

Addressing Invasive Lionfish in the State of Florida, USA: Outreach, Control Efforts, and Future Directions

Abordando la Invasión del Pez León en el Estado de Florida, EEUU: Divulgación, Control y Planes a Future

Aborder les Envahissant Poisson-lion dans L'état de Floride aux États Unis: La Sensibilisation, les Efforts de Contrôle et Les Orientations Futures

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ABSTRACT

The first reported sighting of invasive lionfish occurred in 1985 off Dania Beach, Florida. The Florida Fish and Wildlife Conservation Commission (FWC) is taking actions to combat this invasion and prevent further damage to native marine ecosystems. In recent years, FWC has implemented rule changes to allow uninhibited harvest of lionfish, hosted summits to collect stakeholder feedback on state involvement in lionfish control, created a Lionfish Outreach Program to encourage further participation in lionfish removals throughout the state, and initiated a draft Lionfish Control Plan specific to the state of Florida.

Here, we address the specific rule changes that have been approved to assist stakeholders in removal of invasive lionfish and gauge their effectiveness based on public surveys. We review goals and lessons learned from the stakeholder meetings and summits FWC has held and how this has led to the draft of a state Lionfish Control Plan. We also review the accomplishments of the Lionfish Outreach Program and its future directions. This includes the expansion of the Reef Rangers Lionfish Control Program, in which divers pledge to clean lionfish off their local reefs and engage with other dive groups in their community.

The FWC highly encourages removals of lionfish from Florida waters, and continually seeks out new ways in which to control this invasive species.

KEY WORDS: Lionfish, invasive, outreach

INTRODUCTION

Since the rapid expansion of the invasive lionfish population began in 2009 (Schofield 2009), the Florida Fish and Wildlife Conservation Commission (FWC) has recognized this issue as a high priority. Since 2011, FWC has taken great strides to mitigate the negative impacts from this nonnative invasive species. In an effort to determine research and management gaps and to bring together leaders in the lionfish issue, the FWC hosted a Lionfish Summit in 2013. Though outreach efforts had already been initiated, the Summit identified a need for increased awareness throughout the state.

The Florida Legislature appropriated \$259,852 to FWC for the 2014 - 2015 fiscal year to raise awareness of invasive lionfish and other marine nonnative invasive species. Specifically, the funding is being used by the FWC Lionfish Outreach Program to educate the public about lionfish impacts to native marine ecosystems, safe lionfish handling and removal techniques, and to use lionfish as a case study to encourage the public to be more attentive to the potential for other nonnative species of marine organisms to become established in Florida waters. Specific actions taken by the program are described here.

GUIDANCE FROM 2013 LIONFISH SUMMIT

The first FWC Lionfish Summit was held in October 2013 in Cocoa Beach. This meeting brought together stakeholders, including local government agencies, researchers, environmental groups, recreational divers, commercial fishing organizations and the public to brainstorm desired future conditions for lionfish in Florida and identify lionfish management needs. The goal of the summit was to develop a collaborative framework for partnering on future lionfish management that includes identification of research priorities, management actions, and outreach initiatives.

Participants were asked for input on ranking prioritized goals and providing comment on desired future conditions through facilitated discussions. Identified needs were broken down into categories and voted on by attendees. Categories included: research, policy and regulation, control strategies, education and outreach and other. The agency has since acted upon many of the recommendations that were brought forth and continues to seek out novel ways in which to achieve the goals highlighted at the summit. Ultimately, the Lionfish Summit was just the beginning of what warrants a sustained long-term effort. To emphasize this effort, and to gather updates in lionfish research, outreach efforts and suggested management strategies, FWC will host the 2nd Florida Lionfish Summit in October 2016. The FWC Lionfish Summit Summary Report was compiled summarizing the procedures and primary conclusions from this meeting (FWC 2013).

REGULATORY CHANGES

A necessary component of lionfish management is a partnership between the public and FWC. The first step in this partnership is identification and evaluation of regulatory barriers to lionfish harvest. FWC has continuously searched for new ways to alleviate these barriers. Lionfish rule changes have been proposed at numerous Commission Meetings since 2012 and consistently draw strong support from both staff and stakeholders.

One of the first regulations to change was waiving the recreational license requirement for lionfish harvest. A recreational saltwater fishing license is not required to harvest lionfish using dip nets, pole spears, Hawaiian slings or other spearing devices marketed exclusively for lionfish. Simultaneously, the default daily recreational bag limit of 100 lbs. was removed for lionfish, allowing recreational divers to harvest an unlimited number of lionfish. To prevent further introductions, Florida prohibited the importation of live lionfish of the genus *Pterois*, and also prohibited possession of eggs or larvae for purposes other than destruction. Table 1 summarizes the complete list of regulatory changes approved by the Commission in regards to lionfish.

LIONFISH CONTROL AND ACTION PLAN

Several lionfish control plans have been created to outline efforts to combat invasive lionfish throughout the invaded range. Morris compiled a Guide to Control and Management (GCFI 2012) that included topics such as research, education and outreach, control strategies, monitoring, legal and regulatory actions, resources, partnerships and sustainable funding. This guide encompasses the majority of the invaded region, touching on actions taken by the U.S., Bahamas and other Caribbean nations. This was followed by the creation of a National Invasive Lionfish Prevention and Management Plan by the Aquatic Nuisance Species Task Force (ANSTF). This task force is an intergovernmental agency that is established under the National Invasive Species Act of 1996 (NISA). This plan discusses the background of lionfish, followed by impacts and regulations, prevention and management, education and outreach, leadership, communication and coordination, followed by funding needs.

There has been an identified need for a plan specific to the state of Florida. Several nations throughout the Caribbean developed plans prior to the start of the invasion in those respective regions. However, with the invasion

initiating in Florida waters (Schofield 2009), advanced preparation was not an option for the state of Florida. A draft *Florida Lionfish Control and Action Plan* is currently being written by FWC staff to list present actions to-date, as well as plans for the future. The plan will include accomplishments and future plans for regulatory changes, lionfish harvest incentives, control actions, monitoring and research needs, effective removals, as well as education and outreach. One focus of the state plan will be to address various regions' specific needs. Florida is home to a wide range of marine habitats, each of which are affected by the invasion in various ways that may require specific attention or distinct control methods. Since several guides and plans have already been developed at other locations across the western Atlantic and Caribbean, the Florida state plan will refer to these for more information on background topics that are not integral for the execution of the state-specific plan, in an effort to remain concise and focused on actions and implementation.

LIONFISH OUTREACH EFFORTS

Lionfish management requires a cooperative effort between government and stakeholders. This collaboration requires that the public understand the potential threats that can result from invasive species, and what they can do to help prevent or mitigate these impacts. The Florida Legislature appropriated \$259,852 to FWC for the 2014-2015 fiscal year to raise awareness about the impacts of invasive lionfish in Florida waters. The FWC Lionfish Outreach Program was established to accomplish this goal, as well as encourage diver involvement in localized control efforts. The program has several components, including a traveling outreach booth, workshops and presentations and an active diving team.

The program developed a guide for outreach and messaging that lists key topics for discussion when speaking with the public, including words to avoid, how to circumvent misconceptions and frequently asked questions. This guide is provided to staff and volunteers who participate in any FWC Lionfish Outreach event. This ensures that agency messaging remains factual and consistent to prevent misinterpretation and provide accurate information to the public.

Outreach messaging can also be used to cater to an individual's experiences and provide a personalized "call to action" during discussion. When speaking with divers, encouraging lionfish removal and reporting is applicable. For non-divers, it may be more appropriate to suggest asking for lionfish in their local restaurants or seafood markets. Rather than simply answering questions or providing similar information to each person, the FWC Lionfish Outreach program seeks out ways for each individual to become involved in lionfish control (Figure 1).

The traveling "Be the Predator" lionfish education booth is brought to various events to try to reach a large volume of people with the agency's lionfish messaging. The booth is an exciting platform used to provide information to the public about lionfish, the potential threats of the invasion, and how to participate in lionfish control. In the 2015 calendar year, the booth was present at 17

Table 1. Timeline of regulatory changes related to lionfish approved by the Commission

August 2013	Waived recreational fishing license requirement when harvesting lionfish with specific gear (68B-5.006(2), F.A.C.) Removed the 100 lb. recreational default daily bag limit (68B-5.006(3), F.A.C.)
June 2014	Allowed participants in permitted tournaments to spear lionfish where spearfishing is prohibited (68B-20.004, F.A.C.)
August 2014	Allowed divers using rebreathers to harvest lionfish (68B-5.006(4), F.A.C.) Prohibited importation of live lionfish (68B-5.006(5), F.A.C.) Prohibited breeding of lionfish (68B-5.006(6), F.A.C.)
November 2014	Prohibited harvest and possession of lionfish eggs or larvae (68B-5.006(7), F.A.C.)
February 2015	Declared the first Saturday after Mother's Day each year as Lionfish Removal and Awareness Day (Resolution)
June 2015	Divers allowed a single spiny lobster over the bag limit during the 2015 lobster two-day sport season if in possession of 10 lionfish (Executive Order 15-16)

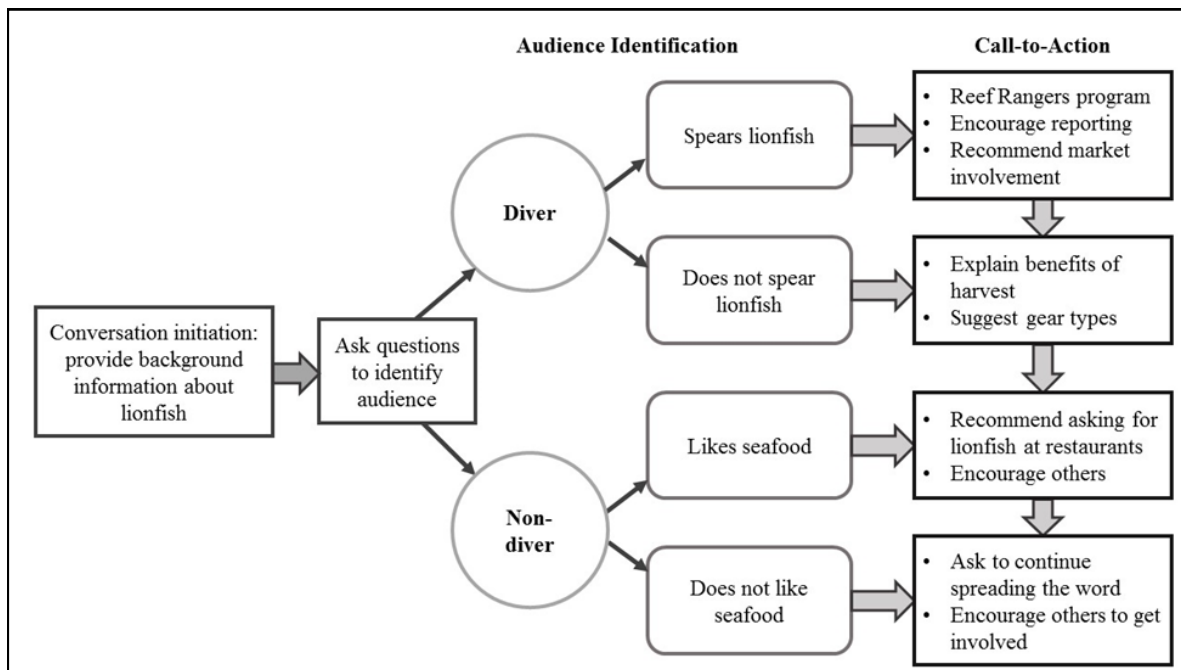


Figure 1. Flow chart describing an example of steps to determining appropriate call-to-action for individual audience members. Groups with more experience or appliance to lionfish removal do not have exclusive calls-to-action, but can instead build upon the actions appropriate for less involved target groups.

tournaments, either lionfish-specific or including a lionfish category. A total of 9,052 lionfish were removed at these tournaments. FWC often supplies raffle items or promotional giveaway items at the booth that are designed to help encourage divers to continue participating in these removal events. The booth has also been utilized at other outdoor festival events such as seafood festivals and educational days focused on conservation. These venues provide a way to engage in conversation with members of the general public who have an interest in similar subjects.

Additionally, presentations and workshops are planned with local clubs and organizations who are interested in learning more about lionfish. These talks are planned on a per-request basis. Oftentimes, small groups such as rotary clubs, fishing organizations or yacht clubs will hear about the lionfish invasion, and request additional information from FWC. For groups of 10 or more people, staff will travel to local meetings to explain the potential impacts of the invasion and efforts to control lionfish. At these presentations, staff also provides in-person demonstrations on how to safely handle and fillet lionfish. These performances reduce public hesitancy to participate in lionfish removal.

The FWC Lionfish Program continues to expand its reach across the state of Florida. In 2015 alone, the program has reached over 7,400 individuals by way of in-person discussion, with an average of 235 people per event (including small-scale occasions such as workshops). This number may in reality be much greater due to increased conversation after these interactions with FWC.

REEF RANGERS LIONFISH CONTROL PROGRAM

FWC initiated the Reef Rangers Lionfish Control Program to encourage targeted lionfish removals on Florida's reefs. Reef Rangers pledge to conduct regular lionfish removals on local reefs of their choice. Sustained removal efforts have been shown to keep localized lionfish populations at reduced levels (Côté et al. 2014, Green et al. 2013). With this localized control effort applied to Florida's reefs, the Reef Rangers program aims to mitigate the effects of the invasion on a statewide scale. The design of the program is similar to "Adopt-A-Highway" program in which individuals, or teams, pledge to maintain a section of highway by removing trash and debris.

The Reef Rangers website features an interactive map which displays coordinates for public artificial reefs. Divers can choose a reef from this list or choose a more private reef to protect, which will not display on the map. Lionfish reports are also displayed on this map to assist divers in determining which areas are in need of targeted attention.

FWC developed a Report Florida Lionfish app on which divers could report lionfish sightings or catches, along with a picture of their catch. As an expansion of the Reef Rangers program, this app is being reconstructed to accommodate merging of these two databases.

To sign up for Reef Rangers, divers can login to ReefRangers.com, sign up at the mobile kiosk at the "Be the Predator" booth or follow Reef Rangers on Facebook.

LIONFISH REMOVAL AND AWARENESS DAY

FWC staff proposed the creation of an annual event to encourage statewide lionfish removal and increased awareness. Lionfish Removal and Awareness Day (LRAD) was created by a resolution at the February 2015 FWC Commission meeting. Lionfish Removal and Awareness Day will be celebrated the first Saturday after Mother's Day each year.

For the inaugural event, a festival and lionfish tournament were held the weekend of May 16-17, 2015 in Pensacola, FL. This region was chosen based on record-high historical catch data from previous tournaments. To obtain large catches of lionfish and gain public attention, an area with consistently high lionfish harvest was necessary. Though headquartered in Pensacola, 12 other events from the panhandle to Southeast Florida were hosted outside of the FWC to help encourage participation in this statewide effort. FWC staff was able to attend and assist with six of these satellite events.

The Lionfish Removal and Awareness Day festival in Pensacola required a planning committee composed of various local organizations and government agencies. The committee consisted of representatives from FWC, Coast Watch Alliance, Gulf Coast Lionfish Coalition, Escambia County, Florida Sea Grant, Guy Harvey Magazine, University of Southern Mississippi, University of West Florida, City of Pensacola, Visit Pensacola and the Guy Harvey Ocean Foundation. Tasks were assigned to each member of the committee, and planning meetings were held twice a month for five months. This collaborative effort led to the event's success.

A subcommittee was composed to organize a media and advertising plan for the event. Advertising for Lionfish Removal and Awareness Day was achieved through flier distribution, radio ads, television commercials, social media, press releases and grassroots communications. The event was a popular news piece, being covered by more than 50 internet media outlets.

More than 3,000 people attended the Lionfish Removal and Awareness Day festival in Pensacola. The event showcased over 40 vendors, including marine conservation booths, kids' activity stations, a fishing clinic, marine art, local dive shops, and lionfish removal gear companies. The festival also hosted eight local celebrity chefs from the Pensacola region, each of which prepared lionfish in a unique way and provided samples to the public.

The Gulf Coast Lionfish Coalition (GCLC) hosted the Lionfish Removal and Awareness Day tournament during the festival. Despite difficult weather conditions, local divers removed 877 lionfish during the weekend. In addition, GCLC promoted pre-tournament participation by providing raffle tickets for every 10 lionfish turned in. This collection ensured that the event had enough lionfish to serve to the public regardless of event weekend weather conditions. More than 1,400 lionfish were collected in the Pensacola region prior to Lionfish Removal and Awareness Day weekend. In total, over 3,600 lionfish were removed statewide as part of this collaborative removal effort.

Many factors contributed to the success of the inaugural Lionfish Removal and Awareness Day. The volume of participants at the festival and throughout the state of Flori-

da indicated a strong public interest in gaining awareness about this invasive species, as well as a desire to engage in lionfish control efforts. The number of lionfish removed despite strong winds indicated a strong determination of divers to remove as many lionfish as possible from Florida waters.

PUBLIC AWARENESS SURVEY

To determine the effectiveness of FWC's lionfish outreach campaign, the agency has contracted with the University of Florida to complete a human dimensions survey. The survey goal is to compare pre- and post-campaign public awareness, centered on Lionfish Removal and Awareness Day. Three audiences were chosen for distribution of the survey: Florida residents, Florida saltwater licensees, and SCUBA divers certified through the PADI dive training agency in Florida.

Preliminary work by Harvey and Mazzotti (2015, unpublished) indicates that most SCUBA divers (96%), saltwater anglers (87%), and the general public (52%) knew invasive lionfish were present in Florida's waters. However, they were less informed about particular topics. For example, only 12% of the general public, 17% of anglers, and 31% of SCUBA divers knew that there have not been any deaths reported in the United States from a lionfish sting.

The preliminary survey revealed areas for improvement, including dispelling safety concerns about handling and consuming lionfish and clarifying misconceptions about the risks associated with these actions. The survey also highlighted a need to further encourage reporting of lionfish sightings and harvest, as the number of people submitting reports was low relative to the number of people harvesting lionfish. One significant reason why there is a lack of reporting was that lionfish harvesters are not aware that agencies want them to report. By clearly communicating the purpose of reporting to divers and anglers, they could be more willing to participate in reporting systems. Another notable finding from Harvey and Mazzotti's (2015, unpublished) work shows that most people think that agencies aren't doing enough to control lionfish. This presents an opportunity for FWC to fill this gap by being active in encouraging lionfish removal and awareness.

The final survey report will be provided to FWC in early 2016. The program has already begun to integrate suggestions from the interim report into its messaging strategies. Once the complete report is examined, the FWC Lionfish Outreach Program will be able to integrate these findings into their outreach goals, and target specific areas where public understanding is lacking. This will also assist in further identifying specific calls-to-action for particular audiences such as saltwater anglers and SCUBA divers.

SUPPORT FOR LIONFISH TOURNAMENTS

Due to increased funding and stakeholder request, financial assistance is available for tournaments that are either lionfish-specific or contain a lionfish category. An application is available on the FWC Lionfish website for interested organizations. Strength of an application is based on outreach and education efforts as well as participation. The goal for this funding is to create excitement to encour-

age participation in lionfish removals while raising awareness about this invasive species and its impacts to native marine systems. Tournaments are an enjoyable way for divers to become introduced to lionfish harvesting, often leading to more time dedicated to lionfish removals. Applicants are required to submit a report upon completion of the tournament including prize breakdown, results, and participant information for verification purposes. Successful lionfish tournaments are awarded \$1,500 to be used to enhance the effectiveness of their tournament’s outreach. In 2015, FWC has sponsored 30 tournaments that removed 12,874 lionfish.

MARKET DEVELOPMENT

With increasing interest in lionfish throughout the invaded range, there has been a rise in demand for lionfish in the market. Several restaurants around the state of Florida occasionally serve lionfish as a menu item special, however, it is rare for the market to find a consistent supplier of lionfish. Divers are faced with many collection obstacles including weather and sea conditions. Though these are also hindrances for other commercial fisheries, those fish that are primarily diver-caught, such as lionfish and hogfish, have additional limitations such as currents and low visibility conditions. Harvest via SCUBA diving is also time consuming and expensive compared to conventional commercial fishing methods, leading to a more sporadic rather than consistent supply.

Though a dependable supply may never be attained, FWC continues to encourage the public to get involved in the development of this market. Public demand continues to increase, along with diver interest in selling their catch. Anglers interested in selling fish must purchase a Saltwater Products License (SPL) through the state. This allows the

sale of non-restricted species to be sold to a licensed Wholesale Dealer who can then sell the fish to a Retail Dealer or restaurant. An SPL can be purchased for a total of \$50, and also serves as a recreational fishing license, as well as recreational spiny lobster and snook permits. This license is important to ensure the harvester is following necessary food safety guidelines for handling and transport of fish.

FWC has taken strides to increase communication between lionfish harvesters and those WDs interested in purchasing lionfish. Average weight of lionfish is small in comparison to comparable food fish, and influences stricter requirements by wholesale dealers. A survey was sent out to the list of licensed WDs in Florida to track purchasing requirements, including fish and catch size minimums. This information is valuable to divers interested in selling their catch to avoid wasting limited dive time harvesting fish smaller than acceptable market size. This issue is thought to be a deterring factor for commercial spearfishers who do not have an interest in harvesting lionfish. The survey responses are made available to lionfish harvesters interested in networking within the market and participating in lionfish sales.

When lionfish were first sold to the market in 2011, they were primarily captured as by-catch in lobster traps. Historical landings data shows a recent shift in commercial landings from primarily trap-caught to diver-caught majority in 2014 (Figure 2). This also corresponds to more than a 50% increase in landings from the previous year (FWC 2015). This is evidence of increased diver activity and involvement in the commercial market. In the future, this could lead to more consistency in the supply for the lionfish market in Florida.

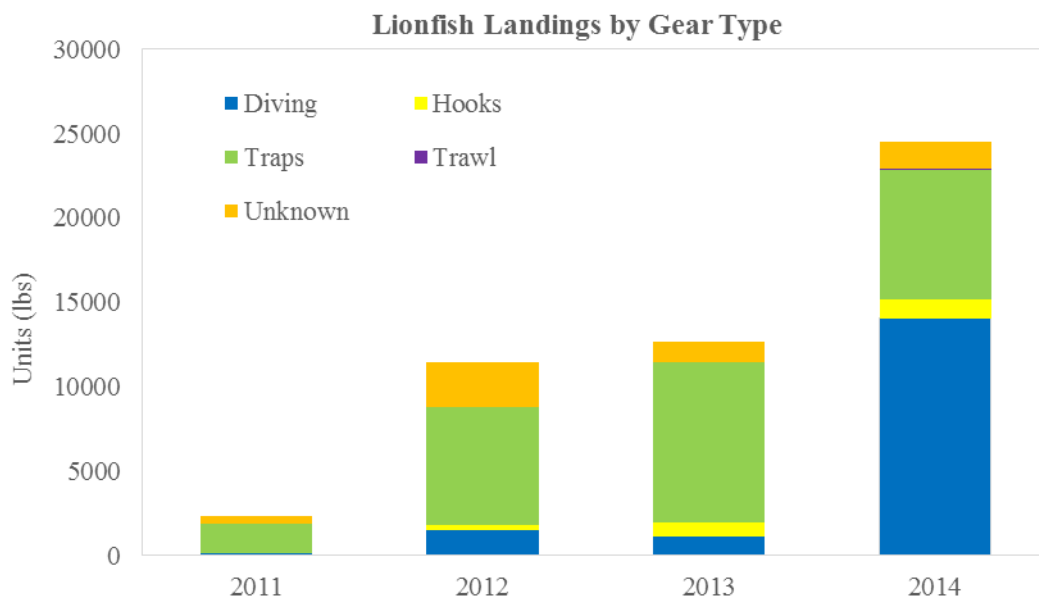


Figure 2. Commercial lionfish landings from 2011 - 2014 (FWC 2015), categorized by gear types. “Diving” includes gear type codes for diving, spears, hand nets and snorkeling. “Traps” include lobster traps and stone crab traps. “Hooks” includes long line, hook/line, rod/reel and electric reel. “Unknown” landings are from reports with unreported gear types.

FUTURE DIRECTIONS

The lionfish invasion is a priority topic for resource managers throughout the invaded range. As a threat to native marine wildlife and habitat, FWC recognizes this as a concern and will continue to search for innovative control mechanisms. Outreach and education are key components for the control of invasive species, since these are the mechanisms by which the public masses are inspired to take action and assist with fighting the invasion.

The development of a formal *Lionfish Control and Action Plan* will describe future plans and priorities for the State of Florida. The plan will outline the above actions as well as how these programs plan to develop further. In addition, a second FWC Lionfish Summit will gather updates on recent research, outreach and control efforts to gauge recent efforts and identify priorities for the future.

Adaptive strategies are required to keep up with various aspects of this invasion. FWC will continually update messaging based on new research findings, and increase efforts on the lionfish awareness campaign as needed. The agency will also explore options for regulatory changes and incentive programs to increase participation in lionfish harvest.

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