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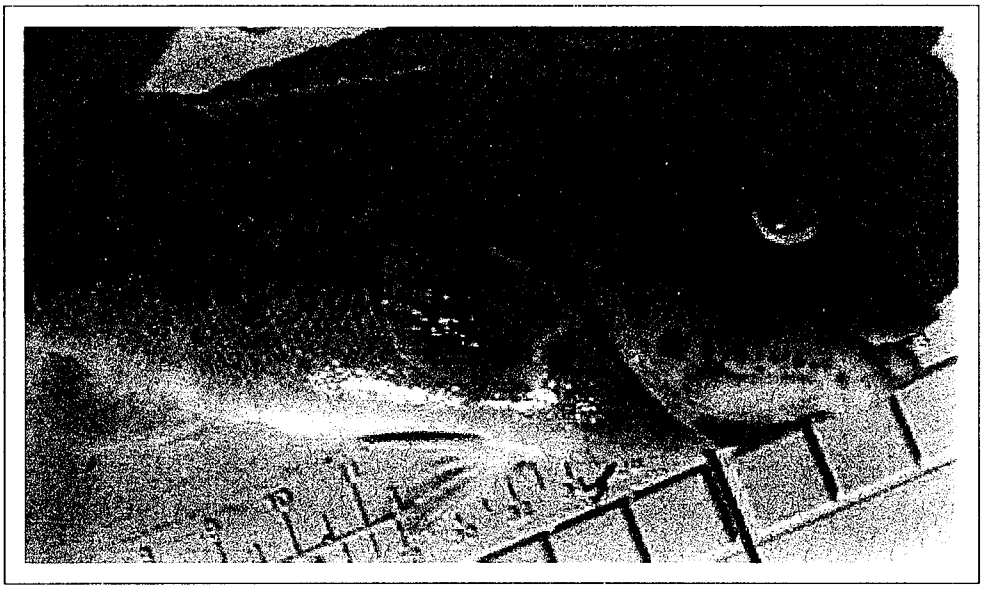

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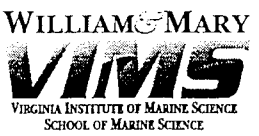

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Abstract

In April 1996, the Atlantic States Marine Fisheries Commission approved a Tautog Fishery Management Plan (FMP) requiring states to systematically adopt a 14 in. (356 mm) TL minimum size limit. Release-mortality was assumed to be 25%. Between October and December 1997-1998, 299 tautog (235-520 mm TL; 9-20 in.) were caught using angling gear to estimate release mortality in Virginia's tautog fishery. Fishing occurred at shallow (3-10 m; 10-33 ft.) and deep (12-17 m; 39-56 ft.) water depths at temperatures between 9-18°C (48-64°F). Tautog were tagged, accumulated in aerated livewells, then returned to depth of capture in galvanized wire cages. Mean fish density per cage was six tautog and mean soak time per cage was 115 h (4.8 days). Release-mortality for tautog (n=5) for both years was 1.67%, all occurring in fish taken from deeper water. Mortality rates were comparable to rates reported in Connecticut waters (1994-98).

Introduction

Catch-and-release fishing has gained popularity among recreational anglers in recent years. This paradigm shift among recreational anglers has come about due to large scale educational efforts (Lucy et al., 1990) and as a result of law enforcement (i.e., anglers required to release under-sized fish). Many states, including Virginia, now have incentive programs to encourage catch-and-release fishing. The Virginia Saltwater Fishing Tournament (VSFT) awards citations for 32 species. In an effort to promote conservation, "release only" citations (9 species) and "release" citations (4 species) are designated for 41% of total species in the program (www.state.va.us/mrc/citation). The angler-based Virginia Game Fish Tagging Program (VGFTP) also promotes tag-release

for eight recreationally important finfish species (Bain and Lucy, 1996, 1997; Bain et al., 1998; Lucy et al., 1999). As catch-and-release fishing continues to become integrated into mainstream recreational fisheries, there is increasing need to document short- and long-term survival rates for released fish.

Release-mortality results from a host of factors including location of hook wound, handling stress, bait type, and an assortment of environmental factors such as temperature, depth/pressure, and dissolved oxygen concentration (Muoneke and Childress, 1994). Release-mortality rates are typically species-specific (Muoneke and Childress, 1994) and have been reported to be less than 5% (Malchoff and Heins, 1997; Matlock et al., 1993; Murphy et al., 1995) to greater than 25% (Diodati and Richards, 1996; Wilson and Burns, 1996; Lucy and Holton, 1997). Mortality rates are typically greater for fish hooked deeply or in sensitive areas (Lucy and Holton, 1997), for fish caught at deeper depths (Wilson and Burns, 1996) and for fish caught at warmer water temperatures (Murphy et al., 1985). Unfortunately, fisheries management plans often must set minimum size limits and apply release-mortality rates without the benefit of significant field research data. The Fisheries Management Plan (FMP) for Tautog (ASMFC, 1996) provides an example of this scenario.

Tautog (*Tautoga onitis*) are a large temperate wrasse (Perciformes: Labridae) distributed along the eastern seaboard of North America between Nova Scotia and Georgia (ASMFC, 1996). In the mid-1980's, annual tautog landings began to decline throughout the distribution and reached record lows in 1993-1994. Tautog are considered over fished (fishing mortality > natural mortality) throughout their distribution range (ASMFC, 1996). In an effort to reduce fishing mortality to a level equal with natural

mortality (F=M=0.15), the Atlantic States Marine Fisheries Commission (ASMFC) passed a management plan for tautog in April 1996. The tautog FMP required states to systematically increase the minimum legal catch size for tautog to 13 in. (330 mm) TL in 1997 and 14 in. (356 mm) TL in 1998 (ASMFC, 1996). The tautog FMP assumed a recreational discard mortality of 25% (ASMFC, 1996).

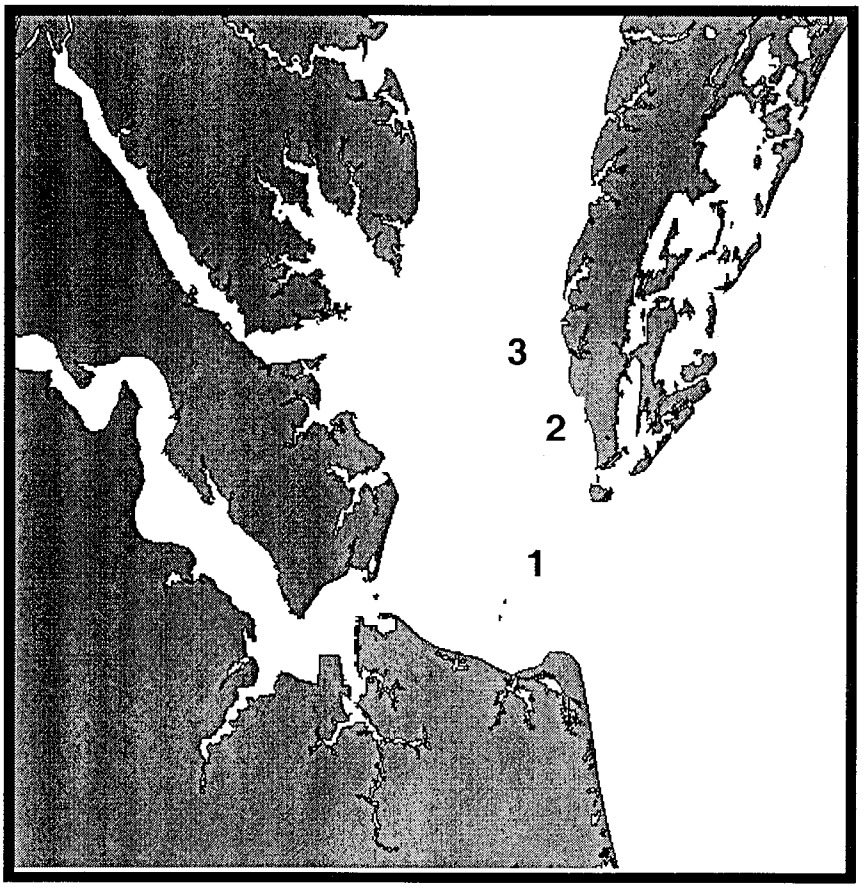
Determining mortality for fish hooked and released was specifically requested by the tautog FMP (ASMFC, 1996). Preliminary estimates from laboratory studies indicated much lower (1.8-2.6%) release-mortality rates than listed in the tautog FMP (Lucy, 1995; Bain and Lucy, 1997). Beginning in November 1997, a field-based study was undertaken to estimate catch-and-release mortality rates in Virginia's recreational tautog fishery. The primary objective of this study was to quantify release-mortality for tautog, particularly for sub-legal sized fish. The second objective of this study was to evaluate the impact of environmental variables (water temperature, depth/pressure) on survival.

Methods

Tautog were collected using standard recreational fishing gear (two-hook bottom rigs) at several fishing locations in the lower Chesapeake Bay (Figure 1.). Bait consisted of fresh cut hard blue crab (*Callinectes sapidus*) or hard clam (*Mercenaria mercenaria*) and hook sizes were variable (Eagle Claw 1/0 – #3/0 Long-shank J-hooks, Mustad #2-3 blackfish hooks or Virginia tautog hooks). Tautog were reeled to the surface, netted, then brought aboard the boat. After removing the hook, tautog were measured for total length, tagged with a Virginia Game Fish Tagging Program (VGFTP) t-bar anchor tag (TBA2, Hallprint), then held in an aerated livewell. Hooking information, handling times, and

fish conditions were recorded. After sufficient numbers of tautog were accumulated in the livewell (generally less than 2 h), tautog were placed in weighted (iron re-bar)

Figure 1: Location of Study Sites in the Lower Chesapeake Bay (1=Chesapeake Bay Bridge Tunnel, 3rd and 4th Islands; 2=Concrete Ships; 3=Cape Charles)



galvanized-wire crab pot cages (60 cm^2; 24 $in.^2$) and lowered to the depth of capture using braided-nylon crab pot line. Cages were accessible from the sea surface via crab pot floats attached to the crab pot line. Cages were retrieved after a minimum of 48 h and fish condition and mortality (if applicable) were noted. All surviving tautog were released with VGFTP tags at the conclusion of each cage trial.

A two-sample t-test was used to test for significant differences in total length of fish collected in 1997 and 1998, to determine if fish from both years could be combined. Descriptive statistics were then used to determine mean mortality rate. Because mortality estimates were not normally distributed, 95% confidence intervals around estimates were computed using confidence limits for percentages (Rohlf and Sokal, 1969).

A Chi-square contingency test was used to test the null hypothesis of no difference in mortality for fish caught and released in shallow (≤10 m) versus deep (>10 m) water. A Chi-square contingency test was used to test the null hypothesis of no difference in mortality for fish caught and released at warm (≥15.5°C; 60°F) versus cool (<15.5°C) water temperatures. Mean surface water temperature (daily) was computed from hourly observations at the First Island of the Chesapeake Bay Bridge Tunnel (www.co-ops.nos.noaa.gov).

Results

Between November-December 1997 and October-December 1998, 299 tautog (235-521 mm; 9.25-20.5 in. TL) were caught and released into live cages to estimate catch-and-release mortality. Fifty-nine percent of fish were collected in fall 1997 (n=177) and the remaining 41% of fish were collected in fall 1998 (n=122). Size range of fish in both years was similar ($p>0.05$, Table1). Sixteen percent of fish in 1997 (n=29) and 39% of fish in 1998 (n=47) were smaller than the respective minimum legal size limits each year (Figure 2). Forty-nine percent of fish (n=146) were used in shallow water trials and 51% of fish (n=153) were used in deep-water trials. Forty-four percent (n=133) of fish were caught at warm water temperatures and 56% of fish (n=166) were caught at cool water.

Tautog were caught, netted, and brought aboard the fishing vessel using the same methods and materials used by recreational fishers. Ninety-seven percent of fish were hooked either in the lip or just inside the mouth and hooks for these fish were removed with fingers, pliers, or de-hooking devices (Figure 3). Only one percent of fish were gut-hooked and the hook was cut and the leader was left in the fish. Ninety-six percent of fish experienced none to slight tissue damage from hooking, but bleeding from hook wounds was recorded for 38% of fish landed (Figure 4).

Fish exhibited two physical conditions in response to swim bladder expansion resulting from rapid decompression as they were reeled to the surface. These conditions were protrusion of the intestines out the vent and eyes bulging out of the eye sockets, the latter referred to as "pop eye" condition. Both intestinal protrusion and pop eye conditions were significantly greater for fish caught in deep water ($p\leq0.05$, Table 2).

Cage density varied between 3-8 fish per cage (x=5.2) in 1997 and 5-10 fish per cage (x=7.2) in 1998. Mean fish per cage trial for both years combined was 6 fish per cage. Cage trial duration (soak time) varied between 43.4-191.6 h in 1997 and 65-144 h in 1998. Mean soak time for both years combined (46 trials) was 114.7 h (4.8 d). Poor weather and rough sea conditions prevented short-term recovery of three cages in 1997 and two cages in 1998, and these cages were not retrieved until after 357 h (15 d) and 264 hours (11 d) later, respectively. Of the thirty-one fish subjected to these long-term holding periods, only one fish (with a deformed opercle) died (3.2%).

Release-mortality for both years combined (n=5) was 1.67% (0.63-3.68%, 95% CI). Release mortality was significantly greater for fish in deep water trials ($p \leq 0.05$, Table 3). All mortality occurred in deep-water trials. No significant differences in mortality at warm and cool water temperatures were detected ($p > 0.05$, Table 3).

Table 1: Two-Sample t-test, Total Length of tautog in 1997 and 1998
(Mean total length in 1997 was 376mm (14.8in.) and 366mm (14.4in.) in 1998)

	1997	**1998**
Mean	376	366
Variance	102	132
Observations	172	121

t=1.56, df=291, p>0.05

H_o: No Difference in Total Length (mm) in 1997 and 1998

Figure 2: Total Length (mm) of Tautog in 1997 (n=177) and 1998 (n=122).

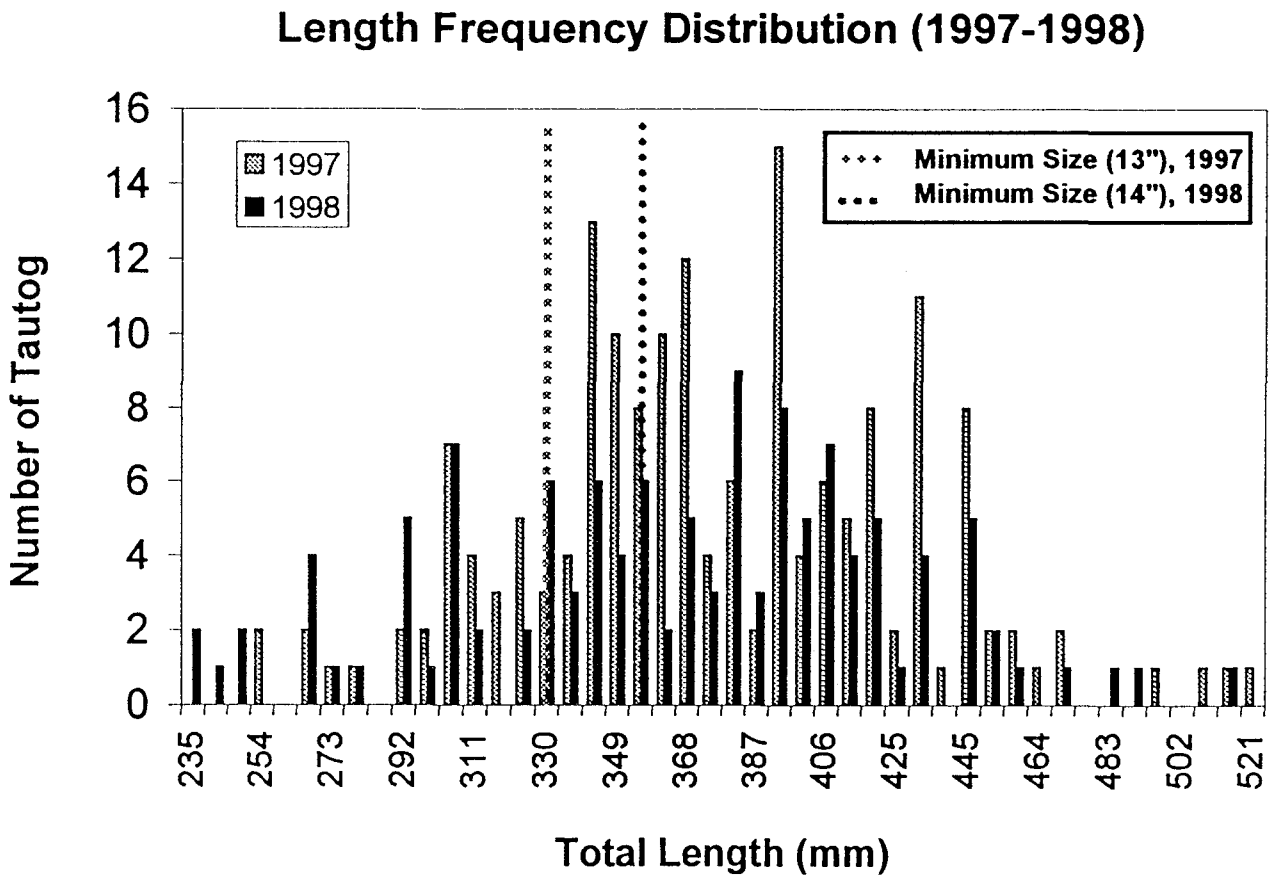


Figure 3: Hook Locations and Hook Removal Methods.

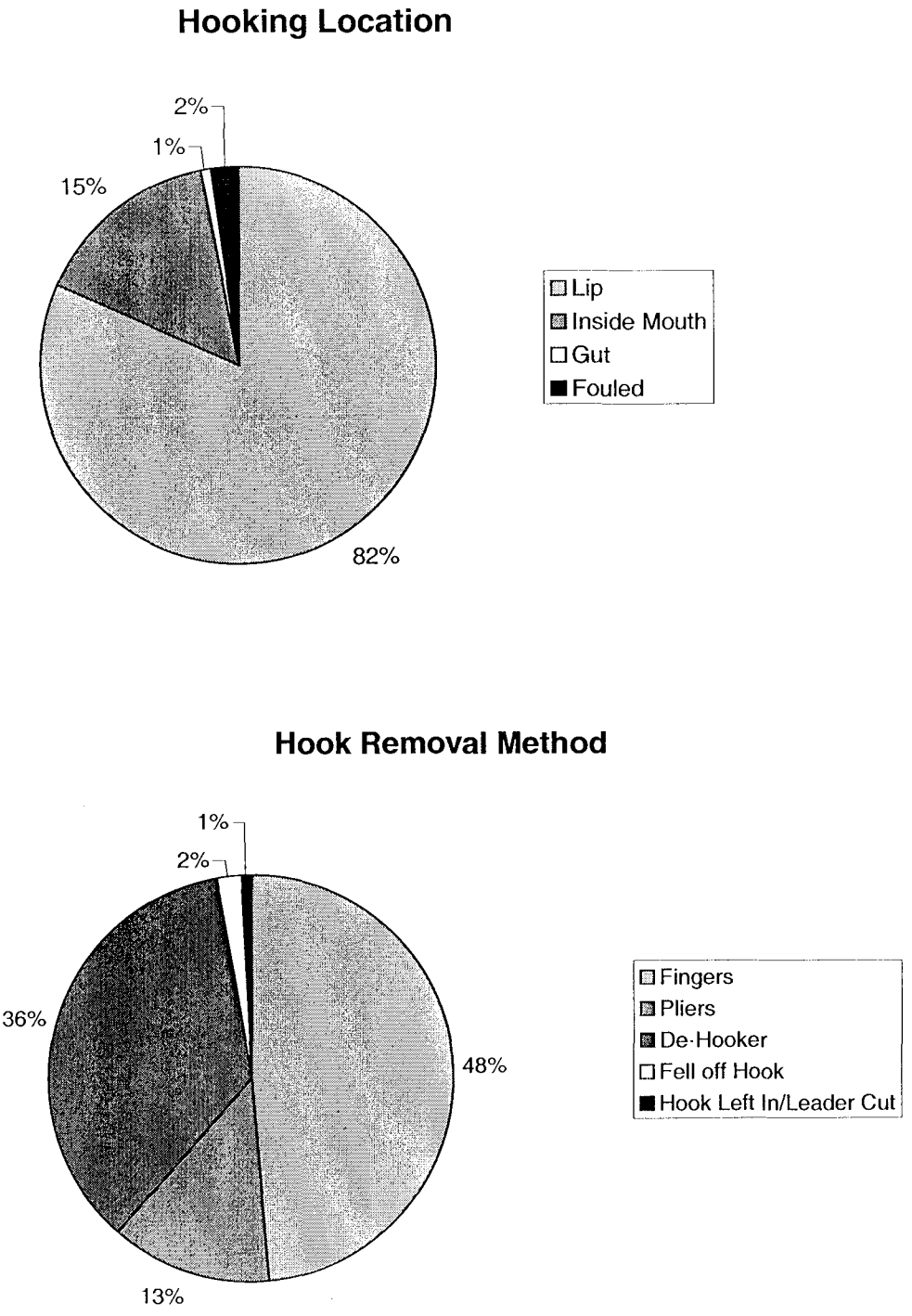
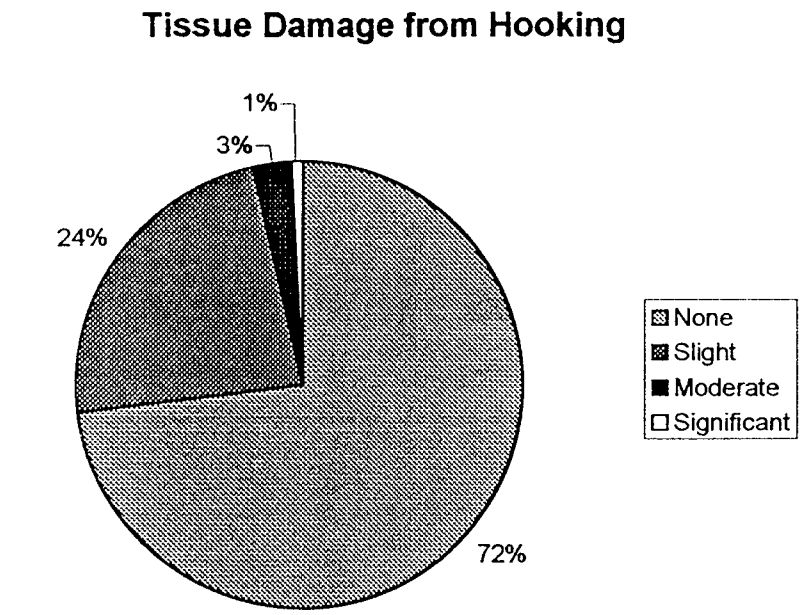


Figure 4: Hook Wound Damage and Bleeding.



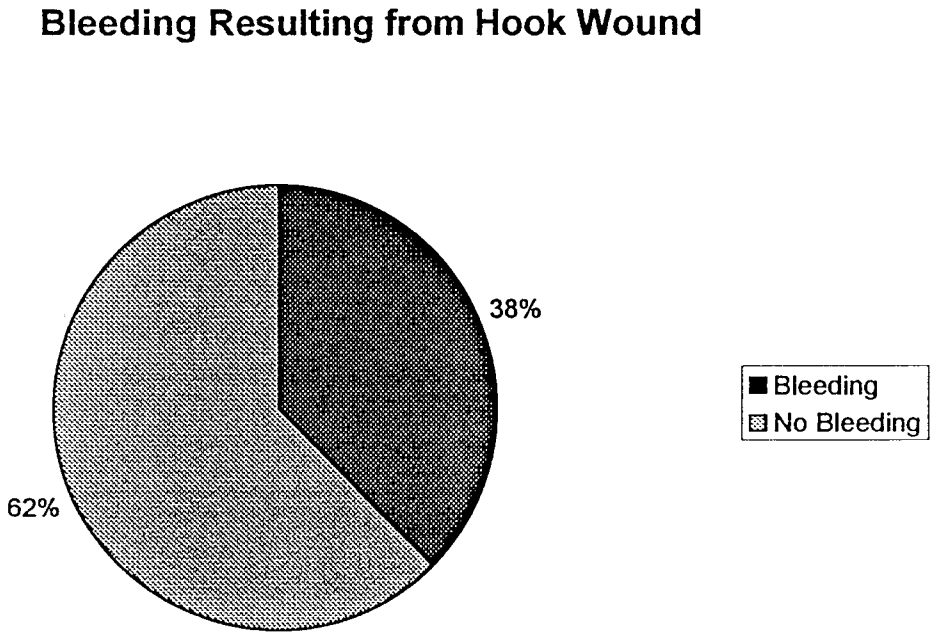


Table 2: Chi-square Contingency Tests, Frequency of Occurrence of Protrusion and Pop Eye Conditions.

	Protrusion	No protrusion	Total
Shallow (≤10m)	36	56	92
Deep (>10m)	130	47	177
Total	166	103	269

Chi-Sq=30.169, df=1, $p \leq 0.05$

Ho: No Difference in Occurrence of Protrusion Condition with Water Depth.

	Pop Eye	No Pop Eye	Total
Shallow (≤10m)	2	84	86
Deep (>10m)	43	83	126
Total	45	167	212

Chi-Sq=30.915, df=1, $p \leq 0.05$

Ho: No Difference in Occurrence of Pop Eye Condition with Water Depth.

Table 3: Chi-square Contingency Test, Mortality versus Water Depth and Water Temperature.

	Survived	Mortality	Total
Shallow (≤10m)	146	0	146
Deep (>10m)	148	5	153
Total	294	5	299

Chi-Sq=4.852, df=1, $p \leq 0.05$

H_o: No Difference in Mortality From Shallow and Deep Water.

	Survived	Mortality	Total
Warm (≥15.5°C)	131	2	133
Cool (<15.5°C)	163	3	166
Total	294	5	299

Chi-Sq=0.041, df=1, $p > 0.05$

H_o: No Difference in Mortality versus Water Temperature.

Discussion

Release-mortality rates observed during this study were considerably lower than the 25% level initially used in the tautog FMP. All mortality involved fish caught and released in deep water (>10 m; 33 ft.). Wilson and Burns (1996) reported increased mortality for red grouper (*Epinephelus morio*) in the Gulf of Mexico with increased depth, however, survival rates were high (86-100%) for red grouper caught at depths shallower than 44m (145 ft.). Tautog in this study were not collected from water deeper than 17 m (56 ft.). In Virginia, tautog are generally distributed in the lower Chesapeake Bay and coastal waters up to 111 km (60 nm) offshore (White, 1996; White et al., 1997). The depths at which tautog were caught in this study were consistent with the depths at which tautog are most often caught in bay and coastal waters of Virginia.

Low levels of short-term release mortality found in this study were consistent with low short-term mortality rates documented in a similar study in Connecticut (Simpson, 1999). In the Connecticut study, 284 tautog were caught on recreational angling gear (1994-1998). Fish were caught in the vicinity of the study area then transferred and held up to 2 weeks in a 1.2 x 0.9 m (4 x 3 ft.) plastic coated wire live car located in 3m (9.8 ft.) of water. Condition of fish was evaluated approximately every two days. Seven fish died, a mortality rate of 2.46% (0.80-4.31%, 95% CI, Table 4).

Table 4. Summary of data for tautog release-mortality studies in CT and VA.

Location	Dates	Sample Size	Mortality	%Mortality / 95%C.I.
Connecticut	1994-1998	284 tautog	7 tautog	2.46% (0.80-4.32%)
Chesapeake Bay	1997-1998	299 tautog	5 tautog	1.67% (0.63-3.68%)

Low short-term release mortality rates were also observed in tautog held in tanks to evaluate tag retention and tagging mortality for the Virginia Game Fish Tagging Program. Tautog were collected from shallow (6-8 m; 20-26 ft.) and deep (12-21m; 39-69 ft.) water sites in the lower Chesapeake Bay. Fish were held in aerated coolers for several hours, transported in aerated coolers to the laboratory, then held at ambient temperatures (flow-through design) in tanks between 7-48 d. Release mortality rates were 2.6% in 1995 (Lucy, 1995) and 1.8% in 1996 (Bain and Lucy, 1997). All surviving fish were released with tags.

High long-term release survival rates are supported by recent observations on tautog surgically implanted with ultrasonic transmitter tags. Submerged, acoustic receiver data and recaptures of ultrasonically tagged fish documented long-term survival rates of 100% for tautog (n=26). Mean survival time was 156 days (range 100-183 d) before either transmitter tag batteries expired, acoustic receivers were removed or fish were recaptured and killed (Arendt, 1999; Arendt and Lucy, 1999).

Survival rates are also supported by tag-recapture events in the Virginia Game Fish Tagging Program. Between 1995-1999, approximately 15% of tautog tagged and released (n = 4,764) were recaptured, being at large 0 to 1,214 d (<1 to 3.3 yr) (Lucy et al., 1998). These recaptures include seven fish released from the laboratory tag retention study in 1996 (recaptured 18-311 d post release). These fish were subjected to atypically high stress levels, having been handled, held in tanks, and transported in live wells several times prior to release in the lower Bay. Also surviving atypical stress levels (held in submerged cages then released with tags), 24 fish (at large 19-737 d) have been recaptured as of December 1999 from the hook-release mortality study (Appendix A).

The tautog FMP seeks to systematically reduce fishing mortality to the level of natural mortality (F=M=0.15). Prior to the tautog FMP, several states did not regulate tautog harvest. Throughout the species distribution, tautog are primarily harvested by recreational fisheries. Low catch-and-release mortality rates documented from laboratory and field studies, throughout the geographic range of tautog, suggest that minimum size limits and bag limits have the potential to be effective management tools for reducing fishing mortality levels.

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Appendix A: Tautog released in HRM study in fall 1997 and fall 1998 and recaptured 1997-1999.

Tag	Release	Location	TL (in.)	Recapture	Location	TL (in.)	Fish Fate	Days out
34444	10/31/98	Concrete Ships at Kiptopeke	15.00	4/18/98	Concrete Ships at Kiptopeke	15.50	RWT	347
34445	11/29/98	Coral Lump off Cape Charles	15.50	4/29/98	Coral Lump off Cape Charles	14.50	*	347
34450	11/9/98	Mussel Beds 2.6 miles NW of Cape Charles	17.50	10/10/98	Mussel Beds 2.6 miles NW of Cape Charles	17.00	RWT	349
34504	12/10/98	Mussel Beds 2.6 miles NW of Cape Charles	15.25	10/24/98	Coral Lump off Cape Charles	17.75		41
34515	11/9/98	Mussel Beds 2.6 miles NW of Cape Charles	14.25	10/25/98	Mussel Beds 2.6 miles NW of Cape Charles	15.00	RWT	349
34520	4/29/98	Airplane Wreck	13.25	10/27/98	Cape Henry Wreck	14.00		133
34536	10/24/98	Texeco Wreck	14.00	10/31/98	Thimble Shoals Light	18.02		311
34537	11/1/98	Coral Lump off Cape Charles	14.25	11/1/98	Coral Lump off Cape Charles	16.02		319
34538	10/2/99	Mussel Beds 2.6 miles NW of Cape Charles	12.00	11/9/98	Mussel Beds 2.6 miles NW of Cape Charles	13.00	RWT	294
34544	4/18/98	Concrete Ships at Kiptopeke	16.00	11/9/98	Concrete Ships at Kiptopeke	16.50		144
41002	11/13/99	Coral Lump off Cape Charles	15.75	11/20/98	Coral Lump off Cape Charles	16.50		370
41004	10/30/99	Coral Lump off Cape Charles	14.25	11/28/98	Mussel Beds 2.6 miles NW of Cape Charles	16.50		682
41043	12/17/99	Texeco Wreck	17.75	11/29/98	Off Cape Charles	16.00		737
41055	5/11/99	Texeco Wreck	10.50	12/7/98	CBBT, 3rd Island	15.00		510
41085	5/21/99	Texeco Wreck	0.00	12/7/98	CBBT, 4th Island	16.00		532
41088	10/2/99	Airplane Wreck	16.75	12/10/98	Coral Lump off Cape Charles	18.50		654
41110	12/7/98	Airplane Wreck	16.00	12/10/98	Airplane Wreck	15.75	RWT	19
41117	12/10/98	Coral Lump off Cape Charles	10.50	5/11/99	Coral Lump off Cape Charles	17.75		32
41169	11/28/98	Coral Lump off Cape Charles	16.00	5/21/99	Unidentified Structure off Cape Charles	18.00	RWT	346
41180	10/27/98	Mussel Beds 2.6 miles NW of Cape Charles	17.00	10/2/99	Mussel Beds 2.6 miles NW of Cape Charles	18.00		336
41186	10/25/98	Texeco Wreck	13.00	10/2/99	Mussel Beds 2.6 miles NW of Cape Charles	14.25	RWT	319
41192	10/10/98	Mussel Beds 2.6 miles NW of Cape Charles	18.00	10/30/99	Mussel Beds 2.6 miles NW of Cape Charles	18.00		324
50163	12/7/98	Mussel Beds 2.6 miles NW of Cape Charles	15.75	11/13/99	Off Cape Charles			38
50185	11/20/98	Texeco Wreck	12.00	12/17/99	Texeco Wreck	13.00	RWT	350

* RWT-released again with tag in place; otherwise, fish was killed.