

Assessing Impacts of Catch and Release
Practices on Striped Bass (*Morone saxatilis*)

Implications for Conservation and Management



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Introduction

Striped bass (*Morone saxatilis*) is one of the most sought after marine recreational species along the Atlantic coast of the United States. Shepherd (2006) estimated that between 2000 and 2004, 70% of the recreational striped bass landings occurred in marine waters of Massachusetts, New Jersey, Maryland, and Virginia. In 2006, the National Marine Fisheries Service (NMFS) estimated that New Jersey's marine recreational fishing industry accounted for \$1.6 billion in direct sales (NMFS 2006). That same year, the U.S. Fish and Wildlife Service estimated that approximately 50% of New Jersey's marine recreational fishing effort targets striped bass (FWS 2008).

Although stripers are found in the state's coastal waters throughout much of the year, fishing effort in New Jersey peaks during the spring and fall migrations. Migratory populations of striped bass are managed by the Atlantic States Marine Fisheries Commission (ASMFC). Under ASMFC's Striped Bass Interstate Fisheries Management Plan, states are allocated a harvest quota (ASMFC 2003). Since New Jersey law prohibits the netting or sale of striped bass, the quota is allocated to the recreational fishing sector. Currently New Jersey anglers are permitted to harvest two fish per day with a minimum size of 28 inches and an additional fish at a minimum size of 28 inches if the angler obtains a bonus permit from the New Jersey Division of Fish and Wildlife (NJDEP 2012).

In complying with these regulations, striped bass that do not meet the criteria for harvest must be released by anglers. In addition, the voluntary practice of catch and release fishing is growing in popularity as a conservation ethic among anglers. As a result, the magnitude of striped bass catch and release in New Jersey is substantial. In 2011, NMFS estimated that while 393,193 striped bass were harvested in New Jersey, over 900,000 were released (NMFS 2012).

Catch and release can be an effective practice in offsetting angling-induced impacts to individual fish and their populations, and encouraging the biological, economic, and social sustainability of a fishery (Lucy and Studholme 2002, Policansky 2002). However, poor catch and release practices can cause physical injury and physiological stress to fish. In fact, according to a review by Cooke et al. (2002) in virtually all catch and release fisheries some proportion of released fish die as a result of being captured, while others experience sublethal effects such as injury, physiological disturbance, behavioral alterations, and fitness impairments.

Despite the best intentions of anglers practicing catch and release angling for striped bass, the mortality rate associated with this practice is not trivial. The Atlantic States Marine Fisheries Commission currently applies an 8% hooking mortality rate for striped bass caught and released by recreational anglers in saltwater ecosystems (ASMFC 2011). This mortality rate is based on the results of a study on mortality of hooked and released striped bass in a saltwater

impoundment in Massachusetts by Diodati and Richards (1996). Applying this mortality rate to estimates of striped bass caught and released annually in New Jersey yields the annual discard mortality estimates in Table 1.

This mortality rate may, in part, be due to a general lack of understanding among anglers regarding how catch and release techniques can physically injure and physiologically stress fish. Many anglers make the assumption that all fish released survive the experience since they observe that the fish appear relatively unharmed and swim away with dead fish rarely resurfacing. However, Bettoli and Osbourne (1998) suggest that the behavior of released fish is a poor indicator of whether fish live or die.

Muoneke and Childress (1994) reported that fish that appear to be healthy when they are released may exhibit post release injuries or stress caused by angling and handling and actually experience mortality some time after release. Bettoli and Osborne (1998) and Nelson (1998) reported that striped bass that die as a result of hooking damage generally die within the first 24 hours after release. Their studies indicated that while some fish that initially experienced difficulty in maintaining equilibrium or sounding survived, others quickly sounded and appeared healthy but were dead the next day.

Causes of Stress in Angled Striped Bass

Angled striped bass may experience stress for a variety of reasons. The exercise induced by angling is the first cause of physiological stress response. Environmental factors can then exacerbate the rate of stress during angling, including water temperature, air temperature, and salinity.

A number of studies have documented the fact that stress and stress-related mortality in striped bass caught and released is temperature dependent (Harrell 1988, Hysmith et al. 1994, Tomasso et al. 1996, Lukacovic and Florence 1997, Nelson 1998, Wilde et al. 2000, Millard et al. 2003, Lockwood 2012). In general, as water temperatures rise above the striper's optimum temperature range angler-induced stress increases along with increased potential for post release mortality. This is especially true when water temperatures reach or exceed 70°F (Lockwood 2012). Therefore, it can be assumed that the warmer the water temperature, the longer it will take for a striper to recover from a fight or injury post-release.

Air temperature when striped bass are caught and released is also an important factor related to stress and stress-induced mortality (Bettoli and Osborne 1998, Lockwood 2012). Bettoli and Osborne (1988) documented high mortality of striped bass released in freshwater during the warm summer months, with air temperature when fish were landed and handled as the most important factor related to mortality. Any abrupt or substantial temperature increase experienced

Table 1. Estimate of Recreational Striped Bass Discard Mortality in New Jersey

Year	Number of Fish Released*	Estimated Discard Mortality**
2000	885,289	70,823
2001	965,650	77,252
2002	715,099	57,208
2003	925,885	74,071
2004	1,502,694	120,215
2005	1,218,893	97,511
2006	1,890,295	151,224
2007	1,789,294	143,144
2008	1,309,453	104,756
2009	800,510	64,041
2010	690,340	55,227
2011	904,576	72,366

*Data on number of fish released from NOAA MRIP query output (NMFS 2012)

**Estimated discard mortality calculated based on ASMFC assumption of an 8% mortality rate of released striped bass (ASMFC 2011)

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by angled striped bass, even for a brief period of time, can also add physiological disruption to that caused by fighting. This is especially important during hot weather, when there are large differences between water and air temperatures Lockwood (2011).

In general, research has shown that environmental stress and stress-induced mortality of caught and released striped bass is potentially higher in freshwater ecosystems (Diodati and Richards 1996). In marine waters, salinity appears to help moderate physiological imbalances associated with stress by helping to ameliorate potential osmoregulatory dysfunction and electrolyte imbalance that result from stress (Harrell 1988, MD DNR 2010). This is an important consideration for anglers participating in the coastal striped bass fishery, as fish caught in low salinity areas such as the upper portions of estuaries, are more likely to experience stress during catch and release than bass taken in high salinity waters.

Components of the angling event can exacerbate stress imparted on striped bass that are caught and released. Terminal tackle type, including the number and style of hooks and the type of bait used are all factors that can affect anatomical hooking location and the likelihood of physical injury to organs and tissue from hook wounds (Millard et al. 2003). Anatomical location of hook wounds has been found to be one of the most important factors influencing survival rates for released striped bass and, in general, mortality is highest if the wound site includes a vital organ. For example, a fish hooked in the jaw stands a much better chance of survival than a fish that is hooked in the gills, esophagus or stomach (Muoneke and Childress 1994, Millard et al. 2003, 2005). Being hooked in sensitive locations such as the gills, esophagus or stomach increases the risk of injury during angling as well as when hooks are removed and fish hooked in this manner are more likely to die.

Diodati and Richards (1996) and Nelson (1998) reported that the odds of death for gut hooked fish were almost six times the odds of death for fish hooked in the lip. Deep hooking was the single most important factor that caused death of striped bass caught and released in studies conducted by the Maryland Department of Natural Resources. Between 1996 and 2000, nearly 1,300 striped bass were used in their catch and release studies and they estimated 17 times higher chance of dying if a striped bass is deep hooked rather than shallow hooked (MD DNR 2010). Deep hooking in striped bass is often higher with live baits or natural baits than with artificial baits (Hysmith et al. 1994, Harrell 1998, Wilde et al. 2000). Mouneke and Childress (1994), Diodati and Richards (1996), and Nelson (1998) all reported that fish captured on natural or live baits often swallow hooks and baits more deeply which increases the possibility of injury and mortality. In a study of catch and release mortality of striped bass in the Roanoke River, North Carolina, Nelson (1998) found most striped bass caught on artificial lures were generally hooked in the jaw and mouth while fish caught with live bait were more likely to be deep hooked in the gills, pharynx or esophagus.

The use of J-hooks when fishing with live bait affects how deeply a fish is hooked (MD DNR 2010). Many studies have documented that live bait fished on J-hooks often results in gut hooking of striped bass. Millard et al. (2003) hypothesized that any bait configuration that facilitates swallowing of the terminal gear will exacerbate mortality. They attribute this to physical trauma that swallowed hooks induce during the initial hook penetration and subsequent playing time, as well as angler-induced trauma during hook removal.

Most researchers agree that non-offset circle hooks provide a less lethal option for anglers bait fishing for striped bass. Consistent with the analysis by Cooke and Suski (2004) circle hooks appear to decrease the incidence of gut hooked fish. They concluded that circle hooks result in more jaw hooked fish and less damage to vital organs for species such as striped bass. Thus, the use of circle hooks is a viable technique for decreasing angling-related injury in the recreational striped bass fishery by promoting mouth hooking, simple hook removal and reduced injury to released fish (MD DNR 2010, DNREC 2011).

Many studies have reported lower mortality and injury to striped bass when fish are angled with artificial baits (Hysmith et al. 1994, Harrell 1998). However, while lures generally hook fish in the jaw or mouth, they can also present problems. For example, large plugs rigged with multiple treble hooks can cause injury to a striper since the free hooks often swing around and catch in the fish's gills or eyes. Treble hooks may also require an inordinate amount of time for removal.

To counter these concerns it is often recommended that anglers replace treble hooks on plugs and metal lures with single hooks. The International Game Fish Association (IGFA) recently endorsed the idea of replacing treble hooks on crank baits, lipped plugs, top water lures or spoons with single hooks to facilitate easy de-hooking and faster release of fish (IGFA 2011). However, even single hooks can cause problems with hook removal if they are barbed hooks and outdoor writers such as Sosin (1999) and Richardson (2000) as well as many researchers (see Cooke and Suski 2005) recommend crushing hook barbs or using barbless hooks on plugs and lures to facilitate easy hook removal and reduce handling time and hooking injuries.

Aside from physical injury from deep hooking, physiological stress from fighting is another important factor that can result in angler-induced mortality of striped bass caught and released by recreational anglers (Tomasso et al. 1996, Nelson 1998). Fish that struggle intensely for prolonged periods of time during angling become exhausted. When fish are angled to exhaustion, lactic acid builds up in the tissues of the fish from muscle function. Increased levels of lactic acid can lead to a situation known as acidosis and exhausted fish may reach a point that results in physiological imbalance, muscle failure, or death. Therefore, the longer a fish is fought, potentially the less likely it is to survive after release. A fish that is landed quickly has a better chance of survival after release than one that has been exhausted by a lengthy fight.

Even if an exhausted striped bass survives sublethal hooking and fighting stress, once released it may be less likely to resume its normal behavior. For example, feeding patterns may become disrupted, fish may be more vulnerable to attack from predators, and the fish's ability to fight off diseases and parasites and to heal wounds caused by hooks may be compromised.

Stress and the potential for post-release mortality also increase dramatically if fish are mishandled. Landing, handling and release methods all may further exacerbate stress and result in post release mortality (Hysmith et al. 1994, Diodati and Richards 1996, Nelson 1998, Millard et al. 2003, Lukacovic and Uphoff 2007). For example, the longer a fish is kept out of the water, the lower its chances for post-release survival, especially if it has endured a prolonged fight (see Cooke and Suski 2005).

The inability of striped bass to recover from physiological stress incurred during capture can disrupt normal feeding patterns, increase vulnerability to attack from predators, reduce the striped bass's ability to fight off diseases and parasites or heal wounds caused by hooks, and ultimately result in post-release mortality. As a conservation minded angler, the goal is to use best practices for careful catch and release that reduce stress and minimize injury to striped bass.

Best Practices for Striped Bass Catch and Release: **Techniques to Increase Survival of Released Fish**

Anglers control many factors that can exacerbate stress imparted on striped bass that are caught and intended to be released. For example, when fishing for striped bass, anglers should use appropriate weight-class tackle that allows fish to be brought in quickly to reduce exhaustion and minimize stress. Other angler controlled factors include terminal tackle type, playing time, landing, handling and unhooking techniques, and release methods.

Terminal Tackle Type

Terminal tackle type, including the number and style of hooks and the type of bait used can affect anatomical hooking location and the likelihood of physical injury to organs and tissue from hook wounds. Two types of hooks that are known to reduce injury and mortality of released striped bass are barbless hooks and circle hooks. In addition, corrodible, non-stainless steel hooks are encouraged.

- When fishing with plugs and lures with multiple treble hooks, consider removing one or two sets of hooks or replacing them with single hooks. Single, barbless hooks are even better, as they reduce tissue damage and handling stress because they can be quickly and easily removed. In general, use single barbless hooks whenever possible or and crimp, bend, file or flatten the barbs on the hooks to make them easier to remove.
- When fishing with natural or live bait use non-offset circle hooks to minimize gut hooking and the chance of lethal wounding of striped bass to be released. The unique shape and hook point location of a circle hook ensure that when a fish takes a bait and continues to swim or make a turn, the hook pulls until the point catches the fish in the corner of the mouth. This causes minimal damage, reduces the chance of lethal wounding and makes it easier to unhook and quickly release fish. Even if a circle hook is swallowed by the fish it will slide out of the stomach when the fish moves off with the bait. As the line is pulled through the fish's mouth, it guides the hook around the jaw where it locks in place. (Note that octopus-style hooks are not true circle hooks and fish like traditional J-hooks).
- When using the snag and drop technique snag menhaden, herring or other live bait and transfer and swim them on a single circle hook rig.

Playing Time

The longer a fish fights, the higher the stress level and greater the chance for exhaustion and physiological disturbance which reduces the chance of survival after release.

- When you feel a strike, set the hook quickly. Setting the hook as soon as you feel a strike will help prevent the fish from taking the hook deep in its throat where it may cause internal organ damage and be hard or impossible to remove.
- Once a fish is hooked, land it quickly rather than playing it to exhaustion. A fish brought to the boat or shore quickly has a much better chance of survival after release than one that has been exhausted by a lengthy fight.

Landing and Handling Techniques

If at all possible, striped bass should be kept in the water while hooks are removed. If a fish must be removed from the water to unhook it, always try to minimize the amount of time it is kept out of the water, handle the fish as little as possible, and release it quickly.

- Avoid using gaffs to land striped bass that are going to be released. In a jetty situation, if a gaff must be used, gaff fish in the jaw or corner of the mouth only.
- When using a landing net, use a net with small mesh made out of rubber, knotless nylon, or other soft non-abrasive material rather than a large mesh polypropylene landing net. These materials remove less slime and reduce potential wounding. Make sure the net basket is shallow and of sufficient circumference so that it does not bend the fish severely.
- If a fish must be removed from the water refrain from holding fish in a vertical position to avoid displacing or stressing internal organs. If you are bringing a striper onboard a boat using a lip gripper or other landing device to hold the fish while you remove the hook, grab the fish by the lower jaw; however, do not lift the fish clear of the water with the gripper to avoid placing the fish's entire body weight on the jaw. Hold fish horizontally by firmly gripping the lower jaw with one hand and gently supporting its weight under the belly with the palm of the other hand.
- Once a striper is landed, keep it from thrashing around and injuring itself. Stripers can be calmed down by covering their eyes and head with a wet rag or towel or by turning them on their back. On boats, if you have a saltwater wash down on, keep a gentle stream of water flowing over the fish's gills and body.
- When unhooking a striped bass, handle fish carefully using wet hands, wet cotton gloves or a wet towel to minimize removal of the fish's protective mucous layer. Striped bass

have a protective mucous layer that prevents disease and infection from entering through the skin. The more a fish is handled, the more of this protective slime that is removed.

- Avoid touching or injuring the eyes.
- Never touch the gills or insert your hand into a gill cover to hold a striper as this will damage the gills and impair the fish's ability to breath.

Unhooking Techniques

Striped bass should be unhooked quickly and carefully in the water whenever possible, to reduce stress and the potential for injury or post release mortality, especially when air temperature is much higher than water temperature.

- Do not tear tissue when removing the hook. Back the hook through the original wound.
- If a hook is imbedded in a fish's throat or difficult to remove by hand, use a proper dehooking tool for hook removal such as long-nosed pliers, hemostats (forceps) or a commercially available hook removal tool.
- Do not forcefully remove the hook if you cannot see it or it appears that you may cause greater harm to the fish by attempting to remove the hook when a fish is hooked deep in the throat or stomach or hooked in the gills do not forcefully remove it. Cut the leader as close to the eye of the hook as possible and leave the hook in the fish. There is evidence that fish are capable of rejecting, expelling or encapsulating hooks by secreting an inert matrix of calcified cellular material.

Release Methods

Fish in good condition should be quickly and gently returned to the water head first in an upright position. Fish that are stressed by the fight or handling and unhooking should be revived prior to release.

- Revive exhausted fish by holding them headfirst into the current or direction of the seas in the swimming position with one hand under the tail and the other under the fish's belly or grasping its jaw between your thumb and forefinger. Gently move the fish to get water flowing through the mouth and over the gills. Use a figure-8 pattern to always keep the fish moving forward. Never move the fish backwards.
- When the fish is revived, let it swim away on its own. Do not let the fish go until it clamps down on your thumb or is able to swim strongly and freely out of your grasp.

It is our hope that dissemination of the information contained in this report, as well as the results of future studies assessing the impacts of catch and release practices in the coastal striped bass recreational fishery, will allow anglers to better understand the causes of stress in angled striped bass and the potential impacts of their catch and release practices on striped bass angled in marine waters. By utilizing scientifically quantified best catch and release practices, anglers can ensure greater chances of survival of released fish thus increasing angler contributions to conservation of this important recreational species.

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