# MD DNR Fisheries Feature Story

## Recreational Catch-and-Release Mortality Research in Maryland

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The practice of catch-and-release fishing has gained widespread popularity and acceptance in the sport fishing community and has been incorporated into fishery management plans. Anglers catch and release fish for a variety of reasons: fish may not be legal size, they may be out of season or they may be caught and released simply as sport. In an intensive catch-and-release fishery high survival of released fish is essential for this to be a non-consumptive practice.

Fishing mortality is most often perceived as that portion of the catch which is kept. With the increase in catch-and-release fishing, the portion of the catch which is released often exceeds that which is kept. It is currently estimated that more than 90% of the striped bass caught in Chesapeake Bay and along the Atlantic coast are released. Several fisheries in Maryland (American and hickory shad, and the Susquehanna Flats striped bass fishery) exist only as catch-and-release fisheries and numerous trout waters in Maryland allow only catch-and-release fishing.

High angler participation in a catch-and-release fishery, even with a low mortality rate among released fish, can result in a significant number of dead fish. A study examining a striped bass catch-and-release fishery on the Roanoke River, North Carolina determined the mortality rate of released fish to be 6.4%. Because of high levels of fishing effort and high catch rates in this fishery, this relatively low mortality rate accounted for 46% of the allowable annual harvest for that river. Therefore, the mortality rate of the released fish, even if it is low, must be considered as part of total fishing mortality to properly manage a fishery.

Minimum size limits are used to protect and enhance fish populations by allowing fish to live long enough for them to spawn one or more times. It is also an effective way to provide quality fishing by preventing the harvest of smaller individuals and allowing a greater number of fish to survive to a more desirable size. Creel limits reduce fishing mortality if they are less than the typical angler catch. Minimum size limits and creel limits will work if the survival of released fish is high.

There are two main factors that influence the survival of fish that are caught and released: physical injury and stress. Fish can be physically damaged from hook wounds and during handling and release. They can be physiologically stressed by the exertion from the fight.

Numerous studies have shown that the location of the hook wound (physical injury) is the single most important factor influencing catch-and-release mortality. If the wound site is a vital organ the mortality, as expected, is high. The hook wound site can be influenced by hook size or configuration, the use of natural bait verses artificial lures (natural baits tend to be swallowed more frequently), bait size, angler experience or fish behavior.

Stress-related mortality can change because of variations in environment conditions. Studies with a wide variety of fish species have demonstrated that higher water temperatures will cause mortality associated with catch-and-release fishing to increase. The estuarine environment changes seasonally in temperature as well as in oxygen content and salinity. Temperature (both water and air), salinity and fish size have been shown to be three important, interactive factors which affect survival of caught and released striped bass. High water temperatures under low salinity conditions have been shown to increase mortality of released striped bass. Fish size has also been shown to affect survival. Larger fish fight longer and are more difficult to handle than smaller fish. Differences in the ratio of gill surface area to body volume increase as fish get larger. Therefore larger fish have a more difficult time eliminating carbon dioxide from their bloodstream and re-oxygenating their tissues after extreme physical exertion. Time out of water, particularly during hot weather, also

increases stress-related mortality.

Maryland's Department of Natural Resources, Fisheries Service has been conducting studies over the last seven years that evaluate the survival of fish that are caught and released by recreational anglers. These studies have included hickory shad, American shad, summer flounder, white perch, yellow perch and striped bass. Some species, such as American and hickory shad, are only briefly available to anglers at specific locations. Therefore, the environmental conditions in which they are caught, other than normal seasonal temperature increases, are not highly variable. In addition, the tackle used to catch these fish is fairly consistent. A single study for each species, with replicates over time to evaluate temperature change, has been sufficient to evaluate the catch-and-release mortality for each of these fish.

Striped bass and white perch are caught in a variety of aquatic environments by many different angling techniques. They can be caught when water temperatures reach the lower 50's (EF) and they will continue to feed as temperatures rise into the 80's. The salinities from which they are caught range from 0.0 parts per thousand (ppt) in fresh water to estuarine levels (15-20 ppt). Striped bass are also caught at marine salinities (35 ppt). Angling methods include trolling, chumming and flyfishing for striped bass. Bait fishing and casting artificial lures are techniques used for both species. Striped bass have been the focus of a number of catch-and-release studies here in Maryland because of the varied circumstances under which they can be caught.

Following will be a series of study summaries conducted by the Fisheries Service that have investigated various recreational fisheries and the release mortality that may be associated with them. These studies are being used to build predictive models of catch-and-release mortality that will be incorporated into fishery management plans and to educate anglers about ways to maximize survival of their released fish.

## Hickory and American Shad

Changes in regulations may allow catch-and-release fishing on a previously closed fishery. American and hickory shad have been protected in Maryland since 1980 and 1981, respectively, by moratoria because of low population size. During the mid-1990's the numbers of hickory shad returning to spawn in Deer Creek, a tributary to the Susquehanna River, and a few other streams, appeared to be increasing. Along with this apparent increase in population was an increase in angling activity for these fish. In 1996, the regulation that prohibited harvest of these species was changed to allow catch-and-release fishing. To evaluate the effects of this fishery a study was conducted to evaluate the survival of hickory shad caught and released in Deer Creek. Over a four week period in April and May 1996, 150 hickory shad were caught and used as test specimens in ten trials. Participating anglers caught hickory shad using single hooked artificial lures with 6-7 weight fly rods. Fish were transported to holding tanks set up on the shoreline. A pump supplied creek water to the tanks using a flow through system. Survival was monitored 48 hours. No fish died in any of the trials and they appeared healthy and vigorous when released. Hickory shad that were foul hooked were used as well as lip hooked fish when it became apparent that foul hooking was not an uncommon occurrence. Fish were marked at the time of release. Weekly surveys to search for dead fish in the stream were conducted concurrent with the study. These surveys documented a few dead hickory shad in Deer Creek that had physical damage compatible with hooking. None of the observed mortalities had marks indicating they were released test fish.

In April and May of 1997 a similar tank study was conducted which evaluated the survival of American shad caught and released below Conowingo Dam on the Susquehanna River. Volunteer anglers, who used spinning tackle and artificial lures, caught 309 American shad. These fish were used in 13 trials that ran for 48 hours each. Mortality was less than 1%.

These two studies indicated that the change in regulation to allow catch-and-release fishing for these protected species did not jeopardize stock recovery by causing a high rate of angler induced mortality.

## White Perch

White perch caught by recreational fishermen are not protected by either a minimum size or a creel limit. They are the primary species targeted by recreational anglers during their spring spawning run in rivers such as the Choptank and Chester. Currently anglers are discarding 75% of the white perch they catch during the spring spawning run fishery and most are less than 6.5 inches. If a recreational minimum size limit is ever considered, and if the mortality rate is high for released fish, then a size limit may not be an appropriate management tool.

A mortality study was conducted with white perch in Unicorn Branch, a tributary of the Chester River in March and April 1998. Recreational anglers were asked to donate to the study any white perch they would normally have released. Fish were taken from anglers that used shad darts baited with grass shrimp. White perch were observed for 48 hours in fiberglass tanks using a flow-through water system identical to the shad studies. Only one mortality was observed among 524 white perch used in 6 trials. This study indicates that if minimum size regulations, or creel limits, were to be considered in the future, survival of released fish under these circumstances is high enough for these measures to be successful.

## Yellow Perch

Currently, yellow perch caught by recreational fishermen in Maryland's tidal waters are regulated by a nine inch minimum size limit and a five fish per day creel limit except those rivers closed to harvest. Harvest is prohibited in the Magothy, Nanticoke, Patapsco, Severn, South and West rivers.

A study was conducted to evaluate survival of yellow perch caught and released by recreational anglers in Wye Stream, a tributary of the Wye River East in March 2002. Fishermen were asked to donate to the study any yellow perch they would normally have released. Fish were taken from anglers that used shad darts baited with grass shrimp or minnows. Fish were marked to separate deep-hooked fish from shallow-hooked fish. Deep-hooking was defined as being hooked past the gills. Yellow perch were observed for 48 hours in stream-side fiberglass tanks using a flow-through water system similar to the shad and white perch studies.

Most of the yellow perch, 94%, were shallow-hooked and their survival rate exceeded 99%. The deep hooking rate was 5.8% and as expected these fish died at a higher rate (35.7%). Overall mortality was 2.9%. Sub-legal fish (<9 inches) represented 43% of the fish used in this study and their mortality rate was the same, 2.9%. Male yellow perch accounted for 57% of the fish in this study.

Most of the yellow perch sport-fishery occurs in spring with cool air and water temperatures. Survival rates of both legal and sub-legal sized yellow perch are high enough under these circumstances, that size and creel limits appear to be effective management practices for this species.

## Summer Flounder

Recreational fishing reports complied by the Fisheries Service through the mid-1990's indicated that approximately 90% of the summer flounder caught in the ocean-side bays during the summer were less than the minimum size limit and released. Two head boats operating out of Ocean City allowed biologists on board to measure summer flounder caught by their clients and to record type of terminal tackle used and hook wound location.

Natural bait is used almost exclusively for flounder and natural baits tend to be swallowed more often than artificial ones. Terminal tackle can influence the rate of deep hooking. Hook size and style were consistent during this survey. The head boat captains used a wide-gap hook (#1 or 2). This choice was presumably made to reduce the frequency of deep hooking. Handling time for the mate was reduced and fish survival was increased. Deep hooking occurred only 6.7% of the time using

this terminal tackle.

Terminal tackle used by private recreational anglers varies greatly. Several paying customers used their own tackle while fishing on the head boats. A bait-holder style hook was the most common type used by these anglers. Observations of these anglers indicates that those who use hooks other than the wide-gap style generally have a higher rate of deep hooking.

The head boats did not have the space necessary to conduct long term holding that would have allowed us to determine mortality. The 6.7% deep hooking rate could be seen as the potential maximum mortality for head boat anglers.

## Striped Bass

When Maryland's spring trophy season was limited to late April and May, chumming was not widely practiced. The large striped bass that were targeted were not densely schooled up at that time of year and were not very susceptible to that tactic. The expansion of the season through June and into early July in 1996, along with a decrease in the size limit starting June 1, resulted in an increase in chumming which targeted smaller schooling fish. The increased popularity of this fishing technique was followed by complaints of dead and floating striped bass near the fishing areas and concerns from stakeholders about the effect of these deaths on the stock. Examinations of dead fish indicated terminal tackle left in many fish and physical trauma compatible with hook damage.

Nearly 1,300 striped bass were used in catch-and-release mortality experiments conducted during 1996-2000. We conducted catch-and-release mortality experiments with striped bass were caught by chumming because it easily provided both deep- and shallow-hooked fish. One study was conducted during October 1996 and one was conducted in June 1997. Each month, from June through October 1999 and June through September 2000, two 2-day trials were conducted. Charter boats were hired to catch fish for these studies. Conventional j-style bait hook and circle hooks were used. Hook size, tackle strength and fishing location were kept consistent for each season. Cut menhaden and soft clams were used for bait. The location of the hook wound was identified when each fish was landed. Fisheries Service biologists removed the hook if the fish was shallow hooked, but left the hook in place in deep hooked fish by cutting the line. Each fish was marked to identify hook location (shallow or deep) by hole punching the tail fin. They were transported to open water net pens in DNR hatchery vessels. The most optimal conditions for survival (lowest temperature and highest oxygen) found at each site were duplicated in the tank. Their survival and water quality was monitored in the net pens for 72-96 hours.

The striped bass were checked daily for mortality. Temperature, dissolved oxygen and salinity were monitored in the pens each day. Dead fish were measured and hook location (hole punch position) was recorded. All dead fish, marked as deep hooked, were dissected to determine the nature and extent of the internal damage that caused death. All surviving fish were measured, had hook location recorded and were released.

The use of circle hooks to reduce deep hooking rates was briefly evaluated during the spring 1997 study. Striped bass were caught for the mortality study using standard J-style off-set hooks. When sufficient numbers were caught each day to meet statistical constraints for the study, non-offset circle hooks were used to catch and release fish. Deep hooking was reduced more than 75% by the same anglers fishing the same day using non-offset circle hooks.

Deep hooking was reduced 81% over the course of the 1999 study by using non-offset circle hooks and 67% over the course of the 2000 study. This magnitude of deep hooking reduction has been documented in several other Fisheries Service studies (84% in summer 1996; 75% in spring 1997).

Studies done here in Maryland have determined the deep hooking mortality rate of striped bass caught with conventional J-style bait hooks to be about 50% regardless of temperature, salinity or whether or not the hook is removed (57.7% in 1995; 41.0% in 1996, 56.3% in 1997, 53.1% in 1999 and 58.3% in 2000).

Mortality (in order of influence) was higher for deeply hooked fish, fish caught at higher air temperatures (higher in June-July, lower during August-October), and larger fish. Bigger fish were more likely to be deep-hooked. Odds of dying were more than 15-times higher if a striped bass was deeply hooked and standard, j-shaped bait hooks had a 4-times greater chance of deep-hooking than non-offset circle hooks. Fish subjected to abrupt increases in air temperature when removed from water prior to release (typically in June and July) were more likely to experience fatal disruption of their>normal physiology.

## Susquehanna Flats Catch-and-Release Fishery

The rising popularity of catch-and-release fishing lead to the development of catch-and-release fishery in the upper portion of Chesapeake Bay known as the Susquehanna Flats. This activity developed despite regulations that prohibit catching or attempting to catch striped bass in areas designated as spawning rivers and areas during the period March 1 through May 31. A workgroup comprised of stakeholders was formed by the Fisheries Service to investigate what might be done to provide better recreational fishing opportunities in those areas without impacting the spawning stock or the reproductive ability of striped bass. The workgroup recommended that the Fisheries Service design and conduct a study that would determine the mortality of striped bass associated with catch-and-release fishing on the Susquehanna Flats.

Over a five week period in April and May 1998, three 2-day trials were conducted on the Flats. Participating anglers were instructed to use single hooked artificial lures. Fish were marked as deep or shallow hooked, transported and held for three days as in the other striped bass studies.

Two size groups of fish were sought for these experiments: less than 24 inches and greater than 24 inches. This size delineation was selected because mortality data for striped bass greater than 24 inches caught at low water temperatures in fresh water did not exist in the scientific literature.

The results showed that water temperature greatly influenced release mortality of striped bass caught on the Flats. Mortality was 1.6% at temperatures of 57-59EF, 3.7% at 61-62EF and 15.9% at 64-71EF. There was no difference in mortality between large (>24") and small (<24") striped bass at these low temperatures. More than 95% of the fish caught on the flats in this study were small males.

A legal catch-and-release season was implemented in 1999 and was closely monitored by the Fisheries Service. Water temperatures remained low and the size distribution of striped bass caught in the 1999 season was very similar to that seen during the study.

## How have these studies affected Maryland’s anglers?

Changes in regulations and angler education have been and are being used by the Fisheries Service to reduce release mortality and to provide more recreational opportunities for anglers. Reduction in the striped bass minimum size to 18 inches for a portion of the spring season was implemented following the 1997 study. Allowing anglers to keep smaller fish reduced the number of fish that were caught and released before the creel limit of legal fish was reached. Additionally, anglers have been encouraged to use non off-set circle hooks to reduce deep hooking rates of fish that are released. Catch-and-release fishing for American and hickory shad and the Susquehanna Flats, is allowed because our research has determined mortality is low and this practice is compatible with fishery management plans. We found that catch-and-release mortality of species such as yellow and white perch is low and is not likely to impede the effectiveness of management measures in the future.

The Fisheries Service is continuing to conduct research and monitor catch-and-release losses. Work involving the cooperation of organized fishing groups (Maryland Charter Boat Association, Coastal Conservation Association and Maryland Saltwater Sportfisherman’s Association) is currently underway. These studies will determine the deep and shallow hooking percentages for the major recreational fisheries. They will also provide better resolution of deep and shallow hooking mortalities under different environmental conditions, and they will investigate different techniques

and tackle that will reduce mortality of released fish.