



The Importance of Values in Predicting and Encouraging Environmental Behavior: Reflections From a Costa Rican Small-Scale Fishery

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Encouraging people's pro-environmental behaviors is an objective of Education for Sustainable Development. In the context of small-scale fisheries, unsustainable fishing practices are compromising the integrity of coastal communities and ecosystems. Ecopath with Ecosim (EwE) is an ecosystem modeling software that presents interactions/changes in the food web as a result of fishing. Despite the multiple applications of EwE in fisheries management, it is unknown from a quantitative perspective whether the application of EwE trophic modeling in environmental education processes and management produces effects on norms and ecological beliefs, and if it alters behavioral intentions of the participants receiving ecosystem modeling information. We conducted a behavior change intervention with gillnet fishers in the Gulf of Nicoya, Costa Rica, to compare antecedents of pro-environmental behavior between participants who received an ecosystem-based intervention (lectures containing EwE models; treatment) and those who received lectures that didn't involve EwE (control). Based on theories of environmental psychology, we used a pre-post survey design, to evaluate changes between control/treatment, and to assess the influence of psychometric constructs and fishing characteristics on the behavioral intentions to support sustainable fishing measures and owning a fishing license (revealed behavior). *Personal norms* and *values* were significant at explaining management measures' support, along with some fishing characteristics (e.g., fishing site). Deliberating about possible future scenarios (via EwE-modeling) helped reduce uncertainties, increasing legitimacy and a *perceived behavioral control* (PBC) to support measures. Currently, licenses in the Gulf aren't granted under defined ecological criteria, and although altruistic-biospheric values scored highly before the intervention began, due to mistrust and high illegal-unlicensed fishing, fishers may be underestimating how much others care about the environment. Value-oriented and ecosystem-based interventions may

assist to effectively redesign the licensing system and encourage fishers to support sustainable measures. Our research indicates the importance of education interventions that teach about the impacts of fishing in the ecosystem while helping participants to perceive themselves as capable of implementing actions (PBC) and expressing biospheric-altruistic values to restore trust. Redirecting human behaviors to reconnect with ecosystem resilience can be a leverage point for sustainability and for the compliance of small-scale fisheries management measures.

Keywords: behavior change interventions, social psychology, environmentally relevant behavior, value-belief-norm (VBN) theory, theory of planned behavior (TPB), Costa Rican Pacific, Ecopath with Ecosim (EwE) modeling, tropical small-scale fisheries

INTRODUCTION

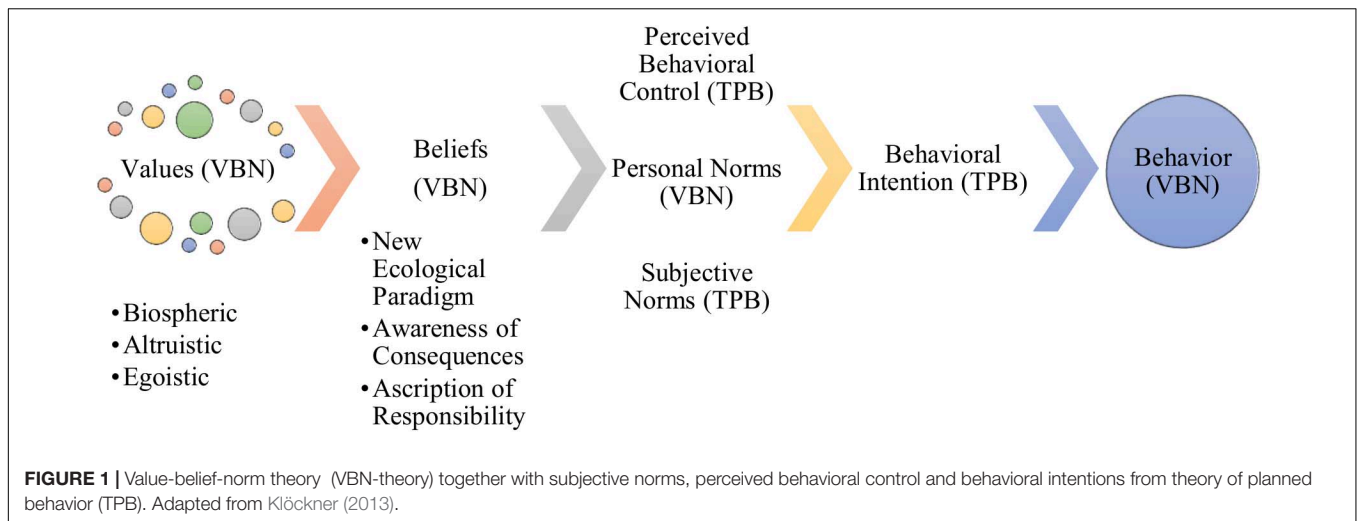
Encouraging people's commitment to protect marine biodiversity and adopt behavior toward sustainability are important objectives of Education for Sustainable Development (ESD) and the Sustainable Development Goals (SDGs) (United Nations, 2016). ESD is particularly relevant today when a rapid response and a behavioral change is needed to address major global environmental problems, such as the climate emergency or biodiversity and ecosystem loss (McKeown, 2002). Overexploitation, ecosystem imbalances, gender inequality and poverty, are some of the environmental and social issues faced by people in coastal areas worldwide, particularly affecting the tropics and small-scale fisheries (Pauly et al., 1998; Salas et al., 2007; Kittinger et al., 2013; Purcell and Pomeroy, 2015). Responding to global challenges requires a shift in our lifestyles and a transformation in the way we think and act (United Nations, 2016). To implement realistic sustainable conservation measures in small-scale fisheries – given irreducible complexity and uncertainty – solutions at the level of whole ecosystem are required (Walters, 1986). Ideally this would be accompanied by experiential education (Stern et al., 2008), active learning, deliberation and participatory processes (Dietz, 2013), as well as an understanding of the human-nature relationships behind behavior of those individuals and communities that are involved in conservation plans (Kollmuss and Agyeman, 2002).

Education for Sustainable Development is clearly recognized as part of the target 4.7 of the SDGs on education which “aims to ensure by 2030 all learners acquire knowledge and skills needed to promote sustainable development, through education and sustainable lifestyles” (United Nations, 2016). ESD is also essential to all efforts to achieve the SDGs by promoting societal, economic and political change as well as by transforming people's behavior (McKeown, 2002). One important step in this direction is to understand how humans make decisions about environmentally relevant behavior (Kollmuss and Agyeman, 2002). For example, in the case of climate change, the question arises: what makes some people use public transportation, a bicycle or a car, or what makes some individuals eat meat while others become vegan or vegetarian? Attributes such as perceptions and socio-ecological characteristics are key drivers of fishers' behavior (Naranjo-Madrigal et al., 2015; Torres-Guevara et al., 2016), in turn, these attributes are based on mental models, particularly values, beliefs, norms and worldviews

(Song et al., 2013). Environmental and social psychology has contributed by proposing and testing theories and models of human-nature relationships that aim to predict environmentally significant behavior (Klößner, 2013) and identify possible interventions that would motivate transformations in peoples' behavior toward sustainable lifestyles and actions (Abrahamse et al., 2005; Bolderdijk et al., 2013).

Values are important components of many models of environmentally significant behavior (Schwartz and Howard, 1981; Ajzen, 1991; Stern et al., 1999; Stern, 2000), and serve as standards to assess whether certain actions are desirable or not in a society (de Groot and Steg, 2008). Within the value orientations (de Groot and Steg, 2008), *biospheric* orientations refer to concern for environment, *altruistic* denote concern for other human beings and *egoistic* orientations represent concern for personal resources and one's own life. Government policy, environmental education and deliberation have been proposed as vehicles to create changes in people's values; however, as values are molded at an early age and tend to remain stable throughout the years, they can be difficult to change (Schwartz and Bardi, 2001). In this sense, a fruitful area of research for environmentally significant behavior, complementary to the investigation of change in values, has been describing values to predict conservation behavior, which is relevant because values contribute to the specific environmental beliefs, norms and actions that people adopt in the course of their lives (Stern and Dietz, 1994). The theory of value-belief-norm (VBN) (Stern, 2000) and the theory of planned behavior (TPB) (Ajzen, 2005) have been widely used and remain broadly prevalent in the field of social psychology to explain human pro-environmental behaviors (e.g., Steg et al., 2005; de Groot and Steg, 2009; Bolderdijk et al., 2013; Klößner, 2013; Clayton and Myers, 2015) including marine conservation and fisheries context (e.g., Fujitani et al., 2017; Riepe et al., 2017; Wynveen and Sutton, 2017; Olya and Akhshik, 2019).

Both theories the VBN and the TPB consist of a causal and hierarchical chain of psychological constructs that inform pro-environmental behavior (**Figure 1**). According to the VBN theory (Stern, 2000) individual's *biospheric*, *altruistic* and *egoistic values* (de Groot and Steg, 2008) give rise to a series of *beliefs*. Beliefs are defined as expectations arising from information and experience (Fujitani et al., 2017). Based on these environmental beliefs, the ecological worldview of an individual is shaped (*new ecological paradigm*, NEP) and people may feel responsible



for reaching specific pro-environmental goals. *Ascription of responsibility* (AR) is in turn influenced by the individuals' *awareness of consequences* (AC) if not acting pro-environmentally (Stern, 2000). The responsibility once recognized, translates into *personal norms* (PN), defined as a perception of what should be done in a given context. Theoretically, all components of the VBN-theory serve as a predictor of environmental behavior, although there are some variations in the prediction power between the variables (Stern, 2000; Steg et al., 2005). For example, norms and beliefs have been identified as strong determinants of environmental decisions (Fujitani et al., 2017; Riepe et al., 2017). It has also been observed that biospheric and altruistic values tend to dominate in prediction (van Riper and Kyle, 2014) and in the stability of pro-environmental behavior, above egoistic values (de Groot and Steg, 2009).

The TPB establishes that the performance of a certain behavior is directly associated with the *intention* of an individual to perform that behavior (Ajzen, 1991, 2005). This intention increases with an increase in *subjective or social norms* (SN) and with an increase in *perceived behavioral control* (PBC) (Ajzen, 2005) (Figure 1). Specifically, individuals tend to perform pro-environmental behavior if there is a perception that other relevant people expect them to act in this way and support them in doing so (SN) (Nyborg et al., 2016), and if they perceive themselves as capable of implementing or changing this behavior (PBC) (Clement et al., 2014) also known as *perceived self-efficacy* (Wynveen and Sutton, 2017). Scholars have expanded or combined relevant psychological theories of behavior change (Olya and Akhshik, 2019), and for instance have pointed out the importance of habit strength alongside intention in predicting behavior (Klöckner, 2013). Ajzen (2005) indicates that intention also increases with an increase in an individual's attitude toward behavior (Attitudes, i.e., a positive evaluation of behavior). Even some authors outside of social psychology, include intention formation and intention realization as antecedents of behavior (e.g., Schüler et al., 2019, for clinic behavior change). For the present study, we used a comprehensive approach of determinants of

individual environmentally relevant behavior based on a meta-analysis (Klöckner, 2013) and a combination of two of the most important theories in social psychology, the TPB and VBN. Thus, in addition to revealed *behavior* and the VBN factors, we measured subjective norms, PBC, and behavioral intentions from the TPB.

To promote environmental sustainability in public policies and management, the existence of citizens with environmental awareness and scientific knowledge is crucial (Kinzig et al., 2013). Educational programs are among the most popular means to foster pro-environmental behavior and actions toward sustainability (Smyth, 2006; Arbuthnott, 2009). Education for Sustainable Development aims to equip individuals with knowledge but also fostering skills and engagement to bring about transformations that lead to more sustainable societies (McKeown, 2002). Nevertheless, it has been shown that the provision of information alone is usually insufficient to affect long-lasting changes in behavior (Sterman, 2008; Fujitani et al., 2016). If the goal of an educational program is to encourage positive behavior, following models of environmentally significant behavior these programs should target beliefs (Bolderdijk et al., 2013) and foster AC and AR (Menzel and Bögeholz, 2009). In order to alter mental models and fundamental beliefs, it has been proposed to create spaces within educational programs for people to reflect, express and negotiate their views, and learn socially and actively (Fujitani et al., 2017).

A deliberative processes – in which through discussion respondents are given the opportunity to exchange opinions and arguments (Völker and Lienhoop, 2016) – can deepen consideration of issues, facilitate social learning and help to form preferences in social contexts, for situations that people usually do not have to make decisions about (Macmillan et al., 2002). A large body of literature indicates that deliberative process anchored on scientific information and management can both provide useful knowledge for decision making as well as foster environmentally significant behavior (Wilson and Howarth, 2002; MacMillan et al., 2006; Spash, 2008; Kenter et al., 2011).

One hypothesized way to affect behavioral antecedents, such as beliefs and norms in favor of the environment, is to provide individuals with scientific knowledge, in turn promoting positive connections between people and nature. We suggest that deliberating on an ecological model in environmental education, can help bridge science and society while showing the relationships between people and ecosystems in an accessible way. A food-web model can provide a basic visual experience of the structure of the marine ecosystem, the interconnection between marine species in addition to showing the role that people play in that ecosystem. A representative example of ecological modeling is the Ecopath with Ecosim (EwE) approach, a software that presents interactions and changes in the food web as a result of fishing (Christensen and Pauly, 2004; Christensen and Walters, 2004b). EwE modeling also allows managers to project past and future states of the system, exploring optimal fishing policies and environmental changes (Pauly et al., 2000; Pitcher, 2001; Christensen and Walters, 2004a). As models are targeted to answer specific scientific and management questions, the use of a trophic model in a workshop as a scientific educational tool, can create a space for reflection, deliberation and the two-way exchange of information on the management of shared natural resources (e.g., Sánchez-Jiménez et al., 2019).

Despite the multiple applications of EwE in fisheries management (Christensen and Walters, 2005), it is unknown from a quantitative perspective whether the application of the EwE food web model in environmental education processes produces effects on norms and ecological beliefs, and if it alters the behavioral intentions of the people who receive information from ecological modeling. In our case study in the Gulf of Nicoya (GoN), Costa Rica (Pacific Ocean), behavior change interventions were developed combining an Ecopath model with Ecosim (EwE) with deliberation, to stimulate an active learning process. Based on Alms and Wolff (2019), a description and modeling of the ecosystem of the Gulf of Nicoya and its fisheries was presented to discuss the changes in biomass over the last two decades (Wolff et al., 1998; Alms and Wolff, 2019) and a management scenario that involves the reduction of fishing effort for the restoration of species at high trophic levels, as a proxy for ecosystem health.

Within the context of an environmental education experiment, we conducted a behavior change intervention with gillnet fishers, to compare antecedents of pro-environmental behavior between participants who received an ecosystem-based intervention (a lecture with workshop materials containing EwE models) (treatment) and those who received lectures that didn't involve EwE models (non-EwE) (control). Based on the VBN theory and the TPB, we used a pre-post survey control design, to evaluate changes in psychological factors between control and treatment, as well as to assess the influence of psychometric constructs and fishing characteristics on measures of pro-environmental behavior, specifically on the intentions to support fisheries sustainability and a reduction in fishing effort of 25% (measures A and B), along with owning a fishing license (revealed behavior, measure C).

Two hypotheses have been raised: (1) after the intervention we would observe an increase in the scores of psychometrics related with pro-environmental behavior in the treatment compared to the control; (2) of psychometric factors, *values*, *personal norms*, and *perceived behavioral control* would have a significant influence on behavioral intentions and behavior (Klößner, 2013). Our interest has been to explore the role that EwE trophic modeling can play in a behavior change intervention both in a context of Education for Sustainable Development and in small-scale fisheries management. It is expected that in practical applications, participatory management processes of this nature should be reflected in a greater willingness to support policies or projects aimed at sustainability.

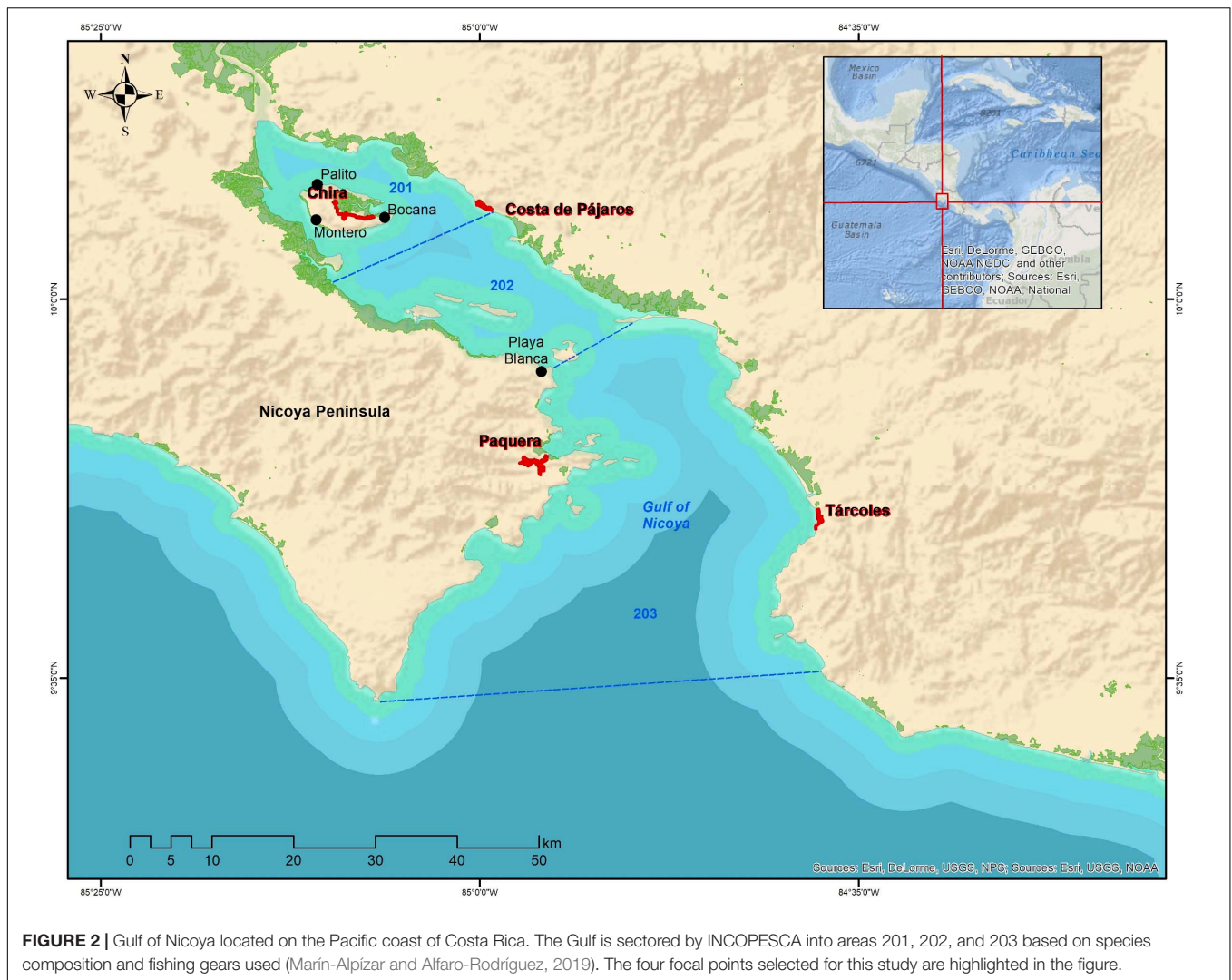
MATERIALS AND METHODS

The Gulf of Nicoya Ecosystem

The Gulf of Nicoya (Figure 2), located on the central Pacific coast of Costa Rica, is considered one of the most important estuaries in Central America (Wolff et al., 1998) due to high productivity and marine biodiversity (Vargas, 1995). Thousands of artisanal fishers depend on seafood in the GoN (FAO, 2014). Small-scale fishers rely on fishing nets, bottom and drifting longlines, handlines, as well as practice shellfish harvesting (Marín-Alpízar and Vásquez, 2014). Sardine purse-seiners and shrimp trawlers (new permits cannot be granted due to environmental damage; the debate to reactivate shrimp trawling is open) are other two semi-industrial fleets operating in the GoN (Ross-Salazar, 2014). From 1994 to 2005, the reported landings of the GoN represented 65% of the total production in Costa Rica, with a peak that occurred in 2000 and a downward trend since then (Chacón et al., 2007). In this regard the majority of commercially species are exploited beyond sustainable levels (Wehrtmann and Nielsen Munoz, 2009).

For management purposes, the Costa Rican institute of fisheries, INCOPECA, have sectored GoN into three different areas, the inner (zone 201), middle (202), and outer Gulf (203) (Marín-Alpízar and Alfaro-Rodríguez, 2019). For this study, we followed the criteria of INCOPECA and selected four focal points that geographically represent the diversity of artisanal gillnet fisher communities along the GoN. (1) Isla Chira (North internal region), (2) Costa de Pájaros (North intermediate region), (3) Paquera-Tambor (South-West external region) and (4) Tárcoles (South-East external region). Across the sectors is a common presence of species such small pelagics (*Anchoa* sp., *Centengraulis mysticetus*, *Ophistonema* spp.), shrimps (*Litopenaeus* spp.), snapper (*Lutjanus* spp.), and corvinas and snook (*Cynoscion* spp., *Micropogonias altipinnis*, *Centropomus nigrescens*) (Vargas-Zamora et al., 2019).

The basic input parameters collected to create the updated EwE food web model of the Gulf of Nicoya, come from INCOPECA's monthly artisanal landings statistics for the main target groups of the fisheries (Alms and Wolff, 2019). Within the EwE modeling software, Ecopath enabled the analysis of the trophic mass balance (biomass and flow) and functioning of the ecosystem (Christensen and Walters, 2004a). Estimation of biomass with Ecopath



required making explicit assumption about the ecotrophic efficiency; i.e., the proportion of the total mortality rate of a group accounted by the predation, migration, biomass accumulation and fishing rates (Christensen and Walters, 2004a). EwE is characterized by its simplicity and management applications, since it is flexible to accommodate future input updates and requires relatively few key data, making it useful in some data-limited fisheries contexts (Bacalso and Wolff, 2014). One potential limitation in applying the EwE approach lies in the quality of available data, so this and other possible limitations were addressed based on Christensen and Walters (2004a).

The time dynamic modeling capability (Ecosim) of EwE (Pauly et al., 2000), facilitated estimating future results of fisheries management alternatives in the Gulf, at combining fishing data with ecological data (biomass and consumption estimates, ecotrophic efficiencies and diet composition). Based on Alms and Wolff (2019), a fishing effort reduction by 25% was modeled, within which relatively small economic losses and the potential for substantial restoration of high trophic level functional groups

(large corvina, snook, catfish, mackerel and barracuda) were identified (Figure 3).

Experimental Design

We conducted an experiment of environmental education with small scale gillnet fishers in the Gulf of Nicoya to assess outcomes of providing and deliberating upon scientific information. The topic concerned complex ecological issues in the GoN, discussed in relationship with fishing activities, especially the impact of gillnet fisheries on the ecosystem. We compared antecedents of pro-environmental behavior (van Riper and Kyle, 2014; Fujitani et al., 2017) in fishers who were members of an ecosystem-based intervention (a lecture with workshop materials containing EwE) (Figure 3), with those who received lectures that didn't involve EwE. Using a pre-survey (recruitment) and post-survey (applied to the fishers that participated in the three phases of the study) control design, changes in environmental values, beliefs, norms, and behavioral intentions were evaluated.

The experimental design consisted of three main phases (Figure 4): (1) a pre-survey in which 101 small-scale gillnet

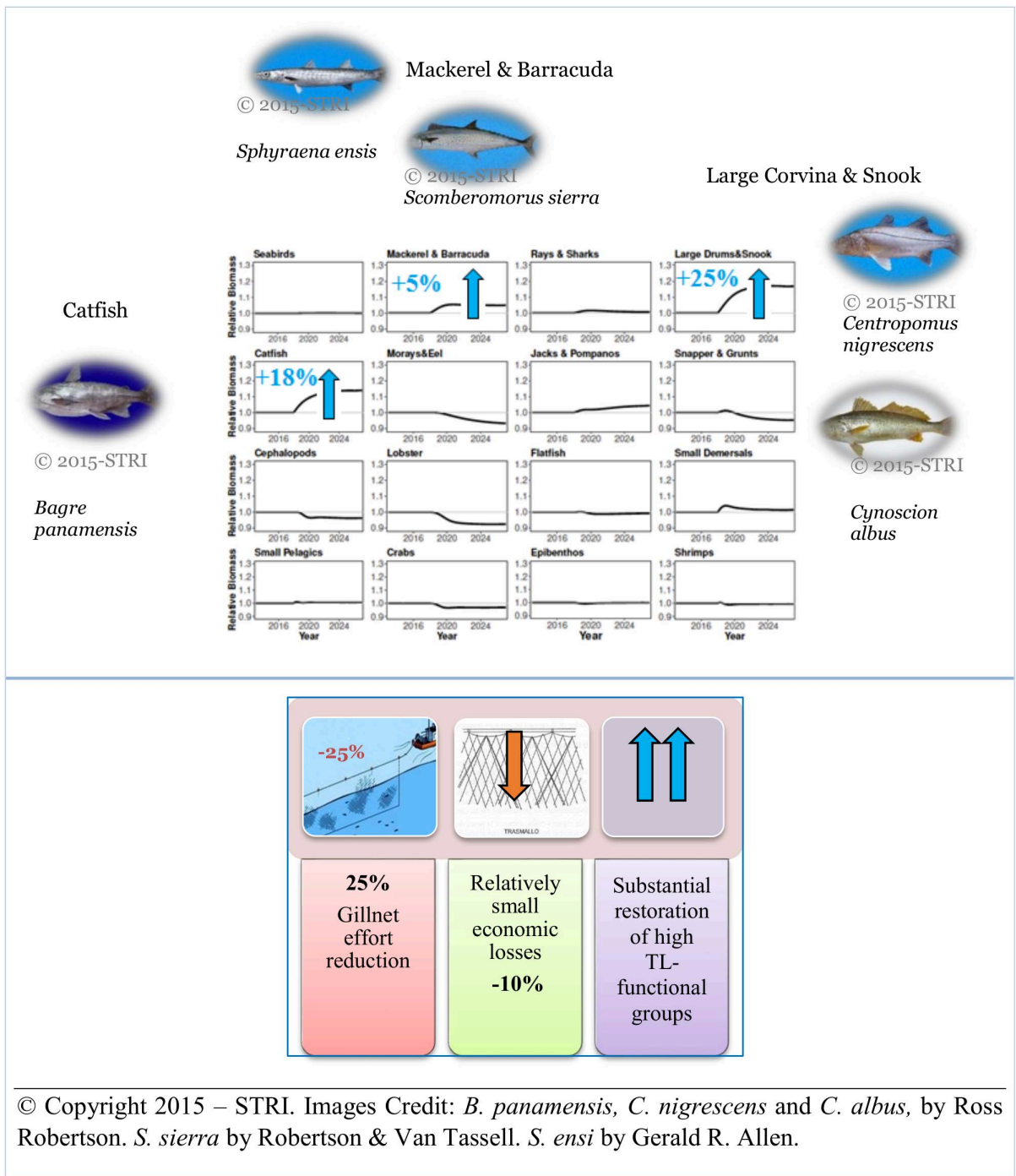
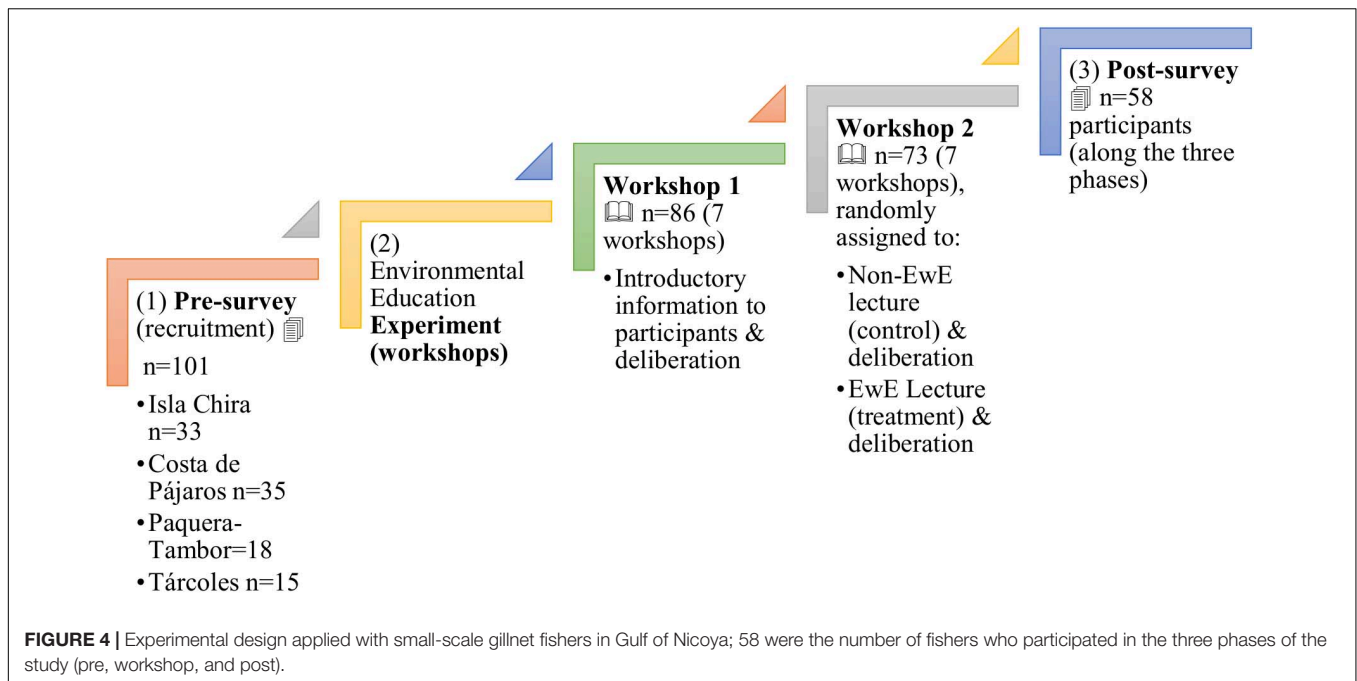


FIGURE 3 | Scenario 25% effort reduction was delivered to the members of an ecosystem-based intervention (lecture containing EwE models), based on Alms and Wolff (2019).

fishers participated, carried out along the Gulf of Nicoya: inland zone (Palito, Bocana and Montero in Isla Chira), middle Gulf (Costa de Pájaros) and external (Paquera-Tambor and Tárcoles); (2) an environmental education program that included two workshops 1 week apart (to discuss different information each week), in which a total of 86 people

were part of the 101 pre-survey fisher and participated in the first workshops, then 73 people were part of the 86 fishers participating in the second workshops; and finally (3) a post survey (after the workshops) for the fishers who participated in the three phases of the study. In total, 14 workshops were held in all communities, with a retention



rate from before to after the survey of 57.42%. This study focuses on the 58 fishers who participated in the three stages of the research. The 15 respondents from the Tárcoles community, who only completed the pre-survey and did not show positive availability for the workshops, were not included in the analysis.

Summary tables of the respondent's profiles are provided in the **Supplementary Material**. The majority of respondents identified as male (82.8%). The average age of respondents was 41, ranging from 18 to 70 years old. These characteristics of our sample are similar to the population data for the communities visited (Biomarcc-SINAC-GIZ, 2013); 96.6% of respondents were long term residents of Gulf of Nicoya (more than 10 years) from which 36.8% reported having fishing experience of 10–20 years and 47.4% of more than 20 years. The majority of fishers (51.7%) completed elementary school and just 12.1% completed high school.

With respect to the surveys, the quality of the responses are determined by the extent to which the respondent understands the question, retrieves and integrates information to form a general judgment and formulate an answer; the type of instrument used (e.g., in person or self-administered surveys/interviews/questionnaires) can have an effect on the responses (Lindhjem and Navrud, 2011). When using in-person surveys, the respondent may feel inclined to provide answers that are socially acceptable or that he/she thinks the interviewer would like to hear, that effect is called social desirability bias (Ressurreição et al., 2012).

Taking into account social desirability bias (Nunnally, 1967), the present study was framed within an experimental setting in which group control was used for comparison with the members of an EwE (ecosystem modeling) groups (treatment). The level of social desirability also seems to be related to the

degree of anonymity and confidence felt by the respondent (Lindhjem and Navrud, 2011), hence in order to improve this anonymity and trust (1) we sought and obtained authorization from community leaders before conducting the surveys, and the wording was pretested and modified accordingly in a pilot survey (and workshop pilot); (2) participants were asked for prior informed consent and provided with a description of the project and the uses of the research data; (3) the interviews were carried out by trained interviewers to clarify the doubts of the respondents, thus minimizing the non-response rates; (4) respondents were encouraged to give honest answers and the confidentiality of the answers was emphasized.

The survey used in this investigation contained some reversed statements interspersed so people needed to put the necessary effort and take some time to think to optimally answer (Lindhjem and Navrud, 2011), in addition we counted with follow up questions (post survey) to test for consistency of the responses (see more details in the “Data Analysis” section).

The study was conducted primarily from May to July, 2017, as this was a 3-month period of fishing closure in the inner and intermediate zones of the Gulf, created for the protection of the reproductive peak events of target resources (small pelagic fish species, shrimps, snapper, and corvinas) (Sánchez-Jiménez et al., 2019). Usually fishers from internal zones are not involved in any fishing activity during the closure, which facilitated their recruitment to this study. To maximize respondent attention when answering questions, the interviews were preferentially performed when respondents were apparently relaxed and unoccupied (Ressurreição et al., 2012). A minimum of 10 people were interviewed per community in the expectation of having 5–12 attendees in each workshops, facilitating thus fluency in the conversations within small groups (Macmillan et al., 2002).

Pre-survey

In the pre-survey (**Supplementary Material**) the items were designed to elicit: (1) Socio-economic, demographic characteristics and fishing practices of the respondents; (2) antecedents of pro-environmental behavior through psychological factors associated with pro-environmental behavior; (3) behavioral intentions to support fisheries sustainability and a reduction in fishing effort of 25% (measures A and B), along with owning a fishing license (revealed behavior, measure C); (4) the last part of the survey elicited the availability of fishers to participate in workshops. Each survey session lasted an average of 45 min.

Values, beliefs and norms were measured in the survey using 22 items adapted from previous surveys (Steg et al., 2005; Kenter et al., 2016). The values were measured through a Likert response format -1 to 7 where -1 indicated “opposition” to this value,” and 7 indicated “of supreme importance.” Beliefs and norms were measured in a format 1 to 5 where 1 indicated “strongly disagree,” and 5 indicated “strongly agree.”

Environmental Education Experiments (Workshops)

Two workshops (**Figure 4**), 1 week apart, took place and lasted approximately 4 h. Both workshops included deliberation to provide participants with a space to discuss complex ecological issues in the GoN associated with fishing practices. In the first workshop, everyone received the same introductory information about the state of the ecosystem in the GoN to familiarizing them with the topic. In the second workshop the differences lay in the way the information was presented, since they were randomly assigned to a lecture that either had EwE or did not.

Within **workshop 1** (introductory information and deliberation): (1) all participants received the same introductory information about the state and changes over 20 years in catches of shrimps, corvinas and large predatory species, taken from Alms and Wolff (2019). (2) Fishers were asked to deliberate in groups around the information received (see details in Sánchez-Jiménez et al., 2019). Within **workshop 2**, people were randomly assigned either to a treatment (containing EwE) or to a control lecture (non-EwE), this served as the control for comparison (Fujitani et al., 2017). Control and treatment both involved deliberation on the info presented, the differences lie in the way the information was offered.

The **control lecture**: (1) Taught general issues regarding the concepts of marine tropical food webs (Christensen and Pauly, 2004) without discussing the trophic modeling, serving as the control for comparison with the EwE lecture groups to account for social desirability bias and the observer effect in respondents' answers (Nunnally, 1967; Fujitani et al., 2017); (2) participants were told about a hypothetical management option in which a reduction of 25% in the fishing effort would take place but without the modeling context; and (3) they were encouraged to deliberate about this possibility. In the **treatment lecture** the facilitator provided in the classroom, via a flip chart presentation (**Figure 3** and **Supplementary Material**): (1) a description of the EwE food web model of the Gulf of Nicoya (Alms and Wolff, 2019); (2) an explanation about the execution of an EwE model that implied a 25% reduction in fishing effort, with

evidence of the recovery of large predatory species implicit in this scenario; (3) participants were encouraged to deliberate about the information provided.

Post-survey

A follow up survey was administrated after the end of the second workshop based on the pre-survey to measure changes in the psychometric factors after the deliberation.

Data Analysis

Data were analyzed using R studio version 3.5.3 and JASP version 0.10.2, item and construct relationships were tested with confirmatory factor analysis, as well as reliability analysis (Cronbach's alpha) for internal consistency in respondent's answers (Cronbach, 1951; Ward et al., 2018).

Since we hypothesized that the means of the psychometric constructs would obtain a higher score after treatment (EwE lecture) as an increase in the fishers' environmental commitment, in order to address this hypothesis, we compared via an independent group *t*-test, the changes in psychometric indicators between samples from pre and post surveys, within control and treatment groups (Fujitani et al., 2017).

Weighted least square (WLS) regression analyses were run to test the level of influence of constructs and socio-demographic characteristics on the Gulf of Nicoya residents' behavioral intention and revealed behavior to support three measures of pro-environmental behavior (measures A, B, and C). Each management action served as the dependent variable in a regression with antecedents of pro-environmental behavior and socio-demographic characteristics as independent variables. Variable selection for models used the backward elimination which is a stepwise approach that begins with a full (saturated) model and at each step gradually eliminates variables, in order to find a reduced model that best explains the data. It reduces the number of predictors, reducing the multicollinearity issues (Hocking, 1976).

The dependent variables behavioral intentions measures A and B were continuous variables, and we performed a linear regression. For measure C, the response was categorical (binary, owning a license or not), and so a logistic regression was applied.

RESULTS

Psychometric Constructs

Psychometric indicators were measured in the questionnaire using 22 items. Factor analysis extracted eight expected constructs from these questions: AR (two items), PBC (two items), universal values (biospheric and altruistic values) (four items), AC (two items), Egoistic values (three items), PN (two items), Subjective norms (two items), NEP (five items) (**Tables 1, 2**).

Reliability estimates for the eight constructs ranged from 0.512 to 0.917 for the pre-survey sample (**Table 1**) and from 0.621 to 0.935 for the post-survey sample (**Table 2**). Overall Cronbach's alpha was improved by deleting three items of the NEP construct. The recommended corrected item total correlations of 0.4 was

TABLE 1 | Factor analysis on values, beliefs, and norms regarding restoration of high-trophic level species and sustainable fisheries in the Gulf of Nicoya and reliability estimates for each extracted factor (pre-survey sample).

Constructs	Theory	Survey code	Factor								Mean	SD	Cronbach's alpha
			1	2	3	4	5	6	7	8			
Ascription of responsibility	VBN												0.917
I feel responsible. . .		BAR1	0.88								4.12	1.14	
*I don't feel. . .responsible		BAR2	0.93								4.21	1.17	
Perceived behavioral control	TPB												0.952
It is easy to take action		BPBC1		0.99							3.61	1.53	
*It is difficult. . .		BPBC2		0.89							3.53	1.46	
Biospheric and altruistic values	VBN												0.772
Respecting the earth.		BBV1			0.41						5.91	1.31	
Unity with nature. . .		BBV9			0.65						5.71	1.37	
Equality. . .		BBV4			0.81						5.61	1.64	
A world at peace. . .		BBV5			0.43						6.14	1.42	
Awareness of consequences	VBN												0.777
. . .seas are under a real threat. . .		BAC1				0.72					4.68	0.66	
*If the diversity diminished. wouldn't impact. economy		BAC2				0.89					4.82	0.51	
Egoistic values	VBN												0.596
Wealth. . .		BBV3					0.64				3.84	2.20	
Influence		BBV6					0.49				4.82	2.04	
Authority		BBV8					0.62				4.02	2.02	
Personal norms	VBN												0.643
We should protect. . .		BPN1							0.41		4.77	0.47	
*We should think about economic. . .and then about environment		BPN2							0.97		4.48	0.76	
Subjective norms	TPB												0.549
Most people. think I should support. . .		BSN1								0.57	4.75	0.55	
Most people. . .take action		BSN2								0.76	4.66	0.59	
New ecological paradigm	VBN												0.512
*. . . the ecological crisis" has been exaggerated		BNEP4									0.67	4.64	0.48
Plants and animals have. . . right. . .		BNEP5	0.29								4.89	0.31	

*Reversed into a positive statement for analysis. VBN, value, belief, norm theory (Schwartz and Howard, 1981); TPB, the theory of planned behavior (Ajzen, 1991).

TABLE 2 | Factor analysis on values, beliefs, and norms regarding restoration of high-trophic level species and sustainable fisheries in the Gulf of Nicoya and reliability estimates for each extracted factor (post-survey sample).

Constructs	Theory	Survey code	Factor								Mean	SD	Cronbach's alpha
			1	2	3	4	5	6	7	8			
Biospheric and altruistic values	VBN												0.774
Respecting the earth...		ABV1	0.89								5.58	1.18	
Unity with nature...		ABV9	0.61								5.60	1.63	
Equality...		ABV4	0.50								5.75	1.54	
A world at peace...		ABV5	0.73								5.91	1.31	
Perceived behavioral control	TPB												0.935
It is easy to take action...		APBC1		0.96							3.36	1.53	
*It is difficult...		APBC2		0.84							3.42	1.49	
Egoistic values	VBN												0.726
Wealth...		ABV3			0.57						4.17	2.00	
Influence...		ABV6			0.57						3.96	1.99	
Authority...		ABV8			0.94						3.87	2.02	
Ascription of responsibility	VBN												0.918
I feel responsible...		AAR1				0.93					4.07	1.25	
*I don't feel...responsible		AAR2				0.89					4.09	1.19	
Awareness of consequences	VBN												0.825
...seas are under a real threat...		AAC1					0.65				4.65	0.78	
*If the diversity...diminished wouldn't impact economy...		AAC2					0.96				4.63	0.68	
Subjective norms	TPB												0.835
Most people... think I should support...		ASN1						0.88			4.69	0.85	
Most people... take action...		ASN2						0.73			4.48	0.72	
New ecological paradigm	VBN												0.621
*The "ecological crisis" has been exaggerated		ANEP4							0.96		4.57	0.75	
Plants and animals have right...		ANEP5							0.43		4.84	0.50	
Personal norms	VBN												0.685
We should protect...		APN1								0.67	4.84	0.50	
*We should think about the economic... and then about environment		APN2								0.82	4.25	0.65	

*Reversed into a positive statement for analysis. VBN, value, belief, norm theory (Schwartz and Howard, 1981); TPB, the theory of planned behavior (Ajzen, 1991).

exceeded in all cases (Ward et al., 2018). For these reasons, all items were grouped together with their respective indicator theme constructs.

Pre and Post Survey Control Comparisons

The results of the independent group *t*-test for the pre and post surveys samples, are reported in **Figure 5**. Two values differed between the pre and post surveys samples: Egoistic values decreased significantly ($p < 0.05$) in the post survey sample within the EwE lecture (treatment). Likewise, an increase ($p < 0.1$) was found in the PBC values in the post survey sample within the treatment (EwE lecture). No significant differences were found between pre and post survey samples for subjective norms, AC, NEP, PN, AR or for biospheric and altruistic values.

Behavioral Intentions and Revealed Behavior to Support Sustainability (Regression Analysis)

Regression analysis assessed the influence of psychometric constructs and fishing characteristics on measures of pro-environmental behavior, specifically on the intentions to support fisheries sustainability and a reduction in fishing effort of 25% (measures A and B), together with owning a fishing license (revealed behavior, measure C) (**Table 3**).

The estimated correlation between the error terms (adjusted R^2 or Nagelkerke R^2) for all three models fall within the ranges usually reported in regression models (0.3–0.7), suggesting a reasonable explanatory power (Bacalso et al., 2013). Coefficients for subjective norms, NEP, PBC, fishing profits, fisheries organization and gender fell short of significance. The significant (positive or negative) coefficients under management actions A, B, and C are shown as follows:

Behavioral Intention to Support Sustainable Fisheries (Measure A)

The pre survey sample reflected that PN ($\beta = 0.36$, $p < 0.01$) regarding marine conservation issues, was the most significant factors in the model. Catching finfish predominantly with large-size mesh gillnet (≥ 3 inches) was also a significant factor (0.78, $p < 0.001$).

The regression explained 52% of the total variance ($R^2 = 0.5182$) suggesting reasonable explanatory power. On the other hand, the post survey sample showed no significant factors with a 36% of the total variance explained by the regression ($R^2 = 0.3610$).

Behavioral Intention to Support 25% Fishing Effort Reduction (Measure B)

Regarding the support to reduce 25% the fishing effort, the pre survey sample showed that fishing in the middle Gulf (Costa de Pájaros) ($\beta = 0.60$, $p < 0.01$) was the most significant factor in explaining support. Similarly, fishing in the outer Gulf (Paquera-Tambor) ($\beta = -1.66$, $p < 0.001$) and egoistic values ($\beta = -0.18$, $p < 0.05$) were important factors, but the relationship was negative, that is, the more the participants fish in the GoN's

outer area and the more the egoistic values, the less support for sustainability.

In the post survey sample, fishing in the outer GoN also indicated an important significant factor of opposition ($\beta = -1.01$, $p < 0.01$); whereas PN ($\beta = 0.33$, $p < 0.05$), biospheric and altruistic values ($\beta = 0.41$, $p < 0.01$) together with fishing with large-size mesh gillnet ($\beta = 1.29$, $p < 0.01$) and being a resident of Costa de Pájaros ($\beta = 0.48$, $p < 0.05$) were the most significant positive factors influencing support. The regression explained 72% of the total variance ($R^2 = 0.72$).

Revealed Behavior: Owning a Fishing License (Measure C)

At the third level of support sustainability by means of owning a fishing license, for the pre survey sample, owning fishing vessel ($\beta = 2.89$, $p < 0.01$) was the most significant factor behind owning a fishing license.

The regression explained 51% of the total variance ($R^2 = 0.51$). While own a vessel alone ($\beta = 2.86$, $p < 0.001$) was the most significant factor influencing support for the post survey sample. The regression explained 44% of the total variance ($R^2 = 0.4424$).

DISCUSSION

Our interest has been to explore the role that value-oriented, ecosystem-based interventions can play in environmental education and fisheries management. This study showed that EwE treatments altered *perceived behavioral control* of fishers, and that *values, personal norms* and fishing attributes were factors that influenced pro-environmental behavior in the GoN. Details on these findings are discussed below.

Influence of Cognitive and Fishing Characteristics on Pro-environmental Behavior

Regression analysis supported the first hypothesis of this study, in terms of the potential that *personal norms* have to explain the intention to support sustainable fishing, both in the pre-survey (support sustainable fisheries measure A) and post-survey (support a 25% fishing reduction, measure B). By definition, PN are defined as one's own expectations of specific actions in particular situations that are constructed by the individual and this is relevant since such expectation has proven to be a direct prerequisite for expressing pro-environmental behavior (Stern et al., 1999; Klöckner, 2013) and be related to compliance with management measures in small-scale fisheries (Battista et al., 2018).

Universal values (Schwartz and Bilsky, 1987), both *biospheric* and *altruistic*, as well as *egoistic*, showed potential to explain the support (or lack of it) to reduce the fishing effort by 25%, as has been found in other studies of environmental behavior (Steg et al., 2005; van Riper and Kyle, 2014). Since *egoistic* values focus on the individual's own life over taking care of other people or the environment, they tend to have a negative influence on the prediction of support (de Groot and Steg, 2010), which is the case for measure B in the pre-survey before the

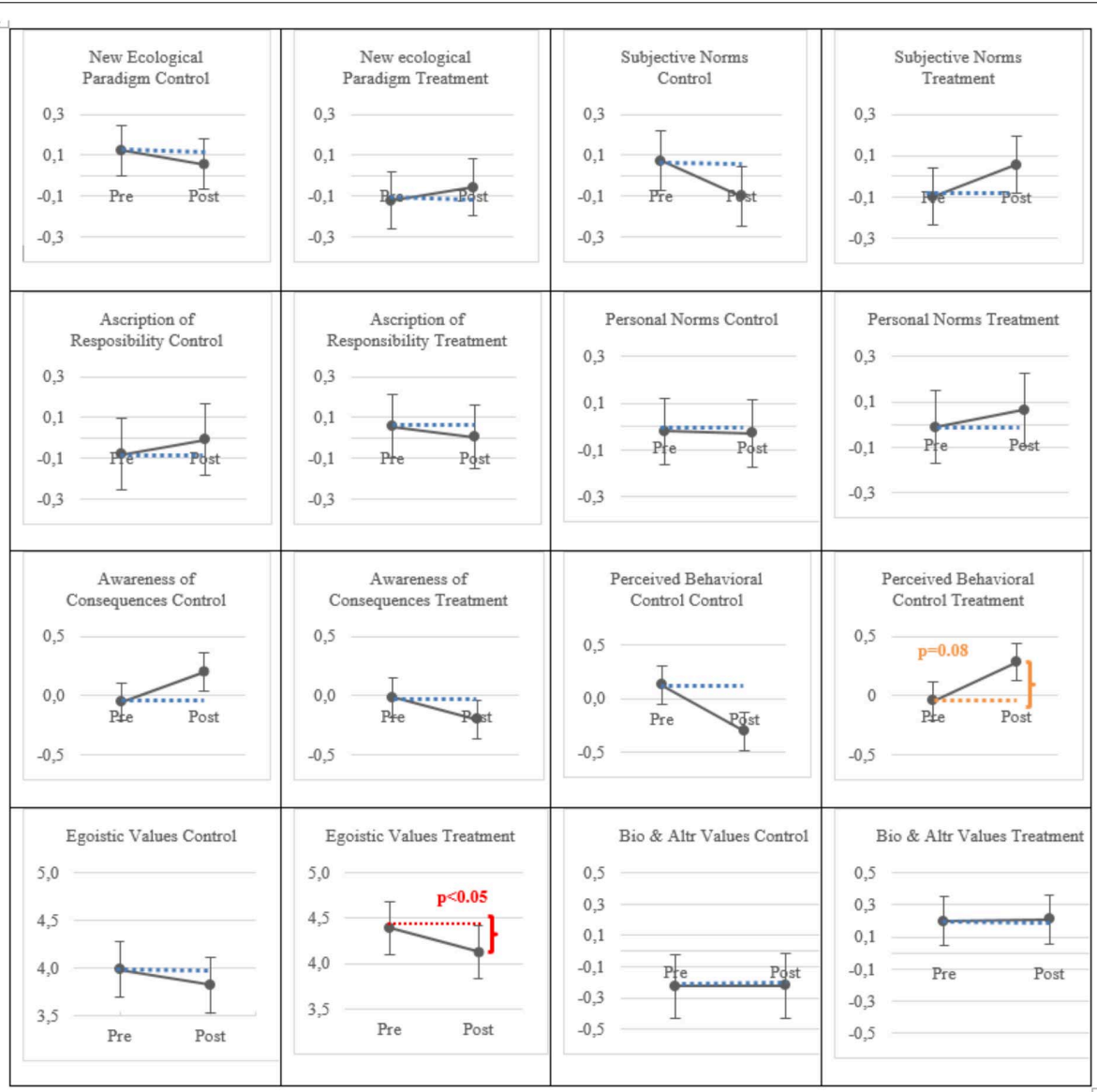


FIGURE 5 | Comparison between means of the pre and post survey sample within the control (non-EwE lecture) and treatment (EwE lecture). Blue dotted lines represent the difference between pre and post survey. A red dotted line indicates a significant difference at the $p < 0.05$ level; an orange dotted line shows a difference at the $p < 0.1$ level.

workshops. It is noteworthy that after the workshops and the deliberation process, a change is identified and the *biospheric* and *altruistic* values showed a significant positive influence in supporting the reduction of fishing effort, which makes a call for educational programs that promote an orientation in values (de Groot and Steg, 2009); for instance, informational interventions can make those who care deeply about the environment more inclined to act in accordance with its values (Bolderdijk et al., 2013). Values are developed at an early age and can remain relatively stable during an individual’s life (Manfredo et al., 2017), therefore, complementary options include educational programs aimed at children and young people (tentatively future fishers) to call the attention to the importance of nature

and promoting early care relationships with their environment (Menzel and Bögeholz, 2009).

In addition to cognitive indicators, fishing characteristics, such as *fishing gear* and *fishing sites* played a role in explaining support for sustainable fishing in the GoN. *Owning fishing vessel* also proved to be one of the factors that influence the ownership of a fishing license. The coefficients for *fishing profits*, *fisheries organization*, and *gender* were not significant in this case. The *fishing gear* variable showed a significant positive coefficient in the regressions, indicating that fishers using large mesh sizes (gillnets for finfish ≥ 3 inches) tend to support general notions of sustainability of fishing (measured A) and a 25% reduction in fishing effort (measure B). In other words,

TABLE 3 | Results of regression analysis for the pre and post surveys samples.

Predictor	Behavioral intentions A and B, and revealed behavior C					
	(A) Support sustainable fisheries [linear regression]		(B) Support a 25% fishing effort reduction [linear regression]		(C) Owning a fishing license [binomial regression; yes, no]	
	Pre (n = 51)	Post (n = 46)	Pre (n = 50)	Post (n = 45)	Pre (n = 54)	Post (n = 49)
Personal norms	0.3605**	n.s.	n.s.	0.3312*	n.s.	n.s.
Subjective norms	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Perceived behavioral control	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Ascription of responsibility	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
New ecological paradigm	n.s.	n.s.	n.s.	ns	n.s.	n.s.
Egoistic values	n.s.	n.s.	-0.1758*	n.s.	n.s.	n.s.
Biospheric and altruistic values	n.s.	n.s.	n.s.	0.4094**	n.s.	n.s.
Fishing profits	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Fishing-site (outer gulf, PT)	n.s.	n.s.	-1.6595***	-1.0057***	n.s.	n.s.
Fisheries organization (member)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Fishing gear (finfish gillnet \geq 3 inches)	0.7796***	n.s.	n.s.	1.2856***	n.s.	n.s.
Fishing-site (middle gulf, CP)	n.s.	n.s.	0.6039*	0.4778*	n.s.	n.s.
Gender (male)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Own fishing vessel (yes)	n.s.	n.s.	n.s.	n.s.	2.89484**	2.86521***
R²	0.5182	0.3610	0.6217	0.7188	0.5125 (Nagelkerke R ²)	0.4424 (Nagelkerke R ²)
Adj. R²	0.4525	0.2986	0.5787	0.6656	0.3690 (Cox and Snell R ²)	0.3237 (Cox and Snell R ²)

All figures (except R² and Adj. R²) are standardized β -coefficients. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, n.s., no significant; PT, Paquera-Tambor; CP, Costa de Pájaros.

fishers using gillnets \geq 3 inches to catch finfish tended to choose management measures that favored rebuilding the biomass of predatory fish over earnings. This is understandable, since in practice they are already utilizing sizes considered legal for the protection of juvenile fish. Illegal fishing is a serious threat to sustainability in the Gulf of Nicoya, and although mesh sizes < 3 inches are prohibited, the use of 2.5 and 2.75 inches is widespread. A reflection of this is that 80% of corvina catches in the 2010s have not reached the size of spawning maturity (Alms and Wolff, 2019).

The *fishing site* variable showed statistically significant coefficients to support a 25% reduction in fishing effort (measure B). Participants fishing mainly in the middle of the Gulf (Costa de Pájaros) support rebuilding the biomass of predatory fish over earnings. In contrast, fishers whose fishing site is the outer Gulf (Paquera-Tambor) show opposition to the measure. The combination of fishing with other economic activities such as tourism in the Paquera-Tambor sector (Chavez Carrillo et al., 2019) and less dependence on fishing activity, may explain the lower interest in supporting the fisheries management measure B. When considering the discussions in the workshops, the positive coefficients of measure B for the middle gulf seem to respond to a genuine interest in the reconstruction of the biomass of high trophic level species, motivated by the concern of the participants about the high fishing effort in the area and the associated problems of poverty in Costa de Pájaros (Fernández-Carvajal, 2013).

The variable *owning a fishing vessel* alone was found to be a statistically significant coefficient for measure C (ownership

of a fishing license). The granting of fishing licenses in the Gulf of Nicoya is a management measure to ensure control of fishing effort and that fishers have access to fishing resources. The absence of a clear pattern of what may be influencing people to acquire a license (other than owning a fishing vessel), uncovers a great underlying problem: licenses are not granted under any technical or ecological criteria, and this is contributing to increase both mistrust among fishers and illegal fishing. Some of the fishers in this study expressed that unlicensed people would have less to lose if caught fishing illegally during a closure season: “The worst consequence in this case is that their gear would be confiscated.” There is a widespread perception among licensed fishers that others will continue to violate restrictions due to unlicensed fishing and a lack of concern for the environment. This has led some people to reconsider their own legal fishing practices, anticipating that others will fish illegally anyway; a social-ecological trap that needs to be addressed (Kittinger et al., 2013). EwE modeling can be useful to provide ecological feedback in redesigning a licensing scheme for effective control of fishing effort. In turn, behavioral interventions can also assist the process by addressing issues of mistrust, compliance and legitimacy among fishers. We refer to this last aspect below.

Changes Before–After the Ecopath Intervention

Average PBC scores, increased in the post-survey for those people who received the EwE lecture, probably attributable to treatment when differences between control and treatment groups are

considered. This is promising, as *perceived behavioral control* is clearly associated with pro-environmental behavior in other studies (Kinzig et al., 2013; Klöckner, 2013; Clement et al., 2014). If people perceive that they are capable of changing behavior and implementing an action (PBC) – and they are guided with plausible routes to follow-, they are more likely to act accordingly (Klöckner, 2013). Given the changes in PBC scores, EwE interventions may be bringing fishers closer to concrete and possible pathways to sustainability, by presenting how a particular reduction in fishing effort has the potential to restore higher trophic level groups (a proxy of ecosystem health). Deliberation about management initiatives can influence not only the perceived ability of people to act (Kenter et al., 2016), but also the perception of the legitimacy of these initiatives (Dietz and Stern, 2008; Fujitani et al., 2017). Such validity is important for a measure to be implemented and is often behind the success of alternative forms of fisheries governance, such as co-management and collective action (Battista et al., 2018).

Educational interventions are recommended that allow people to perceive themselves as capable of implementing actions or changing their behavior, which, for example, strengthen co-management schemes (García Lozano and Heinen, 2016; Herrón et al., 2020) that already exist in the Gulf of Nicoya and combine them with deliberation strategies (Partelow et al., 2017). Integrating the EwE food web modeling approach into participatory processes can help people envision possible scenarios for the future and thus reduce some of the uncertainties associated with complex environmental problems (Steenbeek et al., 2020) characteristic of small-scale fisheries. This last aspect may be related to the greater *perceived behavioral control* by the fishers after deliberating with EwE. After the workshops, several of the participants' comments indicated the need for more educational processes such as the current one, finding it as an attractive way to learn, we suggest that these types of interventions can act as an active learning process (Kenter et al., 2016) that also contribute to more legitimate and empowered ways of creating conservation plans.

Egoistic values decreased significantly in the post survey within the lecture presenting an EwE model (treatment) and a similar decrease also occurred within the control lecture (non-EwE). Though one cannot know for sure, this change observed in both the control and treatment could be due to social acceptability bias (Steenkamp et al., 2010) in response. This simultaneous change in the two groups is not attributable to the treatment, and illustrates the utility of a pre-test post-test control experimental design. On the other hand, altruistic and biospheric values did not vary significantly after the EwE lecture, however, is notable that their scores were already high from the beginning (Figure 4). Our study indicates that the baseline values held by fishers consulted in the Gulf of Nicoya tend toward altruistic and biospheric. This aspect coincides with (Bouman and Steg, 2019), who have indicated that the lack of action in favor of the environment is usually caused by people who structurally underestimate how much others care, rather than being caused by people who undervalue the natural environment. Consequently, highlighting that many value the environment and that they participate in concrete sustainability actions is key to inspiring

pro-environmental actions at a broader level (de Groot and Steg, 2009; Bouman and Steg, 2019).

General Conclusion and Future Directions

People's commitments to sustainability are influenced by a complex suite of factors (Nyborg et al., 2016), we found for the study sites in the Gulf of Nicoya that the support of three management measures was influenced by a combination of psychological and fishing characteristics, particularly universal values (biospheric, altruistic, and egoistic), PBC, norms (PN) and fishing attributes (fishing gear, fishing site and fishing vessel). Understanding cognitive indicators and human-nature relationships is key step in determining support levels for potential management measures.

The use of the EwE model combined with deliberation performed as an active learning approach that provided people with useful skills and encouraged their PBC to increase resilience to environmental change, which is a psychological construct greatly related to pro-environmental behavior in other studies (Kinzig et al., 2013; Klöckner, 2013; Clement et al., 2014). We propose that visualize and deliberating about possible future scenarios (via EwE modeling) helped reduce uncertainties associated with complex environmental problems and thus contributed to more legitimate and empowered ways of discussing such intricate issues and potentially of creating conservation plans. An important area for future research would be to follow the fishers longitudinally, conducting a post survey at a later date to detect the impact of the EwE intervention over time (for example, after 1 year as in Fujitani et al., 2017).

The baseline values for the fishers in this study tend toward altruistic and biospheric but due to high incidence of illegal fishing, people may be underestimating that many others do care about neighbors and the gulf's environment. The lack of a clear pattern of what may be influencing people to acquire a license exposes a large underlying problem: licenses are not granted under any technical or ecological criteria, and this is contributing to increase both mistrust among fishers and illegal fishing. A scheme that grants licenses according to an ecosystem-based management for the effective control of fishing effort, is a necessary step for the sustainability of the gulf; ecosystem models can be very useful to assist in these processes. However, the absence of psychological characteristics that promote cooperation can negatively impact the effectiveness of a fisheries management system (Battista et al., 2018). Therefore, value-oriented and ecosystem-based educational interventions can also assist in an effective redesign of the licensing system and encourage participants' already existing intentions to support sustainable fisheries measures. Our research indicates the importance of behavior interventions that teach about the impacts of fishing in the ecosystem while helping participants to perceive themselves as capable of implementing actions (PBC) and stimulating the expression of biospheric-altruistic values toward a trust restoration process.

The lack government resources for adequate surveillance in addition to the generalized problems of distrust among fishers,

have been previously identified as two of the main factors that hinder compliance and collective action in the Gulf (Chavez Carrillo et al., 2019). Alternative types of governance systems, such as co-management, are emerging forces (García Lozano and Heinen, 2016) that already complement existing government policy in the region, but these alternatives depend on mechanisms such as norms and trust (Battista et al., 2018). Hence, investing in the development of capacities for self-organization and deliberation processes is vital for the sustainability of the SSF in the gulf (Chavez Carrillo et al., 2019). Complementarily, behavior change interventions can be developed to address misinformed beliefs (Ward et al., 2018), such as the generalized conception that people care little about the environment and others.

For future studies in the Gulf of Nicoya, we suggest the explicit incorporation of a relational (Chan et al., 2016; Klain et al., 2017) and systemic approach to values (Raymond and Kenter, 2016; Manfredo et al., 2017), to better understand the relationships between main agents of the fishing system (e.g., fishers, scientists, decision makers, a healthy ecosystem) (Skubel et al., 2019) and potentially to address some of the mistrust problems identified in the gulf. Relational values link people and ecosystems through relationships with nature, including the notions of a good life, such as trust in neighbors or a sense of purpose (Chan et al., 2016). By connecting with other people, the places that people care, the family and human well-being, nature can become part of what an individual cares for; therefore, as (Klain et al., 2017) suggest, appealing to those relational values has the capacity to improve connections with the natural world. Further exploration of the role of EwE interventions in terms of reconnecting actors with each other and with the ecosystems' ability to support life is recommended.

The expression of biospheric, altruistic and tentatively relational values, carries the possibility of making more evident the prevalence of personal choices that already have a positive effect on ecosystems and other people (Bouman and Steg, 2019), which could potentially inspire trust among fishers, as well as new norms that would lead from individual to collective action (Nyborg et al., 2016). Since values are formed in childhood, value-oriented programs could also target young people (future fishers) to engage from an early age in new ways of relating to others and to ecosystems (Menzel and Bögeholz, 2009).

In order to complement government policy, non-governmental organizations (NGOs) can channel educational campaigns that strengthen trust among participants and other expected social reactions (Lucas et al., 2008; Mackay et al., 2018), for example, make visible certain behaviors within communities (Nyborg et al., 2016), such as the notion that neighbors are actually involved in sustainable fishing practices or specific social movements. Government agencies can make use of interventions that have already been tested in experimental contexts such as the current one, to implement at scale in the Gulf of Nicoya, and create participatory spaces that allow a better understanding of the PN and values of the actors involved in specific behaviors (Raymond and Kenter, 2016). Our research indicates the importance of behavior change interventions (Battista et al.,

2018) and recognizes that redirecting human behaviors to reconnect with ecosystem resilience (Folke et al., 2016) can be a leverage point for sustainability (Abson et al., 2017) in the Gulf of Nicoya, and for the compliance of small-scale fisheries management measures.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/**Supplementary Material**.

ETHICS STATEMENT

This study involving human participants was reviewed and approved by the Ombudsperson, who is the point of contact for good scientific practice and ethical human research at the Leibniz Centre for Tropical Marine Research, the institute for which authors conducted the research. The participants (fishers) provided written informed consent to participate in this study. This study follows the standards of good scientific practice outlined by the German Science Foundation.

AUTHOR CONTRIBUTIONS

All authors conceived and designed the research. AS-J conducted the field work accompanied by MF, AS, and MW. AS-J analyzed the data in collaboration with MF. AS-J and MF wrote the manuscript, and all authors participated in the revision of the document.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2021.543075/full#supplementary-material>

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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