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Recreational Fishing Effort and How Management Actions Can Affect It—Part 1: Theory[1]

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Introduction

Recreational fisheries are especially crucial to the state of Florida, with the marine fisheries alone providing approximately $8B total economic output (NOAA 2017), as well as satisfaction and enjoyment to millions of Floridians and visitors. Recreational fisheries can also have substantial negative effects on fish populations in Florida, in both fresh and salt water. Fisheries managers seek to sustain aquatic ecosystems and fish populations. They try to ensure fish harvest rates aren't too high and that fish have suitable habitat, especially for recruitment. At the same time, fisheries managers also want to ensure that stakeholders—recreational fishers—achieve desired attributes from the fishery, and that fishing continues to produce market activity (revenue, jobs) for local communities. One of the most important metrics for achieving these ecological and socioeconomic goals is fishing effort.

This publication explains some ways that management decisions affect recreational fishing effort. We begin by providing some background needed to discuss management effects on recreational fishing effort. Then we describe some of the common ways that fishing effort can change because of management actions, in terms of direct effects, indirect effects, and feedbacks. For each, the publication will give some hypothetical examples. We conclude by describing the dynamic nature of fishing effort—how current fishing effort will likely affect fishery conditions in the future. The publication will specifically help management agency personnel better understand and explain fishing dynamics to their stakeholders, allow Extension agents to teach the public about fishing effort, and assist the fishing industry and interested members of the public who seek to understand more of the process behind modern recreational fisheries management. This information is critical to understand potential effects of management decisions and how they can relate to the outcomes of recreational fisheries, especially in Florida, where recreational fishing is so important.

Background Information

What is recreational fishing "effort?"

In recreational fisheries, effort is described as the number of fishing trips. Effort can then be determined for a specific space and time, or even species of fish targeted. For example, one might describe the total number of any kind of fishing trip made in Florida in 2019. Or, one might describe directed effort targeting red drum (*Sciaenops ocellatus*) from Citrus County in 2019. These "effort" numbers are estimated from scientific surveys. In Florida, surveys estimating freshwater fishing effort are conducted by the state management agency, Florida Fish and Wildlife Conservation Commission, but are usually only available for certain specific water bodies as opposed to statewide,

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species-specific, or county-specific. In marine waters off of Florida, however, effort can be estimated at state or county scales and for specific species using data collected as part of the National Marine Fisheries Service (NMFS) Marine Recreational Information Program (MRIP). This allows managers as well as local government to monitor how effort changes over time (Figure 1). Most recreational fisheries in North America, and all those in Florida, are "open access." "Open access" means that neither fishing trips nor fishing licenses are limited. There are no rules about how many fishing licenses can be sold, or how many fishing trips can be made. There are, however, rules about *how* fishers can fish (type of fishing gear used), how many fish each person can harvest and when they can harvest them. Florida also sets goals for the total amount of biomass harvested. "Open-access," then, does not mean that a recreational fishery is completely unrestricted, but it does mean that fishing effort can fluctuate freely within the other rules, depending solely on how much fishers want to fish.

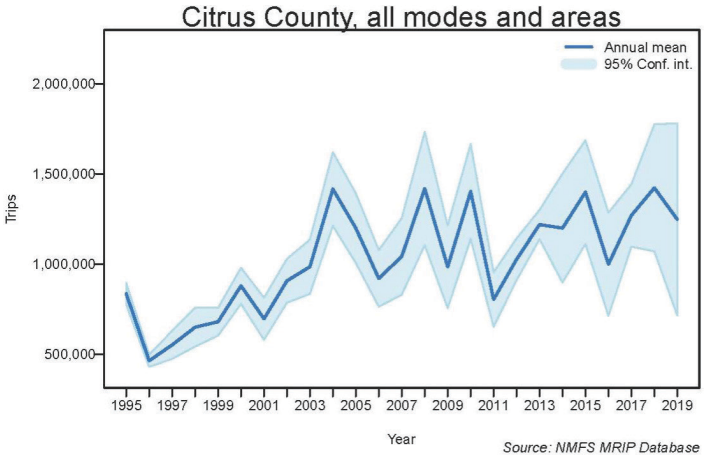

Figure 1. Example of estimated annual marine recreational fishing effort in Citrus County from 1995–2019. The annual mean is the darker interior line, and the 95% confidence intervals (lighter ribbon around the line) provide the uncertainty. These are derived from the National Marine Fisheries Service (NMFS) Marine Recreational Information Program (MRIP) dataset.
Credits: NMFS MRIP Database

Why is recreational fishing effort so important?

Recreational fishing effort plays a critical role in fisheries' ecological and socioeconomic sustainability (Camp et al. 2016). Fishing effort usually reduces fish populations. This is because, if nothing else changes, more fishing effort leads to greater harvest and fewer fish in the population. However, this relationship isn't linear, owing to fish recruitment dynamics (discussed below), which allow for sustainable fishing (Camp et al. 2020; 2021). On the socioeconomic side, greater fishing effort indicates anglers are getting greater satisfaction from fishing. Greater fishing effort also almost always means greater fishing-related revenue—the money spent on fishing trips and related purchases. This increased market activity can support local economies and jobs. Practically, this means many local areas may see increases in fishing effort as a good thing, since increased fishing effort should lead to enhanced market activity, at least in the short-term (Camp et al. 2018). Again, there is a balance—if the fishing effort increases by so much that it decreases fish populations and catch rates substantially, this may eventually lead to decreases in fishing effort, and a consequent decline in fishing-related market activity. Harvest regulations such as bag and size limits and seasonal closures typically mitigate the effects of fishing effort on fish abundance, such that regulations often provide sustainable fisheries even if fishing effort increases. (Discard mortality can still be a challenge, however. See Camp et al.'s "An Introduction to Harvest Tags for Marine Recreational Fisheries" and Coggins et al. 2007). Given the importance of fishing effort to local economies and the potential impacts of effort on fish populations, though, it is important to understand how potential management actions are likely to affect fishing effort.

What causes fishing effort to change?

In open access fisheries, fishing effort ultimately depends on how many people want to fish and how frequently they are able to go. The modern economic theory states that demand for leisure activities like recreational fishing will change according to the utility participants derive. Utility here is essentially satisfaction or enjoyment from fishing, and improving fisher satisfaction should eventually lead to increased fishing effort. Many things affect the satisfaction (utility) that recreational fishers attain from fishing. These are described in terms of catch-related and non-catch-related metrics. Catch-related metrics include things like catch rate, catch size, number of fish harvested, etc. Non-catch-related metrics can include things like fishing site characteristics—such as the habitat in the area fished or the quality of the boat ramp and other access facilities. Additional information about the current science of utility and satisfaction can be found in recent articles by Hunt et al. (2019) and Birdsong et al. (2021). The main thing to remember is that changes to catch- and non-catch-related metrics (like facilities or catch rates) should affect demand for fishing, which in turn affects effort.

So catch-related and non-catch-related metrics drive demand for effort, and both catch-related and non-catch-related metrics can be affected by management. For example, management regulations about things like open harvest seasons or closed areas can affect catch. And certainly

management decisions about things like developing fishing facilities (boat ramps, access, etc.) affect non-catch-related aspects. But more generally and less directly, management decisions affect fish populations and ecosystems, which in turn substantially influence catch- and non-catch-related attributes of angler satisfaction. That means that management actions should have a substantial effect on the demand for fishing and the overall fishing effort.

Processes for How Management Can Affect Recreational Fishing Effort

The challenge is that assessing how recreational fishing effort will be affected by a management action isn't easy. Effects on fishing effort can even be counterintuitive, often because of complex dynamics and feedbacks between human behaviors and their effects (Camp et al. 2016). Management actions can affect recreational fishing effort directly, indirectly, and via feedbacks.

Direct Effects

In open-access fisheries like those in Florida, it is less common that fisheries management decisions directly alter fishing effort, but it can or could happen. The easiest way for this to occur would be rules that prohibit fishing at all—either for a certain time or for certain areas. These types of rules are quite common in other states, which often have seasonal closures on fishing on certain waters and for certain fish (e.g., for salmonid trout, walleye, or black bass) with annual "opening days" when anglers are allowed to fish for the species. Some potential examples of more direct effects of management of fishing effort in Florida might include:

Making changes to the fishing (not harvest) season. For example, a seasonal closure for bottom fishing to decrease discard mortality (Chagaris et al. 2019). This would limit the total number of days available for fishing and would have some direct (though maybe not linear) effect on total fishing effort.

Adding boat ramp lanes or parking. This would almost certainly increase the utility experience per angler, or increase the number of anglers that benefit, or both. Either way, more fishing trips would be expected.

Making changes to the type or use of vessels allowed in certain waters, such as establishing no motor or no internal combustion motor zones, or disallowing non-motorized vessels (e.g., kayaks), or airboats. This would restrict the number of people allowed to fish an area and could influence overall effort.

Indirect Effects

Indirect effects of management actions on fishing effort are probably much more common. These include all the cases where a management action would limit one thing (like harvest allowed), which would then affect how much anglers want to fish and thus the demand for trips and effort. This could also happen with non-restrictive, augmentative actions (like habitat restoration or stock enhancement). Finally, there are often indirect effects that follow direct effects. That is, an observed direct or indirect effect may not tell the entire story of how effort would change. Here are some examples of indirect effects:

Changing the minimum size limit of a fish, such as an increase in the minimum size limit of tripletail (Figure 2) from 15 inches to 18 inches. This may change whether potential tripletail anglers think they'll be able to harvest a fish and may alter how often they choose to fish for tripletail. If would-be tripletail anglers choose not to fish, overall effort would decline. However, they may also choose to fish for a different species, instead. Thus, management changes directed at one species may affect overall fishing effort, as well as potentially effort directed towards other species or areas.

Figure 2. Tripletail is a sought-after marine species for which the harvest regulations recently changed. This change could be expected to have indirect effects on the effort targeting tripletail.
Credits: Ed Camp, UF/IFAS

Habitat restoration/enhancement could make it more enjoyable to fish and lead to more effort. For example, restored mangroves may create a more aesthetically pleasing experience that attracts more anglers. Or adding artificial reefs or fish attractors could lead to anglers believing they'll have better fishing.

Conversely, management actions that fail to prevent habitat decline may lead to a less aesthetically pleasing experience, or lead anglers to not want to fish an area. The seagrass die-offs in the Mosquito Lagoon provide an example of how a habitat change can alter demand for fishing. Habitat changes could lead to declining effort if they result in reduced aesthetic qualities of the fishing site, reduced fish catches from habitat degradation, or both.

A change in the type or use of vessel could also have indirect effects in addition to direct effects. For example, airboats being prohibited from a National Wildlife Refuge (NWR) estuary might initially be thought to decrease effort (since it would limit allowable vessels). But this action might have the indirect effect of creating an experience more enjoyable to anglers who dislike the noise. It could actually lead to net no-change, or even an increase in fishing effort.

Feedbacks

Perhaps the trickiest thing about fishing effort is that it's not just affected by things like management actions, it also affects and is affected by fish populations. Thus, when a management action changes fishing effort, that effort influences the fish population, which could in turn further affect effort, and so on. These complex dynamics are called "feedbacks." The feedbacks create linked systems between fishers and fish, much the same as between predators and prey. Some examples of common fisher–fish feedbacks in recreational fishing systems might include:

- **A change in the allowable bag limit.** For example, if the red drum bag limit changes from 2 to 1 per day per person, this would immediately alter the satisfaction or utility that some fishers receive, and would likely cause some people to fish less for redfish. But perhaps the decrease in harvest (by lowering the bag and/or less fishing) causes the number or size of redfish caught to increase. This in turn might cause more people to fish for redfish, even though they couldn't keep them.
- **A change in the type or use of a vessel.** Following the example above of airboats prohibited from a NWR: if this exclusion results in greater abundances or catch rates of fish, non-airboat anglers may be attracted to the area even if they don't object to airboats. But then the feedbacks continue. If so many anglers are attracted to the NWR, the fish populations and catch rates could again decline and lead to a leveling off of effort.

The final example describes a more general expectation of feedbacks, which is that they often tend to moderate or "dull" the eventual effects. If a management action leads to an initially large increase in effort, it is likely that effect will shrink over time as the increased effort translates to more harvest, smaller fish populations, and lower catch rates and/or size. Conversely, if the initial effect of a management action (such as a spatial closure) decreases fishing effort, it's possible that the resulting fish population increase will cause catch size and rate to increase enough for effort to come back up to some degree. It is important to remember, though, that these moderating feedbacks (1) often take time—especially when they depend on a fish population rebuilding (which can take decades), and (2) aren't guaranteed. For example, some fish populations can slip into alternative stable states and may never rebound (Jensen et al. 2012). Other times, social norms and expectations change (sometimes this is called shifting baselines), and fishing effort can remain high even at lower fish abundance (Ulman and Pauly 2016).

The Dynamic Nature of Fishing Effort

It seems obvious that fishing effort may change over time. Because of the direct and indirect effects discussed above, and the feedback effect that modulates them, current effort is partially a function of previous effort and hence will partially determine future effort. This is why effort is understood as "dynamic."

The dynamic nature of fishing effort brings up two important points. The first is that management decisions that involve feedbacks associated with long-lived species may take a long time to be apparent. This is because most feedbacks involve fish populations, and population dynamics of long-lived species can take a while to change. For example, the Florida redfish fishery is almost wholly targeted on two- to four-year-old fish that that are juveniles (Camp et al. 2020). If the population becomes overfished to the point that recruitment declines because of limited egg production of adults (Camp et al. 2021), it might take many years to rebuild the population of spawning adults to the point at which recruitment and then the abundance of catchable two- to four-year-old fish recovers. Essentially, this means that once a fish population is reduced, it will take time for recovery. A second important point is that some management actions (or inaction) can have even longer effects if they trigger changes in habitat that transition to alternative stable states. A management action or inaction that allows loss of habitat-forming organisms like seagrass, salt marsh grass, oysters, or mangroves may be semi-permanent. This is because these habitats can

transition to alternative stable states that might be less desirable for juvenile or adult fish survival (Love et al. 2022). Once this happens, it can be very difficult for fish populations to recover unless they can use alternative habitats (Figure 3).

Figure 3. Commonly targeted recreational species like common snook and red drum are both relatively long-lived and are thought to require structural habitats like saltmarsh grass, mangroves, and seagrasses for good survival of juveniles (recruitment). Their long lifespans mean these species may take a long time to recover from reductions in their populations, and their habitat dependence means losses of habitat may result in recoveries to lower population levels.
Credits: Ed Camp, UF/IFAS

Summary

Recreational fishing effort, defined as the number of fishing trips that happen within a place and time, is one of the most important metrics for fisheries management because effort is so intrinsic to both ecological and socioeconomic outcomes. Even though most recreational fishing effort in Florida is open-access, management actions do affect effort by altering the catch-related and non-catch-related aspects of a fishing trip that determine demand for fishing. Some direct ways management actions or inaction affect effort include things that make it much easier for more or fewer fishing trips to happen, like changes in the rules of the type of access to certain waters; different seasons for fishing or harvest; or changes to facilities that help provide access to fishing (e.g., better boat ramps or construction of pier facilities that allow fishing). Management actions can indirectly affect effort mostly by affecting fish populations through harvest restriction or enhancement. Finally, there can be feedbacks resulting from direct or indirect management actions that further affect effort, such as where a management change that alters demand, which then alters fishing effort, which then causes a change to the fish population, which in turn affects fishing demand and effort. These feedbacks, and the fact that the changes occur over sometimes longer time periods (years to decades), mean that fishing effort should be understood as a dynamic process. Recognizing fishing effort's dynamic nature and its inherent complexity is critical to understanding recreational fisheries management decision processes.

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