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How Stocking Recreational Fisheries Works (and Sometimes Does not)[1]

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Abstract

Fish stock enhancement or "stocking" is one of the oldest, most common, and most popular ways of improving recreational fisheries. Stocking is usually supposed to increase the number of fish available for anglers to catch. Unfortunately, stocking does not always achieve this goal. The reasons why it may not work as planned relate to some important concepts of fish ecology. This publication first describes these fish ecology concepts needed to understand stocking. Then the publication describes the three primary results or "outcomes" of stocking that anglers might see in the waters they fish. The main point of the publication is that stocking can be very effective, but only if the stocked fish survive well and do not actually hurt wild fish populations.

Introduction

Stock enhancement or "stocking" of recreational fisheries means raising fish in hatcheries and then releasing them into waters that already have some wild fish. Usually, stocking is done to increase fish populations and angler catch rates. Stocking is one of the oldest and most common fisheries management actions. It is also usually one of the most popular with anglers. This is understandable: it seems clear that if we stock more fish, there will be more fish to catch. Unfortunately, it does not always work like that. A lot of things have to go right for anglers to actually see a change in their catch rates from stocking (Camp et al. 2013). In this publication, we first describe some of the most important processes of stocking. These processes explain why stocking sometimes, but not always, results in increased fish populations and angler catches. Then, we describe the most common broad types of stocking results or "outcomes."

To start, we explain a few key points about fish and fisheries to help us understand the potential outcomes of stocking:

- **Survival for very small fish is incredibly low.** Usually the chances of a "fry" (about a 1-inch fish) surviving to an adult or catchable fish is around one in thousands (Figure 1).

Figure 1. It is really rare for small stocked fish to survive to trophy size like this largemouth bass, but it can happen. Credit: Ed Camp, UF/IFAS.

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- **Young fish have what is called "density-dependent survival."** Each individual little fish's chances of surviving the first few months of life depend on how many young fish there are. In general, the more small fish there are, the lower the survival rate. And the fewer small fish there are, the greater the survival rate. This is called density-dependent survival and scientists think it occurs because there is only so much food to go around and a limited number of places to hide from predators in the wild environment. Density-dependent survival is one of the most important parts aspects of fish populations, and it is the only reason a fishery can be sustainable (Walters and Martell 2004). Density-dependent survival does not last forever—once the fish is grown (somewhere around 20% of its maximum size; Lorenzen and Camp 2019), survival typically stops being density dependent (more information on this can be found in: UF/IFAS FA222 "Fish Population Recruitment: What Recruitment Means and Why It Matters").
    - One way to understand density dependency is to think about a really strict game of musical chairs with only 5 chairs in the next round. If we have 8 players, my chances of "surviving" into the next round are pretty good, and the "survival rate" in the game is high. But what if we add in more players so that there are now 20 players but the same number of chairs? My chances of finding a chair and making it to the next round are not as good, and the overall "survival rate" in the game is lower. This is what happens in density-dependent survival. Only so many little fish can survive. The more little fish there are, the lower each fish's chances of making it to the next round because there are only so many resources to go around.
- **Survival of small fish in the wild is "selective."** This means that generally only the fish best at finding food and avoiding predators will survive. Those young fish that are not as good at finding food or avoiding predators do not survive.
- **Fisheries management agencies usually stock smaller fish.** Raising larger fish can be tricky. They may eat each other, get diseases, and take up more hatchery space (Trippel et al. 2018). It can also be really expensive.
- **Hatchery fish do not survive as well in the wild as wild fish.** Unlike wild fish, young fish in the hatchery do not have to find food or escape predators, and so they do not "learn" or develop the instincts necessary for each. This helps them survive better in hatcheries, but it also means they are often not as good at surviving in the wild where they do have to search for food and avoid predators. It also means that fish get stocked that would not have survived in the wild (where there is "selective" mortality that means only the best fish survive).

So putting all of this together, when we stock small hatchery fish in the wild, two things likely occur: (1) at first, the overall density of fish usually increases and the overall survival rate of all the small fish (wild and hatchery) usually decreases, and (2) often, though not always, the hatchery fish get outcompeted by wild fish for food and places to hide. Both of these things are most common when fish are stocked at small sizes—before density-dependent mortality ends. For many species though, these are the sizes that are easiest and least costly to raise in a hatchery. It's understandable that hatcheries would want to use small fish in their stocking programs, but anglers should not expect that stocking with very small fish will increase catchable fish populations noticeably.

Potential Outcomes

What does this mean for how stocking works? There are three general types of outcomes resulting from stocking (Figure 2):

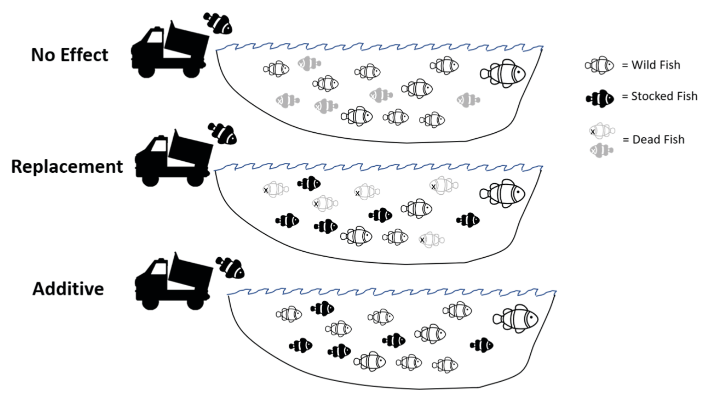

Figure 2. Visual depiction of three potential outcomes to stocking. Note that the "No Effect" and "Replacement" ponds have the same total number of fish alive, however the "Additive" pond has many more. Credit: Nicholas Fisch, UF/IFAS

No Effect

A stocking effort will have no effect if stocked fish survive really poorly right after stocking, which could happen if they are bad at finding food or bad at avoiding predators, or for other reasons. Regardless of the reason, very low stocking survival means that there is virtually no chance that anglers will ever see the effects of the stocking. Imagine stocking 5,000 1- to 2-inch largemouth bass in a lake that has a population of, on average, 1,000 adult fish. If only a couple dozen stocked fish survive the first couple of weeks in the wild, probably only a few individuals would survive long enough to be caught. While hatcheries have tried lots of ways to make stocked fish survive better, like "teaching" them to find food, these usually have not improved wild survival very noticeably.

Replacement

Sometimes the stocked fish actually survive pretty well. However, if this is the case, it means they are likely to compete with the wild fish of the same size—potentially even replacing them! This happens because of density-dependent survival. No matter how many small fish start off, only a certain number can survive through the density-dependent period because of limited hiding places and food. Think of our musical chairs metaphor; there are still only 5 chairs in the next round, and so now 2 of those chairs have been taken by stocked fish instead of wild fish. This would mean anglers would not actually catch more fish—their catch would just include more stocked fish. The better the hatchery fish are at surviving, the more likely they are to replace wild fish.

Additive

The final category of stocking outcomes is that the stocked fish survive and actually add to the total number of fish in the lake, river, or bay. This would likely also result in higher catch rates for anglers. This most often happens when:

- Fish are stocked at larger sizes than where the bottleneck of density-dependent mortality occurs. This means the fish are not as likely to replace wild fish, but also that the fish are probably able to be caught by anglers sooner. It is almost always harder and more expensive to raise fish in hatcheries to these larger sizes, so usually fewer fish can be stocked.
- There are few wild fish to begin with. This happens when "restocking" after a fish kill, when the wild fish population is depleted, possibly by cold, drought, or severe overfishing. It could also occur when doing fish introductions. Fish introductions are when a new species that would not naturally occur in the water is stocked. Examples of this practice in Florida include stocking butterfly peacock bass in south Florida canals, sunshine bass (a cross between white bass and striped bass) in Florida rivers and reservoirs, or channel catfish in Florida ponds. Note that fish introductions are not actually stock enhancement because they are introducing a new species rather than enhancing an existing population.

Although the additive outcome is the most desired from stocking, it, too, can have some downsides. First, because the stocked fish probably have not gone through intense survival selection, they are not likely to be as "fit" as fully wild fish. This means that they do not have the genetics that are advantageous for survival in the wild. So, if these stocked fish reproduce with the wild fish already in the system, they will be introducing less "fit" genetics into the population that may actually hurt the population in the long run. It is important to realize this issue applies only to fish species that do actually reproduce on their own in Florida—like largemouth bass or bluegill, and it is not a concern for species that do not reproduce in Florida on their own—like sunshine bass (white bass – striped bass hybrids) or, generally, channel catfish. Second, if the overall fish population does increase with these new stocked fish, usually fishing effort quickly does too. If the greater fishing effort results in stocked fish being caught and harvested it decreases the chance they will contribute less "fit" genes to the population. However, it also means the catch rates will probably go back down pretty quickly.

Summary

What all of this means is that often stocking simply does not work the way we hope it will. The most common outcomes are likely somewhere between the first and second outcomes described here—few fish survive, and those that do may replace wild fish. This means it is unlikely for anglers to see a big increase in catch from stocking. But it does not mean stocking is always bad. Restocking can really speed up recovery of a severely depleted wild population, and introduced species can provide new angling opportunities. Also, put-and-take stocking—where catchable-sized fish are stocked, expecting them to be quickly caught by anglers—produces popular short-term fisheries. (Put-and-take is common in northern states with trout.) In the end, stocking is like almost every other fisheries management tool—it can work well when it is applied to the right circumstances, but it is not a silver bullet to fix everything. Additional details on stocking recreational fisheries in Florida can be found in UF/IFAS 216: "How to Define Successful Stocking of Florida's Freshwater Recreational Fisheries."

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Glossary

Stocking: The act of placing fish raised in hatcheries into wild settings (lake, pond, river, ocean, etc.).

Stock enhancement: The type of stocking where hatchery fish are added to wild populations of the same species. This is the most common type of stocking in Florida.

Restocking: The specific type of stock enhancement where a depleted or completely extinct wild population is restocked. In Florida, this would most often happen after a fish kill (like a cold kill or drought).

Fish introductions: The type of stocking in which hatchery-raised fish are added to a water body in which they would not normally live. Florida examples include stocking sunshine bass or butterfly peacock bass.

Recruitment: The time or stage in a fish's early life when survival (and mortality) is density dependent.

Density-dependent survival: A survival rate that depends on the density of fish in an area. This occurs because food and hiding places (habitat) are limited. The same concept can be called density-dependent survival and also "density-dependent mortality," because survival and mortality are two sides of the same coin.

Fitness: This term describes the reproductive success of an individual as a result of its survival probability and its ability to reproduce. The more fit an individual, the more likely its genes will pass on to the next generation. A fish may be said to be more fit than another if it has a greater chance of survival and is more likely to find a mate. This could occur if a fish is bigger than another (as outlined in stocking examples).

Selection: The process where only the most fit fish survive. Selection is especially strong during the recruitment period when survival (and mortality) is density dependent.

Costs of Stocking

In the United States, it has been estimated that $509,000,000 is spent on stocking each year (Hatchery operational costs in 2011 US dollars, Trushenski et al. 2018). Just in Florida it is estimated that $1,510,000 is spent annually on operating public hatcheries.