

Public Knowledge, Attitudes, and Behaviors toward Invasive Lionfish: Pre- and Post- Campaign Surveys

Final Report to the Florida Fish and Wildlife Conservation Commission

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Introduction and Objectives

Nonnative Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) are established in Florida's marine waters where they have the potential to negatively impact native fish populations, alter reef habitats, and compete with economically important species. Control of lionfish populations is a high priority for the Florida Fish and Wildlife Conservation Commission (FWC), and recent regulatory changes facilitate public participation in lionfish removal efforts. FWC launched a statewide outreach campaign in 2015 with the goals of raising awareness and influencing behaviors toward lionfish.

University of Florida (UF) conducted pre- and post-campaign surveys to help FWC develop and evaluate the lionfish outreach campaign. Purposes of this research were to provide baseline data to help FWC understand its target audiences prior to launching the outreach campaign, and to assess the ability of outreach to change public perceptions and behaviors. The *Interim Report* (Harvey and Mazzotti 2015) described baseline data on knowledge, attitudes, and behaviors of three Florida populations: the general public, recreational saltwater anglers, and recreational SCUBA divers.

This Final Report analyzes results of the PRE and POST surveys, which were conducted in January–February and September–October 2015, respectively. Objectives of this report are as follows:

1. Quantify exposure to lionfish outreach efforts and news coverage among the three survey groups
2. Assess changes between PRE and POST surveys in knowledge, attitudes, and behaviors toward lionfish among the three survey groups (general public, saltwater anglers, and SCUBA divers)
3. Assess effects of exposure to outreach/news coverage on knowledge, attitudes, and behaviors
4. Perform multivariate analyses to simultaneously examine effects of time, exposure to news coverage, direct experience, and demographic factors on knowledge, attitudes, and behaviors

Hypotheses and Key Findings

- ✓ Hypothesis supported
- ✗ Hypothesis not supported

Hypothesis 1:

Awareness and knowledge of lionfish will increase from PRE to POST.

- ✓ Between the PRE and POST surveys, there was a significant increase in percentages of saltwater anglers and SCUBA divers who had *seen something about lionfish in news coverage in the last month*. The increase was not statistically significant among the general public.
- ✓ Awareness that “there are invasive lionfish in Florida’s coastal waters” increased slightly among all groups between PRE and POST, but the increase was only statistically significant among the saltwater angler group. In multivariate analysis, POST survey respondents were 1.3 times more likely than PRE respondents to know that there are invasive lionfish in Florida’s coastal waters.
- ✓ Knowledge that a recreational fishing license is *not required* to legally remove lionfish in Florida using a spear or handheld net increased significantly among the general public, but did not change among anglers and divers. In multivariate analyses, there was no significant effect of POST survey on knowledge of license requirement.

- ✗ From PRE to POST, SCUBA divers became significantly *less likely* to know that aquarium releases were the most likely explanation for how lionfish first arrived in Florida. There was no significant change among the general public or saltwater anglers. In multivariate analyses, POST respondents were 0.8 times as likely as PRE respondents to know that lionfish were introduced through aquarium releases.
- ✗ SCUBA divers became significantly *less likely* to respond both “true” and “false” to the statement “People have died from lionfish stings” (correct answer is “false”) and more likely to answer “I don’t know.” Responses of the general public and anglers did not change. In multivariate analyses, there was no significant effect of POST survey on knowledge of fatality of lionfish stings.

Hypothesis 2:

From PRE to POST, attitudes will become more “management-aligned” as follows:

DECREASE: Component 1, Invasive Species have Intrinsic Value and should be Left Alone

DECREASE: Component 2, Fear of Lionfish

INCREASE: Component 3, Lionfish are a Serious Threat to Florida’s Ecosystems and Fisheries

INCREASE: Component 4, Support for Invasive Species Control in Florida

- ✓ Between the PRE and POST surveys, Component 1 (attitude that invasive species have intrinsic value and should be left alone) decreased significantly among the general public. However, timing (PRE/POST) did not significantly affect this attitude in multivariate analysis.
- ✓ Component 2 (fear of lionfish) decreased significantly among saltwater anglers. In multivariate analysis, POST respondents had significantly less fear of lionfish than PRE respondents.
- ✓ Component 3 increased significantly among the general public and saltwater anglers. In multivariate analysis, POST respondents were significantly more likely than PRE respondents to believe that lionfish are a serious threat to Florida’s ecosystems and fisheries.
- ✗ Component 4 (support for invasive species control in Florida) did not change significantly PRE/POST.
- ✗ There were no statistically significant changes in any of the attitudes among SCUBA divers.

Hypothesis 3:

Involvement in lionfish control efforts (behaviors) will become more prevalent from PRE to POST.

- ✓ Saltwater anglers were significantly more likely POST than PRE to report that they would talk with others about lionfish, eat lionfish, order lionfish in a restaurant, and filet a lionfish in the future.
- ✗ There was no significant PRE/POST change among any of the groups in percent who had seen lionfish or who had reported their sightings to the FWC. There was also no change in likelihood of reporting lionfish sightings in the future. POST survey had no effect on reporting behavior in multivariate analyses.
- ✗ There were no significant PRE/POST differences in percentages that had removed lionfish, heard or downloaded the “Report Florida Lionfish” app, eaten or fileted lionfish, ordered lionfish in a restaurant, or talked with people about the lionfish invasion. In multivariate analyses, POST survey did not affect likelihood of removing or eating lionfish.

- ✗ SCUBA divers and the general public became significantly *less likely* to say that they would download the “Report Florida Lionfish” app.
- ✗ In multivariate analysis, POST respondents were 0.7 times as likely as PRE respondents to report that they had talked with people about the lionfish invasion during the past year.

Hypothesis 4:

Exposure to news coverage about lionfish will be associated with greater knowledge, more “management-aligned” attitudes (as listed in Hypothesis 2) and greater behavioral involvement in lionfish control efforts.

- ✓ Exposure to news coverage was significantly associated with all three knowledge measures among all groups (except SCUBA divers about aquarium releases) and in multivariate analyses.
- ✓ Exposure to news coverage was significantly associated with lower Attitude Component 1 and 2 scores, and higher Component 3 and 4 scores among all groups (except general public on Component 2) and in multivariate analyses.
- ✓ Among all three groups, exposure to news coverage exposure was correlated with increases in hearing about and downloading the “Report Florida Lionfish” app, eating lionfish, ordering lionfish in a restaurant, fileting lionfish, and talking with people about lionfish in the past year. In multivariate analyses, it was linked to 1.9 times greater odds of eating and 3.2 times greater odds of talking with people about lionfish.
- ✓ Exposure to news coverage was linked to 2.7 times greater odds of reporting lionfish to FWC. However, there was no significant effect on reporting in bivariate analyses.
- ✓ Exposure to news coverage was linked to 1.6 times greater odds of removing lionfish in multivariate analyses, and had a significant bivariate effect on lionfish removal among SCUBA divers.

Methods

We developed the pre-campaign and post-campaign questionnaires to address FWC's specific research questions about public awareness, beliefs, and involvement, as well as broader questions about invasive species knowledge and attitudes raised in the literature (e.g., Bremner and Park 2007, García-Llorente et al. 2008, Harvey et al. 2015, Odera and Lamm 2014, Sharp et al. 2011). Questionnaire drafts were reviewed by FWC staff, an executive at the Professional Association of Diving Instructors (PADI), and members of the Everglades Cooperative Invasive Species Management Area (ECISMA) Steering Committee. We pre-tested the pre-campaign survey on a convenience sample of 36 students and 12 colleagues, and revised questions based on results of preliminary data analyses. The post-campaign questionnaire was mostly the same as the pre-campaign questionnaire, but we added specific questions about awareness and involvement in FWC's 2015 outreach efforts.

Final questions were approved by FWC staff. The University of Florida Institutional Review Board exempted this study from human subjects review because its primary purpose involves program evaluation rather than contributing to generalizable knowledge.

We administered the surveys online via Qualtrics software to samples of two populations: the general population of Florida and FWC's list of licensed saltwater anglers in Florida.¹ Details of sampling and administration for each group are described below. The online survey took an average of about 15 minutes to complete (about half of respondents completed it in less than 12 minutes). Upon completion of data collection, we downloaded and merged all data into IBM SPSS Statistics 22 for analyses.

Qualtrics General Population Samples

We purchased two "opt-in" Internet samples (pre- and post-campaign) of the general Florida population from Qualtrics, LLC. Use of opt-in Internet panels is a non-probability sampling method that is increasingly used in public opinion research (Baker et al. 2013). If attention is paid to sample quality, opt-in samples can provide minimally biased results that sometimes outperform traditional probability samples (Vavrek and Rivers 2008). Qualtrics works with private Internet panel providers to recruit survey respondents using two methods. They recruit people who are immediately incentive-driven, such as someone playing an online game who can take a survey instead of paying to continue their game. They also recruit through advertisement via online banner ads or email campaigns, where respondents are incentivized with "E-points" to spend in an online marketplace. Potential respondents are asked screening questions to determine if they meet the survey and quota criteria. To reduce bias, the survey topic is concealed from respondents until they have chosen to participate.

To estimate true population values within plus or minus five percentage points (i.e., +/- 5% sampling error), at a 95% confidence level, we obtained complete sample sizes > 400 (Dillman et al. 2014). Qualtrics collected survey responses using quotas to represent the Florida population according to three attributes: gender, age category, and geographical location within the state (Table 1). Qualtrics provided a pre-campaign sample of 422 and a post-campaign sample of 410 "good completes," i.e., respondents who were at least 18 years old, Florida residents, and fit the quotas for gender, age, and geographic location. After a thorough review of the data, we removed 7 respondents from the PRE survey and 29

¹ The pre-campaign survey was also administered to a sample of PADI SCUBA divers, but we were not able to survey this group again for the post-campaign survey so they are not included in analyses in this report.

respondents from the POST sample due to inconsistent responses, bringing the sample sizes to 415 and 381, respectively.

Table 1. Demographic attributes of Florida population and the general population survey samples provided by Qualtrics.

	Florida population ^a	Pre-Campaign Sample	Post-Campaign Sample
Gender			
Female	51.1%	51.3%	54.3%
Male	48.9%	48.7%	45.7%
Age Group			
18 to 29	19.7%	20.2%	19.7%
30 to 39	15.5%	15.9%	13.1%
40 to 49	17.9%	18.1%	15.5%
50 to 59	17.2%	18.1%	18.9%
60 to 69	14.2%	14.9%	15.7%
70 or Older	15.5%	12.8%	17.1%
Geographic Region of Florida			
Northwest	7.0%	6.5%	7.9%
North Central	9.5%	11.6%	8.9%
Northeast	22.0%	28.2%	20.2%
Southwest	26.9%	29.2%	28.1%
South	34.5%	24.6%	34.9%

^a Statistics for the state of Florida based on 2010 U.S. Census (www.census.gov)

FWC Saltwater Angler Samples

We downloaded FWC's list of 2013 saltwater fishing licensees, removed 250,187 duplicate entries and 720,288 entries that did not have email addresses, resulting in a dataset of 471,844 saltwater anglers with email addresses. We drew random samples from this list (6000 for pre-campaign survey and 8000 for post-campaign survey) and emailed the survey using the Qualtrics email distribution system. We made four contacts to maximize response rate. The second reminder email included an incentive for the next 200 anglers to complete the survey: either a waterproof cell phone holder or a T-shirt with the "lionfish: be the predator" logo. These gifts were mailed to respondents after data collection was complete.

For the pre-campaign survey, 110 emails bounced. Of the 5890 emails that went through, 820 people (14%) completed the survey. Qualtrics' system tells us that only 2163 (37%) of the emails were opened. Based on number of anglers who opened the email, our response rate is 38%. Three respondents who reported that they "have never been saltwater fishing for recreation" were removed from the sample, bringing the sample size to 817.

For the post-campaign survey, 237 emails bounced. Of the 7763 emails that went through, 899 people (12%) completed the survey. Qualtrics' system tells us that only 2651 (34%) of the emails were opened. Based on number of anglers who opened the email, our response rate is 34%. One respondent who reported that they "have never been saltwater fishing for recreation" was removed from the sample, bringing the sample size to 898.

Weighting to Reduce Nonresponse Bias

Saltwater Angler Sample

We examined nonresponse among Florida saltwater anglers two ways. First, we used auxiliary data from FWC's database of saltwater fishing licensees to compare characteristics of survey respondents to those of the overall population of saltwater anglers. In the combined pre-campaign and post-campaign angler samples (which exhibited statistically equivalent biases), respondents were significantly more likely than the population to be male (84.1% vs. 78.0%), white (92.1% vs. 89.3%), to live outside of Florida (18.0% vs. 14.3%), to be age 55 or older (34.8% vs. 27.3%); and less likely to be age 18–39 (29.3% vs. 36.6%).

Second, we emailed a very short (4-question) survey to all nonrespondents in the post-campaign angler sample and received 450 responses. Because this short nonresponse survey demanded much less commitment than the long survey, we assumed that these 450 “nonrespondents” more closely represented the population of saltwater anglers (in terms of their awareness of and interest in the topic) than did those who completed the full post-campaign survey. Indeed, we found that these representatives of the population were less likely than our post-campaign survey sample to know that there are invasive lionfish in Florida's coastal waters (85.5% vs. 92.7%)². We assumed that the pre-campaign sample of anglers would exhibit an equivalent discrepancy from the population at that point in time. Thus, we used the same values (below) to weight pre-campaign and post-campaign survey samples.

We used poststratification weighting to make the samples more closely represent the population of saltwater anglers. For each subgroup of the five variables assessed above, we assigned adjustment values by dividing the population percentage by the sample percentage as shown in Table 2 (Lee and Forthofer 2005). We assigned each respondent a final weight that was calculated as the product of the five subgroup adjustment values (Lee and Forthofer 2005). The weights ranged from 0.52 to 4.62 with a mean of 1.03 (SD 0.49). To avoid inflating the variances of our survey estimates, we capped the weights at a top value of 2.0 (Kalton and Flores-Cervantes 2001).

General Population Sample

Weighting procedures are frequently used in non-probability samples (as well as probability samples) to compensate for non-participation biases (Baker et al. 2013). As noted above, Qualtrics provided samples of Florida residents who represented the state population in terms of gender, age, and geographic area. However, compared to U.S. Census data for the state of Florida, the samples underrepresented Hispanics/Latinos (13.1% vs. 24.1%) and African Americans (8.4% vs. 16.8%), and overrepresented non-Hispanic whites (75.0% vs. 55.8%). Thus, we assigned each respondent a weight that was equivalent to the adjustment value for race/ethnicity as shown in Table 2.

We weighted the saltwater angler and general population samples for all univariate and bivariate analyses presented in this report. In multivariate analyses, demographic and awareness-related variables were included as predictors to account for potential bias.

² The nonresponse survey was conducted two months after the post-campaign survey, so we excluded nonrespondents who said they had first learned about lionfish within the last two months. The other two questions asked in the nonresponse survey were “Are you a certified SCUBA diver?” (no significant difference between the sample and “population” (36.2% vs. 35.1%) and “What was your main reason for not completing the [original] survey?” (56% said “I don’t recall receiving an email,” 20% said “I didn’t have time,” 6% said they thought it might be spam, 2% said they were not interested in the topic, and 16% gave other reasons).

Table 2. Derivation of poststratification adjustment values to assign weights to respondents in the saltwater angler and general population samples.

Subgroup	Population %	Sample %	Adjustment Value
SALTWATER ANGLER SAMPLES			
<i>Gender</i>			
Male	0.780251	0.841463	0.927255
Female	0.219749	0.158537	1.386108
<i>Ethnicity</i>			
White	0.893408	0.921022	0.970018
Hispanic/Latino	0.069777	0.054007	1.292007
Other	0.036815	0.024971	1.474315
<i>Residency</i>			
FL Resident	0.857306	0.819977	1.045525
Out of State	0.142694	0.180023	0.792643
<i>Age</i>			
18–39	0.366196	0.292828	1.250553
40–54	0.360536	0.359218	1.003670
55 +	0.273268	0.347955	0.785354
<i>Awareness of Lionfish</i>			
Aware	0.854911	0.926503	0.922728
Unaware	0.145089	0.073497	1.974094
GENERAL POPULATION SAMPLES			
<i>Race/Ethnicity</i>			
Non-Hispanic White	0.558	0.750000	0.744000
Non-Hispanic Black	0.168	0.084171	1.995940
Hispanic/Latino	0.241	0.130653	1.844577
Other races	0.033	0.035176	0.938143

Group Categorization

Based on preliminary analyses described in the *Interim Report* (Harvey and Mazzotti 2015), we split the FWC saltwater angler sample based on their response to the question “Are you a certified SCUBA diver?” This division resulted in three groups for comparative analyses: Florida General Public, Saltwater Anglers, and SCUBA Divers. The weighted sample sizes of each group are presented in Table 3.

Table 3. Weighted sample sizes for intergroup and pre/post comparisons.

Survey Group	Weighted Sample Sizes		
	PRE Survey	POST Survey	Totals
Florida General Public	414	382	796
Florida Saltwater Anglers	532	591	1123
Florida SCUBA Divers	291	297	588
Totals	1237	1270	2507

Detailed Results

Respondent Characteristics

Table 4 describes socio-demographic characteristics of the three survey groups, after the data were weighted for nonresponse adjustment as described above. Average age was approximately the same in all groups. The saltwater angler and SCUBA diver groups had large male majorities (75% and 82%), and higher proportions of non-Hispanic whites (84% and 88%) compared to the general public group (48% male, 56% non-Hispanic white). These groups also had sizeable proportions of out-of-state residents (13% and 8%). Educational attainment and household incomes were highest among the divers and lowest among the general public. Divers were more likely than the other groups to be members of conservation or wildlife organizations. Nearly half of the general public, and much larger majorities of the other two groups, had been snorkeling or skin diving.

The saltwater angler and SCUBA diver groups exhibited many years of saltwater angling experience, and large majorities (94% of each) had been angling very recently (2014–2015; Table 5). By comparison, the 384 anglers in the general public sample had less fishing experience overall and in Florida, and were much less likely to be fishing recently (2014–2015). Similarly, the 68 SCUBA divers in the general public sample had fewer years of, and less recent, diving experience compared to the SCUBA diver group (Table 6).

Table 4. Socio-demographic characteristics of the three survey groups (pre- and post-campaign samples combined; weighted data).

	Florida General Public (N = 796)	Saltwater Anglers (N = 1123)	SCUBA Divers (N = 588)	Comparative Statistic
Average Age (SD)	46.5 (17.7)	44.4 (13.7)	46.1 (12.3)	F = 5.0**
Sex				
Female	52%	25%	18%	$\chi^2 = 232.6^{***}$
Male	48%	75%	82%	
Florida Residency				
Full-time FL resident	97%	81%	86%	$\chi^2 = 127.4^{***}$
Part-time FL resident	3%	6%	6%	
Not a FL resident	0%	13%	8%	
Race/Ethnicity				
Non-Hispanic White	56%	84%	88%	$\chi^2 = 340.2^{***}$
Non-Hispanic Black	17%	2%	0%	
Hispanic/Latino	24%	11%	9%	
Other/More than one race	3%	3%	3%	
Education Level				
Less than Bachelor's	63%	54%	45%	$\chi^2 = 81.5^{***}$
Bachelor's degree	24%	32%	35%	
Advanced degree	13%	14%	20%	
Household Income				
Less than \$50,000	51%	28%	20%	$\chi^2 = 237.5^{***}$
\$50,000 to \$100,000	35%	37%	32%	
\$100,000 or More	15%	35%	48%	
Conservation Organization Membership				
Member	6%	13%	19%	$\chi^2 = 53.2^{***}$
Not a member	94%	87%	81%	
Ever Been Snorkeling or Skin Diving				
Yes	48%	82%	99%	$\chi^2 = 520.0^{***}$
No	52%	18%	1%	

** $p < .01$, *** $p < .001$

Table 5. Recreational saltwater fishing experience *of anglers* in the three survey groups (pre- and post-campaign samples combined; weighted data).

	Florida General Public (N = 360)	Saltwater Anglers (N = 926)	SCUBA Divers (N = 473)	χ^2
Total Years of Saltwater Fishing Experience				
Less than 2 years	29%	6%	3%	328.8***
2 to 20 years	50%	49%	35%	
More than 20 years	21%	45%	62%	
Most Recent Saltwater Fishing Experience				
2015	13%	63%	70%	848.1***
2014	21%	31%	24%	
Pre-2014	66%	6%	6%	
Ever Saltwater Fished in Florida				
Yes	35%	100%	100%	1557.8***
No	65%	0%	0%	

*** $p < .001$

Table 6. SCUBA diving experience *of divers* in two survey groups (pre- and post-campaign samples combined; weighted data).

	Florida General Public (N = 51)	SCUBA Divers (N = 586)	χ^2
SCUBA Certification Level			
Open Water	67%	61%	2.4
Advanced Open Water	24%	23%	
Higher Levels	9%	16%	
Total Years of SCUBA Diving Experience			
Less than 2 years	18%	8%	18.8**
2 to 20 years	66%	59%	
More than 20 years	16%	33%	
Most Recent SCUBA Diving Experience			
2015	15%	22%	58.5*
2014	21%	28%	
Pre-2014	64%	50%	

* $p < .05$, ** $p < .01$

Exposure to Lionfish Outreach

Between the PRE and POST surveys, there was an increase in percent of respondents who said they had seen something about lionfish in news coverage in the last month (Figure 1). These PRE-POST differences were statistically significant among saltwater anglers ($\chi^2 = 17.3$, $p < .001$) and SCUBA divers ($\chi^2 = 15.7$, $p < .001$), but not among the general public ($\chi^2 = 4.0$, $p = .135$).

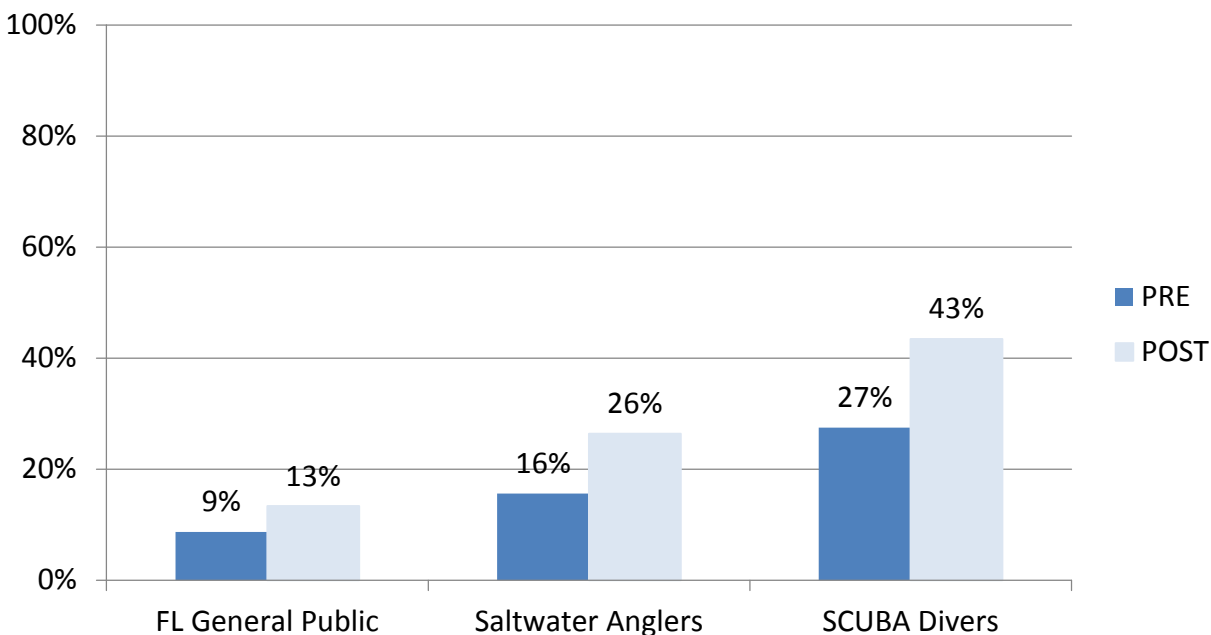


Figure 1. “Have you seen anything related to lionfish in news coverage in the last month?” Percentages of each group who answered “yes” in pre- and post-outreach campaign surveys.

We asked respondents “Where have you learned about lionfish?” asking them to “check all that apply” out of eight information sources plus an “other” option. Newspapers became a more common information source among the general public (9.9% PRE to 15.7% POST, $\chi^2 = 7.2$, $p = .007$), and television became more common among saltwater anglers (31.2% PRE to 39.1% POST, $\chi^2 = 7.0$, $p = .008$). Frequency of other information sources (Internet/social media; radio; school/the classroom; personal outdoor experiences; interpreters at zoos, nature centers, or eco-tours; friends, family members, or acquaintances) did not change significantly. Specific newspapers and television shows/channels from which people received information on lionfish are listed in Appendix 1.

On the *POST* survey only, we asked specific additional questions about exposure to FWC’s outreach campaign. Fourteen percent of the general public, 37% of saltwater anglers, and 47% of SCUBA divers reported that they knew that the first annual Lionfish Removal and Awareness Day (LRAD) was held on May 16, 2015 (Figure 2). Figure 2 also shows percentages that were aware of FWC’s “Reef Rangers” lionfish control program and of FWC’s rule that allowed divers to take one extra lobster per day of the spiny lobster mini-season if they removed 10 lionfish on that day.

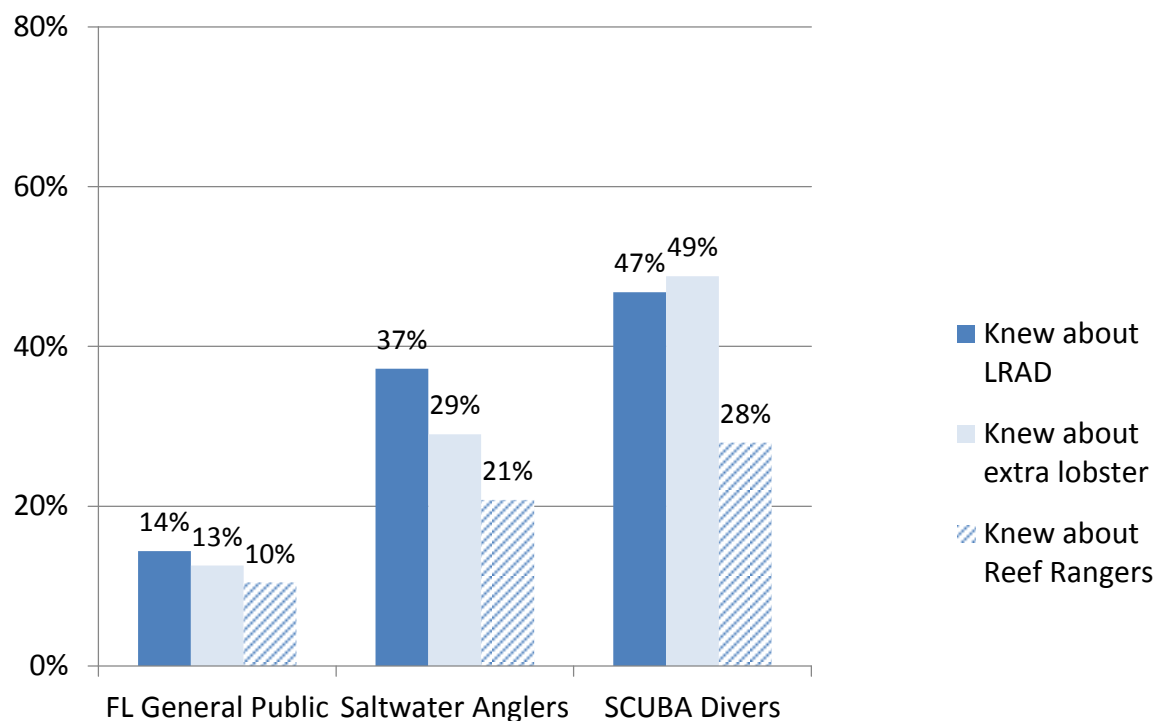


Figure 2. Percentages of each group in post-outreach campaign survey who answered “yes” to: “Did you know that the first annual ‘Lionfish Removal and Awareness Day’ was held on May 16, 2015?”, “Did you know that FWC allowed divers to take one extra lobster per day of the spiny lobster mini-season (July 29-30, 2015) if they removed 10 lobsters on that day?”, and “Have you heard about FWC’s “Reef Rangers” lionfish control program?”

Fifty individuals (47 from the SCUBA divers sample and 3 from the general public sample) reported that they participated in the 2015 spiny lobster mini-season. Eight of them (16%) reported that they had removed 10 lionfish and took an extra lobster on either day of the mini-season, and 12 more (24%) reported that they removed some lionfish (but less than 10 in a day) during the mini-season.

Four percent of the general public, 4% of saltwater anglers, and 14% of SCUBA divers said they had “attended any events, workshops or presentations about invasive lionfish in Florida.” Of the 82 total respondents who indicated they had attended events, 18 (22%) attended LRAD (locations listed included Fort Lauderdale, Gainesville, Jacksonville, Jupiter, the Keys, UNF, Panacea (Wakulla Diving Center), and Wilton Manors), 19 (23%) attended other events hosted by FWC (including presentations/dinners hosted by Meaghan Faletti, Annual Lionfish Meeting, “couple years ago a contest for most lionfish removed,” Fishing Club, Jeff Beal presentation, Key West wildlife museum, lionfish derbies, lionfish tent at REEF lionfish derby, fishing boat tour, outreach at seafood festival, and Tampa outdoor/boat show), and 55 (67%) had attended event hosted by other organizations (See Appendix 2 for list).

Of the 245 total respondents who reported being aware of “Reef Rangers,” one SCUBA diver reported they had signed up to be a Reef Ranger and one saltwater angler said they had signed up to sponsor a reef.

PRE/POST Comparisons (Bivariate Analyses)

Knowledge

General awareness that there are invasive lionfish in Florida increased slightly between the PRE and POST surveys (Figure 3). However, this increase was only statistically significant among the saltwater angler group ($\chi^2 = 3.0, p = .049$).

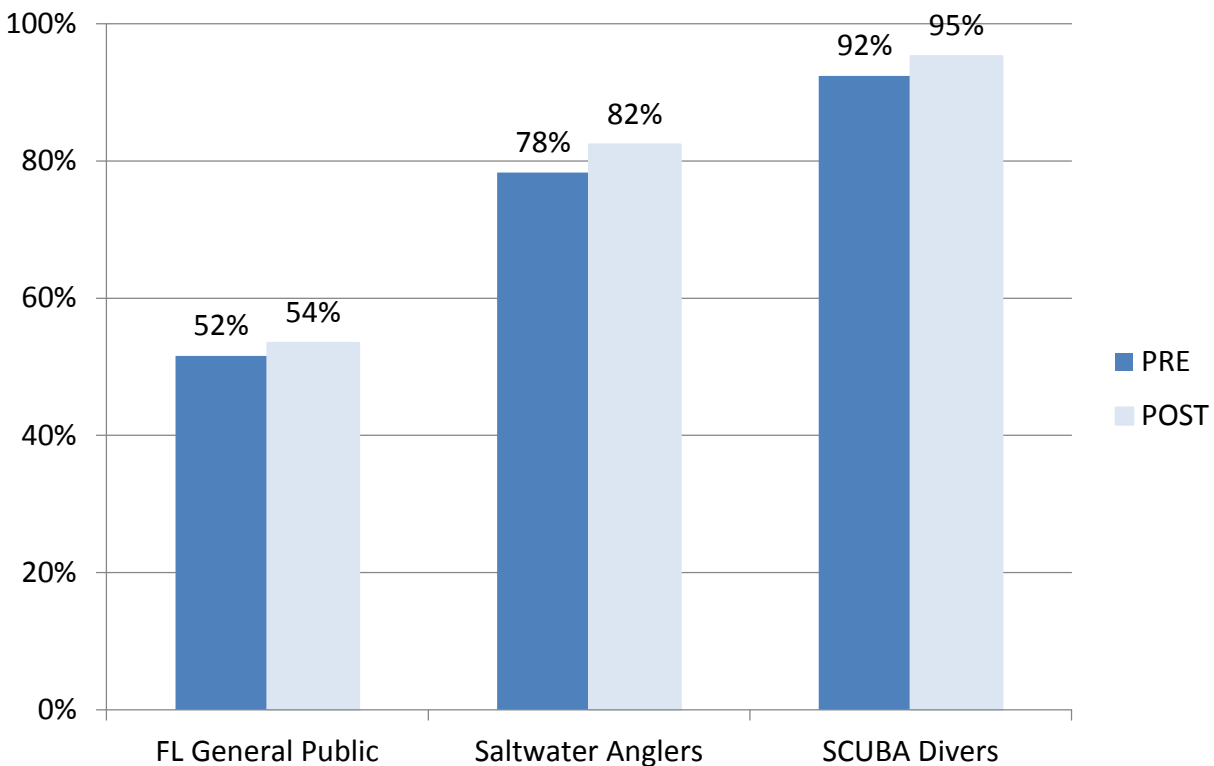


Figure 3. “Before taking this survey, did you know that there are invasive lionfish in Florida’s coastal waters?” Percentages of each group who answered “yes” in pre- and post-outreach campaign surveys.

The survey included three knowledge questions. First, “What do you think is the most likely explanation for how lionfish first arrived in Florida’s coastal waters?” There was no significant PRE/POST difference in responses among the general public or saltwater anglers; however, SCUBA divers became significantly *less likely* to give the correct answer: aquarium releases. PRE and POST responses of SCUBA divers were as follows: released from people’s aquariums (80% to 72%), released from the ballast water of ships (8% to 14%), swam from their native range (3% to 2%), I don’t know (8% to 12%; $\chi^2 = 5.9, p = .015$).

The second knowledge question was “True or false? You must have a recreational fishing license to legally remove lionfish in Florida using a spear or handheld net.” Among the general public, there was a *significant increase in correct answers* (“false”) in the POST survey ($\chi^2 = 6.8, p = .033$). There was no significant PRE/POST change among the other two groups.

Third, we asked “True or false? People have died from lionfish stings.” In the POST survey, SCUBA divers were significantly *less likely* to respond both “true” and “false” and more likely to answer “I don’t know” ($\chi^2 = 7.6, p = .023$). Responses of the general public and anglers did not change.

The survey also asked about awareness of four other invasive species in Florida. Between the PRE and POST surveys, there was a significant increase in percentage of the general public ($\chi^2 = 7.2, p = .027$) and saltwater anglers ($10.8, p = .005$) who were aware of Burmese pythons. There was no significant change in awareness of the other species (Table 7).

Table 7. Percentages of each group who said “I know what this is and I know it is an invasive species” for each of the following invasive species in pre- and post-outreach campaign surveys. Bold values indicate statistically significant PRE/POST differences at the $p < .05$ level.

Plant or animal species	FLORIDA GENERAL PUBLIC		SALTWATER ANGLERS		SCUBA DIVERS	
	PRE	POST	PRE	POST	PRE	POST
Burmese python	52.5%	55.0%	85.5%	88.1%	93.1%	92.5%
Argentine black & white tegu	8.7%	7.8%	12.5%	14.4%	16.6%	21.7%
Melaleuca	13.1%	17.8%	24.3%	23.4%	36.6%	35.5%
Water hyacinth	16.4%	15.9%	34.0%	32.0%	42.2%	45.9%

In the POST survey only, we added a question to directly compare awareness of lionfish to awareness of Burmese pythons. Figure 4 shows PRE and POST awareness of lionfish compared to POST awareness of Burmese pythons.

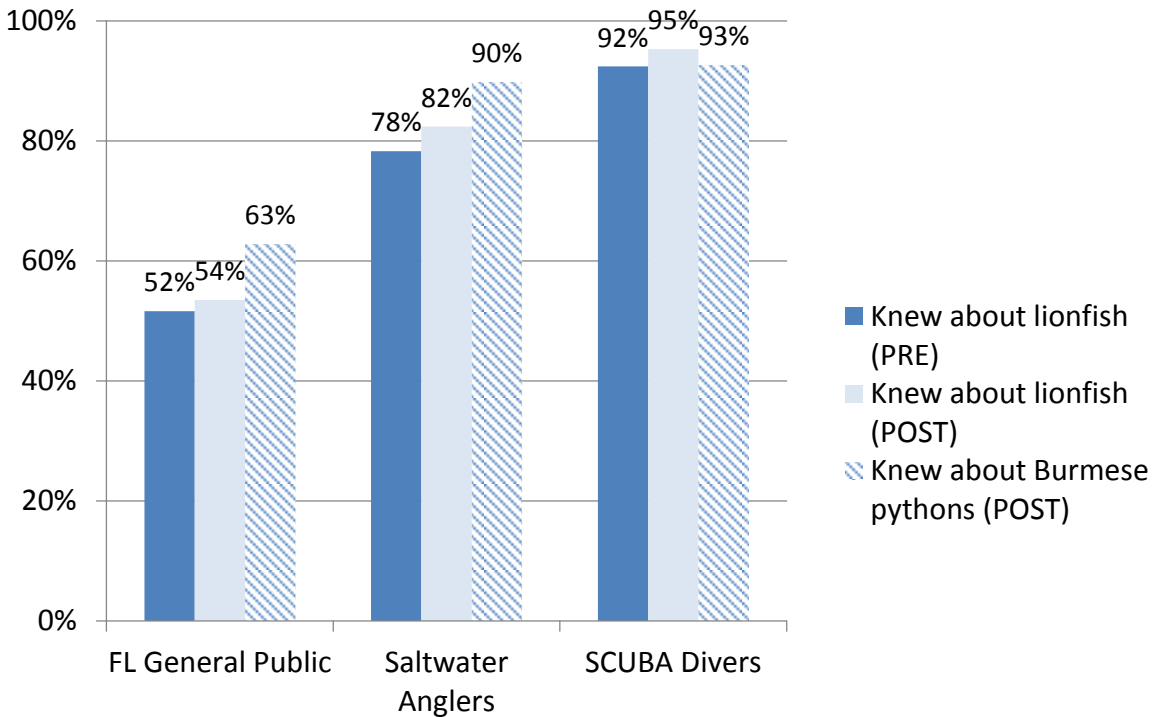


Figure 4. “Before taking this survey, did you know that there are invasive lionfish in Florida’s coastal waters?” and “Did you know that there are invasive Burmese pythons in Florida?” Percentages of each group who answered “yes” in pre- and post-outreach campaign surveys.

Attitudes

The survey included 19 attitude/belief statements: 10 about lionfish and nine about Florida invasive species more generally. Respondents were asked to indicate the extent to which they agreed or disagreed with each statement on a 5-point scale from 1=strongly disagree to 5=strongly agree. As reported in the *Interim Report* (Harvey and Mazzotti 2015), we conducted exploratory factor analysis of the 19 items resulting in four distinct attitudinal components (Table 8).

Table 8. Items used to measure 4 attitudinal components regarding lionfish and other invasive species in Florida.

<i>Component 1: Invasive Species have Intrinsic Value and Should be Left Alone (Cronbach's $\alpha = .93$)</i>
I feel that lionfish have the right to live in Florida's waters. I feel it is wrong to kill lionfish that are found in Florida's waters. If we leave lionfish alone, Florida's coastal ecosystems will balance themselves naturally. Invasive species have as much right to exist in Florida as native plants and animals. I feel that it is wrong to kill wildlife, even if it is an invasive species. Invasive species are as important to Florida's ecosystems as other plants and animals. Wildlife managers should worry less about getting rid of invasive species and just let nature run its course.
<i>Component 2: Fear of Lionfish (Cronbach's $\alpha = .84$)</i>
I would be afraid to eat a lionfish because I think it may contain toxins like mercury or ciguatera. I would be afraid to eat a lionfish because I think it may contain venom. I would feel scared if I saw a lionfish while diving or snorkeling.
<i>Component 3: Lionfish are a Serious Threat to Florida's Ecosystems and Fisheries (Cronbach's $\alpha = .78$)</i>
There are large numbers of lionfish in the waters surrounding the state of Florida. Lionfish threaten Florida's commercial fisheries by reducing game fish populations. Lionfish are harmful to Florida's coastal ecosystems. Lionfish may greatly reduce populations of native fish species.
<i>Component 4: Support for Invasive Species Control in Florida (Cronbach's $\alpha = .76$)</i>
Regulations on pet ownership can help prevent the introduction of nonnative species into Florida's environment. Preventing the establishment of new nonnative species should be a top priority for wildlife managers. Invasive species in Florida are a concern to me. Control of some wildlife is necessary to help conserve Florida's natural ecosystems. Native plants and animals are more important to an ecosystem than nonnative plants and animals.

For each component, we computed a composite attitudinal measure as the mean response (from 1 to 5) of the individual items making up that component. Responses to the four composite measures were not normally distributed; therefore we used nonparametric Mann-Whitney *U* tests to compare PRE/POST attitudes of each survey group. As the distributions of attitude scores were generally not similar between PRE and POST surveys, we compared the *mean ranks* of each distribution to determine whether the values in the PRE survey were lower or higher than the values in the POST survey (see Agresti 2013, Hart 2001).

Table 9 displays results of the Mann-Whitney *U* tests examining PRE/POST differences in attitudes within each survey group. Between the PRE and POST surveys, the general public became significantly *less likely* to feel that invasive species have intrinsic value and should be left alone (Mann-Whitney *U*, $Z = -2.05$, $p = .041$), and *more likely* to view lionfish as a serious threat to ecosystems and fisheries (Mann-Whitney *U*, $Z = 2.17$, $p = .030$).

Saltwater anglers became significantly *less likely* to fear lionfish (Mann-Whitney *U*, $Z = -2.30$, $p = .021$) and significantly *more likely* to view lionfish as a serious threat to ecosystems and fisheries (Mann-Whitney *U*, $Z = 2.38$, $p = .017$). There were no statistically significant changes in any of the attitudes among SCUBA divers.

Table 9. Means and mean ranks of distributions of scores on 4 attitudinal measures, based on Mann-Whitney *U* tests comparing PRE and POST respondents. Bold values indicate statistically significant PRE/POST differences at the *p* <.05 level.

Attitudinal Component	FLORIDA GENERAL PUBLIC		SALTWATER ANGLERS		SCUBA DIVERS	
	PRE	POST	PRE	POST	PRE	POST
	Mean on five-point scale (1=strongly disagree to 5=strongly agree) MEAN RANKS OF DISTRIBUTIONS					
<i>Component 1: Invasive Species have Intrinsic Value and Should be Left Alone</i>	2.6 501.6	2.5 464.9	1.8 617.8	1.8 611.5	1.5 328.6	1.5 340.2
<i>Component 2: Fear of Lionfish</i>	3.7 490.5	3.6 476.9	2.7 638.9	2.6 592.6	2.0 343.4	2.0 325.9
<i>Component 3: Lionfish are a Serious Threat to Florida's Ecosystems and Fisheries</i>	3.8 465.4	3.9 504.1	4.0 589.3	4.1 637.1	4.4 341.9	4.3 328.4
<i>Component 4: Support for Invasive Species Control in Florida</i>	3.8 476.0	3.9 492.6	4.1 595.4	4.1 624.0	4.3 337.2	4.3 332.8

Behaviors

There was no significant PRE/POST change among any of the groups in percent who had seen lionfish or who had reported their sightings to the FWC. Of all respondents who indicated they had seen lionfish in Florida, 12% in the PRE survey and 10% in the POST survey said they reported their sightings. See *Interim Report* (Harvey and Mazzotti 2015) for details on sightings and reports.

POST survey respondents who had seen lionfish but had not reported their sightings (*N* = 253) gave the following reasons for not reporting. The percent who gave the first reason (did not know) was approximately the same as in the PRE survey (73%).

- 75% -- Did not know that the FWC wanted people to report lionfish sightings
- 6% -- Knew the FWC wanted reports, but they did not know how to make a report.
- 19% -- Did not think it was necessary because lionfish sightings are so common.
- 13% -- I reported my sighting to someone else (e.g., dive master, dive shop).
- 6%* -- It was a long time ago.
- 2%* -- I remove them (rather than report).
- 3% - Other reasons

* Indicates write-in responses.

There was also no significant PRE/POST difference in likelihood of reporting lionfish sightings in the future.

We added two questions about lionfish sightings on the POST survey: "About how many TOTAL LIONFISH have you seen in the wild while SCUBA diving, snorkeling, and/or saltwater angling in Florida?" and "At what depth(s) have you seen lionfish while SCUBA diving?"

Of all respondents who reported seeing lionfish while diving, snorkeling, and/or angling in Florida (*N* = 280), 31% reported seeing a total of 1-5 lionfish, 21% reported seeing 5-10, 16% reported seeing 10-20, 18% reported seeing 20-100, and 15% reported seeing more than 100 lionfish.

Out of all certified SCUBA divers surveyed who had seen lionfish while SCUBA diving ($N = 180$), most reported seeing them at 20-40 ft. and < 20 ft. depths, with smaller proportions reporting them at greater depths (Figure 5).

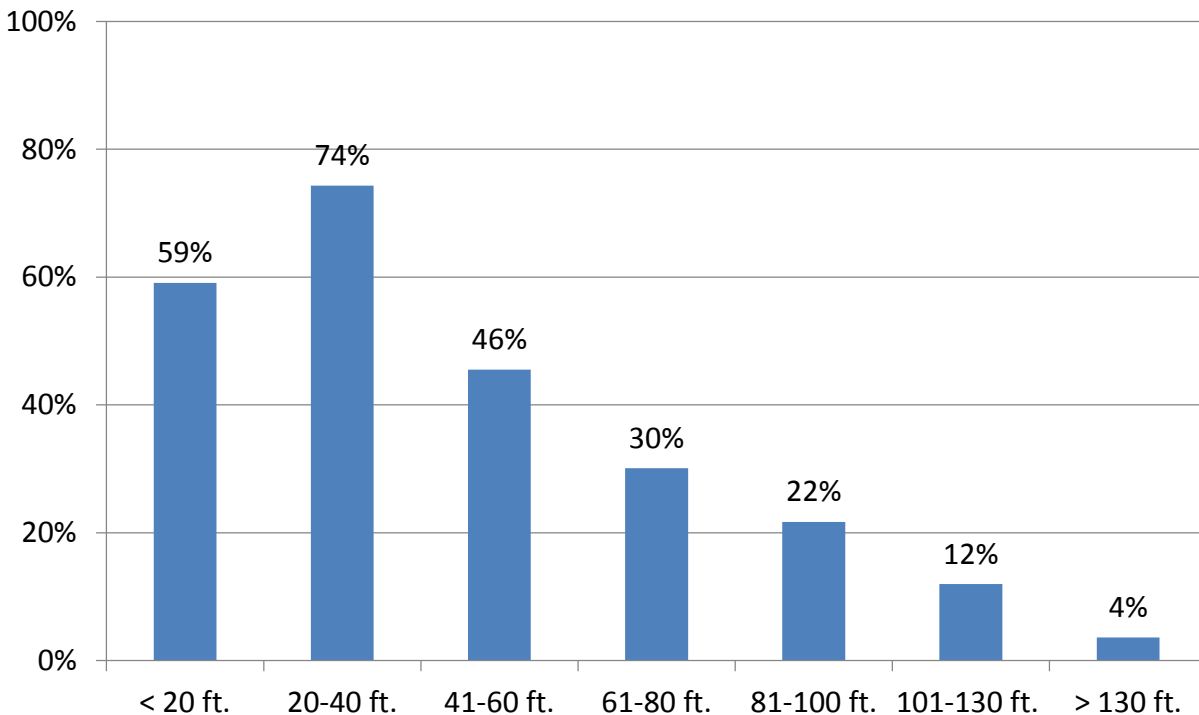


Figure 5. “At what depth(s) have you seen lionfish while SCUBA diving? (CHECK ALL THAT APPLY).” Percentage of all certified SCUBA divers in post-outreach campaign survey who had seen lionfish while diving ($N = 180$).

In the POST survey, 42% of all respondents who had *ever seen lionfish* while SCUBA diving or snorkeling reported that they had *removed a lionfish* (51% of SCUBA divers, 34% of saltwater anglers, and 4% of the general public who had seen lionfish). This represents 31% of the entire SCUBA diver group, 6% of the saltwater anglers, and 0.2% of the general public group, and was not significantly different from the PRE survey ($\chi^2 = .18, p = .364$).

Reasons given for removing lionfish did not differ significantly between the PRE and POST surveys. In the POST survey, 93% of those who had removed lionfish said that one of their reasons was “To remove an invasive species from the reef ecosystem”; 50% said “They are good to eat”; 41% said “They are an easy target once spotted”; 31% said “I might as well spear them since I’m already hunting”; 25% said “It is fun to spear them as a dive activity”; and 7% gave other reasons that included the following:

- Because there are hundreds on every spot I dive
- Can sell them to restaurants
- FWC says “kill them”
- I have a SPL and sell them commercially (2 respondents)

- Part of the mini lobster season
- To protect species in that particular reef

Reasons given for *not removing lionfish* (among those who had seen a lionfish while diving or snorkeling) also did not differ significantly PRE/POST. POST-survey responses ($N = 181$) were as follows:

- 56% -- I do not have appropriate gear
- 23% -- They are not my target species
- 27% -- I do not spearfish
- 18% -- I am afraid of getting stung
- 11% -- Someone else in my group removed the lionfish (e.g., the dive master)*
- 9% -- I did not know that lionfish were an invasive species*
- 9% -- I do not have enough dive time
- 3% -- I am not comfortable killing animals*
- 12% -- Other reasons

** Indicates response options that were not asked on the PRE survey.*

We added an additional question on the POST survey for respondents who indicated “I do not spearfish” as a reason for not removing lionfish ($n = 50$): “How interested are you in learning how to spearfish?” 10 people (20%) said they were “very interested,” 22 (44%) said “somewhat interested,” 8 (16%) said “undecided,” 6 (12%) said “not very interested,” and 4 (8%) said “not at all interested.”

There were no significant PRE/POST differences in other behaviors toward lionfish (Table 10). We compared likelihood of taking actions in the future using Mann-Whitney U tests because responses on the 5-point likelihood scale were not normally distributed (Table 11). Saltwater anglers were significantly more likely in the POST survey to report that they would talk with others about lionfish (Mann-Whitney U , $Z = 1.97$, $p = .048$), eat lionfish (Mann-Whitney U , $Z = 2.98$, $p = .003$), order lionfish in a restaurant (Mann-Whitney U , $Z = 2.19$, $p = .029$), and file a lionfish (Mann-Whitney U , $Z = 2.18$, $p = .029$). SCUBA divers and the general public were significantly *less likely* to say that they would download the “Report Florida Lionfish” app (divers, Mann-Whitney U , $Z = -2.90$, $p = .004$; general public, Mann-Whitney U , $Z = .63$, $p < .001$).

Table 10. Percentages of each group who answered “yes” in pre- and post-outreach campaign surveys to a series of questions about experiences with lionfish. None of these differences are statistically significant at the $p < .05$ level based on χ^2 tests.

Action	FLORIDA GENERAL PUBLIC		SALTWATER ANGLERS		SCUBA DIVERS	
	PRE	POST	PRE	POST	PRE	POST
Heard about the “Report Florida Lionfish” app	3.6%	5.8%	11.7%	12.6%	18.9%	19.5%
Downloaded the “Report Florida Lionfish” App	1.4%	1.8%	0.9%	1.2%	3.1%	2.0%
Eaten lionfish	1.2%	2.1%	7.0%	5.9%	26.0%	25.3%
Ordered lionfish on a restaurant menu	0.5%	1.6%	2.4%	2.7%	10.0%	9.1%
Fileted a lionfish	0.5%	0.8%	3.8%	2.5%	15.4%	16.5%
Talked with people about the lionfish invasion more than “a few times” in past year	19.7%	10.7%	18.4%	11.8%	33.8%	29.5%

Table 11. Respondents’ reported likeliness of taking future actions related to lionfish in pre- and post-outreach campaign surveys. Means and mean ranks of distributions of scores on five-point scale, based on Mann-Whitney U tests. Bold values indicate statistically significant PRE/POST differences at the $p < .05$ level based on t - tests.

Action	FLORIDA GENERAL PUBLIC		SALTWATER ANGLERS		SCUBA DIVERS	
	PRE	POST	PRE	POST	PRE	POST
	Mean on five-point scale (1=very unlikely to 5=very likely)					
	MEAN RANKS OF DISTRIBUTIONS					
Talk with others about the lionfish invasion	3.7 497.6	3.5 469.2	3.8 593.1	3.9 629.9	4.3 340.5	4.2 328.7
Download the “Report Florida Lionfish” app for smart phones	2.9 511.1	2.5 438.9	2.8 611.3	2.8 601.3	3.3 345.6	3.0 304.3
Eat a lionfish	1.7 475.6	1.8 493.1	2.6 580.6	2.8 639.3	3.5 329.0	3.6 336.8
Order lionfish on a restaurant menu	1.7 476.7	1.8 492.0	2.5 591.4	2.6 634.3	3.3 329.9	3.3 337.0
Filet a lionfish	1.6 479.3	1.6 489.1	2.3 589.5	2.5 632.1	3.1 327.3	3.2 337.5

Effects of Exposure to News Coverage (Bivariate Analyses)

To understand effects of lionfish outreach on knowledge, attitudes, and behaviors, we used a single independent variable, *exposure to news coverage*, which was measured with the question: “Have you seen anything related to lionfish in news coverage in the last month?” We chose this question because a) it was asked in both surveys and b) it exhibited significant PRE/POST change in two of the survey groups (see Figure 1). Other questions assessing exposure to lionfish outreach, which were only asked on the POST survey, correlated significantly with exposure to news coverage (awareness of LRAD, $\Phi = .393$, $p < .001$; knowledge of extra lobster for catching 10 lionfish, $\Phi = .326$, $p < .001$; knowledge of REEF Rangers, $\Phi = .136$, $p < .001$; attended any lionfish events or workshops, $\Phi = .103$, $p < .001$). In preliminary analyses, we found that these other measures exhibited effects similar to those found for exposure to news coverage.

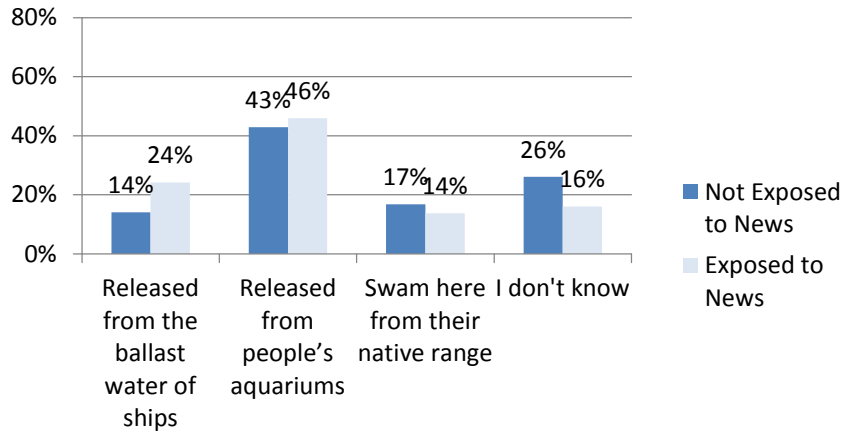
Knowledge

Exposure to news coverage about lionfish was associated with greater knowledge about lionfish. Among the general public, those who had seen news coverage were more likely to answer correctly that lionfish were introduced to Florida via aquarium releases (46% to 43%); however they were also more likely to think lionfish were introduced via ballast water (24% to 14%; $\chi^2 = 8.8$, $p = .032$; Figure 6a). Saltwater anglers who had seen lionfish news were more likely to know that lionfish were introduced via aquarium releases (70% to 60%; $\chi^2 = 10.8$, $p = .013$; Figure 6b). Among SCUBA divers, the difference was not statistically significant (81% to 74%; $\chi^2 = 5.7$, $p = .129$; Figure 6c).

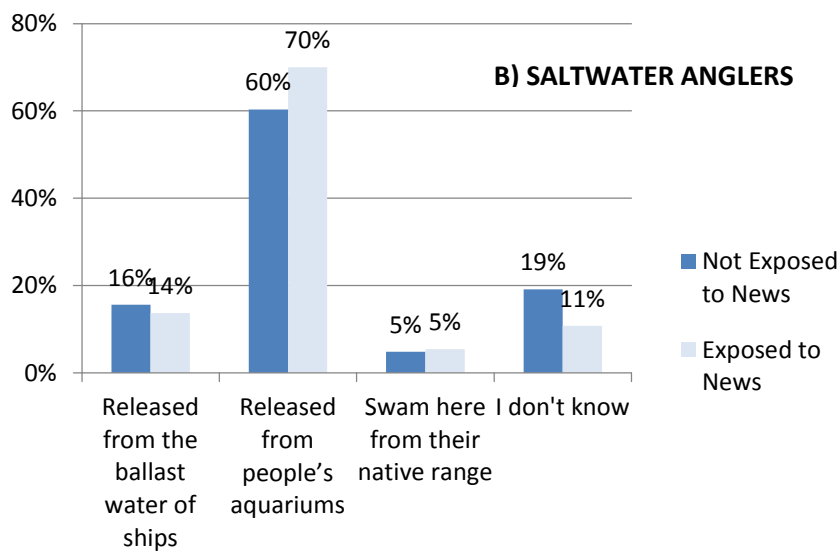
Respondents of all three groups who had seen news coverage were more likely to answer correctly (“false”) to the second knowledge question about whether a recreational fishing license is required to remove lionfish in Florida (when using a spear or handheld net): general public (37% to 14%, $\chi^2 = 31.3$, $p < .001$; Figure 7a), saltwater anglers (47% to 33%, $\chi^2 = 30.4$, $p < .001$; Figure 7b), and SCUBA divers (59% to 45%, $\chi^2 = 11.2$, $p = .004$; Figure 7c).

Exposure to news was also associated with more correct responses (“false”) to the third knowledge question, “True or False? People have died from lionfish stings”: general public (18% to 12%, $\chi^2 = 14.5$, $p < .001$; Figure 8a), saltwater anglers (23% to 11%, $\chi^2 = 21.8$, $p < .001$; Figure 8b), and SCUBA divers (36% to 22%, $\chi^2 = 15.2$, $p < .001$; Figure 8c).

A) GENERAL PUBLIC



B) SALTWATER ANGLERS



C) SCUBA DIVERS

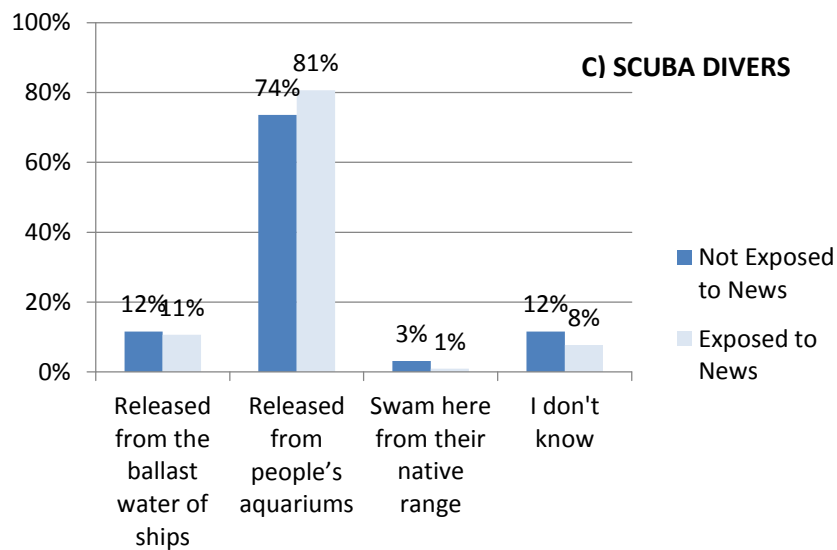


Figure 6. "What do you think is the most likely explanation for how lionfish first arrived in Florida's coastal waters?" Percentage response of those who had or had not "seen anything related to lionfish in news coverage in the last month" among a) General Public, b) Saltwater Anglers, and c) SCUBA divers.

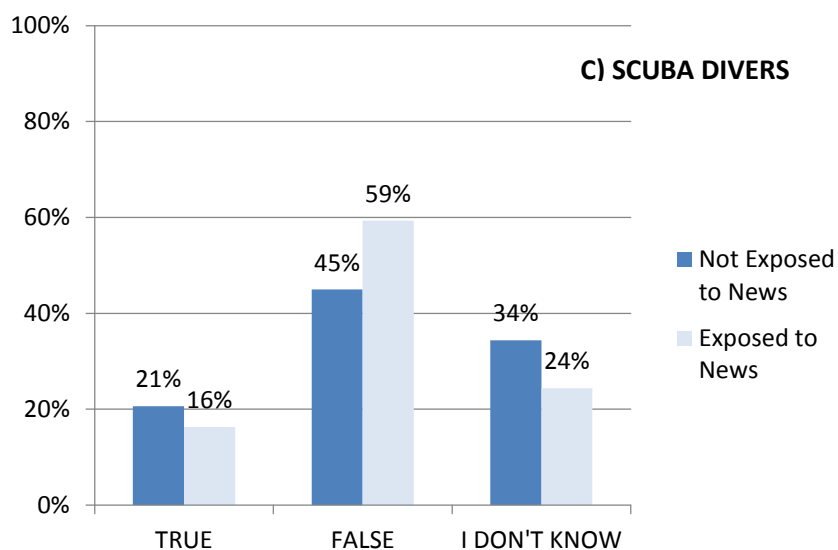
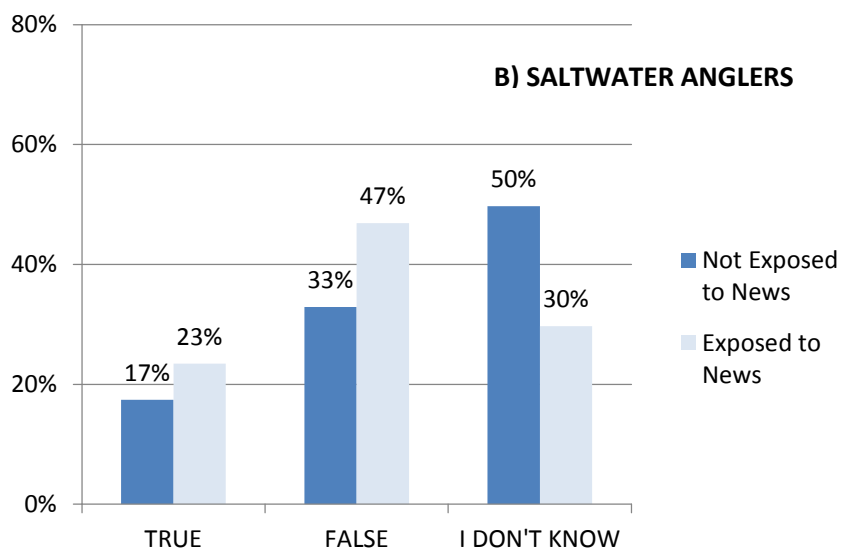
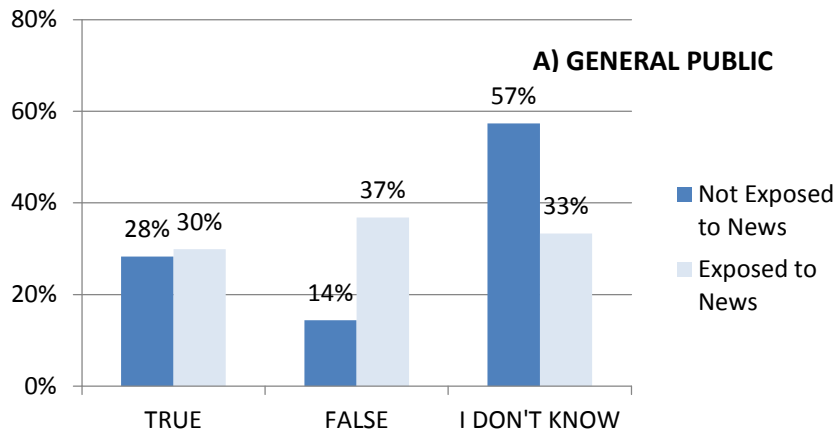


Figure 7. "True or False? You must have a recreational fishing license to legally remove lionfish in Florida." Percentage response of those who had or had not "seen anything related to lionfish in news coverage in the last month" among a) General Public, b) Saltwater Anglers, and c) SCUBA divers.

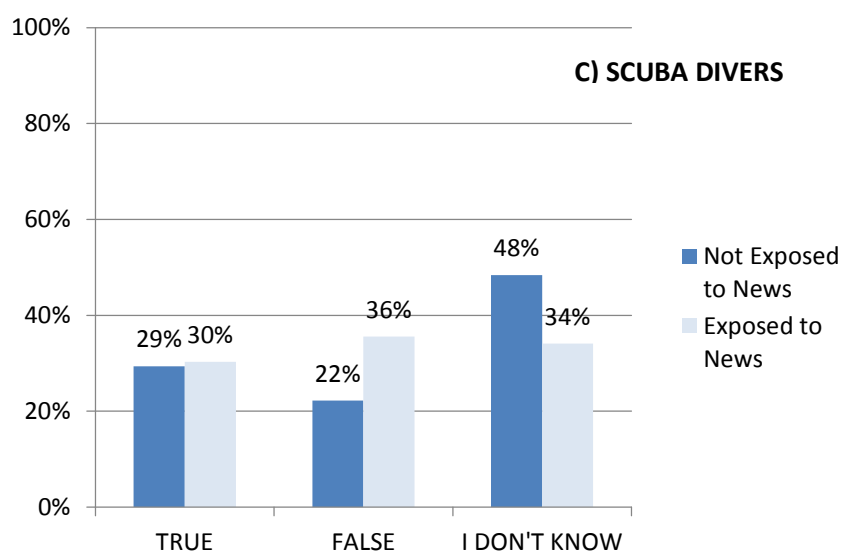
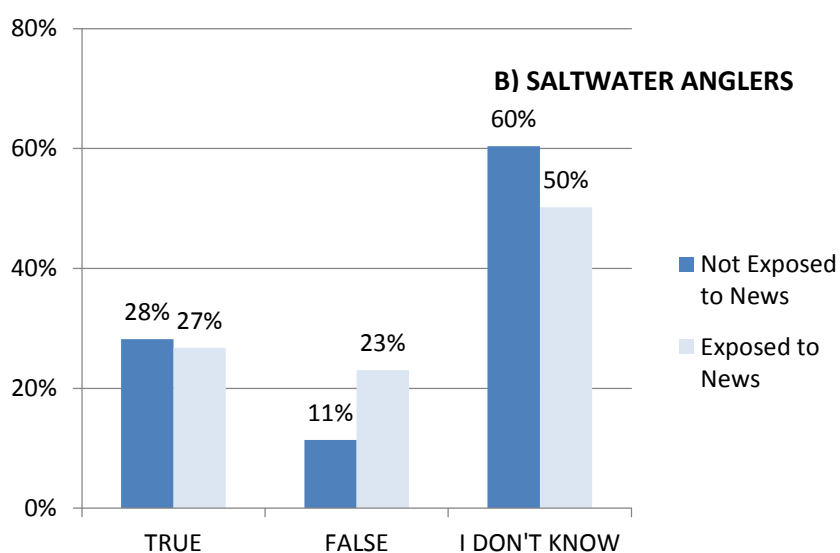
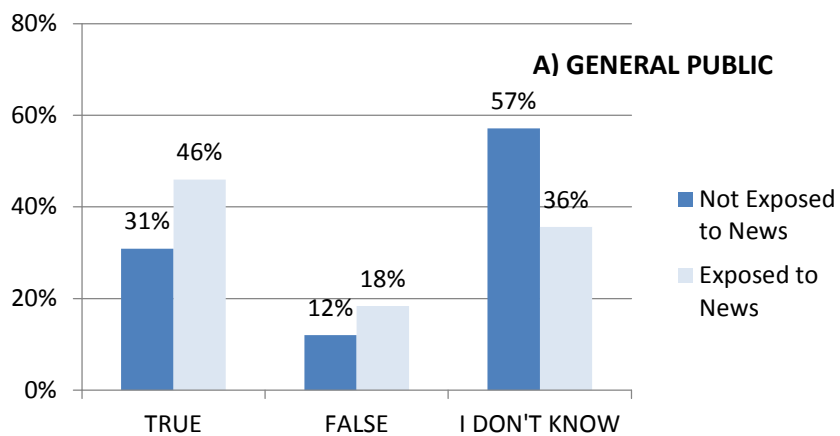


Figure 8. "True or False? People have died from lionfish stings." Percentage response of those who had or had not "seen anything related to lionfish in news coverage in the last month" among a) General Public, b) Saltwater Anglers, and c) SCUBA divers.

Attitudes

Table 12 shows differences in attitudes toward lionfish/invasive species based on exposure to lionfish news coverage within the last month. General public respondents who had seen news coverage were significantly *less likely* to think invasive species should be left alone (Component 1, Mann-Whitney U , $Z = -3.4$, $p = .001$), *more likely* to view lionfish as a serious threat (Component 3, Mann-Whitney U , $Z = 7.4$, $p < .001$), and *more likely* to support invasive species control (Component 4, Mann-Whitney U , $Z = 5.3$, $p < .001$).

Exposure to news coverage was linked to significant differences on all four attitudinal measures among both saltwater anglers (Component 1, Mann-Whitney U , $Z = 5.0$, $p < .001$; Component 2, Mann-Whitney U , $Z = -6.0$, $p < .001$; Component 3, Mann-Whitney U , $Z = 7.5$, $p < .001$; Component 4, Mann-Whitney U , $Z = 4.5$, $p < .001$) and SCUBA divers (Component 1, Mann-Whitney U , $Z = -2.8$, $p = .006$; Component 2, Mann-Whitney U , $Z = -4.6$, $p < .001$; Component 3, Mann-Whitney U , $Z = 4.0$, $p < .001$; Component 4, Mann-Whitney U , $Z = 3.5$, $p < .001$). Among both groups, exposure to news coverage was *negatively associated* with the attitude that invasive species should be left alone and fear of lionfish (Components 1 and 2), and *positively associated* with the attitude that lionfish are a serious threat and support for invasive species control (Components 3 and 4).

Table 12. Means and mean ranks of distributions of scores on 4 attitudinal measures, based on Mann-Whitney U tests comparing respondents who had and had not seen anything related to lionfish in news coverage in the last month. PRE and POST samples are combined. Bold values indicate statistically significant differences at the $p < .05$ level.

Attitudinal Component	FLORIDA GENERAL PUBLIC		SALTWATER ANGLERS		SCUBA DIVERS	
	Didn't See News Coverage	Saw News Coverage	Didn't See News Coverage	Saw News Coverage	Didn't See News Coverage	Saw News Coverage
	Mean on five-point scale (1=strongly disagree to 5=strongly agree) MEAN RANKS OF DISTRIBUTIONS					
<i>Component 1: Invasive Species have Intrinsic Value and Should be Left Alone</i>	2.7 494.8	2.0 398.7	1.7 638.5	1.6 517.8	1.4 349.5	1.3 307.5
<i>Component 2: Fear of Lionfish</i>	3.7 489.6	3.7 440.3	2.7 643.7	2.0 499.1	2.0 360.0	1.7 289.4
<i>Component 3: Lionfish are a Serious Threat to Florida's Ecosystems and Fisheries</i>	3.8 460.6	4.3 668.6	4.0 572.4	4.5 753.2	4.5 312.0	4.8 372.9
<i>Component 4: Support for Invasive Species Control in Florida</i>	3.8 467.0	4.2 618.0	4.0 584.2	4.2 692.6	4.2 314.6	4.4 368.3

Behaviors

Table 13 shows differences in behaviors toward lionfish based on exposure to lionfish news coverage. Members of the general public who had seen news coverage were significantly more likely to have heard about the "Report Florida Lionfish" app for smart phones ($\chi^2 = 48.0$, $p < .001$) and to have downloaded the app ($\chi^2 = 12.1$, $p = .001$). They were also more likely to have eaten lionfish ($\chi^2 = 24.7$, $p < .001$), ordered lionfish in a restaurant ($\chi^2 = 33.6$, $p < .001$), fileted a lionfish ($\chi^2 = 12.3$, $p < .001$), and talked with people about the lionfish invasion ($\chi^2 = 30.1$, $p < .001$). They were not significantly more

likely to have reported their lionfish sightings to FWC ($\chi^2 = 3.7, p = .054$) or to have removed a lionfish ($\chi^2 = 3.0, p = .083$).

Saltwater anglers who had seen news coverage were significantly more likely to have heard about the “Report Florida Lionfish” app for smart phones ($\chi^2 = 31.5, p < .001$), downloaded the app ($\chi^2 = 3.9, p = .048$), eaten lionfish ($\chi^2 = 24.4, p < .001$), ordered lionfish in a restaurant ($\chi^2 = 24.6, p < .001$), fileted a lionfish ($\chi^2 = 9.8, p = .002$), and talked with people about the lionfish invasion ($\chi^2 = 32.1, p < .001$). They were not significantly more likely to have reported their lionfish sightings to FWC ($\chi^2 = 3.0, p = .082$) or to have removed a lionfish ($\chi^2 = .3, p = .620$).

SCUBA divers who had seen news coverage were significantly more likely to have heard about the “Report Florida Lionfish” app for smart phones ($\chi^2 = 18.8, p < .001$), downloaded the app ($\chi^2 = 5.0, p = .025$), eaten lionfish ($\chi^2 = 5.1, p = .023$), fileted a lionfish ($\chi^2 = 6.2, p = .013$), talked with people about the lionfish invasion ($\chi^2 = 42.9, p < .001$), and removed a lionfish ($\chi^2 = 5.3, p = .021$). They were not significantly more likely to have ordered lionfish in a restaurant ($\chi^2 = 1.4, p = .233$) or to have reported their lionfish sightings to FWC ($\chi^2 = 3.7, p = .055$).

Table 13. Percentages of each group who engaged in behaviors toward lionfish, based on whether they had seen anything related to lionfish in news coverage in the last month. PRE and POST samples are combined. Percentages are out of total respondents unless otherwise indicated. Bold values indicate statistically significant differences at the $p < .05$ level based on χ^2 tests.

Action	FLORIDA GENERAL PUBLIC		SALTWATER ANGLERS		SCUBA DIVERS	
	Didn't See News Coverage	Saw News Coverage	Didn't See News Coverage	Saw News Coverage	Didn't See News Coverage	Saw News Coverage
Heard about the “Report Florida Lionfish” App	2.8%	19.3%	9.2%	22.6%	14.0%	28.7%
Downloaded the “Report Florida Lionfish” App	0.3%	12.5%	0.5%	3.3%	0.8%	5.7%
Eaten lionfish	0.8%	8.0%	4.6%	13.4%	22.7%	31.3%
Ordered lionfish on a restaurant menu	0.3%	6.8%	1.4%	7.1%	8.5%	11.5%
Fileted a lionfish	0.3%	3.4%	2.3%	6.3%	13.2%	21.1%
Talked with people about the lionfish invasion more than “a few times” in past year	5.8%	26.1%	9.7%	20.5%	21.1%	45.5%
Reported lionfish sightings to FWC*	20.8%	50.0%	5.0%	11.6%	8.6%	15.6%
Removed lionfish while diving or snorkeling**	2.9%	15.8%	36.8%	40.3%	45.9%	58.3%

*Percentages of respondents who had *seen lionfish in Florida*.

** Percentages of respondents who had *seen lionfish (anywhere)* while SCUBA diving or snorkeling.

Multivariate Analyses

We performed multivariate regression analyses to examine the factors that influence people's knowledge, attitudes, and behaviors regarding lionfish. We included 11 independent variables in the models: time (PRE/POST survey), survey group (general public, SCUBA diver, or saltwater angler), news exposure, direct experience with lionfish (ever seen a lionfish while diving, snorkeling or angling), and demographic characteristics (gender, education, age, ethnicity, and race). Multicollinearity was not a problem: the highest bivariate correlation between independent variables was $\phi = -0.396$ ($p < .001$, between General Public and SCUBA Diver), and the highest variance inflation factor was 1.45 (for General Public).

We examined three sets of dependent variables: knowledge, attitudes, and behaviors toward lionfish.

Knowledge

We used binomial logistic regression to predict knowledge because all four dependent variables were dichotomous (i.e., yes/no or correct/incorrect response). For the first variable, awareness that there are invasive lionfish in Florida, the logistic regression model was statistically significant, $\chi^2(10) = 558.3$, $p < .001$ (Table 14). Lack of significance of the Hosmer and Lemeshow goodness-of-fit test suggested a good-fitting model: $\chi^2(8) = 15.1$, $p = .057$. The model explained 31.7% (Nagelkerke R^2) of the variance in awareness and correctly classified 80.6% of cases.

For the three measures of knowledge about lionfish (knowledge of introduction source, knowledge that a license is not required to remove lionfish when using a spear or handheld net, and knowledge that people do not die from lionfish stings), logistic regression models were statistically significant (Table 14). In addition, for all three, lack of significance of the Hosmer and Lemeshow goodness-of-fit tests indicated good-fitting models (p -values 0.215, 0.598, and 0.764 respectively). The models explained between 10.0% and 14.3% (Nagelkerke R^2) of the variance in correct answers and correctly classified 65.0–82.8% of cases (Table 14).

Significant results were as follows (Table 14):

- POST survey respondents were 1.3 times more likely than PRE respondents to know that there are invasive lionfish in Florida's coastal waters. However, POST respondents were less likely than PRE respondents (0.8 times) to know that lionfish were introduced through aquarium releases.
- The general public was 0.2 times as likely as anglers/divers to know there are lionfish in Florida, 0.5 times as likely to know that lionfish were introduced through aquarium releases, and 0.5 times as likely to know that a license is not required to remove lionfish.
- SCUBA divers were 2.2 times more likely as others to know there are lionfish in Florida, 1.4 times more likely to know that lionfish were introduced through aquarium releases, and 1.5 times more likely to know that people haven't died from lionfish stings.
- People who had seen lionfish news coverage were 1.3 times more likely to know that lionfish were introduced through aquarium releases, 1.7 times more likely to know that a license is not required to remove lionfish, and 1.9 times more likely to know that people haven't died from lionfish stings.
- People who had direct experience with lionfish (i.e., had seen a lionfish while diving, snorkeling, or angling) were 4.4 times more likely to know there are lionfish in Florida, 1.5 times more likely to know that lionfish were introduced through aquarium releases, 1.7 times more likely to know

that a license is not required to remove lionfish, and 2.1 times more likely to know that people haven't died from lionfish stings.

- Women were 0.6 times as likely as men to know that there are lionfish in Florida, 0.6 times as likely to know that a license is not required to remove lionfish, and 0.6 times as likely to know that people haven't died from lionfish stings.
- Older people were less likely than younger people (0.99 times odds for each year older) to know that people haven't died from lionfish stings.
- Blacks/African Americans were 0.6 times as likely as whites/others to know that there are lionfish in Florida, and 0.6 times as likely to know that lionfish were introduced through aquarium releases.
- Education, Hispanic/Latino ethnicity, and other race had no significant effects on any of the knowledge measures.

Table 14. Odds ratios and significance values from binomial logistic regression analyses examining effects of time, news exposure, lionfish experience, and demographics on knowledge of lionfish.

<i>Dependent variables</i> → <i>Independent variables</i> ↓	Did you know that there are invasive lionfish in Florida's coastal waters? ("yes")	What do you think is the most likely explanation for how lionfish first arrived in Florida? ("aquarium releases")	True or False? You must have a recreational fishing license to legally remove lionfish in Florida. ("false")	True or False? People have died from lionfish stings. ("false")
POST Survey	1.272*	.790**	.922	.812
General Public	.216***	.535***	.460***	1.207
SCUBA Diver	2.220**	1.448**	1.238	1.523**
News Exposure	---†	1.298*	1.695***	1.880***
Seen Lionfish	4.363***	1.513***	1.729***	2.082***
Female	.592***	.891	.648***	.632**
B.A. or higher	.924	1.082	1.085	1.180
Age	1.006	1.002	.994	.989**
Hispanic/Latino	.749	1.069	.806	.745
Black	.570*	.576*	1.126	1.278
Other race	.913	1.281	1.045	1.505
Omnibus χ^2	558.3***	189.8***	270.8***	158.7***
N	2481	2471	2475	2475
Nagelkerke R^2	31.7%	10.0%	14.3%	10.3%
% of cases correctly classified	80.6%	65.0%	67.2%	82.8%

* $p < .05$, ** $p < .01$, *** $p < .001$

Measures included: time (POST vs. PRE survey), survey group (General Public or SCUBA Diver vs. Saltwater Angler), news exposure (seen anything related to lionfish in last month vs. not), direct experience (ever seen a lionfish while diving, snorkeling or angling vs. not), gender (female vs. male), education (B.A. or higher vs. less than B.A.), age (continuous), ethnicity (Hispanic vs. non-Hispanic), and race (black/African-American or other races vs. white).

† News exposure was not included in model predicting response to "Did you know that there are invasive lionfish in Florida's coastal waters?" because respondents who answered "no" to this question were not asked whether they had seen news about lionfish.

Attitudes

We used linear regression to predict attitudes because the four dependent variables (composite attitude scales) were ordinal scales that can be treated as continuous variables (Vaske 2008). The models met the assumptions of linear regression. Durbin-Watson statistics were close to 2 for each of the dependent variables (1.83, 1.99, 1.84, 1.99), confirming independence of residuals. Visual examination of histogram and normal probability plots confirmed homoscedasticity and approximately normal distribution of residuals.

For attitude component 1, the independent variables explained 30.6% (adjusted R^2) of the variance, and the model was statistically significant, $F(11, 2461) = 100.0, p < .001$ (Table 15). For component 2, the independent variables explained 36.8% (adjusted R^2) of the variance, and the model was statistically significant, $F(11, 2461) = 131.8, p < .001$. For component 3, the independent variables explained 11.2% (adjusted R^2) of the variance, and the model was statistically significant, $F(11, 2462) = 29.5, p < .001$. For component 4, the independent variables explained 8.9% (adjusted R^2) of the variance, and the model was statistically significant, $F(11, 2458) = 22.8, p < .001$.

Significant results were as follows (Table 15):

- POST survey respondents were less likely than PRE respondents to fear lionfish and more likely to view lionfish as a serious threat to ecosystems/fisheries.
- The General Public were more likely than other groups to believe invasive species should be left alone, more likely to fear lionfish, less likely to view lionfish as a serious threat to ecosystems/fisheries, and less likely to support invasive species control efforts.
- SCUBA divers were less likely than other groups to believe invasive species should be left alone, less likely to fear lionfish, and more likely to view lionfish as a serious threat to ecosystems/fisheries.
- People who were exposed to news coverage about lionfish and people who had direct experience with lionfish were: less likely to believe invasive species should be left alone, less likely to fear lionfish, more likely to view lionfish as a serious threat to ecosystems/fisheries, and more likely to support invasive species control efforts.
- Women were more likely than men to believe invasive species should be left alone, to fear lionfish, and to view lionfish as a serious threat to ecosystems/fisheries.
- Education level (B.A. or higher vs. less than B.A.) had no significant effect on any of the attitude measures.
- Older people were less likely than younger people to believe invasive species should be left alone, more likely to fear lionfish, and more likely to support invasive species control efforts.
- Hispanics/Latinos were more likely than non-Hispanics to believe invasive species should be left alone and to fear lionfish.
- Blacks/African Americans and other races were more likely than whites to believe invasive species should be left alone. Blacks/African Americans were also more likely than others to fear lionfish.

Table 15. Standardized regression coefficients (β) and significance values from multiple linear regression analyses examining effects of time, news exposure, lionfish experience, and demographics on attitudes toward lionfish and other invasive species.

Dependent variables → Independent variables ↓	Component 1: Invasive Species have Intrinsic Value and Should be Left Alone	Component 2: Fear of Lionfish	Component 3: Lionfish are a Serious Threat to Florida's Ecosystems and Fisheries	Component 4: Support for Invasive Species Control in Florida
POST Survey	-.016	-.037*	.039*	.017
General Public	.373***	.301***	-.140***	-.184***
SCUBA Diver	-.073***	-.133***	.059**	.028
News Exposure	-.077***	-.083***	.170***	.123***
Seen Lionfish	-.043*	-.174***	.133***	.053*
Female	.079***	.166***	.046*	.006
B.A. or higher	-.012	-.014	.014	.004
Age	-.200***	.039*	.002	.103***
Hispanic/Latino	.056**	.082***	-.031	-.023
Black	.075***	.053**	.005	-.030
Other race	.051**	.025	-.030	-.030
<i>F</i>	100.0***	131.8***	29.5***	22.8***
<i>N</i>	2473	2473	2474	2470
Adjusted <i>R</i> ²	30.6%	36.8%	11.2%	8.9%

* $p < .05$, ** $p < .01$, *** $p < .001$

Measures included: time (POST vs. PRE survey), survey group (General Public or SCUBA Diver vs. Saltwater Angler), news exposure (seen anything related to lionfish in last month vs. not), direct experience (ever seen a lionfish while diving, snorkeling or angling vs. not), gender (female vs. male), education (B.A. or higher vs. less than B.A.), age (continuous), ethnicity (Hispanic vs. non-Hispanic), and race (black/African-American or other races vs. white).

Behaviors

We used binomial logistic regressions to predict participation in four behaviors toward lionfish: reporting, removing, eating, and talking with people about lionfish (all dichotomous variables). For all four measures, logistic regression models were statistically significant. Lack of significance of the Hosmer and Lemeshow goodness-of-fit tests indicated good-fitting models (p -values 0.647, 0.927, 0.710, and 0.625 respectively). The models explained between 10.5% and 35.4% (Nagelkerke R^2) of the variance in correct answers and correctly classified 65.5–90.9% of cases (Table 16).

Significant results were as follows (Table 16):

- POST respondents were less likely than PRE respondents (0.7 times) to report that they had talked with people about the lionfish invasion during the past year.
- Members of the general public were 3.8 times more likely than anglers/divers to say they had reported lionfish to the FWC. However, they were much less likely to have removed (0.1 times), eaten (0.4 times), or talked to people about lionfish (0.5 times).

- SCUBA divers were 2.2 times more likely than others to have removed lionfish, 2.4 times more likely to have eaten lionfish, and 1.8 times more likely to have talked with people about lionfish.
- People who had seen lionfish news coverage were more likely to have engaged in all four behaviors (2.7, 1.6, 1.9, and 3.2 odds, respectively).
- People who had direct experience (i.e., had seen lionfish while diving, snorkeling, or angling) were 9.2 times more likely to have eaten and 4.4 times more likely to have talked with people about lionfish.
- Older people were less likely than younger people to have removed, eaten, and talked with people about lionfish (0.96, 0.97, and 0.99 times odds for each year older).
- People of “other races” were less likely than whites/blacks to have removed (0.25 times) and eaten (0.45 times) lionfish.
- Gender, education, Hispanic ethnicity, and black/African-American race had no significant effects on the behaviors.

Table 16. Odds ratios and significance values from binomial logistic regression analyses examining effects of time, news exposure, lionfish experience, and demographics on behaviors toward lionfish.

<i>Dependent variables</i> → <i>Independent variables</i> ↓	Reported lionfish to FWC (only among those who had seen lionfish in Florida)	Removed lionfish (only among those who had ever seen lionfish while diving or snorkeling)	Eaten lionfish	Talked with people about the lionfish invasion in the past year
POST Survey	.691	.889	.991	.719**
General Public	3.836**	.103***	.356**	.525***
SCUBA Diver	1.652	2.242***	2.436***	1.819**
News Exposure	2.722**	1.592*	1.931***	3.217***
Seen Lionfish	---†	---†	9.190***	4.365***
Female	.980	.630	1.028	1.085
B.A. or higher	.697	.923	1.066	.890
Age	.983	.956***	.971***	.989**
Hispanic/Latino	2.135	1.201	1.081	.995
Black	4.222	2.135	1.681	1.384
Other race	---†	.247*	.448*	.842
Omnibus χ^2	30.6***	107.7***	443.6***	278.6***
N	578	646	2475	1972
Nagelkerke R^2	10.5%	20.7%	35.4%	21.0%
% of cases correctly classified	89.8%	65.5%	90.9%	81.1%

* $p < .05$, ** $p < .01$, *** $p < .001$

Measures included: time (POST vs. PRE survey), survey group (General Public or SCUBA Diver vs. Saltwater Angler), news exposure (seen anything related to lionfish in last month vs. not), direct experience (ever seen a lionfish while diving, snorkeling or angling vs. not), gender (female vs. male), education (B.A. or higher vs. less than B.A.), age (continuous), ethnicity (Hispanic vs. non-Hispanic), and race (black/African-American or other races vs. white).

† Experience of seeing lionfish was not included in models predicting reporting and removing lionfish because only respondents who had seen lionfish were included in these models.

Other race was not included in model predicting reporting lionfish because of the small number of cases ($n = 15$) in this category.

Discussion

The first objective of this study was to quantify exposure to lionfish outreach and news coverage among saltwater anglers, SCUBA divers, and the general public of Florida. As shown in Figure 1, more saltwater anglers and SCUBA divers were exposed to news coverage about lionfish in the POST survey than in the PRE survey, suggesting that FWC's outreach may have reached target audiences through media coverage of issues and events related to lionfish. In addition, POST survey responses indicated that some of FWC's specific outreach programs had reached the awareness of SCUBA divers (nearly half of whom were aware of LRAD and the extra lobster rule) and to a lesser extent saltwater anglers (see Figure 2). Substantially fewer divers (28%) and anglers (21%) knew about the "Reef Rangers" program than the other two programs, however, suggesting that information about Reef Rangers had not been as widely disseminated at the time of the POST survey (fall 2015).

Our second objective was to assess changes between PRE and POST surveys in knowledge, attitudes, and behaviors toward lionfish. Any changes would presumably be due to effects of outreach conducted between the PRE and POST surveys. We hypothesized, first, that POST responses would manifest greater awareness and knowledge of lionfish compared to PRE responses. Results partially supported this hypothesis. Awareness of lionfish increased significantly. In multiple regression analysis (with respondent group, experiential and demographic variables controlled in the model), POST survey respondents were significantly more likely to know that there are invasive lionfish in Florida's coastal waters. SCUBA divers are equally aware of lionfish and Burmese pythons, but anglers and the general public remain more aware of pythons than lionfish (Figure 4).

However, the specific knowledge questions (lionfish introduction source, license requirements, and fatality of lionfish stings) did not exhibit a detectable increase in the POST survey in multivariate analyses. In fact, we found a decrease in likelihood that respondents knew that aquarium releases were the most likely explanation of lionfish introduction. We do not know the reason for this decrease; a possible explanation could be that people were exposed to misinformation (e.g., about lionfish being transported via ballast water). In any case, results suggest that FWC's specific messages about lionfish introduction, removal, and safety have not yet penetrated the public or target audiences.

In the PRE survey, attitudes of all groups already tended to align with management views and objectives (Harvey and Mazzotti 2015). Nonetheless, we hypothesized that there would be further changes in attitudes toward lionfish and invasive species in the POST survey. This hypothesis was partially supported. Multivariate analyses detected a decrease in fear of lionfish (Component 2) and an increase in beliefs that lionfish are a serious threat to ecosystems and fisheries (Component 3). There is also some indication (in bivariate analysis) that the general public became less likely to feel that invasive species have intrinsic value and should be left alone (Component 1). However, our measure of support for invasive species control (Component 4) did not change significantly PRE/POST. It is not surprising that these effects were not stronger: attitudes tend to change slowly, particularly when they are rooted in people's deeply-held values and personal experiences (Heberlein 2012). Attitude Components 1 and 4 are likely rooted in values about animal rights and government interventions, respectively, which may explain why they are less likely to change. Also consistent with attitude theory, we found that direct experience (seeing lionfish) affected attitudes, and that attitudes changed least among those with the most experience (SCUBA divers). However, when people have weak attitudes toward an object (e.g., lionfish), information has more potential to shape their attitudes (Heberlein 2012). Thus far, FWC's

lionfish outreach may be influencing relatively malleable attitudes (Components 2 and 3) of less-involved segments of the public (anglers and the public).

Because FWC's outreach aimed to increase participation in lionfish removal efforts (e.g., through participatory events and incentives), we hypothesized that behaviors related to lionfish would become more prevalent in the POST survey. This hypothesis was not supported. None of the self-reported behaviors (reporting, removing, eating, ordering in a restaurant, fileting lionfish; talking with others about lionfish; or downloading the "Report Florida Lionfish" app) increased significantly between PRE and POST surveys. On the contrary, we detected a *decrease* in POST respondents' frequency of talking with people about lionfish. The reason for this finding is uncertain, but may be because people are becoming less likely to talk about lionfish over time as lionfish become less of a novel subject. Overall, our findings suggest that FWC's efforts to increase participation in lionfish removal did not reach broadly enough into the aggregate study populations to produce detectable changes in the small population of individuals who are inclined to engage in these behaviors (discussed further below).

We did find increases in saltwater anglers' *behavioral intentions* to talk with others about lionfish, eat lionfish, order lionfish in a restaurant, and filet a lionfish in the future. But we also found a *decrease* in behavioral intention to download the "Report Florida Lionfish" app among SCUBA divers and the public. Behavioral intention is an indirect measure that may not accurately reflect actual behavior (e.g., Bishop and Heberlein 1979), which is why we considered measures of *actual behavior* rather than behavioral intention as our dependent variables in multivariate analyses.

Some demographic characteristics had significant relationships with knowledge, attitudes, and behaviors toward lionfish. Women were significantly less knowledgeable than men on three of our knowledge measures. They also expressed greater fear of lionfish, stronger attitudes that invasive species have intrinsic value and should be left alone, and (perhaps counter-intuitively) stronger beliefs that lionfish are a serious threat to ecosystems and fisheries. Blacks/African Americans had lower knowledge on two of our measures. Blacks and Hispanics scored higher on attitude components 1 and 2 (and other races on component 1). Age affected responses on one of the knowledge measures, three of the attitudinal, and three of the behavioral measures. Perhaps surprisingly, education level had no significant effects on any of the dependent variables. Outreach practitioners should keep in mind these demographic differences when targeting various groups with information and persuasive communication.

Overall, knowledge, attitudes, and particularly behaviors did not change dramatically between PRE and POST samples *in the aggregate*. However, one variable that did change substantially PRE/POST was exposure to news coverage (Figure 1). Thus, we focused on this independent variable as a proxy measure for exposure to outreach (it had similar effects on the dependent variables as other measures of outreach exposure in the POST survey—e.g., awareness of LRAD, awareness of extra lobster rule). We hypothesized that exposure to news coverage would predict greater knowledge, more management-aligned attitudes, and greater behavioral involvement in lionfish control. This hypothesis was fully supported: people who had seen news coverage about lionfish were significantly more knowledgeable, more behaviorally involved, and more aligned with management on all attitudinal measures. Correlation is not necessarily causation, however; it may be that greater knowledge, concern, and involvement lead some people to seek out news sources about lionfish. However, the strength and consistency of the relationship between news exposure and all response variables leads us to the following general conclusion:

In the *aggregate populations* of anglers, divers, and the Florida public, FWC's 2015 lionfish outreach campaign may not have reached enough people to produce detectable, strong, and/or consistent changes in knowledge, attitudes, and behaviors. However, members of the target populations who were exposed to lionfish outreach messages (measured as news coverage) exhibited consistently greater knowledge, behavioral involvement, and management-aligned attitudes than people who were not exposed. This finding suggests that future outreach will likely have measurable effects on people's perceptions and actions to the extent that outreach messages are thoroughly disseminated to target populations.

In the future, broader use of news media to disseminate outreach messages may result in greater changes that are detectable in aggregate populations of recreationists and the public. In addition, future human dimensions research may benefit from a tiered approach that includes both broad aggregate surveys and targeted surveys of event participants. Surveying the latter group, using both quantitative and qualitative methods (e.g., interviews or focus groups) will provide a deeper understanding of how outreach effects changes in knowledge, attitudes, and behaviors of engaged segments of the public.

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Appendix 1: Newspapers and television shows/channels listed as information sources about lionfish in POST survey (PRE Survey responses listed in *Interim Report*)

Newspaper Name	Frequency
Fort Myers News Press	17
Palm Beach Post	13
Sun Sentinel	13
Tampa Tribune	7
Orlando Sentinel	5
Florida Today	4
Miami Herald	4
Tampa Bay Times	4
Florida Times Union	3
Free press, Florida Keys	3
Naples Daily News	3
Pensacola News Journal	3
TC Palm	3
Daytona News Journal	2
Destin Log	2
Engelwood Sun	2
Jacksonville Times Union	2
Northwest Florida Daily News	2
USA Today	2
Woods 'N Water	2
Appalachicola Times	1
Charlotte Sun	1
Coastal Magazine	1
Daily Sun	1
DNR fish guide in Florida	1
Florida wildlife guide	1
Gainesville	1
HT	1
Islander	1
Keynoter	1
Keys News	1
Keys Times	1
Local Key Largo paper	1
Local Marathon newspapers in the keys	1
Naples	1

News Journal	1
PC PALM	1
PINE ISLAND EAGLE	1
Port Charlotte Sun	1
Post	1
Salt Water Fisherman	1
Magazine	1
Sarasota Herald	1
SP Times	1
St. Augustine Post	1
St Augustine Record	1
St Lucie Tribune	1
Tallahassee Democrat	1
the weekly Marathon FL	1
Times	1
Toledo Blade	1
USA	1
Wall Street Journal	1

TV Show or Channel Name	Frequency
News (unspecified)	30
Local news (unspecified)	22
Florida Insider Fishing Report	14
Fishing shows (unspecified)	11
Animal Planet	10
Discovery Channel	9
Florida Sportsman	8
National Geographic	8
WSVN 7 Fox	8
NBC News	6
Shark Tank	6
Bay News 9	4
Andrew Zimmerman Bizarre Foods	3
Fox 13 News Tampa	3
Fox News	3
NBC2 local news	3
WINK News	3
WPTV	3
ABC News	2
CBS News	2
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Channel 6 news	2
Channel 7 news	2
Commercials	2
First Coast News	2
Fox 35 News	2
HBO	2
PBS	2
Saltwater Sportsman	2
Scuba Nation	2
WBBH Local Evening News	2
WEAR Channel 3 News	2
Channel 4	1
ABC7	1
all Tampa channels	1
Average Angler	1
CNN documentary	1
Fisherman's Report show	1
Fishing the Flats	1
Florida Sportfishing Journal (online)	1
Florida Sportfishing	1
Food Network	1
Fox documentary	1
Fox Sun Sports fishing shows	1
Guy Harvey show	1
History Channel	1
How to Do Florida	1
Into the Blue	1
I saw it in Germany in 2014	1
national wildlife channel	1
nature channels	1
fishing programs sunshine network	1
Pensacola Scuba program	1
Reel Time	1
Saltwater Adventure	1
Saltwater fishing show	1
Saltwater fishing shows on Sun network	1
Today NBC	1
US News	1
WCTV News	1
WESH Channel 2	1

WJHG or WMBB	1
World Fishing Network	1
WPBF	1

Appendix 2: Lionfish events, workshops, or presentations hosted by other organizations which respondents attended

Event Name	Frequency
Lionfish Derbies and Roundups:	15
3rd Annual Lionfish Derby Jacksonville 8/8/2015 (1)	
Divers Den Lionfish roundup (1)	
Lionfish derby in Bradenton and key west (1)	
Lionfish derby, summer 2015 in Sarasota (1)	
Local derby weigh-in at Fort Pierce (1)	
Northeast Florida Lionfish Blast (3 years) (1)	
The Scuba Club Lion Fish Derby (1)	
Lionfish tournaments (unspecified) (8)	
Artificial Reef Summit	2
BEACHERS	1
Biscayne Bay Yacht Club	1
Blue Wild	1
Boat Show	1
Cape Coral yacht club by school teachers	1
CCA Alabama	1
Clearwater Hogs dive club	1
Dagny Johnson Key Largo Botanical State park	1
Deering Seafood presentation	1
Emerald Coast Reef Association	2
Extension Workshop	1
Fishing club meeting	1
Force-E scuba/south Florida diving Headquarters	1
Frappers	1
FSFA	1
Guy Harvey	1
I am a Master Naturalist	1
I have seen local TV fishing shows explaining how to catch and prepare for cooking as well as explaining the poison issues	1
Jon Pennekamp state park winter lecture series	1
Just seen that save on fish company sold them so we asked some questions.	1
Local dive shops	1
local documentary presentation screening WPBT 2	2
Local fishing club meetings I attend	1
Naples spearfishing league	1
National Public Television	1

NOAA	1
Ocean Day	1
PETA	1
Private	1
Reef.org events	4
Road runner fishing club Ft Pierce	1
Rookery Bay	1
Smithsonian Marine Lab	1
Sportsmens caucus	1