

## THE NET BUYBACK AND BAN IN ST. CROIX, U.S. VIRGIN ISLANDS

Juan J. Agar<sup>1</sup>

<sup>a</sup> Southeast Fisheries Science Center

NOAA Fisheries Service

Miami, Florida

Flavia Tonioli

Department of Marine Ecosystems and Society

University of Miami (RSMAS)

Miami, Florida

Chloe Fleming

National Centers for Coastal Ocean Science

NOAA Fisheries Service

Hollings Marine Laboratory

Charleston, South Carolina

<sup>1</sup> Corresponding author

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## **Abstract**

The gill and trammel net ban and buyback were two of the most politically sensitive management reforms in St. Croix, U.S. Virgin Islands. The purpose of the net ban was to protect parrotfish populations, reduce by-catch, and minimize gear-habitat interactions whereas the aim of the buyback was to mitigate the economic hardship imposed by the ban. This paper describes the development of the net fishery and management efforts to protect parrotfish populations and coral reef habitats focusing on the performance of the ban and buyback. The study drew from 43 in-person interviews with select user groups and secondary sources such as government reports and databases.

Our analysis suggests that these reforms had limited success. While local fishery managers promoted a participatory approach, shifting policy directives, implementation delays, limited buyback assistance, and high forgone earnings had unforeseen consequences. Most net fishermen substituted the banned nets with ‘modified’ small mesh seine nets, which were opposed by most stakeholders since they felt that their use defeated the purpose of the ban. The study also found that, with the exception of curtailing the dumping of spoiled fish on land, conflicting views about the health of parrotfish and surgeonfish stocks, excessive by-catch levels, and damaging gear-habitat interactions remained. Most net fishermen believed that the ban had advanced resource conservation; however, other stakeholders had more guarded or skeptical views. The Crucian experience with these reforms suggests that incentive-based regulatory approaches deserve greater attention as a means to improve management outcomes and minimize distrust in the management process.

Key words: Net, buyback, ban, St. Croix, socio-economic, regulatory reform.

## 1. Introduction

The rapid expansion of the gill and trammel net (net) fishery in St. Croix, U.S. Virgin Islands raised substantial concern because it threatened parrotfish populations, generated excessive by-catch, and damaged coral reef habitats (Tobias 2004; Kojis 2004; Toller and Tobias 2007). Healthy parrotfish populations are critical components of coral reef resilience since they are important grazers of macroalgae in reef habitats. Dwindling parrotfish populations have been linked to increased algal cover on reefs, which limits the settlement and survival of coral recruits (Hughes 1994; Mumby 2006; Burkepille and Hay 2010).

In St. Croix, parrotfish populations became vulnerable to overexploitation because fishermen developed a unique and effective harvesting technique where divers placed their bottom tending nets in areas where parrotfish would migrate from their diurnal foraging grounds to nocturnal resting grounds (Toller and Tobias 2007). Because nets were attached to hard bottom habitats, gilled or entangled parrotfishes (and surgeonfishes) were not able to lift the nets, which would have allowed the rest of the school to escape underneath. Divers would also steer schools of fish into the nets. Nets endangered parrotfish populations because a single net could remove an entire breeding school. Nets also generated considerable by-catch since they have limited selectivity. Besides catching large numbers of spawning parrotfish, nets incidentally caught butterfly fishes, coastal sharks, small grunts, and surgeonfishes, as well as entangled threatened and endangered species including sea turtles. Fishermen claimed that they released entangled turtles; however, net by-catch, including sea turtles were found in trash dumpsters (Toller and Tobias, 2007). Most fishermen would not release live, unwanted fish at sea but rather sort their catch from the nets once they returned to shore or to their homes (Toller and Tobias 2007). In addition, there have been accounts of nets passively ‘ghost fishing,’ as well as

uprooting corals, gorgonids, sponges, and other sessile organisms (Tobias 2004; Toller and Tobias 2007).

In the wake of these growing concerns, the U.S. Virgin Islands' Department of Planning and Natural Resources (DPNR) banned the use of nets in St. Croix in May 2008. It also implemented a net buyback program to mitigate the economic hardship caused by the ban. This study examines the biological and socio-economic performance of the net buyback and ban from the perspective of the various actors involved in the process. The evaluation of the perceptions of stakeholders can be an insightful evaluation tool since it can help identify policy shortcomings, impediments, and opportunities. Conflicting perceptions may indicate the need to adjust the scale and scope of earlier interventions, improve their delivery, or halt them completely (Marshall 2007). This paper is structured as follows: Section 2 provides an overview of the Crucian net fishery, Section 3 introduces the methodology employed, Section 4 summarizes the main results from the interviews, and Section 5 offers the main conclusions of this study.

## **2. Rise and Fall of the Net Fishery**

The use of nets rose rapidly in the late 1980's after severe storms and hurricanes hit St. Croix and disrupted many fisheries, especially the trap fishery (Tobias 2004; Toller and Tobias 2007). Fishermen turned to nets because they could not secure federal funds to replace their lost traps, and feared incurring additional losses. Nets became popular because they could be brought back after each fishing trip without fishers worrying about dangerous weather conditions, theft, and poaching. Net usage further expanded when Florida gear suppliers started marketing their surplus nets following the 1995 Florida net ban (Toller and Tobias 2007). Once local fishermen mastered diver-assisted net fishing, this effective fishing method soon out-competed other

fishing gear (Toller and Tobias 2007). Between the 1990/91 and 2002/03 fishing seasons, the share of reef fish species (i.e., parrotfish and surgeonfish) taken by nets increased from 11% to 57% (Tobias 2004). In contrast, the share of reef fish taken by traps fell from 89% to 43% during the same period. Reportedly, many longtime trap fishers were put out of business by overharvesting by net fishermen.

The growing harvesting pressure on parrotfish populations eventually began to be viewed with increased trepidation by commercial fishermen, charter/dive operators, and environmental groups, many of whom demanded increased regulation (Gordon and Uwate 2003; Kojis 2004; Messineo and Uwate 2004). In addition, accounts of wasteful disposal of unsold and spoiled fish along roadsides, beaches, collection bins, and in the Anguilla landfill troubled the general public. Toller and Tobias (2007) reported that sluggish sales were responsible for this situation. Parrotfish reportedly begins to spoil after two days. The intentional dumping or discarding of fish, locally known as ‘wanton waste,’ is prohibited in the U.S. Virgin Islands (Toller and Tobias 2007).

In October 2002, the St. Croix Fishery Advisory Committee (FAC) redressed these concerns by proposing a gill and trammel net ban. FACs are responsible for making management recommendations to local authorities. The FAC membership includes representatives of commercial, sport fishing, and diving interests. The DFW is not a member of the FAC, but serves as an advisor to the committee (Toller and Tobias, 2007). The St. Croix FAC believed that it would be the most effective and easily enforceable management option (Toller and Tobias 2007).<sup>1</sup> It also proposed a one-time net buyback to assist displaced fishermen (Uwate and Tobias 2005; Niesten and Gjertsen 2010). Following FAC recommendations, the U.S. Virgin Islands

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<sup>1</sup> One reviewer noted that the net ban was originally proposed by a net fisherman at an FAC meeting. The net fisherman, who was a committee member, proposed the ban because he perceived that nets were adversely impacting parrotfish populations.

Division of Fish and Wildlife (DFW), a division of the DPNR, held several meetings dealing with the proposed ban, which gave added impetus to a net buyback. Subsequently, the DFW was awarded a \$75,000 grant from the National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program to assist with the buyback. Out of this amount, DFW spent about \$55,000 to purchase nets, and the remaining funds went to administering the grant itself (26% administrative overhead).

Despite the available funds and numerous meetings, progress remained slow until Governor Charles W. Turnbull requested public hearings to be convened in 2005. The meetings were to assist in finalizing legislation (Gjertsen 2009). On January 19, 2005 a public hearing was held to collect public comment and testimony on the proposed ban and buyback. During the public hearing, net fishermen objected to the proposed ban because it would impose an undue financial hardship on their families, their crew, and fishing-related businesses, and instead proposed replacing the ban with a closure regime that included weekly, seasonal, and area closures (Toller and Tobias, 2007).

After deliberating the merits of the closure proposal, the FAC upheld the ban because it believed that the closures would be insufficient to curb overfishing and difficult to enforce (Uwate and Tobias 2005; Toller and Tobias 2007). In addition, the FAC supposedly continued to support the ban because they were concerned that the Caribbean Fishery Management Council (CFMC) would implement additional area and/or seasonal closures in St. Croix, especially in Lang Bank, which would have impacted large numbers of fishermen (Figure 1). In the early 2000s, the CFMC was considering establishing large area closures to rebuild overexploited stocks, which dismayed fishermen (Kojis and Quinn 2012). Fishermen continued to be upset about the 2001 expansion of the Buck Island Reef National Monument (BIRNM), which closed

about 7.4% of St. Croix's fishable area (Karras and Agar 2009; Valdés-Pizzini et al. 2010). Unlike the island of St. Thomas, St. Croix has a small fishable area because most of the shelf area occurs within its three nautical mile territorial jurisdiction (Kojis 2004). In the end, the CFMC decided against additional area closures in St. Croix and St. Thomas/St. John with the exception of a small area closure off St. Thomas (Grammanik Bank).

In July 2006, Governor Charles W. Turnbull signed a bill prohibiting the use of nets that was to take effect on January 1, 2007 when the following administration was to take office. When Governor John P. de Jongh Jr. assumed office, however, the newly-appointed DFW director disagreed with the ban, and proposed replacing it with a limited entry program. Under the limited entry proposal developed by the new DFW director with the assistance from the St. Croix Commercial Fishermen's Association's (SCCFA), net fishermen would be granted non-transferable licenses (capped at nine), which entitled them to land up to 200,000 lbs. of fish annually using nets (about 22,000 lbs. per fisherman; Gjertsen 2009). The non-transferable licenses were to be phased out slowly to allow for an orderly exit from the fishery (Gjertsen 2009). The proposed program would also establish gear restrictions (length, height, and mesh size limits), by-catch reduction targets, a seasonal closure to protect spawning aggregations, and a penalty schedule for non-compliance (SCCFA, n.d.). One reviewer suggested that the limited entry proposal had become more agreeable to net fishers because of the prior consultative process, concerns over the CFMC's proposed regulations, and, more importantly, because the legislation enacting the net ban was on the Governor's desk ready for his signature.

The new administration delayed the enforcement of the ban and the implementation of the buyback for several months to give the new DFW director and net fishermen the opportunity to



find a senator who would sponsor legislation to overturn the ban (Gjertsen 2009).<sup>2</sup> In the meantime, on February 27, 2008 the FAC voted by a slim margin against the net ban and instead supported the limited entry (with a gradual phase-out) proposal. Despite this, Governor de Jongh upheld the ban because the DFW director and net fishermen were not able to secure senatorial support (Gjertsen 2009).<sup>3</sup> The bill prohibited the use of gill and trammel nets with the exception of surface gill nets for catching baitfish, ballyhoo, gar, and flying fish.

In May 2008, DPNR began implementing the buyback program and enforcing the ban. A month later, nine fishermen signed the net buyback memorandum of agreement. The memorandum stipulated that to qualify for buyback funds, active net fishermen should have landed at least 10,000 lbs. between the 1998/99 and 2002/03 seasons. It also stated that for every 10,000 lbs. above the initial 10,000 lbs., an additional equal share of the total buyback funds was to be allotted. Additionally, the memorandum stated that fishermen had to relinquish their nets to the Division of Environmental Enforcement (DEE), and also reminded them of the penalties for violating the ban, including a \$1,000 fine and the confiscation of vessel and equipment. All in all, net fishermen each collected between \$865 and \$16,435, depending on their reported landing history. The average and median payments were \$6,549 and \$4,325, respectively.

### **3. Data and Methods**

To understand the socio-economic impacts of the net ban and buyback, we planned to sample all 43 documented gill and trammel net fishermen (Kojis 2004); however, while conducting our fieldwork, our liaisons from the CFMC, DFW, and FAC informed us that many

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<sup>2</sup> One reviewer observed that changing recommendations midway offered some net fishermen hope that they could continue net fishing and likely increased conflict when the ban was implemented.

<sup>3</sup> One reviewer remarked that strong support for the ban from various commercial, sport fishing, and diving interests (while the limited entry proposal was being considered) made it hard for the DFW director to find a senator interested in amending the bill.

fishermen had misreported the number of nets they owned to pre-empt future regulations. Our liaisons estimated that about half of the fishermen in our sampling frame were bona fide net fishermen. Consequently, we revised our survey plan and decided to include additional stakeholders to better understand the ban and buyback process. To increase stakeholder diversity, we interviewed 17 net fishermen, 8 charter/dive operators, 6 members of environmental organizations, and 12 professionals involved in resource management, research, and/or outreach. In hindsight, the inclusion of non-net fishermen, such as displaced trap fishermen, would have provided a richer perspective.

We grouped stakeholders into four groups to facilitate the exposition of the main results. The four stakeholder groups included: all but one of the net fishermen who had participated in the buyback (8 in total; the 9<sup>th</sup> fisherman left the island), net fishermen who did not qualify for the buyback (9), resource managers (12), and charter and dive operators grouped with members of environmental groups (14). Resource managers, charter/dive operators, and members of environmental groups were surveyed opportunistically based on the recommendations of our liaisons. We aggregated the opinions of charter/dive operators and members of environmental groups into a single group because of their shared views.

The survey instrument contained both open- and closed-ended questions. It elicited information about demographics, participation in the fishery, perceptions about the reasons for the buyback and ban, changes in fishing practices, and views about the biological, economic, and social impacts of the ban. In addition, the survey inquired about the efficacy of the ban protecting parrotfish populations, mitigating by-catch, and protecting coral reefs. The survey concluded by asking whether the ban had impacted fishermen's ability to support themselves and their families, generated economic hardships to the local fishing community, and reduced user

conflicts. In addition to interviews with key informants, our work drew from government reports and databases to contextualize our findings. The fieldwork took place in July 2012.

## **4. Results and Discussion**

### **4.1. Views about socio-economic impacts of the buyback**

Most net fishermen were dissatisfied with the buyback process because payouts were neither adequate to purchase gear to enter other fisheries, nor sufficient to counteract their lost income (Table 1). The intended purpose of the buyback funds, however, was not to compensate fishermen for the entirety of their forgone earnings, but instead to assist them in transitioning to other gear or livelihoods (Gjertsen 2009). Additionally, after six years of deliberations facing renewed demands to protect parrotfish populations and reduce by-catch, DPNR could no longer delay implementation of the ban while waiting for additional funds to become available for compensation. DFW is entirely supported by the federal government, with approximately 85% of its funds coming from U.S. Fish and Wildlife and the remainder from NOAA (Gjertsen 2009).

Net fishermen indicated that reasonable payments should have been in the \$25,000 to \$50,000 range, which was significantly larger than the average sum paid (\$6,549; range \$865-\$16,435). One fisherman explained that the purchase of new gear alone would set them back about \$30,000, considering that current management proposals wanted to establish a 150-trap limit where a single trap (with ropes and buoys) retails between \$200 and \$300. The fisherman also noted that nets caught more fish and had lower upkeep costs than traps. A reviewer added that if a fisherman decided to switch from nets to rebar-framed arrowhead traps (which cost \$200-\$300 each) rather than to more affordable wooden arrowhead traps (which cost \$165 each in today's dollar; Agar et al. 2008), then the resulting costs of switching could be even higher because the heavier rebar-framed arrowhead traps may require the purchase of a trap hauler and

a larger boat. Most net fishermen said that they used their buyback payments to buy traps, SCUBA equipment (including superguns), and handlines. Only one fisherman claimed that he split part of the payment with his crew and used the rest to buy traps.

In contrast to the views of net fishermen, other stakeholders felt that the buyback and ban process had been fair because it was the result of a lengthy, consultative process (Table 1). While most stakeholder groups were reluctant to comment on the adequacy of the buyback payouts specifically because they were unfamiliar with the financial arrangements, most who opined were influenced by their personal beliefs (Table 1). For example, resource managers, who were critical about the payouts, believed that these should have covered the cost of the forfeited nets and fishermen's forgone income. On the other hand, charter/dive operators, members of environmental groups, and resource managers who believed that the compensation offered had been sufficient felt that fishermen should consider themselves fortunate for the assistance awarded. Resource managers reported that they strived to be fair by directing the available funds towards the most dependent fishermen. Moreover, resource managers remarked that net fishermen were mainly concerned over the ban because they felt that they could delay or defeat the buyback bill.

When we asked about the appropriateness of the eligibility criteria, net fishermen's views were divided (Table 1). Of those who responded, half believed that the set conditions had appropriately directed relief towards the most dependent fishermen, while others felt that every net fisherman should have qualified for assistance. Many net fishermen held that compensation payments should have been also extended to helpers and licensed fishermen (fishing for someone else), since fish dealers received buyback assistance. Purportedly, a fish dealer received buyback payments because a licensed fishermen working for him had recorded landings under his license.

We also inquired as to what could have been done differently to improve the buyback process. Net fishermen, especially those who qualified for the buyback, believed that payments should have been more substantial to secure their buy-in. They reiterated that the payments failed to cover their costs of switching to other fisheries and forgone income. Similarly, non-qualifying net fishermen restated that the assistance should have been extended to all net fishermen and their crews because they all had families to support. A few fishermen wished that DPNR had pursued their proposed limited entry program, while others suggested that the government should have provided them with new gear or at least with materials to build their own. Other recommendations included a temporary unemployment stipend and the adoption of a fairer buyback compensation formula based on a fixed amount per net, plus an additional amount based on the revenue it generated.

Resource managers offered similar ideas. In addition to recommending larger payouts, a few believed that DPNR should have adopted the limited entry program before moving forward with the ban. Others felt that the transition should have been more gradual. On the other hand, charter/dive operators and environmental groups wished that the government had shown more resolve by deciding earlier on a phase-out date to give net fishermen ample time to prepare (2-3 years). Members of the environmental community believed greater efforts should have been devoted to supporting alternative livelihoods programs. They felt that that the government should have identified additional sources of funding for the transition and/or offered training and grants to help net fishermen secure employment opportunities.

#### **4.2. Views about socio-economic impacts of the ban**

The majority of net fishermen reported that the ban had adversely impacted the bottom line of their fishing operations (Table 2). Only five of the nine buyback-qualifying net fishermen

remained owner operators. Two of the displaced owner operators told us that they fished full-time for others. The third fisherman said that he fished part-time and worked in construction, and the fourth one no longer lived on the island. In contrast, the number of non-qualifying net fishermen that remained owner operators stayed the same.

Buyback participants stated that their landings and gross revenues declined substantially notwithstanding rising parrotfish prices and changing fishing practices.<sup>4</sup> They reported that, on average, their overall landings and gross revenues per trip declined by 56% (from 368 lbs. to 161 lbs.) and 41% (from \$929 to \$550), respectively. These figures are in line with four-year pre- and post-ban averages, which showed that overall landings and revenues declined by 34% and 28%, respectively, and parrotfish landings and revenues fell by 42% and 32%, respectively (Figure 2; NMFS 2018).

These marked declines, however, were also influenced by the introduction of annual catch limits (ACLs) and accountability measures (AM) in 2010. The Magnuson Stevens Act required CFMC to implement ACLs for various species considered to be overfished or undergoing overfishing, including five popular parrotfish species. The parrotfish ACL was set at 240,000 lbs., which represented a 37% decline relative to the previous four-year average landings. Remarkably, parrotfish ACLs have never been met (ranging from 68% in 2010 to 31% in 2014; Figure 2), raising concerns that fishermen may be underreporting their actual landings so as not to exceed the ACLs and trigger AM, which would lower future ACLs.

To offset the forgone income from net fishing, fishermen reported switching to (or intensifying their use of) spearguns and traps, taking longer fishing trips, and diversifying the composition of their catch. Spearguns were favored over traps because of their lower investment

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<sup>4</sup> According to the USVI trip ticket database, average parrotfish prices rose from \$4 per pound in 2007/08 (or \$4.19 in 2012 dollars) to \$5 per pound in 2011/12. Fishermen recounted that parrotfish prices increased because of the tighter supply and higher fuel costs being passed onto customers.

and maintenance costs as well as the absence of catch and gear theft issues associated with traps. Spearguns, however, can impose greater health risks due to the potential for decompression sickness, embolism, and shark encounters (Kojis et al. 2017; Agar and Shivilani 2017). Fishermen also reported targeting more lobsters, conchs, and snappers. A few mentioned turning to handlines to fish for coastal pelagics. On average, the number of trips taken remained the same (3-4 trips/week), but trip duration slightly increased (from about 8 hours to 9 hours) because some fishermen began fishing with multiple gear (e.g., SCUBA and traps). While many fishermen rearranged their fishing practices to comply with the ban, not all did. In 2009, DEE officers arrested six fishermen (including two buyback participants) for illegally fishing with proscribed gill nets (St. Croix Source 2009; Gjertsen 2009). In 2010, an endangered Hawksbill sea turtle was found dead in an illegal gill net (Shea 2010).

An unintended consequence of the ban was the emergence of a contentious fishing practice known as ‘fish bagging.’ Because the legislation only prohibited the use of gill and trammel nets, fishermen exploited a loophole which allowed them to use small mesh nets that did not gill or entangle fish. Fishermen started using a ‘modified’ (¼-inch mesh size) seine net (300-400 ft. long x 6-14 ft. deep).<sup>5</sup> Analogous to the proscribed fishing practice, ‘fish bagging’ has divers steer parrotfish and surgeonfish into a circular bag at one end of the net. Once fish enter the bag, the bag is closed and a diver removes it from the net and transports it to the boat (USVI DFW 2010). This fishing practice reportedly yields about \$750 per trip. Despite FAC petitions to close this loophole, the use of the ‘modified’ seine nets remains legal.

Most resource managers agreed that the ban had harmed fishermen’s earnings, at least initially. They reasoned that if the replacement gear had delivered comparable benefits, then

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<sup>5</sup> Kojis (2004) reported that trammel nets ranged from 200-1000 ft. in length and 4-8 ft. in height (3-3.5 in. mesh size), and that gillnets ranged from 90-1000 ft. in length and 3-12 ft. in height (1.3-3.5 in. mesh size).

fishermen would have not ‘fish bagged’ nor (some of them) continued to fish illegally with the banned nets. Similarly, a majority of charter/dive operators and members of the environmental groups believed that the ban had adversely impacted profits, especially early on; however, they also believed that past landings and earnings were unsustainable.

Net fishermen reported having greater difficulty supporting themselves and their families after the ban. They held that the meager payouts and their limited financial resources prevented them from purchasing materials (e.g., wire, ropes, buoys) and fishing equipment (e.g., spearguns, SCUBA) to remain in business. Moreover, many said that they already held loans on their houses, trucks, and boats. A number of fishermen mentioned that running their operation had become more expensive because they had to venture farther out to sea. Only a couple of buyback participants reported building up their landings to pre-ban levels. To help mitigate fishermen hardship, DPNR partnered with The Nature Conservancy to provide alternate livelihoods training (e.g., interpretive ranger, captain licensing) following the ban. Despite this initiative, no fishers took advantage of these livelihoods programs, likely due to literacy and language barriers, or perhaps because these opportunities would not afford the same earnings and lifestyle provided by fishing (Niesten and Gjertsen 2010). Net fishermen reportedly earned between \$40,000 and \$80,000 per year (Lohr 2007).

Charter/dive operators, members of environmental groups, and to a lesser extent, resource managers doubted that the ban had severely impacted fishermen’s livelihoods. They believed that any hardships were short-lived due to their resilient nature. Moreover, they noted that many fished on a part-time basis, and that pre-ban harvesting practices were both biologically and economically unsustainable. In contrast, a small group of resource managers, who were more



sympathetic towards fishermen, believed that the ban had pushed net fishermen to break the rules, and viewed the forgone limited entry program as a missed opportunity.

When we asked net fishermen how the ban had affected the local community, they mentioned that fishing-related employment and remuneration had declined. Though they could not quantify net losses because their crew (and other helpers) also engaged in odd-jobs, they remarked that the average net operation employed between four and seven crew members and helpers (e.g., net menders and onshore helpers), excluding the captain. Onshore helpers are responsible for picking fish from the nets and sorting them into coolers for sale the following day (Tobias 2004). Net fishermen also reported that the average fish trap or spearfishing operation employed between one and two crew members (excluding the captain). Crew employment figures were consistent with those reported elsewhere (Kojis, 2004; Toller and Tobias, 2007; Agar et al., 2008). One of the reviewers commented that most crew members of net operations tended to work on a part-time basis because they fished twice a week whereas most crew members of spearfishing operations tended to work on a full-time basis because they fished 4-5 times a week. Higher-volume net operations fished less often than (lower-volume) spearfishing operations because they were concerned about flooding local markets. Net fishermen also mentioned that the lower supply of parrotfish affected restaurants and tackle shops.

Resource managers had conflicting views on the impact to the local community. About half of them believed that the ban resulted in fewer employment alternatives for crew and fish cleaners, while the other half felt that impacts were minimal and short-lived because they were concentrated on few fishermen. Some contended that the ban had been positive for the community because more fish became available to other fishermen. Most charter/dive operators and members of environmental groups believed that community impacts were negligible.

When we probed whether the net prohibition had lessened user conflicts, most net fishermen believed that tensions had stayed the same (Table 3). They perceived that resource users were still quarreling, and other resource users, especially recreational divers, ‘had to learn to share the resource.’ Nonetheless, a small group of net fishermen conceded that tensions with the wider fishing community had eased. Most fishermen who did not use nets, supported the ban because they felt that net fishermen were taking ‘too much fish’ (Kojis 2004; Kojis and Quinn 2012). Resource managers acknowledged that some progress had been made; however, they were concerned about the use of the ‘modified’ seine nets, which is widely perceived as a means to circumvent the ban. The use of the ‘modified’ seine nets was strongly opposed by the other stakeholders as well.

One of the factors that precipitated the ban was public outrage over the illegal dumping of finfish, turtles, corals, and other invertebrates on land (Duval 2003; Toller and Tobias 2007). Most net fishermen believed that this issue had been resolved because landings had declined and they were taking measures to minimize by-catch.<sup>6</sup> While resource managers tended to agree that this practice waned due to lower catches, they also credited fishermen’s increased mindfulness that dumping unsettled residents. DEE officials reported that they had not received wanton waste complaints since the ban took place. One resource manager suggested that most of the dumping had been caused by an inexperienced fisherman who disposed of his unsold fish rather than giving it away; however, Toller and Tobias (2007) reported that the dumping of spoiled fish tended to take place when large catches overwhelmed fishermen’s processing and marketing capabilities. The majority of the charter/dive operators and members of environmental groups were uncertain about the impact of the ban on dumping; however, those who voiced an opinion

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<sup>6</sup> Table 3 gives the impression that net fishermen had mixed views about the impact of the ban on dumping; however, the perceived mismatch arises because dissenting fishermen never believed that there was a wanton waste problem to begin with. Hence, they questioned the efficacy of the ban.

believed that dumping had declined due to the lower landings and the absence of wanton waste complaints.

### **4.3. Views about biological impacts of the ban**

The survey found differing opinions about the ability of the ban to protect parrotfish populations (Table 4). Overwhelmingly, net fishermen held more favorable views about the health of parrotfish stocks than the other stakeholders. Most net fishermen believed that parrotfish stocks had improved due to the reduced fishing pressure and the lower productivity of spearguns and traps relative to the proscribed nets. Several net fishermen claimed that they witnessed more parrotfish after the ban. In contrast, some fishermen who held critical opinions believed that the ban had been unnecessary because there were ‘plenty of fish prior to it.’ Moreover, they stated that parrotfish abundances had not changed. Only one net fisherman conceded that parrotfish populations needed a ‘break to be able to spawn.’

In contrast to net fishermen, resource managers were more guarded about their views. The majority felt uneasy voicing an opinion due to on-going biological monitoring; however, a few stated that the lower fishing pressure was likely restoring parrotfish populations and improving the size-structure of the population. Because parrotfish switch gender (from females to males) during their lifespan, the chronic removal of large individuals can have significant impacts on their reproductive output (Hawkins and Roberts 2003; Vallès and Oxenford 2014). Fish surveys off the northeast coast of St. Croix did not find significant changes in parrotfish abundance following the ban (Pittman et al. 2008; NOAA 2013; Pittman et al. 2014).

Most charter/dive operators and members of environmental groups perceived no or very slight changes in parrotfish abundance; however, they recognized that the recovery would be slow. Most believed that parrotfish stocks continued to be overfished as evidenced by the

continued presence of small-sized parrotfish and reports of continuing net fishing. This stakeholder group was also concerned over the absence of biological monitoring and the government's limited enforcement capabilities. During the interviews with this stakeholder group, it became evident that some of them were unaware that net fishermen could legally fish with the 'modified' seine nets.

Most stakeholder groups believed that the ban had helped reduce the incidental take of species like butterfly fishes, coastal sharks, small grunts, and surgeonfishes. Net fishermen and resource managers alike felt that the ban had mitigated by-catch because there were fewer nets in the water. Net fishermen also claimed that traps, spearguns, and the 'modified' seine nets were more selective, and that the design of the 'modified' seine nets made it easier to release undesired fish; however, this claim was not corroborated by the DPNR. A majority of charter/dive operators and members of environmental groups also believed that the ban had helped reduce by-catch. One dive operator reported observing higher numbers of turtles and blue tangs following the ban. In contrast, a few resource managers, charter/dive operators, and members of environmental groups expressed disbelief about the ability of the 'modified' seine nets to reduce by-catch.

The survey concluded by asking about the impact of the ban on coral reefs. Generally, net fishermen argued that the ban had not protected corals reefs because their nets did not interact with reefs to begin with. They stated that they never placed their nets over coral reefs to avoid entanglement, and instead blamed hurricanes for the condition of local coral reefs. They conceded, however, that the prohibition of bottom tending nets and the use of 'modified' seine nets may have reduced gear-habitat interactions. Resource managers were divided about the impact of the ban on coral reefs. About one-third of them believed that the ban had been

ineffective because the use of ‘modified’ seine nets continued to threaten coral reefs. Another third felt it had been somewhat useful because there were fewer nets in the water, and the remaining one third was unsure as to its impacts. Charter/dive operators and members of environmental groups thought that the ban had been a first positive step towards the protection of coral reef habitats; however, they believed that additional efforts addressing other anthropogenic threats (e.g., land-based pollution, climate change) were needed.

## 5. Conclusions

The gill and trammel net ban and buyback were two of the most politically sensitive fishery management reforms in St. Croix, U.S. Virgin Islands. Our study found conflicting opinions about their efficacy, suggesting that these reforms had mixed success. With the exception of curtailing the dumping of spoiled fish on land, concerns about the health of parrotfish and surgeonfish stocks, excessive by-catch levels, and damaging gear-habitat interactions remained because net fishermen substituted the banned nets with ‘modified’ small mesh seine nets. Net fishermen reported that buyback payouts did not ease the burden of the ban.

The study also found that perceptions about buyback and ban process varied by stakeholder group. People tend to evaluate management processes not only based on the fairness of the outcome (outcome fairness), but also based on the fairness of the process that leads to that outcome (process fairness; Lind and Tyler 1988; Kuperan and Sutinen 1998; Smith and McDonough 2001; Nielsen 2003). Processes are perceived to be fair if they meet procedural rules (Jentoft 1989). Net fishermen felt that the buyback process had been unfair because the financial support afforded was insufficient to transition to other fisheries and to compensate for their forgone income. They also believed that the ban had been unfair because they and their crew bore the brunt of the reform costs. On the other hand, most resource managers, charter/dive

operators, and members of environmental groups held the opposite position. These groups viewed the buyback and ban process more favorably because they felt it was the result of a long, consultative process; however, they remained unconvinced about the ability of these reforms to meet their objectives.

Although it is hard to foresee the best path for reforming the net fishery to protect parrotfish populations, reduce by-catch, and minimize impacts to benthic habitats, perhaps one option would be to reconsider the early limited entry proposal supported by the net fishermen. Under this proposal, net fishermen would be allowed to fish on a restricted basis with nets being phased out as fishermen retire or after a transition period.<sup>7</sup> Acheson (2006) observes that user groups are more likely to support and enforce rules that they design, especially if these rules are believed to be effective, congruent with the local culture, and impose low costs. In addition, incentive-based mechanisms, such as the limited entry proposal, may be preferable because they tend to align fishermen's long-term interests with conservation needs (Grafton et al. 2006; Agar et al. 2014). The assignment of individual non-transferable quotas among a small group of fishermen is expected to encourage them to bear the full costs and benefits of their actions and comply with the rules (Grafton et al. 2006). If harvesting rates continued to exceed the reproductive potential of the stocks due to regulatory circumvention, then quotas would eventually be reduced (Hatcher and Gordon 2005; Hauck 2008). On the other hand, if stocks rebounded, quotas could be increased, and fishermen would reap the benefits of sound stewardship.

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<sup>7</sup> Revising or developing new management arrangements will require suitable socio-economic data to assess the ramifications of the various management options, including determining the size of the affected population, costs and benefits of the various management alternatives, and the acceptability of the various proposals to current net fishermen, as well as (non-net) commercial fishing, recreational, and diving interests.

Moving forward, fishery managers and net fishermen must work together to find renewed means to reconcile conservation requirements with the economic and social needs of the main user groups; otherwise current fishing practices have the potential to alter the local ecosystem in profound ways and increase tensions among groups. Moreover, the credibility of the management process may be questioned and regulation adherence may be diminished. An active and engaged leadership is necessary to address this on-going management issue. Strong leadership has been shown to play an important role in activating latent social capital (Bodin and Crona 2008; Crona et al. 2016). Social capital, or the functioning of social ties that facilitate cooperation within and between communities, has been reported to lead to increased compliance, higher economic returns, lower management costs, improved resource sustainability, and may help foster perceptions of process fairness (Dyer and Poggie 2000; Grafton 2005; Holland et al. 2013). Irrespective of the management arrangement, pursued management decisions must be grounded in sound and timely data. Management decisions must be supported by appropriate research and data collections that permit the periodic evaluation of the condition of parrotfish stocks as well as the impact of fishing practices on by-catch and habitat.

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Table 1: Perceptions about the buyback process.

Beliefs about the performance of the buyback	Stakeholder group	Responses (%)			N
		Yes	No	DK/NA	
Was the buyback process fair?	Net fishermen (qualifying) <sup>1</sup>	-	100.0	-	8
	Net fishermen (non-qualifying)	33.3	66.7	-	9
	Resource managers	41.7	33.3	25.0	12
	Charter, dive, and env. groups	57.1	-	42.9	14
Was 'right' group bought out?	Net fishermen (qualifying)	37.5	37.5	25.0	8
	Net fishermen (non-qualifying)	44.4	44.4	11.1	9
	Resource managers	58.3	16.7	25.0	12
	Charter, dive, and env. groups	28.6	-	71.4	14
Were buyback payments sufficient?	Net fishermen (qualifying)	-	100.0	-	8
	Net fishermen (non-qualifying)	11.1	77.8	11.1	9
	Resource managers	25.0	33.3	41.7	12
	Charter, dive, and env. groups	42.9	-	57.1	14

<sup>1</sup> Qualifying net fishermen refers to those fishermen who received buyback compensation, whereas non-qualifying net fishermen refers to those who were not eligible to these payments.

Table 2: Perceptions about the socio-economic performance of the buyback and ban.

Beliefs about socio-economic performance	Stakeholder group	Responses						
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	DK/NA	N
Adversely impacted profitability	Net fishermen (qualifying) <sup>1</sup>	75.0	25.0	-	-	-	-	8
	Net fishermen (non-qualifying)	66.7	11.1	11.1	-	-	11.1	9
	Resource managers	33.3	41.7	-	8.3	-	16.7	12
	Charter, dive, and env. groups	7.1	42.9		14.3	14.3	21.4	14
Adversely impacted ability to support themselves and families	Net fishermen (qualifying)	62.5	25.0	-	-	-	12.5	8
	Net fishermen (non-qualifying)	55.6	11.1	33.3	-	-	-	9
	Resource managers	8.3	33.3	-	33.3	16.7	8.3	12
	Charter, dive, and env. groups	-	14.3	-	50.0	7.1	28.6	14
Generated hardships to the local fishing community	Net fishermen (qualifying)	75.0	12.5	-	12.5	-	-	8
	Net fishermen (non-qualifying)	55.6	22.2	22.2	-	-	-	9
	Resource managers	16.7	25.0	-	25.0	16.7	16.7	12
	Charter, dive, and env. groups	-	28.6	-	28.6	28.6	14.3	14
Buyback eased transition to other gear and/or livelihoods	Net fishermen (qualifying)	-	-	-	-	100.0	-	8
	Net fishermen (non-qualifying)	11.1	22.2	-	11.1	44.4	11.1	9
	Resource managers	-	33.3	8.3	33.3	8.3	16.7	12
	Charter, dive, and env. groups	7.1	35.7	-	28.6	-	28.6	14

<sup>1</sup> Qualifying net fishermen refers to those fishermen who received buyback compensation, whereas non-qualifying net fishermen refers to those who were not eligible to these payments.



Table 3: Perceptions about the socio-economic performance of the net ban.

Perceptions about socio-economic performance	Stakeholder group	Responses						N
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	DK/NA	
Reduced user conflicts	Net fishermen (qualifying)	-	37.5	50.0	12.5	-	-	8
	Net fishermen (non-qualifying)	-	22.2	77.8	-	-	-	9
	Resource managers	8.3	33.3	8.33	41.7	8.3	-	12
	Charter, dive, and env. groups	-	35.7	7.1	42.9	7.1	7.1	14
Reduced dumping of by-catch	Net fishermen (qualifying) <sup>1</sup>	25.0	25.0	-	37.5	-	12.5	8
	Net fishermen (non-qualifying)	-	55.6	-	11.1	-	33.3	9
	Resource managers	16.7	58.8	8.3	-	-	16.7	12
	Charter, dive, and env. groups	21.4	14.3	7.1	-	14.3	42.9	14
Impacted parrotfish market	Net fishermen (qualifying)	37.5	50.0	12.5	-	-	-	8
	Net fishermen (non-qualifying)	22.2	44.4	33.3	-	-	-	9
	Resource managers	8.3	16.7	16.7	8.3	-	50.0	12
	Charter, dive, and env. groups	-	-	21.4	7.1	-	71.4	14

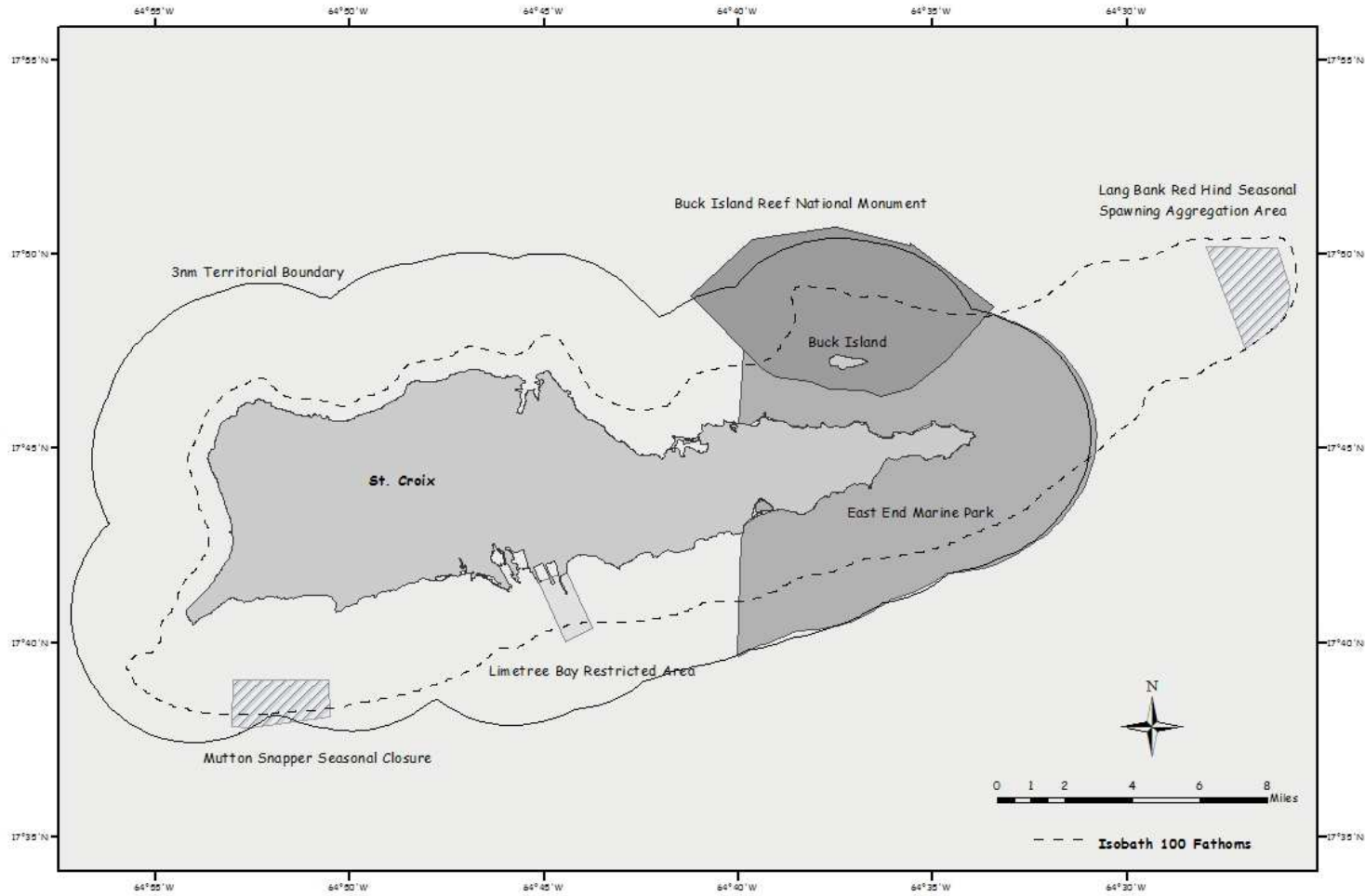
<sup>1</sup> Qualifying net fishermen refers to those fishermen who received buyback compensation whereas non-qualifying net fishermen refers to those who were not eligible to these payments.

Table 4: Perceptions about the biological performance of the net ban.

Perceptions about the biological performance	Stakeholder group	Responses						N
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	DK/NA	
Protected parrotfish populations								
	Net fishermen (qualifying) <sup>1</sup>	37.5	37.5	12.5	12.5	-	-	8
	Net fishermen (non-qualifying)	22.2	44.4	-	33.3	-	-	9
	Resource managers	16.7	16.7	-	8.3	16.7	41.7	12
	Charter, dive, and env. groups	-	21.4	35.7	7.1	14.3	21.4	14
Reduced by-catch from nets								
	Net fishermen (qualifying)	12.5	62.5	-	12.5	-	12.5	8
	Net fishermen (non-qualifying)	-	77.8	22.2	-	-	-	9
	Resource managers	33.3	58.3	-	-	-	8.3	12
	Charter, dive, and env. groups	21.4	50.0	-	14.3	7.1	7.1	14
Protected coral reefs from nets								
	Net fishermen (qualifying)	-	-	-	37.5	62.5	-	8
	Net fishermen (non-qualifying)	-	44.4	-	11.1	44.4	-	9
	Resource managers	8.3	25.0	-	16.7	16.7	33.3	12
	Charter, dive, and env. groups	14.3	42.9	7.1	14.3	-	21.4	14

<sup>1</sup> Qualifying net fishermen refers to those fishermen who received buyback compensation whereas non-qualifying net fishermen refers to those who were not eligible to these payments.

Figure 1: Main marine protected areas and seasonal closures in St. Croix, U.S. Virgin Islands.



Note: Eighty-one percent of the St. Croix East End Marine Park is open to fishing and harvesting (Pittman et al. 2013); only no-take zones and recreational zones (excluding recreational shoreline fishing, catch and release guide fishing, and cast-net bait fishing) prohibit fishing and harvesting (USVI DFW 2012).

Figure 2: Reported landings of parrotfish and other species in St. Croix.

