

Using Lessons Learned from Six Years of Reef Fish Spawning Aggregation Site Validation, Collaboration, and Outreach in St. Croix, USVI

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ABSTRACT

Fragmented knowledge of spawning resources and inadequate protection of aggregation sites has contributed to drastic reductions in reef fish biomass and fish landings on St. Croix. In 2002, The Nature Conservancy initiated a collaborative effort with local fishermen to identify, validate, and study aggregations of reef and pelagic fishes with incorporation of traditional knowledge, utilization of adaptive bathymetric systems methodology, and involvement of fishermen on in-water research. Concurrently, fishermen were engaged in conservation planning forums, trained in spawning aggregations research, and participated in site visits to learn from successfully managed Caribbean fisheries. Initial results from this collaboration were positive; however, maintenance of a high level of community participation and trust between resource managers, fishermen and conservation organizations eroded due to a number of contentious fisheries issues. Research was modified to reduce stakeholder conflict, thus resulting in reduced participation by fishermen and limited spatial scale of spawning site validation. Analyzing results from multi-year monitoring of spawning sites takes this into consideration and has been useful in determining future research priorities. The value of examining the factors contributing to the controversial atmosphere of spawning aggregation research and engagement of local fishermen in resource management activities benefits future protected area planning and fisheries conservation decisions. With lessons learned from St. Croix, sustainable harvest of reef fish and recovery of several reef species will rely on continued education and outreach efforts.

KEY WORDS: Spawning aggregations, fishermen participation, conservation area management

Uso de las Lecciones Aprendidas de los Seis Años de Validación, Colaboración y Concientización sobre Agregaciones Reproductivas de Peces Arrecifales en St. Croix, Islas Vírgenes EstadoUnidenses

El conocimiento fragmentado sobre las agregaciones y la protección inadecuada de los sitios de agregación han contribuido a reducciones drásticas en la biomasa de los peces arrecifales en St. Croix. En 2002, The Nature Conservancy colaboró con pescadores locales para identificar, validar, y estudiar las agregaciones de peces arrecifales, pelágicos incorporando el conocimiento tradicional, la metodología de sistemas batimétricos adaptativos e integrando a los pescadores en la investigación acuática. Los pescadores se comprometieron en esfuerzos de planificación para la conservación, fueron entrenados en investigación sobre agregaciones, y participaron en visitas a diversos sitios para aprender sobre pesquerías caribeñas sostenibles. Inicialmente los resultados de esta colaboración fueron positivos; sin embargo, el mantenimiento de un alto nivel de participación comunitaria y de la confianza entre los manejadores de los recursos, los pescadores y las instituciones de conservación se fueron degradando debido a temas controversiales sobre la pesquería. La investigación fue modificada para reducir conflictos entre los actores, y por tanto se redujo la participación de los pescadores y se limitó la escala espacial de validación de las agregaciones. El análisis de resultados de múltiples monitoreos anuales de los sitios de agregación toma esto en consideración y ha resultado ser útil para determinar las prioridades futuras de la investigación. El valor de examinar tanto los factores que contribuyen al conflicto ante la investigación, como el compromiso de los pescadores en el manejo del recurso beneficia la planificación de futuras áreas protegidas y la toma de decisiones sobre conservación del recurso. Con las lecciones aprendidas, la sostenibilidad de la captura de peces arrecifales y la recuperación de varias especies arrecifales continuará dependiendo de esfuerzos de educación y de concientización.

PALABRAS CLAVES: Agregaciones reproductivas, participación de Pescadores, conservación manejo de áreas

INTRODUCTION

The maintenance of viable reef fish spawning populations through aggregation management is vital to the replenishment of the Caribbean region's fisheries. Many reef fish spawning aggregations (SPAGs) are in decline, including those of particular commercial importance, including certain species of *Lutjanus* (snappers), and *Epinephelus* and *Mycteroperca* (groupers). Reproductive migrations are typically synchronized with the onset of gonadal maturation, leaving species vulnerable to severe depletion if fishermen target aggregation sites during the spawning season. Reef fish SPAGs are essential to replenishing local and regional fish stocks through larval transport and dispersal. One cause of declining spawning aggregations is the overfishing of specific target popula-

tions. Other causes may be local and regional stressors leading to habitat degradation, such as pollution, poorly planned coastal development, and sedimentation. Detrimental impacts on this critical element of the life cycle of these reef fish can be traced to a lack of awareness and understanding of the biological and ecological significance of viable spawning populations.

In many areas of the Caribbean, snapper and grouper species have been fished to site-specific extinction, making the identification and protection of remaining SPAGs a high priority. In the U.S. Virgin Islands (USVI), few historically viable spawning aggregations of reef fish remain, and species such as *Epinephelus striatus* (Nassau grouper) are so rare, they are essentially locally extinct. For the past three years, The Nature Conservancy's (TNC)

Southeastern Caribbean program, partially funded through National Fisheries and Wildlife Foundation grants, has been collaborating with local institutions and fishermen to increase awareness of the importance of viable spawning aggregations coupled with field research to identify and monitor possible spawning sites in the USVI. By combining local traditional knowledge with scientific research, TNC is cooperatively working to reverse the decline of fisheries in the USVI and contribute to broader fisheries conservation in the Caribbean.

TNC, with the help of local fishers, conducted an island-wide investigation of suspected SPAG sites surrounding St. Croix, USVI during spawning seasons from years 2003 to 2008. The objectives of this study were as follows:

- i) To document reef fish spawning aggregation sites around St. Croix and Buck Island Reef National Monument (BIRNM);
- ii) To specifically document the species and quantity of fish using predicted spawning aggregation sites;
- iii) To determine a current baseline of the size of aggregations in order to allow resource managers to continue to monitor for change over time;
- iv) To add to the regional database on spawning aggregations in order to help determine the status of regional stocks and reproductive potential of these stocks; and
- v) To highlight the biological importance of St. Croix, BIRNM, and USVI waters in general as sources of biological seed both locally and regionally.

METHODS

Researchers, fishers and volunteers were trained on the project methodologies outlined below at numerous workshops, meetings and training sessions. These included The Ocean Conservancy (TOC) and TNC Reef Fish Spawning Aggregation Exchange Learning workshop (December 2002); Belize Reef Fish Spawning Aggregation Monitoring Training (March and April 2002); GCFI Meeting (November 2004), TOC/TNC Reef Fish Spawning Aggregation Exchange Learning workshop (October 2005), GCFI Meeting (November 2005) and the Technical Workshop on Spawning Aggregation Research, British Virgin Islands (January 2006). TNC sponsored several St. Croix fishers to participate in each event. Additionally, TNC and other organizations sponsored fishers from various other Caribbean islands in an effort to collaborate with fishers across the region. For example, the TOC/TNC Reef Fish Spawning Aggregation Exchange Learning Workshop at VIERS (St. John, USVI, December 2002) sponsored twenty-three fishers, including 10 from the USVI, and others from the British Virgin Islands, Mexico, Belize, Grenada, and St. Vincent.

The methodology employed in this study is a modified version of the Reef Fish Spawning Aggregation Monitoring Protocol for the Wider Caribbean developed in Belize (Heyman *et al.* 2004). This has been applied to identified sites and suspected spawning grounds based on communications with local scientists and fishers. TNC developed a predictive model by overlaying known SPAG locations on shelf edge segments to determine the most likely benthic characteristics of existing undocumented spawning sites. In order to confirm the model's predictions, a three-tiered identification system was developed:

- Tier 1- Anecdotal locations by fishermen
- Tier 2- Confirmation of at least site-level aggregations
- Tier 3- Confirmation of spawning activities

Once SPAG sites were predicted, site-specific conditions were characterized, including depth and habitat types. Belt transects measuring 30m x 2m (60m²) following the method of Brock (1954) were employed in order to ensure compatibility with on-going research throughout the USVI territory. Researchers utilized SCUBA to affix a transect tape to the seafloor and slowly swam a straight distance at depth while remaining parallel to the reef profile. All fish observed within this swath or passing in front of the diver were identified to species within an allotted 10 minute time period.

Data recorded during each research dive includes species observed, approximate count of individuals, approximate length (in centimeters (cm)) of both the largest and smallest individual within an aggregation, air temperature, water temperature, weather conditions, moon stage, approximate visibility, approximate current direction and strength, depth of dive, and any spawning indicators observed. Physical measurements and habitat characterization of each site were also recorded, as well as GPS position. During some years of the study, data collection focused on a particular geographic area or a particular species. For example, in 2006, data was collected primarily in and around Buck Island Reef National Monument (BIRNM), and in 2007 data was only collected in BIRNM. In 2006, 2007 and 2008, researchers used underwater video cameras while performing each transect. This way, divers could confirm their field observations of species and abundances by watching the video when back in the office. Similarly, in 2006, the study began using a Lowrance LMS 480M Adaptive Bathymetric mapping system, in combination with a fish finder. The area of focus became the reef promontory, where SPAGs are historically known to occur. This method allowed for detailed 3-dimensional maps to be created, highlighting the specific contours on the shelf and promontory in relation to the SPAGs observed. The fish finder was used in order to maximize efficiency of in-water time. Ultimately, these methods allowed for a relatively wider, more comprehensive area of sampling coverage with greater time efficiency.

It should be noted that starting in 2006, due to a number of contentious fisheries issues, including the deliberation of controversial closures and a gill net ban, as well as disputes between participatory and non-participatory fishers, research was modified to take place only within areas of existing fisheries closures, including BIRNM, the Lang Bank red hind seasonal closure area, and the mutton snapper spawning closed area (Figure 1). Such conflicts resulted in reduced participation by fishers and limited spatial scale of spawning site validation.

RESULTS

Between 2003 and 2008, a total of seventy-three different (73) sites were surveyed during a total of 159 sampling days within the spawning season (*e.g.* December through June) (Figure 1). The results of the study provided current baseline data for spawning aggregations around St. Croix. As such, at this time, no comparative or definitive findings have been produced, as continued monitoring is required to assess the status and success of SPAGs.

Nonetheless, several key observations should be noted. Aggregations of fish were observed at many sites each year (with the exception of 2006 when no aggregations were documented) and included commercially important species such as rock hind (*Epinephelus guttatus*) and dog snapper (*Lutjanus jocu*). Other fish observed in aggregations,

sometimes displaying spawning behavior characteristics include doctorfish (*Acanthurus chirurgus*), blue tang (*A. coeruleus*), ocean surgeonfish (*A. bahianus*), ocean triggerfish (*Canthidermis sufflamen*), white margate (*Haemulon album*), french grunt (*H. flaviolineatum*), bar jack (*Caranx ruber*), horseeye jack (*C. latus*), princess parrotfish (*Sparisoma taeniopterus*), yellowtail parrotfish (*S. rubripinne*), stoplight parrotfish (*S. viride*), redband parrotfish (*S. aurofrenatum*), Atlantic spadefish (*Chaetodipterus faber*), queen triggerfish (*Balistes vetula*), permit (*Trachinotus falcatus*), sargassum triggerfish (*Xanthichthys ringens*), Creole wrasse (*Clepticus parrae*), and round scad (*Decapterus punctatus*).

During all years of the study, many commercially important species were observed in aggregations for reasons other than spawning (*e.g.* migration, predation, etc), including mahogany snapper (*L. mahogoni*), mutton snapper (*L. analis*), schoolmaster snapper (*L. apodus*), yellowtail snapper (*Ocyurus chrysurus*), vermilion snapper (*Rhomboplites aurorubens*), coney (*E. fulvus*), dolphinfish (*Coryphaena hippurus*), yellowfin grouper (*Mycteroperca venenosa*) and tomtate (*H. aurolineatum*). Other aggregating fish included black durgon (*Melichthys niger*), squirrelfish sp. (*Holocentrus* spp.) and yellow goatfish (*Mulloidichthys martinicus*).

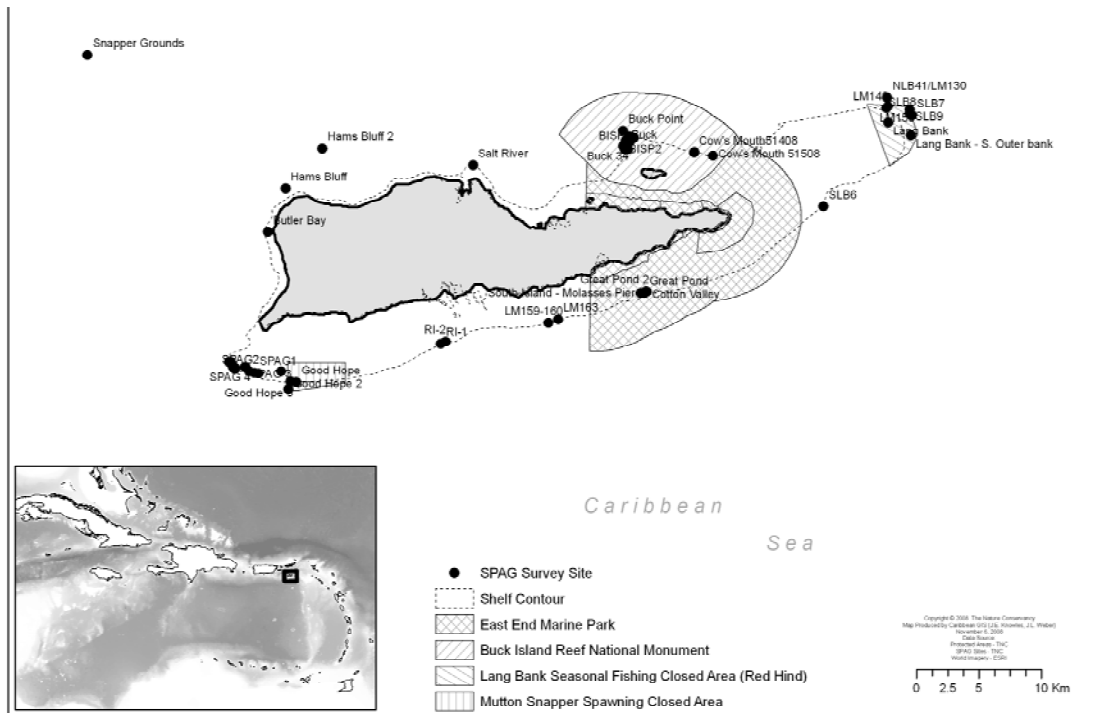


Figure 1. Map of sites surveyed for the presence of SPAGs around St. Croix, USVI between 2003 and 2008. Protected areas and shelf contour also shown. Note that the protected area associated with Salt River is not shown.

DISCUSSION

This intensive, time-consuming effort to collect SPAG data could not have been accomplished without the help of local fishers. With training, they became proficient, knowledgeable researchers responsible for much of the baseline data collection. Their involvement in training sessions, workshops, and conferences was initially valuable for the purposes of this research. However, maintenance of a high level of community participation and trust between resource managers, fishers, and conservation organizations eroded due to a number of contentious fisheries issues. Firstly, non-participating fishers were unsupportive of those who participated, and several incidences of threats and disputes occurred between fishers. In response, research was modified in an effort to reduce stakeholder conflict, thus resulting in reduced participation by fisherman and limited spatial scale of spawning site validation.

Participation of fishers in SPAG site validation research can be greatly beneficial when proper training and community support exists. The involved fishers were eager to participate and gained valuable knowledge about their local resources, hopefully, knowledge they will pass on throughout their community. We have found that it is critical to establish a greater trust between fishers and conservationists (*e.g.* scientists, resource managers, NGOs), which must be established through transparency of information and intent of research. Furthermore, a greater trust within the fishing community must exist so that conflicts do not arise within the fishery.

FUTURE RECOMMENDATIONS

Further SPAG observations will need to be made throughout St. Croix's waters to continue to add to baseline data and to monitor status. However, some methodology changes involving study locations and community involvement must occur.

All diving done near BIRNM focused only on the northwest shelf edge. Performing work here was decided upon by a combination of factors, including local fishermen's knowledge and scientific protocols being used throughout the Caribbean (Heyman *et al.* 2004, Kramer 2004). However, consensus amongst aggregation studies worldwide is that aggregation sites are not exclusive to these environments. Recent studies from the Indo-Pacific region highlight strong currents and temperature driven factors playing a large role in the location of SPAG sites (Pet *et al.* 2005). With no spawning aggregation located at the northwest corner of BIRNM in 2006 and very little observed during the other years, the obvious recommendation is to extend the survey site further east along the reef shelf.

As mentioned, tension between fishers resulted in their reduced participation and limited spatial scale of spawning site validation in 2006, 2007, and 2008. To continue to study all St. Croix's waters, and not just those within BIRNM, a greater trust and support of the entire fishing

community must be gained for research efforts to be successful and without conflict.

Furthermore, the fact that few to no spawning aggregation of commercially important and higher level ecosystem predators such as groupers (Nassau, black, tiger, yellowfin, yellow mouth, and red hind) as well as snappers (vermillion, mahogany, cubera, dog, and grey) had been identified leaves the possibility that these simply no longer exist in the waters surrounding St. Croix. However, there is anecdotal and historic evidence that these SPAGs may still exist in the closed areas such as Lang Bank and the Mutton Snapper Closed Area, but current validation and consistent monitoring is necessary to assess the effects of management on these fish stocks.

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