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Recreational Fishing Effort and How Management Actions Can Affect It—Part 2: Literature and a Case Study[1]

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Abstract

Recreational fishing is especially important to Florida's economy and ecosystems and can be affected in a number of different ways by management agency decisions. Management decisions that change the allowable harvest or the type of access to certain fishing areas are often expected to have strong effects on fishing effort. However, the outcome of these actions is not always obvious. To provide greater insight into what may happen to fishing effort after management decisions, we describe case studies from the North American fisheries literature, and some Florida-specific case studies. What these illustrate is that sometimes the same or similar management actions (e.g., a more restrictive harvest policy) can have opposite effects on total fishing effort depending on the specifics of the case. We use this information as well as additional fisheries theory to explore a specific case study—what might happen if special harvest or access regulations were applied to a popular but ecologically and environmentally sensitive habitat—the St. Martins Marsh Aquatic Preserve in Citrus County, Florida.

Recreational fisheries are especially important to Florida, which boasts the greatest number of marine fishing trips and greatest annual marine fishing total output (approximately $8B) of any state (NOAA 2017; Camp et al. 2018). Florida recreational fisheries provide value and well-being to millions of residents and visitors annually. Recreational fisheries can also have substantial ecological and environmental effects, and in Florida, many of the most obvious are in marine systems. Recreational fisheries produce fishing mortality that can substantially affect fish populations—changing not only the overall number of fish, but also their size structure. Size (or age) structure describes how many fish of what sizes (or ages) there are in a population, which is important because only fish of certain sizes will be mature enough to reproduce and large enough for fishers to catch. Diminishing the abundance of larger fish can affect not only spawning populations, but also the satisfaction that anglers get from the size and number of the fish available to catch, as well as potentially the amount of fishing trips that are made (Camp et al. 2016). Recreational fishing also has environmental effects. For example, inshore-marine fishers in Florida (and other areas throughout the Gulf of Mexico and Southeast Atlantic) can cause prop scars that damage seagrass, and even airboats in very shallow water can harm seagrasses. Fisheries managers seeking to maintain sustainable, enjoyable recreational fisheries that do not degrade the environment must wrestle with what types of management actions to take. Management actions can directly, indirectly, and via feedbacks affect overall fishing effort.

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This publication will help recreational fishing stakeholders, Extension agents, management agency personnel, and the interested public better understand some of the expected and unexpected impacts of management decisions made to protect fisheries and environmental quality. This publication is part two of a two-part series. It follows part one, Recreational Fishing Effort and How Management Actions Can Affect It—Part 1: Theory, which provides some background theory on how management decisions can affect recreational fishing efforts by giving examples and drawing inferences from them. We first describe several case studies from around North America. Then this publication describes some very specific and, in some cases, unpublished examples particular to Florida's inshore fisheries. Finally, we consider how hypothetical changes to spatial regulations around the St. Martins Keys, part of the St. Martins Marsh Aquatic Preserve off Citrus County, could affect fishing effort locally and beyond.

Summary of Background Information on Fishing Effort in Florida

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. Since Florida's recreational fisheries are "open access," the total number of fishing trips taken is not directly limited. Increased recreational fishing effort usually means greater economic activity (that is related to sales revenues and jobs, see Understanding Metrics for Communicating the Economic Value of Florida's Fisheries and Coastal Resources, Camp et al. 2023), and it can indicate greater satisfaction or utility from anglers (which is related to economic value). But all else being equal, more effort usually results in more fish harvested or killed via discard mortality, and in the long run, tends to lead to smaller average sizes of fish being caught. Additionally, if the act of fishing can hurt the environment (for instance, when a vessel steered into shallow waters damages sensitive seagrass or oyster habitats), more effort generally means more environmental damage. Damage to these ecosystems may reduce fish populations that use them as recruitment or nursery habitat (Camp et al. 2021; Love et al. 2022).

Economic theory holds that fishing effort will go up depending on "demand"—which is simply the number of fishing trips the public wants to take given the cost of these trips in money or time. Demand for fishing is dependent on multiple catch and non-catch-related factors. Catch-related factors include catch rate, catch size, etc., whereas non-catch-related factors might include things like boat ramp facilities, fishing site aesthetics, and fishing partners. Management actions influence most of these factors. The effects can be direct, like vessel type restrictions or spatial closures. There can also be indirect effects, such as a change in harvest restrictions that decreases the demand for fishing, and thus effort. For example, an increase in the bag limit (number of a species of fish an angler can take home per day) might lead to greater effort, whereas an increase in the minimum length limit (how long a fish must be to be legally harvested) might be expected to decrease the overall fishing effort. Finally, there can be feedbacks, where a direct or indirect effect causes a change in the fish population that elicits subsequent change in the fishing effort. This, and the fact that the effects can take time to be obvious, means that recreational fishing effort is considered dynamic, related to what has happened in the past and partially determining what will happen in the future. All of this makes it especially important, but sometimes challenging, to understand how fishing effort will respond to management changes, especially those that have not yet been implemented.

North American Examples of How Harvest Regulation Changes May Affect Effort

We examined the fisheries scientific literature to look for examples of how management actions altered effort dynamics. A few examples are listed below; the full citations are available in the references.

- **Cornelius and Margenau (1999)—Effects of length limits on a musky fishery**. The authors found evidence that fishing effort, as well as size and number of fish caught, increased following the imposition of stricter harvest regulations. This suggests that angler decisions to target specific fish are positively related to the size and abundance of fish. So, this study showed that harvest restrictions, surprisingly, increased fishing effort.
- **Newman and Hoff (2000)—Effects of minimum length limits on a smallmouth bass fishery.** The authors found that effort increased following the imposition of length limits in a single lake smallmouth bass fishery in Wisconsin. Catch per unit effort (CPUE) overall, and CPUE of quality fish increased, leading authors to infer that anglers in this fishery cared more about catch rates of quality fish (as measured by the increase in effort) than they did the harvest potential of smallmouths. Ultimately, this study showed that harvest restrictions resulted in an increase in fishing effort.

- **Muoneke (1994)—Dynamics of a heavily exploited white bass fishery in Texas**. These authors described a system where harvest restrictions were imposed and found that effort decreased immediately after (but rebounded the next year), while catch rates remained similar. While these results are based on only a few years of data, they serve as evidence that imposition of harvest restrictions can affect fishing effort, even in the absence of noted changes in the catch rates. Thus, the take-home message from this study was that harvest restrictions could cause at least a short-term decrease in fishing effort.
- **Boxrucker (2002)—Rescinding a minimum length limit for white crappie in a lake in Texas.** This study looked at a white crappie fishery that was believed to be strongly affected by fishing, evidenced by a lower abundance of large fish. A minimum length limit (harvest restriction) was established and resulted in an increase in larger fish. Catch rates increased, but harvest rates (by number and weight) declined, likely because fewer legally harvestable fish were caught under the new length limit. Effort eventually decreased substantially, suggesting that harvest was more important to anglers than fish size or catch rates for this particular fishery. Thus, this provides another example of stricter harvest regulations decreasing effort.

The main point illustrated from these case studies is that sometimes the same type of management action can cause opposite effects for similar fisheries. Sometimes increasing harvest restrictions can cause an increase in fishing effort, presumably because it results in greater quality of fishing that leads to increased demand. It's worth noting that there can be other factors affecting outcomes, such as different types of anglers changing where they choose to fish. For example, anglers who are especially interested in harvest might decrease their effort following stricter harvest regulations. Still, this effort decline from those anglers could potentially be fully replaced by anglers interested in high catch rate experiences who flock to the newly restricted area. The implication from this short cross section of studies is that it should not be presumed how a certain action will affect fishing effort—and even whether the effect of an action will be to increase or to decrease effort!

Estuarine and Florida-Specific Examples for How Spatial-Use Regulations May Affect Effort

But what about how changes in spatial regulations, such as restricting vessel type or use in a defined area, affect effort and the rest of the fishery system? The examples above indicate that the effects of management actions depend on specific species and or regulatory systems. Thus, it would be appropriate to look at ecological systems specific to Florida. Unfortunately, there is limited literature on spatial fishery management in Florida. Given most saltwater fishery resources' open-access nature, spatially constrained effort restrictions (e.g., no motor zones, closed areas, gear limitations) are not common in estuarine systems. Use of spatially explicit marine protected areas (MPAs) has occurred globally and elsewhere in the United States and beyond (Walters et al. 2007; Camp et al. 2021) but remains relatively rare for inshore/estuarine zones. Here we summarize some of the known cases where spatial closures or spatially differentiated regulations were implemented and describe what effects these appear to have on some key fishery metrics, including fish abundance, catch rates, and potentially fishing effort.

- **Stevens and Sulak (2001)—Merritt Island National Wildlife Refuge.** This tagging study evaluated fish immigration from a closed area around Kennedy Space Center. Researchers tagged 3,358 total fish, including red drum, spotted seatrout, black drum, and common snook. They found that tagged fish showed limited movement out of the closed area and were only occasionally captured by anglers in adjoining waters. The study concluded that the closed area effectively protected fish populations within the closed area and provided some influx of fish into the open-access zone adjacent to the refuge area. The work emphasized that, for estuarine fishes with relatively small home ranges, protected areas can effectively limit fishing mortality while providing some recruitment of fish into adjacent open-access areas.
- **Bohnsack (2011)—**This study evaluated catches of world-record-sized game fish in proximity to closed areas around Cape Canaveral and Everglades National Park. Catches of world-record-sized sport fish, including spotted seatrout, red drum, and black drum, increased, particularly around the Cape Canaveral closed area. Overall, the study found that both closed areas increased the size and catch per effort of sport fish in open-access areas adjacent to the closed areas.
- **Guidetti and Claudet (2010)—**This study evaluated fish catch rates around an MPA that was previously closed and then partially reopened under regulated co-management of the fishery in the Mediterranean Sea. The 2,227-ha MPA was closed in 1991 and underwent a limited opening from 2000–2005. After a managed reopening, Guidetti and Claudet found that fisher catch rates initially declined then stabilized at levels that were double the catch rates of adjacent, fully opened areas.

They concluded that co-management could achieve conservation targets and fishery management goals to alleviate overfishing.

- **Hilborn et al. (2004)—**This synthesis paper evaluated the conditions under which marine reserves can provide improved fishery management. The authors concluded that for fisheries that are multi-species and include fish with relatively small home ranges, the use of marine reserves has advantages over traditional bag/size limits. They noted that success is highly case-specific and stressed that understanding the spatial structure of the habitat and fish movement rates are key to success. They further pointed out that this management strategy requires systematic monitoring to be effective.
- **Callum et al. (2001)—**This study evaluated a series of marine reserves in Florida (Merritt Island/Cape Canaveral) and St. Lucia. The authors found that five small reserves in St. Lucia increased fish catch rates in adjacent open-access areas between 46% and 90%. They also noted increased world record catches in the Florida reserve. They concluded that marine reserves could be a key component of successful fishery management.
- **Lester et al. (2009)—**This synthesis paper showed that increases in fish biomass, abundance, and species richness were common among marine reserves and were not an artifact of reserves being focused on the best habitat. Small reserves showed significant localized benefits. The authors concluded that well-designed and enforced reserves can be important conservation and management tools.

These examples suggest that marine reserves can realize benefits in terms of fish abundance, size structure, and biomass. However, as the Hilborn et al. (2004) work suggests, the effects of reserves on regional fishing effort dynamics remain a fundamental uncertainty that will ultimately influence the outcome for management. When read in concert with the North American freshwater examples that were focused on mostly harvest regulations, we can conclude that it is not easy to predict what will happen when new regulations are imposed.

A Hypothetical Application of Spatial Fisheries Management: St. Martins Keys, Florida

Background on St. Martins Marsh Aquatic Preserve

St. Martins Marsh Aquatic Preserve (SMMAP) is located in the nearshore waters of Citrus County, Florida, between Crystal River to the north and the Homosassa River to the south. Renowned for its shallow, clear water and verdant seagrass flats, the area has long provided world-class sight-fishing opportunities to anglers (Figure 1). The fishing opportunities are especially important for supporting for-hire fishing captains who guide clients through these flats in pursuit of red drum, spotted seatrout, tarpon, and, increasingly, snook. Thus, recreational fishing by locals and visitors alike represents an important sector of the local and regional economy. But recent increases in both fishing effort and boat traffic threaten to upset this socioecological system. This system's long-term socio-economic, ecological, and environmental sustainability requires management actions that preserve habitat and sustain fish populations.

Figure 1. The aquatic vegetation around the SMMAP promotes a world-class shallow-water sight fishery for red drum and other species.
Credits: Ed Camp, UF/IFAS

In the SMMAP, particular concern exists for damage to seagrass from boat and prop scarring (Figure 2), especially since such scarring often leads to larger-scale losses or declines in seagrass (Whitfield et al. 2002). Past work in the region shows that educational approaches and non-regulatory waterway markers produce either minimal or very modest results when addressing propeller scar damage. Reducing prop scarring is a specific goal within the SMMAP management plan (FDEP 2017) and has some local support (Barry et al. 2020). Specifically, local stakeholders have expressed interest in exploring the potential for alternative management approaches to address these concerns. Managers in the SMMAP have maintained an active partnership with UF and local environmental groups to explore approaches for propeller scar reduction and prevention, including mapping, restoration, educational campaigns, and informational (non-regulatory) marked zones (Barry et al. 2020). Given the minimal to modest outcomes from past efforts (Barry et al. 2020), it is possible that more innovative approaches to the management of boating impacts to seagrasses and other habitats are needed. Innovative management could include spatially limited areas where strategies such as pole-and-troll zones or trophy fishing areas, approaches employed elsewhere in Florida, could be implemented. Additional or alternative approaches could include harvest limitations, potentially even including mandatory catch-and-release fishing for certain species within the SMMAP or within spatially defined areas within the SMMAP. Below we apply the information discussed above to consider what regulations like this *might* mean for the local area.

Figure 2. Prop scars that damage the sea grass are visible as lighter lines off of an island popular with recreational anglers in the SMMAP.
Credits: Mark Clark, UF/IFAS

Ways in Which SMMAP Might Be Affected by Spatially Explicit Management Changes

Initially, it might seem obvious that a no-motor zone would decrease marine fishing demand since so many Florida recreational fishers use motorized vessels to operate within the SMMAP. However, these zones can create additional opportunities. The absence of fast and loud outboards and the propeller damage and wakes they can produce, can lead to better aquatic habitat. Habitat improvement often benefits fish recruitment (Whitfield 2017; Love et al. 2022), which leads to greater catchable populations (Camp et al. 2020) (Figure 3). If the absence of in-use outboards scares fewer fish, those fish may feed more actively and possibly be more catchable (Lewin et al. 2006). Indirect effects might occur if the zone results in a better aquatic habitat, which could increase local fish abundances or densities (either by attracting fish to forage or by increasing areas for juveniles to recruit).

Further, these factors interact in several potential feedbacks (Ward et al. 2016). The initial decrease in effort could lead to greater abundances or sizes of fish available for capture (Camp et al. 2016). It's even possible that all these things combined (more and or larger fish, more actively feeding fish, less disturbance from other anglers) could result in even more effort than was there originally. This might seem counterintuitive, but it is possible based on the examples listed above. A no-motor zone might mean more fishers could effectively fish an area since each would not disturb fish as much and would allow for greater numbers of boats to use an area before it "fishes" like it's overcrowded. The potential result of greater fishing effort from restrictions on how people operate their boats is far from guaranteed. There would certainly be people who would dislike it—people whose satisfaction utility would decrease. It is possible (but far from proven) that this loss of satisfaction might be compensated to some extent by others who might prefer this type of managed system. For example, anglers with larger vessels might visit the area less. In contrast, others with smaller vessels more easily controlled via trolling motor or push pole might be attracted to this area.

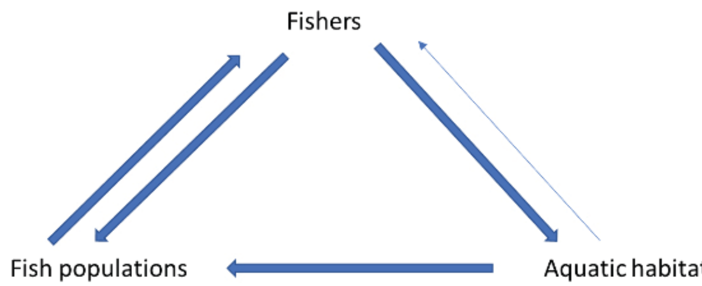

Figure 3. A very simple conceptual model for how fishers, fish populations, and aquatic habitat are related. Fishers affect fish populations (often via harvest or discard mortality) but also fisher behavior is affected by the abundance of fish populations. Fishers can also affect aquatic habitat, sometimes by damaging it with their vessels. Aquatic habitat affects fish populations, often via recruitment processes. Habitat effects on fish populations then affect fishers. Therefore, aquatic habitat can directly affect fishers, especially if fishers have strong aesthetic preferences, but these are not often considered to be as strong as the other effects shown.
Credits: Ed Camp, UF/IFAS

The point of this discussion is that perfectly predicting the effects of a spatial gear restriction like a pole and troll zone is not possible. Better predictions about the overall ecological and socioeconomic effects could be made by using quantitative models and surveys to assess a specific fishery in this example, if there was interest in a no-motor zone, it would be useful for managers to ensure they get a representative understanding of local and non-local stakeholders. This could include listening sessions initially, which could then be followed up with qualitative and quantitative surveys to assess how fishers might respond to new restrictions. Scientists would use these data to build models representing anglers and fish to predict plausible outcomes. Finally, if initial research suggests a favorable outcome is plausible, it can be tested by an experiment (Walters et al. 2007). This could be done as a time-limited measure—such as imposing a 2-year pole and troll and evaluating effects with careful monitoring. Monitoring of habitat, fish, and fishers should take place before, during, and after the experimental management intervention. Ideally, some monitoring would also take place in at least one adjacent region. This could either act as a control (to account for changes over time, like in the cost of vessel fuel, that might effect changes to the studied region independent of the studied management strategy), or to monitor for spillover effects (e.g., a redirection of boating activity) to other regions. Experimentally creating diverse angling experiences would help managers to make better-informed decisions about how to manage recreational fisheries and the ecosystems in which they exist (van Poorten and Camp 2019).

Conclusions

While there are many unknowns, there are some things we can conclude with reasonable certainty about potential management changes to SMMAP:

1. It is impossible to make a confident prediction about how altering harvest or vessel operation regulations around the St. Martins Keys would affect fishing effort in Citrus County—at least without more research. This uncertainty must be recognized, but it is fair to say that such restrictions will not automatically reduce fishing effort. The response would need to be measured to quantify impacts.

2. The uncertainty could be reduced through targeted human dimensions work (focus groups and broader surveys) as well as through active adaptive management approaches (Walters and Martell 2004).

3. Changes in the total effort are not likely to be extreme because recreational fishery feedback processes tend to moderate the response over time. Initially greater effort should lead to lower catch and, eventually, decreased effort. Initially lesser effort should decrease fishing-related mortality and eventually lead to greater catch rates, which could in turn, increase effort.

4. Effort is not the only metric that matters. Increasingly, habitats important to fish like seagrasses or oyster reefs are understood to be sensitive and capable of collapsing, sometimes suddenly (Connell et al. 2017). Restrictions on outboard motor use in some areas could improve seagrass habitats, which would be expected to influence socioeconomic and ecological aspects of the ecosystem and the fisheries that depend on it.

Summary

Spatially explicit management approaches that change the allowable harvest or the type of access to certain fishing areas are often expected to affect fishing effort strongly. However, the total outcome of these actions is not always obvious, and sometimes the same type of restriction can cause directionally opposite responses. For example, more harvest restrictions have resulted in both greater and lesser effort, depending on the fishery. Research on past projects suggests changes in effort from area-based no-motor or pole-and-troll zones are unclear, but these restrictions tend to increase local fish populations. Because these spatial closures or gear restrictions are often small, it is likely effort would redistribute to adjacent areas within the same region (which would not affect market activity). While it is possible that restrictions could trigger spill-over effects (increased fish abundance) that benefit a broader area, these effects cannot be assumed. The hypothetical case study in the St. Martins Marsh Aquatic Preserve illustrates how difficult it is to say anything definitive about how fishing effort would be affected by a management change; it highlights the need for either (1) situations where there is a broad range of acceptable outcomes, or (2) situations where there is a more limited range of accepted outcomes, but research has been applied to reduce uncertainty. In short, decision-makers should either be comfortable with not knowing or invest the resources and time necessary to know.

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