups (ANOVA, $F = 7.78$, $P = 0.001$). Multiple comparisons of means identified that fish caught on offset circle hooks grew at a significantly higher rate than did control and J-type hook groups, but no significant difference was observed between the latter two groups (Figure 3). On average (±1 SD), deeply hooked fish ($n = 10$) grew at a rate of 0.53 mm/d (0.25), which was significantly lower than the average growth rate of 0.70 mm/d (0.14) observed in shallowly hooked fish ($n = 99$) regardless of hook type (Mann–Whitney, $U' = 307.0$, $P = 0.005$). Results from the sampled randomization test support the conclusion of the Mann–Whitney procedure ($F = 10.63$, $P = 0.001$).

Angler Success Rate

An angler success rate of 53% (113/212) for fish caught on offset circle hooks did not differ significantly from the 66% (108/164) of fish successfully captured on the J-type hook ($\chi^2 = 3.14$, df = 1, $P = 0.080$).

Discussion

This study was designed to standardize many of the variables that influence fish growth and survival following catch-and-release angling, including fight time, strike time, angler experience, handling method, depth, fish age, and bait type. The use of a large net-pen system reduced the captive and transport stress to fish. Fish were handled by an experienced angler to reduce stress and mucus loss. The PIT-tagged sites on the fish appeared completely healed both internally and externally following the study period; it is safe to assume that the application and presence of the 15-mm tag had no effect on fish growth or survival. There was no indication of a cumulative effect on mortality caused by hooking individuals twice over the course of the study, as all mortalities were the direct result of injuries sustained from hook damage to the viscera and no fish were deeply hooked more than once. Additionally, active feeding resumed within 24 h, a 90-d recovery period was allowed between hooking events, hooking injuries were completely healed upon final examination, and food was found in the stomachs of all fish, even those containing deeply embedded hooks. It is difficult to compare performance between net-pen-reared and wild fish. However, Gallman et al. (1999) concluded that hatchery-produced red drum *Sciaenops ocellatus* could be used in catch-and-release studies to simulate the responses of wild fish after finding no significant differences in the physiological characteristics of wild and hatchery-reared red drum after catch and release.

The location of hook penetration was dependent on hook type, as offset circle hooks penetrated the lip region significantly more frequently (73%) than did J-type hooks (41%). Recent studies have also documented a significantly greater frequency of penetration in the lip or jaw region for circle hooks versus J-type hooks in striped bass (Caruso 2000; Lukacovic 2000), red drum (Aguilar et al. 2002), bluefin tuna *Thunnus thynnus* (Skomal et al. 2002), sailfish *Istiophorus platypterus* (Prince et al. 2002), and largemouth bass *Micropterus salmoides* (Cooke et al. 2003). Our results support the contention that circle hooks roll or pivot around the bend of the hook, allowing the hook point to penetrate the lip of the fish.

All white seabass mortalities sustained damage to the viscera, confirming that postrelease mortality is directly correlated with the location of hook penetration. Carbines (1999) reported a 25% postrelease mortality rate in New Zealand blue cod *Parapercis colias*; all mortality resulted from hooking within the gut or gills. Other studies have related the cause of fish mortality to hook penetration of vital organs, particularly the heart, esophagus, and liver (Hulbert and Engstrom 1980; Diggles and Ernst 1997). We attributed mortality to injuries sustained by vital organs, but we cannot dismiss the possibility of osmoregulatory dysfunction caused by seawater entering the coelomic cavity through tears in the esophagus and stomach. Only 41% of white seabass mortalities were associated with moderate to heavy bleeding, whereas a relatively large proportion (31%) of mortalities occurred after the hook tore out of the viscera and into a shallow location during the fight. Our findings suggest that lethal wounding is not always evident at the time of release.

Despite significant differences in the location of hook penetration for the two hook types, we observed no difference in mortality between hook types; however, the sample size was relatively small ($n = 22$) for fish that died. Fish hooked in the viscera had a greater mortality rate when caught on offset circle hooks (69%) versus J-type hooks (42%), indicating that circle hooks may be more intrusive when deeply embedded or removed. The total observed postrelease mortality rate for white seabass was 10.0%, regardless of hook type. This rate falls below the 20% value determined as ''high'' by Muoneke and Childress (1994), and is similar to mortality rates reported by Murphy et al. (1995) (4.6% after 2 d) and Matlock et al. (1993) (7.3% after 3 d) for a related species, the spotted seatrout *Cynoscion nebulosis*. All mortality was observed within 5 d of release, which supports the findings of Matlock et al. (1993) that mortality occurs soon after release as a direct result of hook damage.

Mortality rate increased when deeply embedded hooks were removed (65%) compared to when they were left embedded (41%). Removal of deeply embedded hooks resulted in a threefold higher mortality rate of brown trout *Salmo trutta* (Hulbert and Engstrom 1980) and rainbow trout *Oncorhynchus mykiss* (Mason and Hunt 1967), compared to when the leader was clipped. Schill (1996) suggested that the tearing of the esophagus and other sensitive tissues caused increased mortality when deeply embedded hooks were removed.

Hooks were shed from 39% of white seabass that were released with their hooks left deeply embedded. For fish that shed hooks, no visual signs of hook-related injury were observed at the end of the study. The majority of rainbow trout and brown trout shed deeply embedded hooks (Mason and Hunt 1967; Hulbert and Engstrom 1980) through gastric digestion, direct passage via the opercular aperture, or movement through either end of the digestive tract; however, it was not possible to determine the mechanism of actual hook loss (Hulbert and Engstrom 1980). We reject gastric digestion as a probable mechanism, because we observed minimal hook degradation in fish that retained hooks. The high carbon steel composition and corrosion-resistant finish of the hooks inhibited rapid degradation, especially in hook sections that were not exposed to seawater. Portions of the hook that were embedded in the visceral tissue were occasionally encapsulated in a hardened tissue. A similar response was observed in hooks dissected from six smallmouth bass *Micropterus dolomieu* that survived catch and release (Weidlein 1989).

We did not observe lower growth rates in hook-caught fish than in control fish, which indicates that catch-and-release angling does not burden shallowly hooked white seabass that are handled properly. In contrast, fish caught on offset circle hooks grew at a significantly greater rate than either fish caught on J-type hooks or control fish. Growth rates were higher in hook-caught groups because these groups were collected prior to control fish and possibly incorporated a larger proportion of fish exhibiting aggressive feeding behavior. Growth rates were reduced in the J-type hook group because the surviving number of deeply hooked fish included in the growth analysis was higher for J-type hooks ($n = 9$) than for offset circle hooks ($n = 1$). Reduced growth in deeply hooked fish may have resulted from increased time to initial feeding following release, reduced feeding frequency, and reduced amount ingested per feeding.

We conclude that the growth and mortality rates of juvenile white seabass are directly correlated with the initial location of hook penetration. Our results indicate that offset circle hooks increase the likelihood of hooking juvenile white seabass in the lip region. However, the use of offset circle hooks did not reduce the catch-and-release mortality rate in this study. Thus, we encourage continued research on the effectiveness of various hook types, including a comparison of offset versus non-offset circle hooks, in reducing postrelease mortality in recreational fish species. The postrelease mortality of adult white seabass also warrants investigation, because anglers frequently continue to catch and release fish after fulfilling a one-fish bag limit. Our results suggest that incidental hooking mortality is a significant component of the total fishery mortality for white seabass and needs to be incorporated into the fishery management plan.

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References

Aguilar, R., Rand, P. S., and G. H. Beckwith Jr. 2002. Quantifying the catch-and-release mortality rate of adult red drum in the Neuse River Estuary. North Carolina Fisheries Resource Grant Program. Final Report 01-FEG-07. Raleigh, North Carolina.

Barnhart, R. A., and T. D. Roelofs, editors. 1988. Catch-and-release fishing: a decade of experience. Humboldt State University, Arcata, California.

Carbines, G. D. 1999. Large hooks reduce catch-and-release mortality of blue cod *Parapercis colias* in the Marlborough Sounds of New Zealand. North American Journal of Fisheries Management 19: 992–998.

Caruso, P. G. 2000. A comparison of catch and release mortality and wounding for striped bass *Morone saxatilis* captured with two baited hook types. Commonwealth of Massachusetts Division of Marine Fisheries. Sportfisheries Research Project (F-57-R), Job 12, Boston.

CDFG (California Department of Fish and Game). 2002. White seabass fishery management plan (WSFMP). California Department of Fish and Game, Marine Resource Division, Los Alamitos.

Cooke, S. J., B. L. Barthel, and C. D. Suski. 2003. Effect of hook type on injury and capture efficiency of rock bass *Ambloplites rupestris* angled in south-eastern Ontario. Fisheries Management and Ecology 10: 1–3.

Diggles, B. K., and I. Ernst. 1997. Hooking mortality of two species of shallow-water reef fish caught by recreational angling methods. Marine and Freshwater Research 48:479–483.

Diodati, P. J., and R. A. Richards. 1996. Mortality of striped bass hooked and released in salt water. Transactions of the American Fisheries Society 125: 300–307.

Gallman, E. A., J. J. Isely, J. R. Tomasso, and T. I. J. Smith. 1999. Short-term physiological responses of wild and hatchery-produced red drum during angling. North American Journal of Fisheries Management 19:833–836.

Hulbert, P. J., and R. Engstrom-Heg. 1980. Hooking mortality of worm-caught hatchery brown trout. New York Fish and Game Journal 27:1–9.

Lukacovic, R. 2000. Hooking mortality of deep and shallow-hooked striped bass under different environmental conditions in Chesapeake Bay. *In* Weinrich, D., P. G. Piavis, B. H. Pyle, A. A. Jarzynski, J. C. Walstrum, R. A. Sadzinski, E. J. Webb, H. W. Rickabaugh, E. Zlokovitz, J. P. Mowror, R. Lukacovic and K. A. Whiteford, editors. Stock assessment of selected resident and migratory finfish species within Maryland's Chesapeake Bay. Federal Aid Project F-54-R. Annual Report, Department of the Interior, Fish and Wildlife Service. Annapolis, Maryland.

Mason, J. W., and R. L. Hunt. 1967. Mortality rates of deeply hooked rainbow trout. The Progressive Fish-Culturist 29:87–90.

Matlock, G. C., L. W. McEachron, J. A. Dailey, P. A. Unger, and P. Chai. 1993. Short-term hooking mortalities of red drums and spotted seatrout caught on single-barb and treble hooks. North American Journal of Fisheries Management 13:186–189.

Meador, K. L., and A. W. Green. 1986. Effects of a minimum size limit on spotted seatrout recreational harvest. North American Journal of Fisheries Management 6:509–518.

Muoneke, M. I., and W. M. Childress. 1994. Hooking mortality: a review for recreational fisheries. Reviews in Fisheries Science 2:123–156.

Murphy, M. D., R. F. Heagey, V. H. Neugebauer, M. D. Gordon, and J. L. Hintz. 1995. Mortality of spotted seatrout released from gill-net or hook-and-line gear in Florida. North American Journal of Fisheries Management 15:748–753.

Prince, E. D., Ortiz, M., and A. Venizelos. 2002. A comparison of circle hook and ''J'' hook performance in recreational catch-and-release fisheries for billfish. Pages 66–79 *in* Lucy, J. A., and A. L. Studholme, editors. Catch and release in marine recreational fisheries. American Fisheries Society Symposium 30, Bethesda, Maryland.

Schill, D. J. 1996. Hooking mortality of bait-caught rainbow trout in an Idaho trout stream and a hatchery: implications for special-regulation management. North American Journal of Fisheries Management 16:348–356.

Skomal, G. B., B. C. Chase, and E. D. Prince. 2002. A comparison of circle hook and straight hook performance in recreational fisheries for juvenile Atlantic bluefin tuna. Pages 57–65 *in* Lucy, J. A., and A. L. Studholme, editors. Catch and release in marine recreational fisheries. American Fisheries Society Symposium 30, Bethesda, Maryland.

Sokal, R. R., and F. J. Rohlf. 1995. Biometry, 3rd Edition. Freeman, San Francisco.

Taylor, R. G., J. A. Whittington, and D. E. Haymans. 2001. Catch-and-release mortality rates of common snook in Florida. North American Journal of Fisheries Management 21:70–75.

Vojkovich, M., and S. Crooke. 2001. White seabass. Pages 206–208 *in* Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources and their utilization. California Department of Fish and Game.

Vojkovich, M., and R. Reed. 1983. White seabass *Atractoscion nobilis* in California-Mexican water: status of the fishery. California Cooperative Oceanic Fisheries Investigation Report 24:79–83.

Waters, J. R., and G. R. Huntsman. 1986. Incorporating mortality from catch-and-release into yield-per-recruit analyses of minimum-size limits. North

American Journal of Fisheries Management 6:463–471.

Weidlen, W. D. 1989. Mortality of released sublegal-sized smallmouth bass, catch-and-release implications. Pages 221–228 *in* Barnhart, R. A. and T. D. Roelofs, editors. Catch-and-release fishing: a decade of experience. Humboldt State University, Arcata, California.

Zar, J. 1998. Biostatistical Analysis, 4th Edition. Prentice Hall, Englewood Cliffs, New Jersey.