



Assessing an expert education program in support of non-regulatory marine fisheries management

William R. Casola^{a,*} , Savanna Barry^{a,b,c} , Kotryna Klizentyte^d, Chelsey Crandall^e, Michael Sipos^{c,f}, Edward Camp^a

^a Fisheries and Aquatic Sciences Program, School of Forest, Fisheries, and Geomatics Sciences, University of Florida, Gainesville, FL, USA

^b Nature Coast Biological Station, Institute of Food and Agricultural Sciences, University of Florida, Cedar Key, Florida, USA

^c Florida Sea Grant College Program, University of Florida, Gainesville, FL, USA

^d School of Forest, Fisheries, and Geomatics Sciences, University of Florida, Gainesville, FL, USA

^e Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA

^f Collier County Extension Program, Institute of Food and Agricultural Sciences, University of Florida, Naples, FL, USA

ARTICLE INFO

Keywords:

Recreational fishing
Fisheries
Fishing guides
Evaluation
Extension education
Charter captain

ABSTRACT

Educational campaigns are a commonly used tool to alter public behaviors; however, such approaches may be less suitable when the behaviors targeted are activity specific, like recreational fishing. One alternative to large campaigns is targeted education of experts who may function as opinion leaders. We tested the impact of educational programs targeted at marine recreational fishing guides in Florida, USA. We evaluated how course participation impacted confidence and knowledge (self-reported and objective) using pre- and post-course assessments. Additionally, we evaluated the extent to which program participants differed from non-participants using a survey that measured self-reported confidence and knowledge, perceptions of their influence on management and their influence on clients, and environmental attitudes as measured with the New Ecological Paradigm (NEP) scale. Pre-post comparison showed program participation increased at least short-term self-reported confidence, and self-reported and objective knowledge. Additionally, guides who completed the program had higher perceived influence on management compared to those who did not participate. In concert, these results suggest that education programs may positively alter expert knowledge, confidence and, potentially, willingness to engage in management or participatory approaches, though the design of this study limits causal inferences. These results are compatible with the conceptual model of expert education programs supporting non-regulatory governance of specific activities, like marine recreational fishing.

1. Introduction

The quality of many common pool natural resources that provide recreation and leisure can be degraded by undesired public behavior, such as littering, damaging habitats, spreading invasive species, harming fish and wildlife, overharvesting resources etc. (Buckley, 1991; Huddart and Stott, 2019; Sun and Walsh, 1998). Decreasing undesired and deleterious public behavior via regulation can be difficult owing to both logistic challenges and unintended consequences of regulatory enforcement. For example, it may be impractical for enforcement personnel to monitor large areas (Cole et al., 1987; Read et al., 2011), while fines sufficient to deter undesired behaviors may be socially unacceptable or discourage even compliant use. An alternative approach

for affecting public behavior is non-regulatory governance, which typically involves educating to encourage voluntary behavioral modification (Buckley, 1991; Cole, 1993; Cooke et al., 2013). Educational campaigns have been previously employed to alter general public behaviors (e.g., littering, fire safety) that affect the environment (Barry et al., 2020; Domegan et al., 2019; Eastman et al., 2013; Seekamp et al., 2016). Campaigns to alter these broader behaviors have often been implemented via mass media advertising/education (i.e., non-targeted), but such approaches may be less suitable when the behaviors targeted are activity-specific, such as mountain biking, bird watching, or recreational fishing (Borden and Mahamane, 2020; Mackay et al., 2018). An alternative to mass media education, which may rarely reach activity-specialized participants, is targeted education of experts who

* Corresponding author.

E-mail address: wcasolajr@gmail.com (W.R. Casola).

<https://doi.org/10.1016/j.ocecoaman.2025.108046>

Received 18 May 2025; Received in revised form 23 October 2025; Accepted 1 December 2025

Available online 14 December 2025

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may function as activity-specific “opinion leaders,” or an individual who has influence over the attitudes, behaviors, and/or decisions within a specific group or community (Dekoninck and Schmuck, 2022; Howell et al., 2015; Maibach, 1993). Theoretically, this approach would focus resources on intense education of a comparatively small number of expert users who would hopefully then influence the broader user population. The efficacy of an expert-education approach depends on several linkages, the first of which being the capacity of educating opinion leaders who may well already regard themselves as experts, and thus may be less inclined to seek out further education (Dalrymple et al., 2013). However, this has not been well-evaluated, especially in recreational fisheries (Howell et al., 2015).

Educating expert opinion leaders to encourage broad voluntary change among users may be especially tenable in recreational fisheries (Howell et al., 2015). Recreational fisheries, here defined as fisheries in which the motivation is not strictly commercial (Boucquey and Campbell, 2019; Cooke et al., 2018; Nyboer et al., 2022), provide substantial socioeconomic value (i.e., consumer surplus/net benefit and associated satisfaction) and locally important market activity (revenue and jobs) (Abbott et al., 2022; García-de-la-Fuente et al., 2020), but are also capable of negatively impacting ecosystems and the environment (Lewin et al., 2006, 2019; Welcomme et al., 2010). Recreational fisheries in many countries function as government-managed common pool, and usually open access, resources where the primary regulatory action is to control fish harvest to sustainable levels (Boucquey, 2016; Potts et al., 2020). However, recreational fisher non-harvest behaviors can have broad effects (Lewin et al., 2006). Recreational fishers often release captured fish whose post-release mortality largely depends on handling (Barthel et al., 2003; Benoit et al., 2010; Capizzano et al., 2016), they can directly affect ecologically important aquatic habitat like seagrasses, salt marsh grasses, and riparian areas when operating vessels or fishing from shore (Auster and Langton, 1999; Orth et al., 2002), and they can influence the broader environment via behaviors that may exacerbate invasive species spread or pollution (Lewin et al., 2008; Smith et al., 2020). Regulations of non-harvest behaviors can be difficult to enforce because they would require intensive observation through the duration of the fishing trip to document infractions—compared to harvest regulation enforcement which can be assessed via possession and monitored at access points. Accordingly, management agencies may rely on educational approaches that encourage voluntary adoption of positive non-harvest behaviors (Cooke et al., 2013; Nguyen et al., 2013; Read et al., 2011). Influencing recreational fisher opinion-leaders may be particularly effective because fisher behaviors (and the mental models behind them) have been shown to be sensitive to perceived group norms (Allison et al., 2023; Crandall et al., 2018). Further, identifying recreational fisher opinion leaders may be readily achievable because most recreational fisheries support professional, for-hire fishers (called “guides”) who charge a fee to guide other recreational anglers. Guides may function as opinion leaders in recreational fisheries, owing to their typical high level of angling skills and their business incentives to advertise their prowess to the broader population of recreational fishers (Farthing et al., 2022; Howell et al., 2015; Smith et al., 2023). Guides may be ideal experts or opinion leaders to influence the broader recreational fishing population because their livelihood and day-to-day work involves taking less-expert anglers fishing and invariably teaching or “guiding” them how to better catch fish, in addition to typically large social media presence associated with advertising.

Theoretically, it would be efficient to focus education on recreational guides who through their regular business interactions might influence the broader fisher population more effectively, but the efficacy of such an approach depends on several key linkages. One key linkage would be the extent to which educational programs have an impact on recreational guides, who are almost tautologically experts, and their behavior. The extent to which recreational fishery guides perceive themselves to have a need for or benefit from further education has not been often tested, and the capacity of educational programs to alter guides’ actual

and perceived knowledge remains largely unknown. The objective of this project was to empirically test the efficacy of an expert education program, using recreational fishing guides as a case study. We developed an intensive optional educational program for fishing guides and evaluated change in knowledge via pre and post evaluations of program participants, as well as comparisons between participating guides and guides that did not participate in the program, while attempting to account for broader worldviews and pro-environmental orientation. We hypothesized the educational program would increase guides’ perceived knowledge and confidence (i.e., guides in the program would perceive they had increased knowledge), and that participating guides’ knowledge would have objectively increased relative to pre-program.

2. Methods

2.1. About the Florida Friendly Fishing Guide program

We assessed the impact of an educational program targeted towards recreational fishing guides by evaluating the Florida Friendly Fishing Guide (FFFG) program. Several educational programs related to fishing are available in Florida, with one of the most successful programs being the Florida Friendly Fishing Guide (FFFG) program. The FFFG is a voluntary, low-cost certification program developed by extension and research faculty and beta-tested by groups including fishing guides, fishery governance personnel, and extension and research faculty. The program cost is \$130 but scholarships and discounts are often offered to applicants. The program aimed to educate nearshore and marine recreational fishing guides and provides a certificate, decal, and right to use a program logo that might help guides market their services. The FFFG program was implemented as an online, asynchronous (i.e., self-paced) course with eight modules focusing on a broad cross-section of environmental best practices. Modules taught science-based techniques to increase environmental sustainability across every facet of a charter business including fishing practices, wildlife sensitivity, habitat protection, boat maintenance, solid waste and hazardous chemical management, food service and safety, participation in management, and stewardship or participatory science activities. As of publication, the FFFG program is active and accepting new participants, and similar courses have been developed in other states.

We evaluated this education program with two separate assessments. The first was a pre-post assessment that was part of the education program and was taken only by course participants. This was part of the education program, was required for completion, and was intended to evaluate short-term changes in knowledge (self-reported and objective) and confidence in understanding for participants of the FFFG course. The second was a broader industry-wide survey distributed to all fishing guides in Florida and sought to assess differences between those that did and did not participate in the education program.

2.2. Questionnaire development

2.2.1. Pre-/post-assessment of course participants

The pre-/post-assessment consisted of eight self-reported confidence questions, eight self-reported knowledge questions, and 15 knowledge assessment questions. Each assessment section contained one to two questions directly related to content covered in each of the eight educational modules. Additionally, participants answered a series of questions about their motivations for taking the course and their perceived value of the course. The assessment was administered once before (pre) and once immediately after (post) course completion, though time to completion varied (see below). For self-reported confidence and self-reported knowledge gain, guides were asked to rate their level of confidence and knowledge about each of the eight module topics on a five-point Likert-type scale. The objective assessment of knowledge gain consisted of 15 questions designed to measure comprehension of educational content covered in the FFFG course. Questions were

developed by the FFFG instructor team to assess guides' objective knowledge about marine ecology, ethical fishing practices, solid and hazardous waste management, and safe seafood handling, and were vetted by the beta test groups. The questions were a mix of true/false and multiple-choice questions. Participants in the course answered the same set of questions before and after taking the eight-module course and a score for each instance (pre and post) of the test was calculated based on the number of correct answers. The FFFG course is self-paced, therefore the time between taking the pre- and post-assessment varied for each participant. The average length of time between the pre- and post-assessment was 25 days (range 0–560 days, median 3 days), permitting some consideration of retention. A full copy of the pre- and post-assessment are available as supplementary materials.

2.2.2. Broader fishing guide industry survey

To assess the extent to which participants in the FFFG program differed from the broader population of fishing guides in Florida and provide a longer-term view of the outcomes of the FFFG program, we developed a survey questionnaire that was distributed to FFFG participants as well as guides who had not participated in the program. This industry survey consisted of three sections: 1) 13 questions for all respondents, 2) 10 questions only for Florida Friendly Fishing Guides, and 3) three questions only for for-hire guides who did not complete the course. Questions for all guides were designed to gather data on self-reported confidence and knowledge about the topics covered in the FFFG program, to assess guides' perceptions of their influence on management and their influence on clients, and to assess guides' environmental attitudes as measured with the New Ecological Paradigm (NEP) scale. The NEP scale is the most widely used instrument to measure environmental attitudes and ecological worldview in recreation and education studies (Dunlap, 2008; Dunlap et al., 2000; Dunlap and Van Liere, 1978). The revised instrument consists of 15 items, eight of which are framed to measure the respondents' support for a new ecological paradigm (i.e., concern for the environment, pro-environmental behavior), and seven framed to measure their support for the dominant social paradigm (i.e., lack of concern for the environment, environmentally unfriendly behavior). A full copy of the industry survey is available as supplementary materials. All survey respondents completed the survey under informed consent, and all survey questions and procedures were approved as exempt by the University of Florida's Institutional Review Board (IRB protocol # 2017-00025).

2.3. Sampling

The post-course evaluation and objective knowledge assessment were required parts of the FFFG course, so 100 % of FFFG participants who had completed the course as of March 15, 2023 ($n = 135$) had completed the assessment. The industry survey was distributed via email invitations sent through Qualtrics to 2516 total for-hire captains whose contact information was obtained via the Florida Fish and Wildlife Conservation Commission's licensing database and from the FFFG registration data. To ensure FFFG participants did not get two survey invitations, the State of Florida database was filtered by name and email address to remove captains who had completed the FFFG course as of August 5, 2022. Invitations were sent as separate survey distributions to 117 Florida Friendly Fishing Guides and 2399 captains who had not completed the program. Non-respondents were automatically sent up to two reminders about the questionnaire from the Qualtrics system. The first reminder email was sent three days after the initial invitation, and the final reminder was sent seven days after the initial invitation. We received a total of 459 responses (18.2 % overall response rate). Respondents who started the FFFG course but did not complete it ($n = 11$) and responses lacking FFFG completion status ($n = 58$) were excluded from analysis. Response rate varied based on FFFG participation. Of the 117 FFFGs invited, 69 fully completed and four partially completed the questionnaire (62.4 % response rate), while out of the 2399 for-hire

captains invited, 272 fully completed and 46 partially completed it (13.3 % response rate). Partial completions were excluded from analysis.

2.4. Analysis

The analysis was broken into two sections, one for the pre-/post-assessment of course participants and one for the fishing guide industry survey. The pre-/post-assessment of course participants included three measures: (1) self-reported confidence, (2) self-reported knowledge, and (3) objective knowledge assessment. The industry survey included five measures: (1) self-reported confidence, (2) self-reported knowledge, (3) influence on management, (4) influence on clients, and (5) environmental world view as measured by New Ecological Paradigm (NEP) scale. For all measures except the objective knowledge assessment, the Likert-style responses were converted to numerical values for each of the individual scale items and then summed together into a single measure of each. To confirm these scale items could be combined into valid scales, we performed a Kaiser-Meyer-Olkin (KMO) test for sampling adequacy and Bartlett's test of sphericity, followed by Horn's parallel analysis and exploratory factor analysis (with Varimax rotation) to determine the appropriate number of scale factors. We used the Tucker-Lewis index to evaluate fit. Only scale items with factor weights above 0.4 were retained (Stevens, 2009). We calculated Cronbach's alpha values to test for scale validity and reliability. The objective knowledge assessment was graded for correct and incorrect responses and scores were summed into a single value representing how accurately the respondent completed the assessment questions.

All scales demonstrated high scale validity and reliability metrics. For all measures, the results of the KMO test for sampling adequacy were greater than 0.60 for all scale items indicating the data was suited for a factor analysis (Kaiser, 1974) and Bartlett's test of Sphericity further confirmed this finding, with all scales scoring less than 0.05. Horn's parallel analysis indicated scales contained a single factor. Exploratory factor analysis confirmed these findings, and all scales had Tucker-Lewis index scores indicating reliable fit. All scales displayed internal validity, with Cronbach's alpha values greater than 0.70 (Hair et al., 2014).

Pre-/post-assessment changes in self-reported confidence and knowledge, as well as objective knowledge scores, were calculated as the respective difference between the sum of post-program scores and pre-program scores. A positive change within any measure indicated the respondent became more confident or knowledgeable after completing the program. To evaluate the change in the pre-post responses for all three measures, we used the Shapiro-Wilk normality test to determine the appropriate type (parametric or nonparametric) of paired sample comparison. Shapiro-Wilk results indicated that all three measures were non-normal, therefore we used the Wilcoxon signed rank test and calculated Wilcoxon effect sizes to evaluate pre-post change. We used linear regression to test for a relationship between objective knowledge assessment score and time between pre and post course assessment. We used the same strategy described above to evaluate differences in self-reported confidence, self-reported knowledge, influence on management, influence on clients, and NEP responses between participants and non-participants. Shapiro-Wilk results indicated that all measures were non-normal, therefore we used the Wilcoxon signed rank test to evaluate differences between participants and non-participants.

3. Results

3.1. Pre-/post-assessment of course participants

Pre-post comparisons indicated that the FFFG program increased self-reported confidence (Fig. 1) and knowledge (Fig. 2), as well as objective knowledge (Fig. 3). Wilcoxon signed rank test indicated a large significant difference in pre-post self-reported confidence scores ($p <$

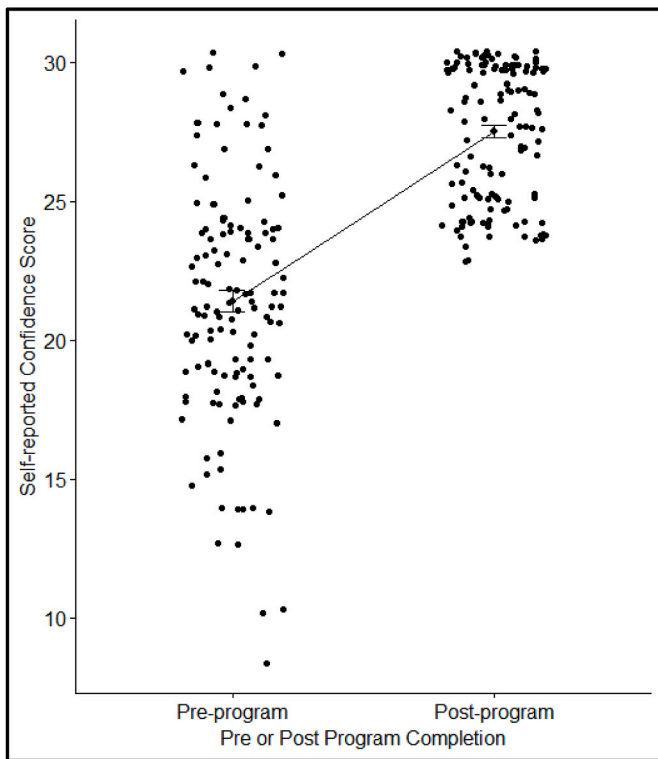


Fig. 1. Pre-/post-assessment self-reported confidence scores among course participants (n = 132).

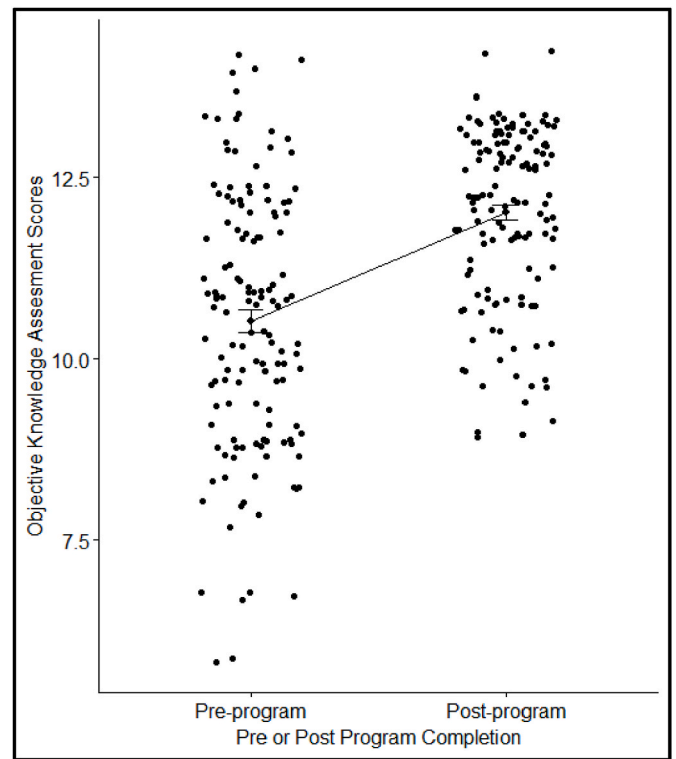


Fig. 3. Pre-/post-assessment objective knowledge scores among course participants (n = 135).

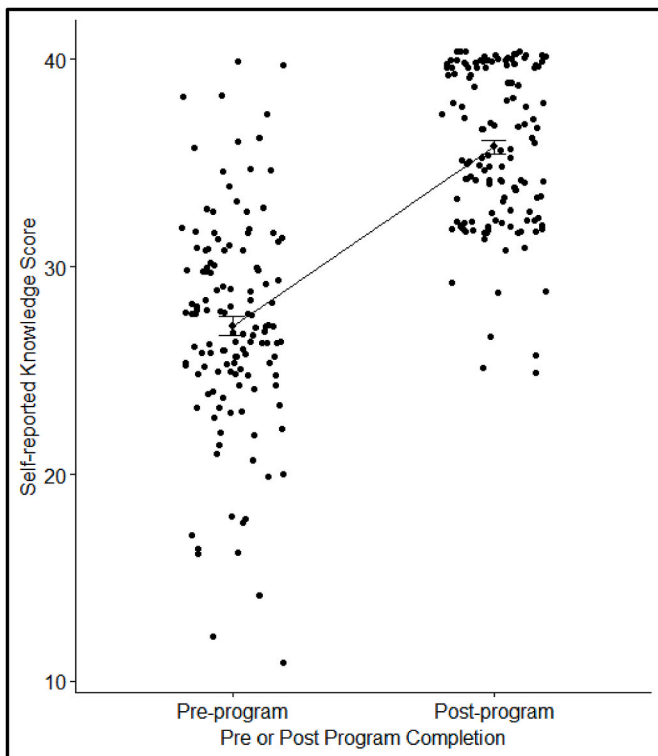


Fig. 2. Pre-/post-assessment self-reported knowledge scores among course participants (n = 133).

0.001, Eff Size: 0.837), with 90 % of participants reporting higher confidence after completing the program. Self-reported knowledge results were similar. Wilcoxon signed rank test indicated a large significant

difference in pre-post self-reported knowledge scores ($p < 0.001$, Eff Size: 0.854), with 93 % of participants reporting higher knowledge after completing the program. Participants also scored higher on the objective knowledge assessment after completing the FFFG program. Wilcoxon signed rank test indicated a large significant difference in pre-post knowledge assessment scores ($p < 0.001$, Eff Size: 0.651), with 68 % of participants scoring higher after completing the program. Individual scale items, factor loadings, mean responses, and pre-/post-assessment differences for all three measures are presented in [Tables 1 and 2](#). Because the course was self-paced, the time between pre-course and post-course assessment varied among participants. The median time between assessments was three days, the mean time was 25 days, and 65 % of participants completed both the pre- and post-course assessment within one week. We found no relationship between knowledge assessment score and time between pre and post course assessment ($p = 0.067$).

3.2. Broader fishing guide industry survey: comparison of participants and non-participants

Comparisons of participants and non-participants indicated that the FFFG program increased perceived influence on management among those who completed the program. Wilcoxon signed rank test indicated a small but significant difference in the perceived influence on management scores ($p < 0.001$, Eff Size: 0.281, [Fig. 4](#)). Wilcoxon signed rank tests indicated no differences between participants and non-participants for knowledge, confidence, or influence on clients. The Wilcoxon signed rank test also indicated no differences in NEP scores between participants and non-participants ([Fig. 5](#)). Lastly, 83 % of participants reported the program made them more confident even though their answers were not significantly different than nonparticipants. This increase in confidence may be in explaining concepts to clients and/or to other guides, however, these two concepts were conflated in the instrument. Individual scale items, factor loadings, mean responses for all three

Table 1
Individual scale items, factor loadings, and mean scores for individual measures of self-reported confidence.

Self-reported confidence	Factor Loadings		Mean Response (n = 132)		
	Pre	Post	Pre	Post	Difference
I am confident I could explain environmental ethics to clients or other guides	0.79	0.73	3.92 (0.82)	4.67 (0.47)	+0.74
I am confident I could explain Florida fisheries management to clients or other guides	0.86	0.75	3.39 (0.90)	4.43 (0.53)	+1.05
I am confident I could describe best practices for catch and release fishing to clients or other guides.	0.84	0.72	3.86 (0.92)	4.72 (0.45)	+0.86
I am confident I could explain sustainable fueling and waste management to clients or other guides.	0.87	0.85	3.35 (0.91)	4.58 (0.50)	+1.23
I am confident I could explain seafood safety to clients or other guides.	0.87	0.90	3.44 (0.91)	4.55 (0.51)	+1.11
I am confident I could tell clients or other guides about giving back to fisheries management and research.	0.87	0.85	3.43 (0.92)	4.57 (0.50)	+1.14

Measured using 5-point scales from Strongly Disagree (1) to Strongly Agree (5). Pre-program $\alpha = 0.90$; Post-program $\alpha = 0.91$. Pre-program Eigenvalue: 3.98; Post-program Eigenvalue: 4.20.

measures are presented in Tables 3–7. We evaluated if there was a difference in the number of years of experience between participants and non-participants. Among participants, the mean years guiding was 11.40 with a median of six years. Among non-participants, the mean years guiding was 13.59 with a median of 10 years. Because of the large standard deviation among both groups, *t*-test results indicated that the mean years guiding between the two groups was not statistically significant ($p = 0.1738$).

4. Discussion

The goal of our study was to better understand the efficacy of expert education to encourage non-regulatory compliance of marine natural resource users. We tested the first aspect of this approach by understanding the extent to which participants in an expert education program increased their knowledge, confidence, and influence. Our methodological approach of comparing pre-post assessments of program participants and conducting surveys with both participants and non-participants provided nuanced answers to our study question. In summary, the pre-post assessment indicated participants both objectively gained knowledge (via empirical assessments) and perceived that they gained knowledge, confidence, and potentially influence as a result of their participation. At the same time, the survey-based evaluation of participants and non-participants indicated each group had similar perceptions of their knowledge and confidence, although program participants had a statistically greater perceived influence of management. While the increase in perceived management influence is expected and has more clear implications, the other results (i.e., no differences

Table 2
Individual scale items, factor loadings, and mean scores for individual measures of self-reported knowledge.

Self-reported knowledge	Factor Loadings		Mean Response (n = 133)		
	Pre	Post	Pre	Post	Difference
I know a lot about environmental ethics for anglers	0.70	0.71	3.78 (0.86)	4.57 (0.53)	+0.79
I know a lot about coastal ecology	0.70	0.83	3.41 (0.80)	4.30 (0.62)	+0.89
I know a lot about fisheries management	0.82	0.83	3.14 (0.84)	4.32 (0.57)	+1.19
I know a lot about best practices for catch and release fishing.	0.75	0.78	3.80 (0.84)	4.64 (0.54)	+0.84
I know a lot about sustainable fueling and waste management	0.68	0.84	3.27 (0.85)	4.52 (0.54)	+1.25
I know a lot about seafood safety.	0.73	0.86	3.35 (0.88)	4.45 (0.57)	+1.10
I know a lot about sustainable onboard materials.	0.73	0.88	3.17 (0.75)	4.50 (0.56)	+1.32
I know a lot about giving back to fisheries management and research.	0.85	0.85	3.23 (0.89)	4.50 (0.55)	+1.27

Measured using 5-point scales from Strongly Disagree (1) to Strongly Agree (5). Pre-program $\alpha = 0.91$; Post-program $\alpha = 0.94$. Pre-program Eigenvalue: 4.91; Post-program Eigenvalue: 5.73.

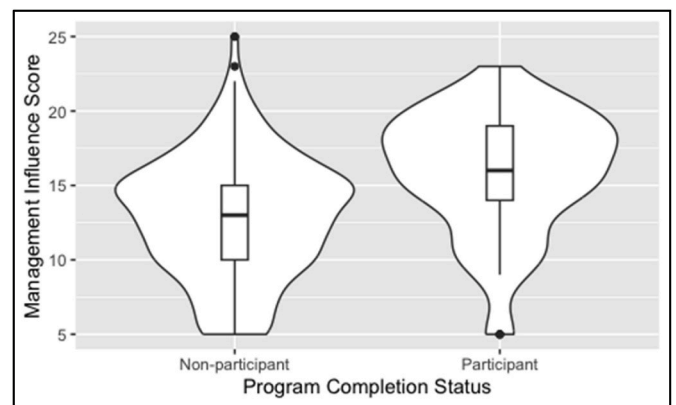


Fig. 4. Comparison of perceived influence on management between non-participants and participants.

between participants and non-participants for self-reported knowledge, confidence, or influence on clients) present an apparent paradox with alternative explanations. Despite the alternative explanations and other study limitations, the study’s findings demonstrate value in fisheries education programs.

Psychological models such as the reasonable person model posit that people are most reasonable when their informational needs are supported by their surrounding environment. This theory is underwritten by three highly interrelated categories by which we gather, process, and respond to information (Kaplan, 2000). First, we acquire and digest information through exploration and understanding, we then act upon the information through meaningful action, and last we maintain our ability to focus, select and respond to additional information from the environment through restoration (i.e., the ability to deal with mental fatigue). Arguably the most important finding of the study was that

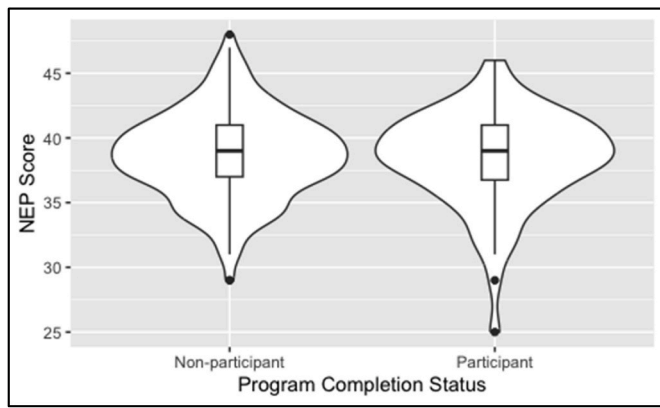


Fig. 5. Comparison of New Ecological Paradigm scores between non-participants and participants.

Table 3
Individual measures of influence on management and associated exploratory factor analysis results, mean response values and Cronbach’s alpha values.

Influence on management ($\alpha = 0.86$)	Factor Loadings	Mean Response by Participant Type	
		Participant (n = 71)	Non-participant (n = 317)
Fisheries managers listen to me	0.81	3.11 (0.98)	2.60 (0.99)
Fisheries managers understand what my needs are	0.88	3.17 (0.94)	2.53 (0.95)
I have power to affect how fisheries are managed	0.70	3.06 (1.05)	2.39 (1.04)
Fisheries management agencies will improve the fisheries I target	0.73	3.42 (1.02)	2.83 (1.05)
Fisheries management agencies will make it harder to be a successful guide (reverse coded)	0.64	3.13 (1.13)	2.62 (1.10)

Measured using 5-point scales from Strongly Disagree (1) to Strongly Agree (5). Reverse coded questions flipped to maintain frame. Eigenvalue: 2.87.

Table 4
Individual measures of self-reported knowledge and associated exploratory factor analysis results, mean response values and Cronbach’s alpha values.

Self-reported knowledge ($\alpha = 0.76$)	Factor Loadings	Mean Response by Participant Type	
		Participant (n = 72)	Non-participant (n = 315)
I know a lot about environmental ethics for anglers	0.75	4.49 (0.67)	4.43 (0.66)
I know a lot about fisheries management	0.67	3.92 (0.76)	3.94 (0.85)
I know a lot about marine and coastal ecology	0.72	4.03 (0.77)	3.94 (0.80)
I know a lot about catch and release best practices	0.55	4.63 (0.59)	4.59 (0.56)

Measured using 5-point scales from Strongly Disagree (1) to Strongly Agree (5). Eigenvalue: 1.82.

program participation increased the perceived influence on management. Two of the course modules were dedicated to (1) participation in management and (2) stewardship and participatory science activities, thus the increase in perceived management influence was expected. The findings of this study specifically speak to meaningful action which hold that an individual’s behaviors (especially in conflict ridden arenas) will

Table 5
Individual measures of self-reported confidence and associated exploratory factor analysis results, mean response values and Cronbach’s alpha values.

Self-reported confidence ($\alpha = 0.76$)	Factor Loadings	Mean Response by Participant Type	
		Participant (n = 72)	Non-participant (n = 314)
I am confident I could explain environmental ethics to clients or other guides	0.73	4.53 (0.63)	4.33 (0.71)
I am confident I could explain fisheries management to clients or other guides	0.65	3.94 (0.73)	3.95 (0.89)
I am confident I could explain marine and coastal ecology to clients or other guides	0.74	3.94 (0.75)	3.85 (0.88)
I am confident I could explain catch and release best practices to clients or other guides	0.55	4.64 (0.61)	4.54 (0.60)

Measured using 5-point scales from Strongly Disagree (1) to Strongly Agree (5). Eigenvalue: 1.80.

Table 6
Individual measures of influence on clients and associated exploratory factor analysis results, mean response values and Cronbach’s alpha values.

Influence on clients ($\alpha = 0.80$)	Factor Loadings	Mean Response by Participant Type	
		Participant (n = 73)	Non-participant (n = 312)
Clients’ knowledge of fish	0.85	4.16 (0.69)	4.13 (0.82)
Clients’ knowledge of fishing	0.84	4.12 (0.71)	4.22 (0.82)
The way clients fish	0.79	4.10 (0.80)	4.23 (0.82)
The way clients operate their boat	0.55	3.25 (1.16)	3.33 (1.17)
The fishing behavior of people who I do not directly guide but may hear about me, such as through social media	0.47	3.29 (0.99)	3.11 (1.10)

Measured using 5-point scales from No influence (1) to Very large influence (5). Eigenvalue: 2.58.

be more reasonable when the individual believes they have some effect on the outcome and studies have demonstrated that participation, and being able to “make a difference”, are principal motivations for pro-environmental behaviors (Grese et al., 2000; Phalen, 2009). Within fisheries, conflicts between managers and fishers are common, and may become especially intractable when fishers do not believe they have any effect on the policies most affecting them (Crandall et al., 2019). In contrast, guides who believe they can influence management, and may pass this belief on to clients, may help introduce more productive conversation and behavior to these conflicts. An additional important implication of this finding is related to cooperative management (i.e., co-management). Co-management is widely considered to be an important attribute for resilient socio-ecological systems (Armitage et al., 2009; Carlsson and Berkes, 2005), but it depends upon users (in this case fishers) being willing to engage with the management decision-making. The perception of increased influence on management might indicate participants in the education program would be more willing to engage with (co-) management of these fisheries—and again that they may pass these beliefs on to their clients.

Similarly, Diffusion of Innovations Theory demonstrates that opinion leaders play key roles in transmitting ideas and shaping adoption behaviors within social networks (Rogers et al., 2008). Opinion leaders, such as fishing guides, are generally extremely influential within their networks, viewed as role models to their peers, and are one of the more

Table 7

New Ecological Paradigm individual scale measures and associated confirmatory factor analysis results, mean response values and Cronbach's alpha values.

New Ecological Paradigm ($\alpha = 0.85$)	Factor Loadings	Mean Response by Participant Type	
		Participant (n = 68)	Non-participant (n = 259)
We are approaching the limit of the number of people the Earth can support	0.41	3.35 (0.94)	3.10 (1.20)
Humans have the right to modify the natural environment to suit their needs (reverse coded)	0.57	2.13 (0.91)	2.36 (1.08)
When humans interfere with nature it often produces disastrous consequences	0.52	3.97 (0.98)	3.91 (1.04)
Humans are seriously abusing the environment	0.56	3.76 (1.13)	3.91 (1.05)
The Earth has plenty of natural resources if we just learn how to develop them	0.42	3.22 (0.96)	3.26 (1.03)
Plants and animals have as much right as humans to exist	0.53	3.91 (0.86)	3.70 (1.10)
The balance of nature is strong enough to cope with the impacts of modern industrial nations (reverse coded)	0.60	2.13 (1.01)	2.20 (0.98)
The so-called "ecological crisis" facing humankind has been greatly exaggerated (reverse coded)	0.62	2.50 (1.03)	2.79 (1.11)
The Earth is like a spaceship with very limited room and resources	0.61	3.46 (1.00)	3.38 (1.00)
Humans were meant to rule over the rest of nature (reverse coded)	0.55	2.49 (1.01)	2.65 (1.11)
The balance of nature is very delicate and easily upset	0.66	3.93 (0.98)	3.88 (0.88)
If things continue on their present course, we will soon experience a major ecological catastrophe	0.77	3.54 (1.07)	3.52 (1.01)

Measured using 5-point scales from Strongly Disagree (1) to Strongly Agree (5). Eigenvalue: 3.99.

NOTE: Reverse coded questions flipped to maintain frame. The following items were dropped because of low factor loadings: Human ingenuity will ensure that we do not make the Earth unlivable (0.34), Despite our special abilities, humans are still subject to the laws of nature (0.38), and Humans will eventually learn enough about how nature works to be able to control it (0.36).

important determinants of the uptake of ideas or innovations (Blythe et al., 2017). The diffusion of innovations theory has been applied to broad fisheries topics including marine protected area education (Mbaru and Barnes, 2017) and fishing technology adoption (Jenkins, 2006; Tango-Lowy and Robertson, 2002), where opinion leaders play a critical role in disseminating information to stakeholders to improve environmental behaviors in fisheries. Combining our results with existing theories on idea adoption, we postulate that the education program we tested may result in broader increased perceptions of influence on management, though this should be verified with future studies.

The apparent paradox of our results arises from the fact that our pre-post evaluation of guides who participated in the education program revealed they thought the program increased their knowledge and confidence, while a separate instrument administered simultaneously to guides who did and did not take the program suggested both groups had similar perceptions of their knowledge and confidence. One possible explanation for the apparently paradoxical findings is that the guides who opted to participate in the education program were those who initially had lesser knowledge, confidence, and perceived influence compared to their non-participating peers. This explanation would

accommodate both the participants increasing their assessments of these metrics while still not statistically differing from non-participants. Previous environmental education studies demonstrate how environmental education programming can lead to a more uniform understanding of a specific subject when participants begin with different levels of understanding. For example, Braun et al. (2018) showed directionally consistent results with groups of differing baseline knowledge testing more similarly after training. Flora et al. (2014); Lawson et al. (2019) found participants who demonstrated the greatest increase in climate change knowledge/concern were those who were, previous to participation, the most doubtful. Our results may be congruent with this pattern if the guides choosing to participate in the education program started with systematically less knowledge, confidence, and perceived influence compared to their non-participating peers. We cannot confirm this because we did not measure the objective knowledge of the participants and non-participants. However, the similar NEP scores measured between the two groups suggest at least no clear ideological gap between those who did and did not opt to take the course. Further, the participants' evaluation did not seem to suggest that lack of knowledge was a key reason for taking the course.

A second possible explanation for the paradoxical findings is that non-participants and participants could be similarly confident even while the non-participants potentially know less objectively. This phenomenon, commonly known as an overconfidence effect, is common in the literature and stems from the well-established bias in which an individual's subjective confidence in a subject will often be greater than their objective knowledge on that subject. For example, an individual who rates their confidence on a subject as nine on a scale from zero to ten, should score about 90 % on an objective knowledge assessment of the same subject; however, individuals with nine out of ten confidence often score much lower. Illusory superiority (Hoorens, 1993; Larwood and Whittaker, 1977) and the Dunning-Kruger effect (Kruger and Dunning, 1999) are specific examples of the overconfidence effect. Illusory superiority is the propensity of individuals to view themselves as above average when drawing comparisons between themselves and others and Dunning-Kruger is similar in that individuals with low knowledge on a subject tend to overestimate their knowledge on that subject. In the context of this study, it is possible and reasonable, that the FFFG education program increased the objective knowledge of the participants, likely above the level of their non-participant peers; however, non-participants overestimated their knowledge, thus responding similarly to the participants when asked to self-report confidence and knowledge. This aligns well with studies demonstrating the impact of illusory superiority often transcends the individual and can influence collective measures (i.e., the mean response) of members belonging to the same group (in this case the non-participants; Giladi and Klar, 2002).

We cannot readily distinguish between these two hypotheses for the apparently paradoxical results because we did not test objective knowledge of participants and non-participants. However, the veracity of either hypothesis would result in a net increase in the overall population knowledge—i.e., more fishing guides would know more and could pass this greater knowledge on to clients. Therefore, we can be confident that the expert education program appears effective at least at increasing objective knowledge among participants. This finding is congruent with broad literature describing the efficacy of education-based knowledge transfer regarding water conservation (Lamm et al., 2015; Taylor and Lamm, 2017), forest conservation (Bakti et al., 2024), climate change (Keys et al., 2016), and broadly across issues (Valente and Pumpuang, 2007). There is less certainty regarding how the education affected confidence and influence, owing to challenges in their objective measurement and the existence of yet another alternative explanation for why they increased pre versus post among participants but did not differ between participants and non-participants. We cannot confidently dismiss the possibility that participants indicated the course increased their confidence and influence to avoid the cognitive dissonance that might occur if they acknowledged the education they purchased did not

have this positive effect. Such behavior might be consistent with [Oliver's \(1980\) Expectation Confirmation Theory \(ECT\)](#) which suggests a consumers anticipated utility of a product may influence their ex post satisfaction with it ([Hossain and Quaddus, 2012; Oliver, 1980](#)). There are two reasons we expect there were still benefits to confidence and influence. First, the objective knowledge gained through participating in the program likely supports an increase in confidence and influence. The participants could have recognized their own increase in knowledge as evidenced via the pre-post comparison, and this could have translated to greater confidence. This aligns well with other fisheries education studies that found increased knowledge of fishing skills also resulted in increased awareness and confidence ([Morales et al., 2020](#)). Similarly, because some of the course materials that participants were evaluated on included information about engaging and communication, a knowledge gain may also have bolstered influence. The second reason is that even if the education essentially amounted to some placebo effect, participants who believed they had increased their confidence and influence might still more confidently exert greater influence. Further assessments seeking to objectively measure how participant behavior changed could decrease uncertainty over these effects.

It is important to recognize some additional limitations of this work. First, our work uses the term “knowledge” in a comparatively shallow and specific way by assuming knowledge can be measured by pre-post online assessments. This comparatively simple view may be largely consistent with some environmental education research ([Monroe et al., 2019](#)), but differs sharply from perspectives in more psychologically-based studies. The methods we used to assess knowledge did not attempt to describe psychological precursors of knowledge nor to measure any type of Local Ecological Knowledge that might not translate to the assessments. Interview or open-ended survey questions could augment similar results in future work. A second but related limitation is that the pre-post evaluation may not have been a good measurement of long-term knowledge gain or changes in behavior. The post course assessment was available to participants immediately after course completion which limits our ability to assess the durability of the results; however, such assessments are fairly common in the literature (e.g., [Delle Palme et al., 2016](#)) though some show that only certain aspects of knowledge are retained long-term ([Fujitani et al., 2016](#)). Additionally, it is possible that we heard from a particular subset of the guide population, and that those who did not participate may be more or less knowledgeable than those who did. Third, the two survey instruments were not designed in conjunction with one another. This study took an opportunistic approach to answer novel questions about this educational program and provides a useful foundation for future research; however, future work should coordinate theory and survey instrument design allowing for additional comparisons across data sets. For example, an objective knowledge assessment conducted with non-participants would be a valuable addition to the study. Future research should address these limitations, work to measure behavior change in both expert groups (e.g., fishing guides) and their customers, and explore how other behavioral theories (e.g., expectancy-value theory) may inform similar work.

5. Conclusion

This study demonstrates the efficacy of an expert fisheries education program to increase the knowledge and confidence of participants, and to increase their confidence in influencing management. While the differences between participants and non-participants for knowledge, confidence, or influence on clients were similar, this study provides valuable insights into education phenomena indicating that it is possible for different groups of people to report being equally confident or knowledgeable in a specific subject, even if real underlying differences exist in their subject knowledge. This study demonstrates the value in fisheries education programs, such as the Florida Friendly Fishing Guide program, that may provide tangible benefits by building a community

that is more knowledgeable of fisheries best practices and possibly more willing to engage in fisheries management through co-management or other participatory processes.

CRedit authorship contribution statement

William R. Casola: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis. **Savanna Barry:** Writing – review & editing, Supervision, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization. **Kotryna Klizentyte:** Writing – review & editing, Methodology. **Chelsey Crandall:** Writing – review & editing, Project administration. **Michael Sipos:** Writing – review & editing, Project administration. **Edward Camp:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation.

Funding

Florida Fish and Wildlife Conservation Commission, the University of Florida, and Florida Sea Grant funded this research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Florida Fish and Wildlife Conservation Commission, the University of Florida, and Florida Sea Grant supported this research. We thank respondents for participating in this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ocecoaman.2025.108046>.

Data availability

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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