2015

MODELING PARTICIPATION IN CITIZEN SCIENCE: RECREATIONAL FISHERMEN IN MASSACHUSETTS

Lena Weiss
University of Rhode Island, lenaweiss2216@gmail.com

MODELING PARTICIPATION IN CITIZEN SCIENCE: RECREATIONAL FISHERMEN IN MASSACHUSETTS

BY

LENA WEISS

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

IN

MARINE AFFAIRS

UNIVERSITY OF RHODE ISLAND

2015

MASTER OF ARTS IN MARINE AFFAIRS THESIS

OF

LENA WEISS

APPROVED:

Thesis Committee:

Major Professor: Tracey Dalton

Robert Thompson

Caroline Gottschalk-Druschke

Nasser H. Zawia

DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND

2015

ABSTRACT

This project investigates the factors that influence a recreational fisherman's choice to participate in citizen fish tagging programs by identifying factors that influence participation in these programs and by exploring three alternative causal models for explaining participation in fish tagging projects: a values-beliefs-norms (VBN) model, a values-attitudes-behavior (VAB) model, and a full theoretical model including socio-demographic and explanatory variables. One hundred recreational fishermen in Plum Island, Massachusetts were given a written survey designed to investigate their experiences with tagging programs, along with their attitudes, perceptions, and beliefs regarding such programs. Responses to the survey were compared between participants and non-participants. Survey items were then used to create behavioral variable indexes and were correlated to a willingness-to-participate index. Three psycho-social behavioral models (VBN, VAB, and the full model) were built and compared to determine which model best fits the data. Although few variables distinguished participants from non-participants in volunteer fish tagging programs, several important factors strongly influenced willingness to participate. Subjective norms, personal obligation, and personal commitment all strongly correlated with willingness to participate. A comparison of three alternative causal models showed that the use of a full theoretical model, including different psycho-social variables as well as demographic and situational factors, provided the best fit for this behavior. Additionally, the modeled data showed that the strongest direct influence of willingness to participate in a volunteer fish tagging program was personal commitment; while perceptions of positive outcomes were a result, rather

than a determinant of participation. This suggests that attempting to increase fishermen's knowledge regarding fish tagging program through educational programs, as is commonly suggested in public engagement literature, is not an optimal strategy. Program scientists and managers could increase participation by reaching out through social networks in order to find fishermen who share a strong sense of personal commitment to their fishery and the areas in which they fish.

ACKNOWLEDGEMENTS

I would like to thank Dr. Tracey Dalton, Dr. Robert Thompson, and Dr. Caroline Gottschalk of the University of Rhode Island for all of their help and advice. I would also like to thank Refuge Manager Frank Drauszewski and the rest of the staff at the Parker River Wildlife Refuge, as well as Dr. James Nelson, Dr. Linda Deegan, and the rest of the Plum Island Estuary Long Term Ecological Research Center for their support of this project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

MANUSCRIPT-I

Prepared for submission to Coastal Management, June 2015

Modeling Participation in Citizen Science: Recreational Fishermen in Massachusetts

Lena Weiss

Department of Marine Affairs, University of Rhode Island, Kingston, RI, USA

Corresponding Author: Lena Weiss, M.A.

Department of Marine Affairs

University of Rhode Island

Suite 205, 1 Greenhouse Road

University of Rhode Island

Kingston, RI, 02881, USA

Phone: +1-516-808-2657

Email address: lena_weiss@my.uri.edu

INTRODUCTION

Citizen science, a research technique which involves the public in gathering and interpreting scientific information (Bonney et.al. 2009), has been growing in popularity in recent years, with some programs, such as the Audubon Society's Christmas Bird Count, enlisting the aid of tens of thousands of volunteers across the US. The goal of most citizen science projects is to utilize volunteers to gather basic environmental data that can help researchers, while simultaneously providing participants with firsthand experience and a deepened appreciation for the process of scientific inquiry. Cohn (2008) characterizes most participants in citizen science programs as "amateurs who volunteer to assist ecological research because they love the outdoors or are concerned about environmental trends and want to do something about them" (p.193). However, the type of person involved in citizen science varies widely depending on the kind of project and scale of the research (Couvet et al, 2008).

From a public engagement standpoint, citizen science research can be a valuable tool as it facilitates the interaction of professional scientists and resource managers with citizens who share mutual goals. These types of participatory scenarios increase the public audience for specific scientific and management issues because a larger number of individuals become involved with the issue and are willing to broadcast the results (Couvet et al, 2008). Additionally, it is hoped that by involving citizens in scientific research and monitoring, the public will gain an increased awareness and understanding of the scientific process (Bonney et al, 2009). In general, citizen science projects usually strive for outcomes that fall into one or more of three main categories: outcomes for research (e.g., scientific findings); outcomes

for individual participants (e.g., acquiring new skills or knowledge); and/or outcomes for social-ecological systems (e.g., influencing policies, building community capacity for decision making, taking conservation action) (Shirk et al, 2012). Thus, from a participant's perspective, volunteers in a citizen science project are expected to emerge from the process as more informed, aware, and engaged members of the public.

However, although the utilization of public volunteers helps to alleviate the problems of limited funding and personnel needed to carry out scientific research (Delaney et al, 2008), the scientific community has had some difficulty fully accepting the validity of studies conducted utilizing citizen volunteers. There has been an increase in the use of public volunteers in collecting data for scientific research (largely due to the fact that research funders such as the National Science Foundation now mandate that every grant holder undertake project-related scientific outreach), yet projects using citizen science tend to be underrepresented in formal scientific research (Silvertown, 2009). This lack of representation is commonly perceived to be due to a reluctance on the part of scientists to accept data collected by non-expert volunteers.

However, scientist concerns regarding the validity of information gathered in citizen science projects seems to be, at least in some circumstances, unfounded. In a study conducted by Delaney et al (2008), students in grades 3 and 7 were able to differentiate between species of crabs with over 80% and 90% accuracy, which lies within the realm of scientific acceptability. Furthermore, a way to enhance volunteer performance seems to be ongoing training by or contact with professionals (Fitzpatrick, 2009). Thus, through careful study design, training, and validation

techniques, citizen-collected data can be just as reliable as data collected by scientists in the field. However, although citizen science as a public engagement and scientific research tool is becoming increasingly popular, there is still a considerable lack of studies characterizing and examining participants and program outcomes from a volunteer's perspective. This study addresses this research gap by examining public perceptions of citizen science projects related to volunteer fish tagging programs.

Fish Tagging Programs

Volunteer fish tagging programs represent a long-standing branch of citizen science. Fishermen began to be recruited to assist scientists in tagging fish in the mid-1950s, starting with tracking the movements of striped bass along the Atlantic coast (Lucy and Davy, 2000). Since then, volunteer fish tagging programs have grown in popularity, with both government-based and independent programs operating in more than a dozen US coastal states.

In general, fish tagging programs can provide useful information to fisheries managers and scientists. Simple tag-recapture programs can provide information such as temporal movement patterns, geographic movement patterns, intermixing of populations, definition of significant habitat requirements, species growth data, size distribution of specific species, and exploitation rates (Lucy and Davy, 2000). Information of this type is commonly used in many different fisheries management decisions, such as the location and timing of fishery closures (where catching fish of a certain species is prohibited), and limits on the size and number of fish that can be

caught. Furthermore, volunteer tagging programs may also benefit fisheries managers by contributing to pre-existing databases, promoting catch and release fishing, increasing adherence to bag limits, providing a more representative sample of harvest in recreational fisheries, and improving working relationships with fishermen (Loftus et. al, 2000; Pereira, 2000; Lucy and Davy, 2000). Volunteer tagging projects may also benefit the recreational fishermen who participate by increasing stewardship of fishery resources, improving the conservation ethic of participants, improving skill in fish handling, and increasing receptivity to changes in fisheries resources (Loftus et.al. 2000).

There is some concern among researchers regarding the value of utilizing volunteers to tag fish and collect data. As with citizen science in general, a major concern is the questionable accuracy and value of data collected by citizen scientists. Other concerns regarding volunteer tagging projects include conflicts with pre-existing tagging programs, increased mortality of fish from improperly placed tags, and difficulty in maintaining a high-quality fishery. Some fishermen also dislike tagging programs due to the fact that information regarding preferred fish habitat gets shared, instead of staying private (Wingate, 2000). On the other hand, none of these claims appear to have been formally substantiated in the literature.

Psycho-Social Environmental Behavior Models

As a behavior, citizen science can be examined using the psycho-social underpinnings of environmental behaviors. For example, in a study of 142 volunteers in citizen science projects, initial motivation to participate in the project was primarily

driven by their perception of the program as valuable, mainly for the scientists who received the collected data, but also for the volunteers who were able to expand their own personal scientific knowledge through the project (Rotman, et.al. 2012). Similarly, in a pooled data study of pro-environmental behavior, researchers found that positive behavioral decisions were primarily influenced by a mixture of self-interest and pro-social motives (Bamberg and Möser, 2007). It should be noted that Bamberg and Möser's study extends beyond citizen science, which cannot be viewed as fitting exclusively within a pro-environmental framework. Nevertheless, the outcome-driven behavioral models in both Rotman and Bamberg and Möser's studies strongly align with the major theories of psycho-social behavior.

Psycho-social behavioral theory examines the underlying factors that influence people to behave in the way that they do. These factors include variables such as values, beliefs, attitudes, norms, and perceptions. *Values* can be considered "enduring beliefs that a specific mode of conduct is personally or socially preferable to an opposite or converse mode of conduct or state of existence" (Rokeach, 1973, 5). They represent single, stable beliefs that individuals use as standards for evaluating attitudes and behavior and transcend objects, situations, and issues (Rokeach, 1973; Vakse &Donnelly, 1999). While values tend to be abstract concepts that are difficult to quantify or measure, *value orientations* are somewhat simpler to identify. A value orientation can be defined as "…a generalized and organized conception, influencing behavior, of nature, of man's place in it, of man's relation to man, and of the desirable and non-desirable as they may relate to man-environment and inter-human relations" (Kluckholn. 1951, 411). Value orientations are generalizable to specific issues. For

example, Manfredo and Teel (2008) identified two key value orientations that affect relationships with wildlife in North America – *domination (*relating to the mastery, physical control, and dominance of nature) and *mutualism* (which envisions wildlife as capable of living in relationships of trust with humans). In terms of examining causal links between values and participation in fish tagging programs, important values may include trust between recreational fishermen and fisheries scientists and managers, while having a more mutualistic wildlife value orientation may predispose fishermen to want to protect or preserve their fisheries.

Beliefs refer to attitude constructions regarding the nature and likelihood of various effects of an object and how these outcomes will affect said object (Stern and Dietz, 1994). Unlike values, beliefs are directed at a specific object or construct. In terms of participation in a fish tagging program, relevant beliefs may include beliefs about the utility or process of science and data collection.

Attitudes represent an individual's consistent tendency to respond favorably or unfavorably toward the object in question (Vaske and Donnelly, 1999). Components of attitudes can include a variety of factors, such as knowledge about the object in question, awareness of behavior consequences, and personal commitment to issue resolution (Ong and Musa, 2011). Attitudes towards fish tagging programs may then be comprised of feelings of strong personal commitment towards fishery preservation, assisting fisheries managers or scientists, environmental preservation; knowledge about fish tagging in general, experience with fish tagging programs, or interactions with other program participants.

Norms are "typicals" or "standards" that help to explain the power of the social group over the actions of individuals (Manfredo, 2008) and can be broken down into several different categories. *Social norms* are group-held rules of acceptable behavior in social life (Manfredo, 2008). In terms of fish tagging programs, social norms may include feelings that participation in such a program is an acceptable behavior for recreational fishermen. *Subjective norms* refer to the extent that certain individuals influence a person's behavior (Ong and Musa, 2011). For example, a person may be more likely to participate in a fish tagging program if a close friend had participated in a similar program. *Personal norms* are feelings of personal obligation (or conversely, feelings of personal guilt), that are linked towards one's self-expectations that impel individuals to act in ways that support a particular goal (Stern et al, 1999). Recreational fishermen may feel a strong sense of personal obligation to participate in fish tagging programs, or might feel guilty if they knew about a program and chose not to participate.

Perceptions can be defined as ways of understanding or interpreting an object. A type of perception is *perceived behavioral control (PBC)* – the perceived ease or difficulty of performing a behavior (Ong and Musa, 2011). Fishermen may choose not to participate in a fish tagging program because they perceive the act of participating as too difficult. *Perceptions of outcomes* may also influence behavior. For example, if fishermen tend to have more negative perceptions of the outcomes of fish tagging (i.e. fish tagging programs will lead to more stringent management regulations, or that fish tagging will lead to oversharing of preferred fishing locations), they may be less willing to participate in a fish tagging program in the first place.

The psycho-social variables discussed above may interact to influence fishermen's decision to participate in fish tagging programs in a variety of ways. One potential approach to visualizing the causal relationships influencing this process would be to adapt Stern et al.'s (1999) value-belief-norm (VBN) theory of movement support. This theory stipulates that individuals who accept a movement's basic values, believe that valued objects are threatened, and believe that their actions can help restore those values experience an obligation for pro-movement action that creates a predisposition to provide support. Thus, in terms of participation in a fish tagging program, it is possible that recreational fishermen who value fish and wildlife, and believe that helping scientists or fisheries managers to collect data on these fisheries can help maintain the fishery, might then feel a strong sense of personal obligation to participate in a fish tagging program, and would be predisposed to do so if given the opportunity. This relationship might appear similar to the proposed model below (Figure 1).

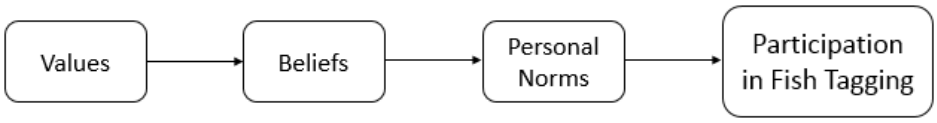

Figure 1. Hypothesized causal model linking values, beliefs, and norms to participation in fish tagging projects.

Another potential model for participation is described in the value-attitude-behavior (VAB) hierarchy. Differences in values have been shown to relate to significant differences in a variety of attitudinal and behavioral outcomes. However, there is some debate in the literature as to whether attitude mediates the relationship between values and behavior, or if both variables influence behavior directly (Vaske

and Donnelly, 1999). Thus, it is possible that fishermen who value fish and wildlife, are more likely to have a positive attitude towards participating in a fish tagging program, and would be more likely to participate. The hypothesized VAB model related to fish tagging is shown in Figure 2.

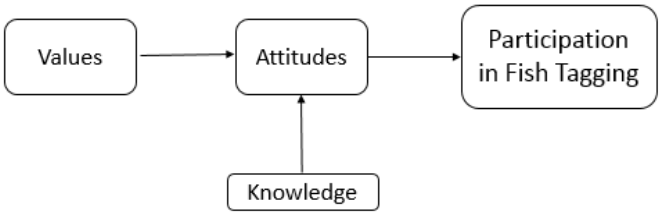

Figure 2.Hypothesized causal model linking attitudes and values to participation in fish tagging projects.

On the other hand, many studies of pro-environmental behavior have neglected to include socio-demographics and other explanatory variables, such as situational factors, which may also be strongly linked to decision-making (Ong and Musa, 2011). Behavioral models including all of these factors are valuable since they can identify factors related to decision-making, the strengths of these variables and their interrelatedness. Planners and managers can then use these models to design practices that target the way people actually think and behave, increasing their effectiveness. This approach can be valuable to citizen science projects such as fish tagging, since the recruitment of volunteers is often a major hurdle to the establishment of a successful project. As a result, a third possible approach to modeling the fish tagging behavioral process might be described as a "full" model, linking several different psychological approaches and incorporating socio-demographic and contextual factors, as proposed in Figure 3.

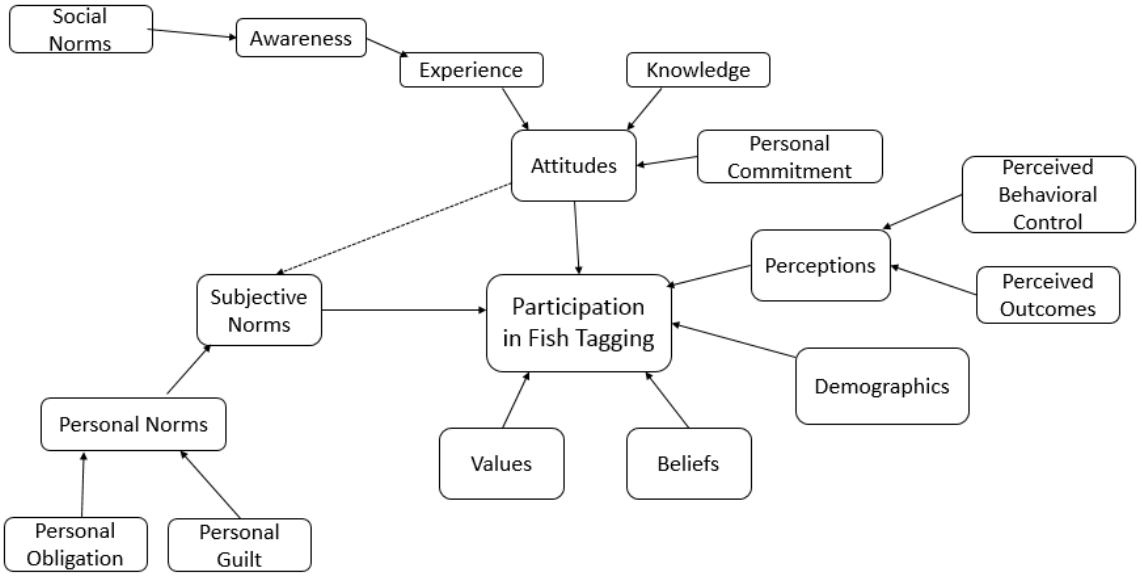

Figure 3.Hypothesized causal model linking norms, values, beliefs, perceptions, and demographics to participation in fish tagging projects.

This project investigates the factors that influence a recreational fisherman's choice to participate in citizen fish tagging programs by identifying factors that influence participation in these programs and by exploring three alternative causal models for explaining participation in fish tagging projects: a VBN model, a VAB model and the full theoretical model.

METHODOLOGY

Study Site and Sampling Locations

This study was conducted in the Plum Island Sound estuary, located in the northeastern portion of Massachusetts (Figure 4). The Plum Island estuary was recommended as a viable study location by fisheries biologists at the Marine Biological Laboratories (MBL) at Woods Hole, MA, who have been using the estuary as a site for long term ecological research since the late 1980s. The area has a history of citizen interactions with scientists, including a loosely structured citizen bluefish tagging and monitoring program that has been conducted by the MBL sporadically over the past several years.

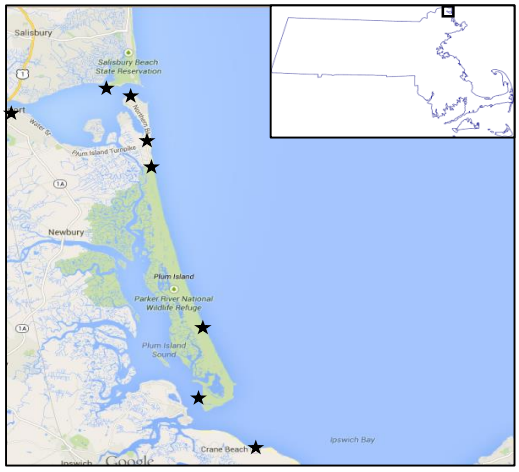

Figure 4. Map of eight sampling locations on the Plum Island Sound Estuary.

Eight sampling locations in the estuary were chosen largely for their popularity with recreational fishermen, recommendations by local "experts," such as bait shop owners, as well as ease of access. For example, while many boat launches in the area had relatively high levels of activity, they were discarded as viable study sites due to use restrictions. Furthermore, each study site was restricted in size to be walkable in two hours – the duration of each sampling period. Thus, the beach area on Plum Island was split into five distinct sites: Sandy Point, Parker River Wildlife Refuge, South Parker River Wildlife Refuge, Plum Island

Beach, and "the sandbar". It is worth noting that local fishermen view this area in a similarly fractured manner, closely mirroring the splits in sampling locations. Other sampling locations included Cashman Park, located in downtown Newburyport, Crane Beach in Ipswich, and Salisbury Beach State Reservation. In the case of Crane Beach and Salisbury State Reservation, verbal permission from park managers was obtained before sampling began. In order to survey fishermen in the Parker River National Wildlife Refuge, a federal use permit was obtained.

Survey Design

A self-administered, structured survey was designed to capture the full range of factors which may influence participation, closely based on psycho-social pro-environmental behavior models, such as those in Bamberg and Möser (2007). Survey questions were adapted from previous studies in environmental sociology.

The survey consisted of five parts: (A) experience with and awareness of fish tagging programs, (B) subjective norms, personal norms, social norms, personal commitment, and perceived behavioral control, (C) beliefs about science and wilderness orientation values, (D) perceived outcomes of fish tagging programs, and (E) demographic data about the participants (see Appendix A for full survey). While Parts A-C were closely adapted from environmental sociology studies (Bamberg and Möser, 2007; Manfredo, 2008; Manfredo and Teel, 2008; Ong and Musa, 2011; Rotman, et al, 2012), survey items in Part D were created from claims in citizen science literature (Johnston, et al, 2008; Lucy and Davy, 2000; Loftus et al., 2000;

Pereira, 2000;Wingate, 2000) , while Part E was adapted from NOAA's "Saltwater Recreational Fishing Attitudes and Preferences" survey.

The majority of items in the survey used a five-point Likert scale, with 1 = strongly disagree to 5 = strongly agree. Some items presented a range of choices for the participant to choose from, while others, such as the participant's occupation or the number of days spent fishing, necessitated an open-ended response.

Sampling Methodology

Surveys of recreational fishermen were conducted from June through early September of 2014. Each site was visited on both weekends and weekdays, as well as at various times of day. A total of 47 two-hour site visits were conducted during the sampling period. A convenience sampling methodology was used, where the researcher approached any person fishing (or carrying a fishing pole) in the area. Convenience sampling is useful because it allows for the recruitment of a reasonably large number of respondents in a short period of time, as compared to more probabilistic sampling methods. This makes convenience sampling useful when resources are limited, although it does produce a slightly biased sample of survey respondents (Robson, 2011). The goal of each site visit was to approach every fishermen who used the area in the two-hour sampling period. The number of fishermen who could not be approached during the time period (e.g., surf casting, left the area while the researcher was occupied, or who could not be reached within the time period) was noted at each site. One limitation of this method was a language

barrier, which prevented some fishermen from completing the survey. The survey was only presented in English, while some fishermen approached were not comfortable reading and writing in English. As a result, the demographics of the fishermen sampled may not be as representative of the fishermen in the area as possible.

Before participating in the study, each fisherman first received a short briefing on the purpose of the research, during which time the usage of the term "participation in a volunteer fish tagging study" was explained as *either* having tagged fish as part of a program or catching a tagged fish and reporting the tag to the appropriate agency or organization. Participants also received a notice of confidentiality before participating in the study. Completion of the survey was taken as agreement to the terms laid out in the confidentiality agreement. Each participant then filled out the paper survey, which took approximately 10-15 minutes per participant. During the study period, 150 recreational fishermen were approached, with a response rate of 67% (100 total participants in the survey). An additional 50 fishermen were seen but not approached during the study period.

Data Analysis

Each set of survey responses was assigned a random identification number and was entered into the computer. Categorical survey responses, such as profession, were coded as dummy variables. For each survey item, total response rate and average response were noted (see Appendix B). The surveys were initially split into two subsets – those who had identified themselves as participants in a fish tagging program

(participants) and those who had identified themselves as non-participants (non-participants). Wilcox tests were performed to determine basic differences between participants and non-participants for each survey item. Each survey item was then correlated with participation (yes/no) and willingness to participate (on a Likert scale of 1=not willing at all to 5=very willing to participate) using Pearson's product moment correlation coefficient to examine relationships between participation and willingness to participate and other variables (see Appendix B). These correlations provided similar results and since so few of the recreational fishermen surveyed had participated in volunteer fish tagging programs (n=9), further statistical analysis used willingness to participate in a fish tagging program as the dependent variable. Similarly, other studies have found that behavioral intentions are the immediate antecedents to behavior (Ajzen, 1991). The stronger a person's intention to perform the behavior, the more the person is expected to try, and the greater the likelihood that the behavior will actually be performed (Ajzen and Madden, 1986). Thus, using intention-related variables correlated with behavior, such as willingness to participate, as the dependent variable rather than participation, seems both reasonable and justified.

Each variable considered for the behavioral model (attitudes, perceptions, personal norms, etc.) was constructed by summing responses of the corresponding survey items (Table 1). Negative survey items were reverse coded at this time. Cronbach's α was conducted for each variable to measure internal consistency. Variables with Cronbach's α scores greater than 0.7 were considered to be reliable and were retained for further analysis. Variables with scores less than this cutoff were

examined and altered accordingly. Following this part of the analysis, several variables still were not considered acceptably unidimensional (beliefs (α=0.66), basic demographics (α=0.46), and fishing demographics (α=0.22)), yet they were considered sufficiently important to be retained in the model for further analysis.

Three different partial least squares (PLS) path models of fish tagging behavior were built and tested using the *plspm* package in R. Each model was based on a different theoretical approach – a values-beliefs-norms path (Figure 1), a values-attitudes-behavior hierarchy (Figure 2) and a "full" approach incorporating many different psycho-social variables and socio-demographic factors (Figure 3). During this process, the models were tested for unidimensionality and cross-loading and were altered accordingly in order to find the best fit possible. The fit of each of the models was evaluated using a Goodness-of Fit index. Each model was further validated through bootstrapping. Each of the full models was then split into participant and non-participant subsets, where any score higher than the mean value from the willing-to-participate index (score of 6.88 out of 10) was coded as a "participant". The relative fit of the theoretical models for the participant and non-participant groups was compared using a permutation test. This type of procedure is useful because it is a distribution-free test that requires no parametric assumptions (Sanchez, 2013). Significance of all statistical tests was determined at the commonly accepted 5% level.

Table 1. Indicators used in path modeling, along with themes of question sets used for each indicator. For indicators that were built using multiple questions, Cronbach's α values are shown. Scores larger than 0.7 indicate acceptable unidimensionality. Despite their lack of unidimensionality, the demographic indicators and beliefs were retained in the path models for completeness.

Indicators	**Theme of question sets**
Attitudes	

Personal Commitment	Level of desire to preserve fish, fishery, and environment; assist scientists and managers with data collection; know about fishery
Social Norms	Knowing participants in fish tagging programs; characterization of known participants; acceptability of participation; acceptability of citizens helping fisheries managers and scientists collect data
Experience*	Characterization of participation in fish tagging program (question applied to participants only)
Awareness*	Cognizance of a fish tagging program(s) (question applied to non-participants only)
Perceived Behavioral Control	Perceived difficulty of participation
Perceived Outcomes	Views on potential benefits and limitations of fish tagging programs
Beliefs	Level of conviction in aspects scientific process and integration of science into management
Values	Level of trust in fisheries scientists and managers; Wilderness Orientation Value
Subjective Norms	Likelihood of participation given X person participating (family member, close friend, etc.)
Personal Norms	
Personal Obligation	Level of perceived responsibility to participate in fish tagging program; willingness to participate in fish tagging program
Personal Guilt	Level of guilt if person knew about a fish tagging program and did not participate

Knowledge	Level of knowledge of types of information fish tagging programs can provide to fisheries scientists and managers
Demographics Basic Demographics Fishing Demographics	Characterization of fishermen based on fishing behavior (type of water body fished, target species, days fished); basic personal data (occupation, gender, etc.)
Participation	Willingness to participate in a fish tagging program; likelihood of participation

**Awareness and experience indicators were removed from path models during analysis due to poor fit*

RESULTS

Profile of Survey Respondents

A total of 100 recreational fishermen participated in the survey. Nine of the fishermen surveyed had been participants in a fish tagging program, while 91 identified themselves as non-participants. A total of ninety men (82 non-participants and 8 participants) and five women (one participant and four non-participants) were surveyed. Five fishermen declined to provide a gender. Participants in fish tagging programs tended on average to be slightly older (M = 53 years old) and fished slightly more days out of the year (M= 74 days) than non-participants (M=45 years old, M=66 days. Both participants and non-participants in fish tagging programs tended to target striped bass, spend most of their time fishing in the ocean from natural shorelines, tended to fish with people, and used online forums, social media sites, newspapers, and magazines as sources of information about fishing, although participants were

more likely to be affiliated with a fishing club or organization (4 out of 9 participants were affiliated, compared with 15 out of 91 non-participants).

Participants versus non-participants

Recreational fishermen who had participated in a volunteer fish tagging program scored significantly differently than non-participants on ten of the 109 survey items (Table 2). The most marked difference between participants and non-participants was the response to the survey item "not counting yourself, do you know someone who has participated in a volunteer fish tagging program". Participants were more likely to know someone who had also participated in a volunteer fish tagging program (W (n_1=8, n_2=9) = 733, p=<0.001). In contrast, only nine out of 91 non-participants indicated that they knew a participant. Interestingly, participants tended to score significantly higher than non-participants on survey items related to Personal Commitment (three out of five items had significant differences between participants and non-participants).

Survey Item	Variable	W
Not counting yourself, do you know someone who has participated in a volunteer fish tagging program? (Y/N)	Social Norm	733**
I feel a strong obligation to participate in fish tagging programs.	Personal Obligation	640.5**
I am willing to spend time participating in a fish tagging program.	Participation	572.5**
I feel a strong sense of personal commitment to help to preserve the fishery in my area.	Personal Commitment	595**
I feel a strong sense of personal commitment to know as much as possible about the areas where I spend time fishing.	Personal Commitment	642**
I feel a strong sense of personal commitment to preserve the areas where I fish.	Personal Commitment	589.5**
Volunteer fish tagging programs can protect vulnerable species of fish.	Perceived Outcome	255.5*

Volunteer fish tagging programs can lead to too much publicity of preferred fishing locations.	Perceived Outcome	219.5*
Are you currently affiliated with any sort of recreational or sport fishing club or group? (Y/N)	Demographics: Fishing	517.5*
Do you currently or have you ever had a job in an environmental management-related field? (Y/N)	Demographics: Basic	477*

** p<0.05 **p<0.01*

Table 2. Shows significant results of Wilcoxon rank-sum tests comparing recreational fishermen who have participated in a volunteer fish tagging program with non-participants on all survey items.

Additionally, participants felt a significantly stronger sense of personal obligation to participate in fish tagging programs ($W(n_1= 8, n_2= 91) = 640.5$, $p= <0.001$), were more willing to spend time participating in a fish tagging program ($W(n_1= 8 , n_2= 90) = 572.5$, $p= <0.001$), were more likely to be affiliated with a fishing club or group ($W(n_1= 9, n_2= 90) = 517.5$, $p= 0.046$), and were more likely to have or have had a job in an environmental management-related field ($W(n_1= 9 , n_2= 90) = 477$, $p= 0.035$). Non-participants were significantly more likely to agree with the statement that fish tagging programs can lead to too much publicity of preferred fishing locations and were less likely to agree with the statement that fish tagging programs can protect vulnerable species of fish ($W(n_1= 9 , n_2= 87) = 255.5$, $p= 0.047$).

Correlations with willingness to participate

Variable	Correlation Coefficient
Experience	0.3737**
Awareness	0.3098**
Personal Commitment	0.5005**
Social Norms	0.4099**

Subjective Norms	0.3316**
Personal Obligation	0.4361**
Personal Guilt	0.2359*
Values	-0.0898
Perceived Behavioral Control	0.2719**
Beliefs	0.0158
Perceived Outcomes	0.0222
Knowledge	-0.0005
Demographics: Basic	0.0870
Demographics: Fishing	0.2458*

** p<0.05 **p<0.01*

Table 3. Pearson's product-moment correlations between the willingness to participate index and all other indicators. Significant correlations have p-values <0.05.

When each indicator was correlated with the willingness to participate index, most variables demonstrated a significant positive correlation. The index for personal commitment was strongly positively correlated with the willingness to participate index (r=0.5, p=<0.001) (Table 3). Experience, social norms, and personal obligation also were strongly correlated with the willingness to participate index. However, the indices for values, beliefs, perceived outcomes, knowledge, and basic demographics were not significantly correlated with the willingness to participate index. Furthermore, both values and knowledge had slightly negative correlations with participation (Values r=-0.09, p=0.37; Knowledge r=-0.0005, p=0.996).

Comparing alternative models of willingness to participate in fish tagging programs

V-B-N Model

Figure 5 shows the results of a fitted values-beliefs-norms (V-B-N) model. The model has an R^2 value of 0.19 and a goodness of fit index score of 0.36, which indicates a poor-to-fair fit (Table 4). This model shows a strong direct relationship

between values and beliefs (0.6103). Beliefs, on the other hand, had a very weak direct influence on personal norms (0.0786). Within personal norms, personal obligation had a larger direct influence on the variable than personal guilt (0.9649 and 0.6531, respectively). Personal norms had a moderate direct influence on participation (0. 4347).

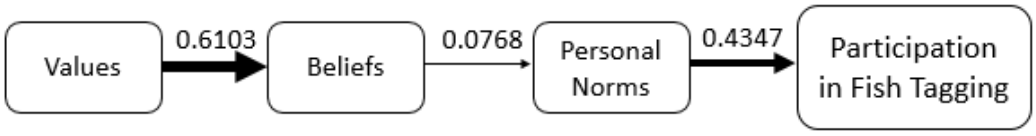

Figure 5. Fitted values, beliefs, norms model. Arrows are weighted to show relative strength of relationships between variables. Goodness of fit of model is 0.36.

Table 4. Shows R-squared values and goodness of fit index scores for three different theoretical models.

Model	**Willingness to Participate R^2 Value**	**Goodness of Fit Index Score**
V-B-N Model	0.19	0.36
Values/Attitudes Model	0.28	0.34
"Full" theoretical model	0.39	0.60

Values, Attitudes, Behavior Hierarchy Model

Figure 6 shows the results of a fitted attitudes and values model. Within this model, social norms and personal commitment were considered as loadings to the attitudes indicator (knowledge was removed to improve fit), while values remained unidimensional. This model had a goodness of fit score of 0.37, and a R^2 value for participation of 0.28, which indicates a poor fit (Table 4). Social norms and personal

commitment had strong influences on attitudes, with loadings of 0.8176 and 0.9169 respectively. Attitudes had a strong direct influence on participation, with a loading of 0.5293, while values had a smaller direct influence on attitudes (0.1646).

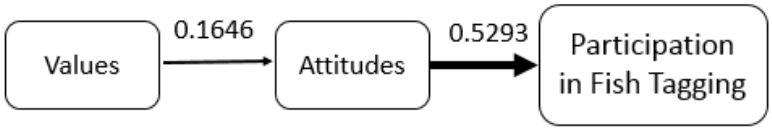

Figure 6. Fitted attitudes and values model. Arrows are weighted to show relative strength of relationships between variables. Goodness of fit of model is 0.34.

Full theoretical model

Figure 7 represents the results of fitting a "full" theoretical model, in which the majority of hypothesized indicators and interactions between indicators were preserved. However, during model fitting, some changes to the hypothesized model were made in order to better fit the data. Within the attitudes indicator, experience and awareness were excluded from the model entirely due to insufficient data and poor unidimensionality with the other indicators within attitudes. Knowledge, values and beliefs were found to be more significantly correlated with perceived outcomes than with willingness to participate index, and were moved accordingly. Subjective norms and personal norms were separated in order to increase unidimensionality. The full model had a goodness of fit of 0.6, and a R^2 value for participation of 0.39, which indicates a fair fit (Table 4). Within the model, personal commitment and social norms both strongly influenced attitudes (with loadings of 0.8978 and 0.843 respectively),

while personal obligation and personal guilt loaded very strongly with personal norms (loadings of 0.9299 and 0.733). Additionally, knowledge strongly influenced perceived outcomes. Overall, attitudes appeared to have the strongest direct effect on participation (0.4175).

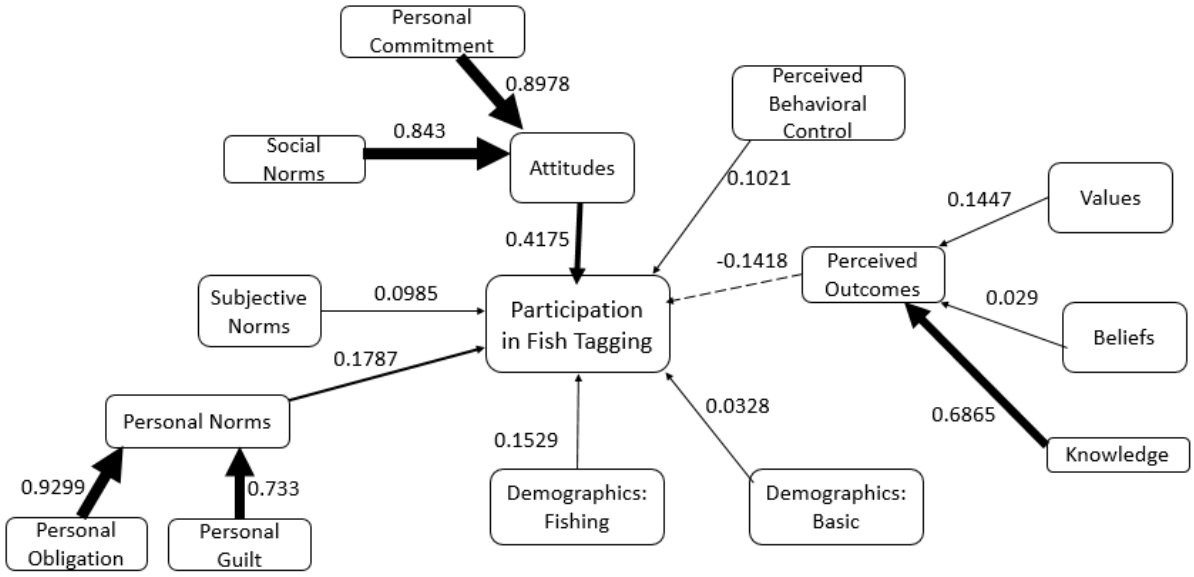

Figure 7. Fitted full theoretical model. Arrows are weighted to reflect relative strength of relationships between variables. Dashed lines indicate negative relationship between variables. Goodness of fit for model is 0.60

Participant versus non-participant model comparison

The permutation comparisons between participants and non-participants for all models were non-significant. This indicates that the strengths of the relationships between indicators, as well as the overall fit of the model, do not vary significantly between people who were considered "very likely' participants and those who scored low on the participant index.

DISCUSSION

Characterization of Project Participants

Few factors examined in this study differentiated participants and non-participants in fish tagging programs. Both participants and non-participants tended to target one particular fish species (striped bass), spent most of their time fishing in the ocean from natural shorelines, tended to fish with people, used online forums, social media sites, newspapers, and magazines as sources of information about fishing, tended to have high levels of trust in fisheries scientists and managers, and mostly agreed or strongly agreed with positive outcomes of fish tagging programs. Participants responded more positively to statements involving subjective norms, personal obligation, and personal commitment. These variables all also had strong direct correlations with participation. Demographic factors, like age, level of education, and fishing preferences, tended to have less of a direct impact. This suggests that socio-demographic factors may be having subtler influences on participation through indirect effects, perhaps by influencing an individual's likelihood of being involved with fishing clubs, or the size of a particular social network. The complexities of these potential linkages warrant further examination and study.

A common criticism of citizen science (including fish tagging programs) is that involving members of the public in research could compromise the integrity of scientific data (Silvertown, 2009). However, the majority of fishermen surveyed (n=79), tended to disagree with this sentiment. In fact, most (n=91) felt that

participation in a volunteer fish tagging program could improve relations between fishermen and fisheries scientists and managers. This finding aligns with the goal of most citizen science programs - to create a deepened appreciation for and understanding of the scientific process (Bonney et al, 2009). Furthermore, these findings show that fishermen tend to agree with proponents of fish tagging programs, who argue that such projects can provide valuable data while allowing anglers to become more actively involved, more aware, and better stewards of natural resources (Loftus, et al 2000). Overall, the generally positive responses from fishermen about potential outcomes of fish tagging programs shows a close alignment between what fisheries scientists and managers think fishermen should get out of a fish tagging program and what fishermen perceive the outcomes to be.

Fisherman Engagement in Fish Tagging Programs

While most recreational fishermen surveyed in the Plum Island Estuary area had not actually participated in a volunteer fish tagging program (n=9), slightly more than half (n=59) scored above the mean on the willingness to participate index and would most likely participate in such a program if given the opportunity. This mismatch between the number of actual participants and the number of willing participants suggests that fish tagging programs in the area are not optimally engaging recreational fishermen. Since most fish tagging programs report very low response rates (usually less than 20%) for tag returns (Johnston, et al 2008**)**, there seem to be challenges in engaging recreational fishermen in fish tagging programs. Future research in this area could focus on identifying the barriers to participation in fish

tagging programs, which researchers have identified as a major factor limiting citizen participation in public and institutional processes in general (e.g., Fischer, 2000).

One substantial barrier to participation for recreational fishermen in the Plum Island Estuary identified through this study was a marked lack of awareness of fish tagging studies in the area. Of the 100 fishermen surveyed, less than half (n=46) reported being aware of a fish tagging program near them. Thus, project managers interested in increasing fishermen's participation in fish tagging programs should spend time evaluating the success of various forms of recruitment and reporting mechanisms. For example, recruitment information and reporting forms could be provided in several different languages, and be easily accessible and visible on a program's website.

Modeling willingness to participate in volunteer fish tagging

Comparisons of the VBN, VAB, and full theoretical models of willingness to participate in volunteer fish tagging programs shows that a "full" model incorporating many different variables as well as socio-demographic and other explanatory factors is a better fit for the data. This finding is interesting in several respects. First, while behavioral models such as the VBN and VAB are commonly used to examine behavior, focusing on a few psycho-social variables at a time to the exclusion of others may lead to incorrect assumptions about the strength of relationships between variables and the predictability of behavior based on these paths. For instance, the strongest direct correlation with willingness to participate in fish tagging programs was personal commitment, an attitudinal variable. The VBN model excludes attitudes altogether, missing this important relationship. Second, the exclusion of socio-

demographic factors in the VBN and VAB models appears to lead to a worse fit of the data than a model including these factors. However, using demographics as a unidimensional variable was not successful from a statistical standpoint. Further analysis is necessary to understand how to better group and link socio-demographic and situational variables into the path model. Utilizing a full theoretical model led to a better-than-typical fit of behavioral data. In a meta-analysis of 46 independent studies of psycho-social determinants of behavior, Bamberg and Möser (2007) found that the studies on average predicted only 27% of the variance of behavior. The full theoretical model presented here predicted 39% of the variance of behavior, and explained 60% of the variance within the data as a whole. While difficult, attempting to capture a full range of relationships between psycho-social variables may lead to more successful behavior modeling.

The results of the fitted full theoretical model differ in several respects from more traditional models of psycho-social behavioral determinants. The full theoretical model showed a strong direct relationship between attitudes and behavior, similar to many other studies in the field (Ong and Musa, 2011; Vaske and Donnelly, 1999). However, the fitted full model contained only social norms and personal commitment variables as components of attitude. This differs from the more traditional view, where attitudes are comprised of three components: knowledge of specific issues (cognitive component), awareness of consequences (belief/affective component), and personal commitment to issue resolution (co-native component) (McGuire, 1992). Only one of these three components (co-native or personal commitment) aligned with attitudes when modeling willingness to participate in fish tagging. Knowledge (measured as

specific knowledge about fish tagging programs) best fit as a variable influencing awareness of consequences (measured in this study as perceived outcomes), which acted in this case as a variable negatively correlated with behavior (willingness to participate). Values and beliefs also fit into this model best as variables influencing perceived outcomes rather than as variables influencing behavior.

These findings suggest that in terms of participation in a fish tagging program, perceived outcomes are *not* a determinant of behavior, but arise as a *result* of participation (or being willing to participate). Furthermore, knowledge of fish tagging programs, values, and beliefs act as influences on this perception of outcomes, but are not direct determinants of participation in the first place. This suggests that participation in fish tagging programs is not a knowledge- or outcome-driven decision but is instead largely the result of a sense of personal commitment to the preservation of the recreational fishery and fishing locations (e.g. maintenance of healthy fish stocks, enjoyment of the fishing experience, etc.).

Increasing participation in volunteer fish tagging programs

Fisheries scientists and managers wishing to start or increase participation in fish tagging programs should not necessarily focus on increasing education about the outcomes and benefits of fish tagging, as is suggested in many citizen science studies. Instead, scientists and managers who want to recruit recreational fishermen for fish tagging projects should focus on identifying and developing relationships with groups of fishermen who share a strong sense of personal commitment to their fishery. This approach would most likely increase participation in several ways. First, fishermen were more likely to participate in a fish tagging program if they knew someone who

had already participated. By reaching out to pre-existing social groups, scientists and managers could encourage a large number of people to participate in tagging programs at once rather than recruiting fishermen individually, improving the efficiency of the recruitment process. Since most recreational fishermen surveyed were either members of a fishing club or organization or utilized some form of social media, such as websites or blogs to find information about fishing, scientists and managers who reach out to groups using these platforms are likely to find fishermen who care about where they fish, the state of their fishery, and have a strong sense of personal commitment to these areas. Taking a more traditional approach and distributing information about the benefits of fish tagging for fishermen, or attempting to educate recreational fishermen on the outcomes of fish tagging programs are less likely to influence behavior, since it utilizes an outcome-driven, rather than a co-native conception of the behavior.

Future studies

While the results from this research are most likely applicable to recreational fishermen in the northern Massachusetts and southern New Hampshire region, similar studies should be conducted in areas with differing socio-economic contexts and other levels of ecosystem and fishery health. The Plum Island Estuary has a robust recreational fishery where fishermen tended to have strong levels of trust in fisheries scientists and managers and generally positive perceptions of the outcomes of fish tagging. Furthermore, PIE is fairly unique in that most citizens in the area have had regular interactions with scientists through the Long Term Ecological Research Center. This could have resulted in reporting higher-than-typical levels of trust in scientists, stronger beliefs in the scientific process, or more positive feelings regarding

the outcomes of fish tagging programs as they related to fisheries scientists and citizen data collection. Relative strengths and importance of variable linkages will most likely change when different baseline levels of trust, personal commitment, and knowledge of fish tagging programs are involved.

CONCLUSION

Citizen science projects, such as volunteer fish tagging programs, attempt to engage members of the public in the collection and interpretation of scientific data. As a result of participation in such projects, it is hoped that citizens become more informed, aware, and engaged in scientific and environmental issues. Citizen science has become a more popular tool for collecting scientific information in recent years, yet few studies have examined the participants in these programs, their perception of the outcomes of the projects, or the factors influencing them to participate. To address this research gap, this study examined the participation of recreational fishermen in volunteer fish tagging projects.

Although very few variables distinguish participants from non-participants in volunteer fish tagging programs, several important factors strongly influence willingness to participate in these programs. Subjective norms, personal obligation, and personal commitment all strongly correlate with willingness to participate. A comparison of three alternative causal models showed that the use of a full theoretical model, including many different psycho-social variables as well as demographic and situational factors, provided the best fit for this behavior. Additionally, the modeled data showed that the strongest direct influence of willingness to participate in a volunteer fish tagging program was personal commitment, while perceptions of positive outcomes were a result, rather than a determinant of participation. This suggests that attempting to increase fishermen's knowledge regarding fish tagging program through educational programs, as is commonly suggested in public engagement literature, is not an optimal strategy. Program scientists and managers

could increase participation by reaching out through social networks in order to find fishermen who share a strong sense of personal commitment to their fishery and the areas in which they fish.

While numerous claims have been made about the benefits of volunteer fish tagging programs, both from the scientists' and fishermen's perspectives, there has been little work done substantiating those claims. There has not been any attempt to characterize the volunteers who choose to participate in tagging programs, nor to determine the underlying factors that influence project participation. Findings from this study can provide scientists and agencies considering tagging projects with a better idea of how to focus resources when recruiting participants, and how to utilize the results such that there is a better alignment between what the participants expect to get out of the program, and what actually is produced.

APPENDIX A: COPY OF SURVEY

Thank you so much for participating in this survey!
This project aims to find out how recreational fishermen feel about volunteer fish tagging programs.
This survey has five parts, and should take around ten minutes to complete. Parts A-D will ask you about your opinions about tagging programs and the environment, while Part E will ask for some demographic information.
Most questions will ask you to read a statement and circle the answer which applies most to you, while others will require that you provide a brief response.
You do not have to complete the survey once you begin. If any question makes you feel uncomfortable, you do not have to provide a response.
All responses will be kept anonymous and no identifying information will be used.

Some terms used in survey:
- **Participation in a volunteer fish tagging project: Either having tagged a fish as part of a program OR catching a tagged fish and reporting the tag to the appropriate agency or organization**
- **Recreational fisherman: any person who fishes for sport or for pleasure.**

Some terms used in survey:
- **Participation in a volunteer fish tagging project: Either having tagged a fish as part of a program OR catching a tagged fish and reporting the tag to the appropriate agency or organization**
- **Recreational fisherman: any person who fishes for sport or for pleasure.**

Part A: For each question, please circle the response that best applies to you.

1. Do you consider yourself a recreational fisherman? Yes No
2. Have you ever participated in a fish tagging program? Yes No
3. If you answered **yes** to question 2:
   a. Did you volunteer to participate in this program (you did not receive a salary for participating? Yes No
   b. Approximately how many times have you tagged a fish or caught a tagged fish in the past year? [ ]
4. If you answered **no** to question 2:
   a. Are you aware of any fish tagging programs? Yes No
   b. On a scale of 1-5, with 1 indicating **not likely** and 5 indicating **very likely,** how likely would you be to participate in a fish tagging program (if you are unsure, circle don't know.

Not likely	Somewhat not likely	Neutral	Likely	Very Likely	
1	2	3	4	5	Don't know

5. Not counting yourself, do you know someone who has participated in a volunteer fish tagging program? Yes No
   a. If you answered **yes**, was this person a (circle all that apply):

Family Member | Close Friend | Acquaintance | Colleague | Other:

Part B: Please rate the following statements on a scale of 1-5, with 1 indicating strong disagreement, and 5 indicating strong agreement. If you have no opinion, or are unsure of what a question is asking, check the box under don't know.

1. I would be more likely to participate in a volunteer tagging program if....	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
a. A family member were participating	1	2	3	4	5	
b. A close friend were participating	1	2	3	4	5	
c. An acquaintance were participating	1	2	3	4	5	
d. A colleague were participating	1	2	3	4	5	
e. I read about a program in a newspaper or magazine	1	2	3	4	5	
f. I read about a tagging program on a website or online forum	1	2	3	4	5	
g. I found out about a program from a fishing club or organization	1	2	3	4	5	
2. I feel a strong obligation to participate in fish tagging programs	1	2	3	4	5	
3. I am willing to spend time participating in a fish tagging program	1	2	3	4	5	
4. I would feel guilty if I knew about a volunteer fish tagging program near me and did not participate	1	2	3	4	5	
5. I trust fisheries scientists to provide accurate information about fisheries	1	2	3	4	5	
6. I trust fisheries managers to provide accurate information about fisheries	1	2	3	4	5	
7. I trust fisheries managers to set fair regulations regarding fisheries	1	2	3	4	5	

Part B (cont.): Please rate the following statements on a scale of 1-5, with 1 indicating strong disagreement, and 5 indicating strong agreement. If you have no opinion, or are unsure of what a question is asking, check the box under don't know.

8. I feel a strong sense of personal commitment to...	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
a. Help to preserve the fishery in my area.	1	2	3	4	5	
b. Assist fisheries scientists and managers in the collection of data	1	2	3	4	5	
c. Know as much as possible about the areas where I spend time fishing	1	2	3	4	5	
d. Preserve the areas where I fish	1	2	3	4	5	
e. Preserve the environment in general.	1	2	3	4	5	
9. I feel as though...						
a. It is acceptable for fishermen to participate in volunteer fish tagging programs.	1	2	3	4	5	
b. It is acceptable for recreational fishermen to help scientists with the collection of data.	1	2	3	4	5	
c. It is acceptable for recreational fishermen to help fisheries managers with the collection of data.	1	2	3	4	5	
d. Participating in a volunteer fish tagging program would be difficult.	1	2	3	4	5	
e. There is no point to participating in a volunteer fish tagging program.	1	2	3	4	5	
f. There is no point participating in a volunteer fish tagging program unless I knew others who were participating as well.	1	2	3	4	5	

Part C: Please rate the following statements on a scale of 1-5, with 1 indicating strong disagreement, and 5 indicating strong agreement. If you have no opinion, or are unsure of what a question is asking, check the box under don't know.

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
1. Science can be applied to everyday life.	1	2	3	4	5	
2. Environmental policy decisions should be made on the basis of scientific findings.	1	2	3	4	5	
3. Conducting an experiment is difficult.	1	2	3	4	5	
4. Consistency in observations is very important in an experiment.	1	2	3	4	5	
5. The needs of humans should take priority over fish and wildlife protection.	1	2	3	4	5	
6. Fish and wildlife are on earth primarily for people to use.	1	2	3	4	5	
7. We should strive for a world where there's an abundance of fish and wildlife for hunting and fishing.	1	2	3	4	5	
8. Animals should have rights similar to the rights of people.	1	2	3	4	5	
9. Wildlife are like my family and I want to protect them.	1	2	3	4	5	
10. I take great comfort in the relationships I have with animals.	1	2	3	4	5	
11. I value the sense of companionship I receive from animals.	1	2	3	4	5	

Part D: Please rate the following statements on a scale of 1-5, with 1 indicating strong disagreement, and 5 indicating strong agreement. If you have no opinion, or are unsure of what a question is asking, check the box under don't know.

Volunteer fish tagging programs can…	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
1. Protect vulnerable species of fish	1	2	3	4	5	
2. Promote catch and release fishing.	1	2	3	4	5	
3. Help fisheries managers create appropriate regulations to manage the fishery	1	2	3	4	5	
4.Create good working relationships between fisheries managers and recreational fishermen.	1	2	3	4	5	
5. Help managers check estimates of recreational fishing rates.	1	2	3	4	5	
6. Be a cost-effective way to monitor a fishery.	1	2	3	4	5	
7. Improve managers' ability to positively affect fish populations	1	2	3	4	5	
8. Contribute to pre-existing data on fish populations	1	2	3	4	5	
9. Improve fishery scientists' abilities to positively affect fish populations.	1	2	3	4	5	
10. Improve the relationship between scientists and fishermen.	1	2	3	4	5	
11. Be a cost-effective way for scientists to study a fishery.	1	2	3	4	5	

Part D (cont.): Please rate the following statements on a scale of 1-5, with 1 indicating strong disagreement, and 5 indicating strong agreement. If you have no opinion, or are unsure of what a question is asking, check the box under don't know.

Volunteer fish tagging programs can…	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
12. Make fishermen better stewards of fishery resources	1	2	3	4	5	
13. Increase the desire of fishermen to conserve the environment.	1	2	3	4	5	
14. Lead to les stringent management regulations.	1	2	3	4	5	
15. Provide unusable data for fisheries managers.	1	2	3	4	5	
16. Compromise the integrity of scientific research.	1	2	3	4	5	
17. Make tagged fish less desirable to catch than untagged fish.	1	2	3	4	5	
18. Lead to too much publicity of preferred fishing locations.	1	2	3	4	5	
19. Make fishermen more likely to follow regulations such as catch limits, size limits, and seasonal closures.	1	2	3	4	5	
20. Provide information on how fish move in an area.	1	2	3	4	5	
21. Provide information on where certain fish species prefer to live.	1	2	3	4	5	
22. Provide information on how specific fish species grow.	1	2	3	4	5	

Part E: Please answer each question as it best applies to you. Remember that this survey is anonymous and no identifying information will be used.

1. What is your gender?

2. What is your age?

3. What is the highest level of education you have completed?
   - Some high school
   - High school graduate
   - Some college
   - Trade/ technical/vocational training
   - College graduate
   - Some postgraduate work
   - Postgraduate degree

4. What is your current state of residency?

5. In what state do you spend most of your time fishing?

6. Within the past **year**, about how many days have you spent recreational fishing?

7. Within the past **couple months**, about how many days have your spent recreational fishing?

8. Do you ever sell any of the fish you catch? Yes No
   If no, please skip to question 11

9. If yes, when you sell your fish, do you consider yourself a commercial fisherman, that is, are you trying to make some income? Yes No

10. Do you consider yourself a full-time commercial fisherman? Yes No

Part E (cont.) : Please answer each question as it best applies to you. Remember that this survey is anonymous and no identifying information will be used.

11. Where do you spend most of your time fishing (circle one)?	Pier or dock Jetty, breakwater, or breachway Bridge or causeway Other man-made structure Natural shoreline (beach, bank, etc.) Own boat Charter boat Private/rental boat Other:
12. Do you spend most of your time fishing in an (circle all that apply)	Ocean Bay River Other:
13. Do you usually fish for any particular type of fish? a. If yes, which fish?	Yes No
14. Are you currently affiliated with any sort of recreational or sport fishing club or group?	Yes No
15. Do you currently use online forums or other social media sites for information about fishing?	Yes No
16. Do you currently use newspapers or magazines for information about fishing?	Yes No
17. Do you spend most of your time fishing with other people?	Yes No
18. What is your occupation?	
19. Do you currently or have you ever had a job in a natural science related field?	Yes No
20. Do you currently or have you ever had a job in an environmental management- related field?	Yes No

Part E (cont.): Please answer each question as it best applies to you. Remember that this survey is anonymous and no identifying information will be used.

21. Do you consider yourself (circle response which best applies)	Strongly conservative Conservative Moderate Liberal Strongly liberal Rather not say
22. Approximately what is your annual household income?	Less than $20,000 $20-$39,999 $40,000-$59,999 $60,000-$79,999 $80,000-$99,999 $100,000-$149,999 $150,000-$199,999 $200,000 or more Rather not say.
23. What is your race?	American Indian or Alaskan Native Asian Black or African-American Latino or Hispanic Native Hawaiian or other Pacific Islander White/Caucasian Other: Rather not say

Thank you so much for participating in this survey!
If you have any additional thoughts or comments, please feel free to add them below:

APPENDIX B*:* SUMMARY STATISTICS

				x=Participate			x= Willing/Time		
Survey Item	**Variable**	**n**	**Avg. Response**	**T**	**p**	**cor**	**t**	**p**	**cor**
Do you consider yourself a recreational fisherman?	Fishing Demographics	100	0.98	1.75	0.08	0.18	1.85	0.07	0.19
Have you ever participated in a fish tagging program?	*Removed (participants were given 5s on Participation measures)*	100	0.09						
Did you volunteer for this program?	*Removed*	11	0.64						
Approximately how many times have you tagged a fish or caught a tagged fish in the past year?	*Removed*	8	0.63						
Are you aware of any fish tagging programs?	*Removed*	91	0.51	7.46	0.00	0.60	3.26	0.00	0.32
On a scale of 1-5, with 1 indicating not likely and 5 indicating very likely, how likely would you be to participate in a fish tagging program?	Participation	89	3.48						
Not counting yourself, do you know someone who has participated in a volunteer fish tagging program?	*Removed*	100	0.17	-2.34	0.04	-0.56	-2.19	0.05	-0.55
If you answered yes, was this person a…	*Removed*	14	1.14						
I would be more likely to participate in a volunteer fish tagging program if a family	Subjective Norm	95	3.45	-0.30	0.77	-0.03	-1.59	0.12	-0.16

member were participating									
I would be more likely to participate in a volunteer fish tagging program if a close friend were participating	Subjective Norm	96	3.61	-0.30	0.77	-0.03	-1.57	0.12	-0.16
I would be more likely to participate in a volunteer fish tagging program if an acquaintance were participating	Subjective Norm	95	3.34	-0.29	0.77	-0.03	-1.56	0.12	-0.16
I would be more likely to participate in a volunteer fish tagging program if a colleague were participating	Subjective Norm	95	3.29	-0.41	0.68	-0.04	0.04	0.97	0.00
I would be more likely to participate in a volunteer fish tagging program if I read about the program in a newspaper or magazine	Subjective Norm	94	3.21	-0.28	0.78	-0.03	0.59	0.55	0.06
I would be more likely to participate in a volunteer fish tagging program if I read about a tagging program on a website or online forum	Subjective Norm	95	3.26	1.81	0.07	0.18	4.33	0.00	0.41
I would be more likely to participate in a volunteer fish tagging program if I found out about a program	Subjective Norm	98	3.40	4.53	0.00	0.42	7.64	0.00	0.62

from a fish tagging club or organization									
I feel a strong obligation to participate in fish tagging programs.	Personal Obligation	98	2.95	3.02	0.00	0.29			
I am willing to spend time participating in a fish tagging program.	Participation	98	3.47	-0.29	0.77	-0.04	0.62	0.54	0.06
I would feel guilty if I knew about a volunteer fish tagging program near me and did not participate.	Personal Guilt	98	2.71	-0.89	0.38	-0.09	0.16	0.88	0.02
I trust fisheries scientists to provide accurate information about fisheries	Values	99	3.78	-1.59	0.11	-0.16	-0.51	0.61	-0.05
I trust fisheries managers to provide accurate information about fisheries	Values	99	3.65	-1.24	0.22	-0.13	-0.37	0.71	-0.04
I trust fisheries managers to set fair regulations regarding fisheries	Values	98	3.57	2.37	0.02	0.23	4.14	0.00	0.39
I feel a strong sense of personal commitment to help to preserve the fishery in my area	Personal Commitment	100	4.36	1.68	0.10	0.17	3.21	0.00	0.21
I feel a strong sense of personal commitment to assist fisheries scientists and managers in the collection of data	Personal Commitment	100	3.84	2.88	0.00	0.28	5.25	0.00	0.47
I feel a strong sense of personal commitment to know as much as possible about the	Personal Commitment	100	4.21	2.55	0.01	0.25	3.56	0.00	0.34

areas where I spend time fishing									
I feel a strong sense of personal commitment to preserve the areas where I fish	Personal Commitment	98	4.48	1.41	0.16	0.14	1.77	0.08	0.18
I feel a strong sense of personal commitment to preserve the environment in general	Personal Commitment	99	4.51	1.10	0.27	0.11	4.64	0.00	0.43
I feel as though it is acceptable for fishermen to participate in volunteer fish tagging programs	Social Norm	99	4.19	1.19	0.24	0.12	3.36	0.00	0.32
I feel as though it is acceptable for recreational fishermen to help scientists with the collection of data	Social Norm	100	4.18	1.19	0.24	0.12	3.90	0.00	0.37
I feel as though it is acceptable for recreational fishermen to help fisheries managers with the collection of data	Social Norm	100	4.18	-0.80	0.42	-0.08	3.26	0.00	-0.32
I feel as though participating in a volunteer fish tagging program would be difficult	Perceived Behavioral Control	100	2.70	1.82	0.07	0.18	-2.03	0.05	-0.20
I feel as though there is no point to participating in a volunteer fish tagging program	Perceived Behavioral Control	100	2.10	0.80	0.43	0.08	-2.17	0.03	-0.22
I feel as though there is no point participating in a volunteer fish tagging program unless I knew others who were participating as well.	Perceived Behavioral Control	100	2.09	-1.67	0.10	-0.17	1.85	0.07	0.19

Science can be applied to everyday life	Beliefs	98	4.40	-1.33	0.89	-0.01	1.86	0.07	0.19
Environmental policy decisions should be made on the basis of scientific findings	Beliefs	98	3.93	0.09	0.93	0.01	1.21	0.19	0.13
Conducting an experiment is difficult	*Removed*	98	3.08	3.31	0.00	0.32	0.59	0.56	0.06
Consistency in observations is very important in an experiment	*Removed*	97	4.32	-0.11	0.91	-0.01	-0.79	0.43	-0.08
The needs of humans should take priority over fish and wildlife protection	Values	97	2.93	-0.28	0.78	-0.03	-0.14	0.89	-0.01
Fish and wildlife are on earth primarily for people to use	Values	98	2.54	1.26	0.21	0.13	1.15	0.25	0.12
We should strive for a world where there's an abundance of fish and wildlife for hunting and fishing	Values	97	4.36	-0.71	0.48	-0.07	0.96	0.34	0.10
Animals should have rights similar to the rights of humans	Values	98	2.92	1.05	0.29	0.11	2.80	0.01	0.28
Wildlife are like my family and I want to protect them	Values	98	3.19	0.96	0.34	0.10	1.42	0.16	0.14
I take great comfort in the relationships I have with animals	Values	98	3.72	0.64	0.52	0.07	1.62	0.11	0.16
I value the sense of companionship I receive from animals	Values	98	3.82	-0.57	0.57	-0.06	0.26	0.72	0.04
Volunteer fish tagging programs can protect vulnerable species of fish.	Perceived Outcome	95	4.26	-0.65	0.52	-0.07	0.62	0.54	0.06
Volunteer fish tagging programs	Perceived Outcome	93	4.02	-0.56	0.57	-0.06	0.37	0.72	0.04

can promote catch and release fishing									
Volunteer fish tagging programs can help fisheries managers create appropriate regulations	Perceived Outcome	95	4.08	-0.56	0.58	-0.06	0.36	0.72	0.04
Volunteer fish tagging programs can create good working relationships between fisheries managers and recreational fishermen	Perceived Outcome	95	4.03	-0.56	0.58	-0.06	0.37	0.72	0.04
Volunteer fish tagging programs can help managers check estimates of recreational fishing rates	Perceived Outcome	95	3.94	-0.73	0.47	-0.07	0.81	0.42	0.08
Volunteer fish tagging programs can be a cost-effective way to monitor a fishery	Perceived Outcome	93	3.81	-0.56	0.58	-0.06	0.36	0.72	0.04
Volunteer fish tagging programs can improve managers' ability to positively affect fish populations	Perceived Outcome	95	3.95	-0.65	0.52	-0.07	0.05	0.96	0.01
Volunteer fish tagging programs can contribute to pre-existing data on fish populations	Perceived Outcome	94	3.99	-0.56	0.58	-0.06	0.36	0.72	0.04
Volunteer fish tagging programs can improve fishery scientists' abilities to positively affect fish populations	Perceived Outcome	95	3.97	-0.56	0.58	-0.06	0.36	0.72	0.04
Volunteer fish tagging programs can improve the relationship between	Perceived Outcome	95	3.86	-0.73	0.47	-0.07	0.81	0.42	0.08

scientists and fishermen									
Volunteer fish tagging programs can be a cost-effective way for scientists to study a fishery	Perceived Outcome	93	3.92	-0.56	0.57	-0.06	0.40	0.69	0.04
Volunteer fish tagging program can make fishermen better stewards of fishery resources	Perceived Outcome	93	3.82	-0.56	0.57	-0.06	0.39	0.70	0.04
Volunteer fish tagging programs can increase the desire of fishermen to conserve the environment	Perceived Outcome	92	3.84	-0.56	0.57	-0.06	0.41	0.69	0.04
Volunteer fish tagging programs can lead to less stringent management regulations	Perceived Outcome	92	3.25	-0.57	0.57	-0.06	0.38	0.71	0.04
Volunteer fish tagging programs can provide unusable data for fisheries managers	Perceived Outcome	92	3.12	-0.56	0.58	-0.06	0.38	0.70	0.04
Volunteer fish tagging programs can compromise the integrity of scientific research	Perceived Outcome	92	2.55	-0.56	0.58	-0.06	0.39	0.70	0.04
Volunteer fish tagging programs can make tagged fish less desirable to catch than untagged fish	Perceived Outcome	93	2.44	-0.57	0.57	-0.06	0.37	0.71	0.04
Volunteer fish tagging programs can lead to too much publicity of preferred fishing locations	Perceived Outcome	92	2.77	-0.56	0.57	-0.06	0.39	0.70	0.04

Volunteer fish tagging programs can make fishermen more likely to follow regulations such as catch limits, size limits, and seasonal closures	Perceived Outcome	93	3.51	-0.57	0.57	-0.06	0.40	0.69	0.04
Volunteer fish tagging programs can provide information on how fish move in an area	Knowledge	93	4.03	-0.57	0.57	-0.06	-0.39	0.69	0.04
Volunteer fish tagging programs can provide information of where certain fish species prefer to live	Knowledge	93	4.10	-0.57	0.57	-0.06	0.40	0.69	0.04
Volunteer fish tagging programs can provide information on how specific fish species grow	Knowledge	93	4.10	0.82	0.41	0.08	1.83	0.07	0.19
What is your gender?	Basic Demographics	95	0.05	1.45	0.15	0.15	-0.24	0.81	0.03
What is your age?	*Removed*	93	45.77	1.76	0.08	0.18	0.38	0.71	0.04
What is the highest level of education you have completed?	Basic Demographics	97	3.10						
What is your current state of residency?	Basic Demographics	96	0.90	2.13	0.04		1.46	0.15	0.15
In what state do you spend most of your time fishing?	Basic Demographics	95	0.81	0.73	0.49	0.28	0.19	0.86	0.08
Within the past year, about how many days have you spent recreational fishing?	Fishing Demographics	94	67.05	0.77	0.44	0.08	4.00	0.00	0.39
Within the past couple months, about how many days have you spend	Fishing Demographics	93	14.31	-0.32	0.75	-0.03	1.71	0.09	0.18

recreational fishing?									
Do you ever sell any of the fish you catch?	Fishing Demographics	96	0.01						
If yes, when you sell your fish, do you consider yourself a commercial fishermen, that is, are you trying to make some income?	*Removed*	8	0.00						
Do you consider yourself a full-time commercial fisherman?	*Removed*	27	0.00	0.57	0.57	0.06	0.14	0.89	0.02
Where do you spend most of your time fishing?	Fishing Demographics	97	3.09	-1.16	0.25	-0.20	1.10	0.28	0.19
Do you spend most of your time fishing in a…	Fishing Demographics	99	0.76	-0.87	0.39	-0.13	0.71	0.48	0.11
Do you usually fish for any particular type of fish?	Fishing Demographics	99	0.71	-0.25	0.73	-0.05	1.45	0.15	0.19
If yes, which fish?	*Removed*	57	1.25	-0.46	0.65	-0.11	0.32	0.75	0.08
Are you currently affiliated with any sort of recreational or sport fishing club or group?	Fishing Demographics	99	0.19	0.74	0.46	0.07	1.29	0.20	0.13
Do you currently use online forums or other social media sites for information about fishing?	Fishing Demographics	99	0.67	1.66	0.10	0.17	1.43	0.15	0.15
Do you currently use newspapers of magazines for information about fishing?	Fishing Demographics	99	0.52	-0.40	0.69	-0.04	-0.96	0.34	-0.10
Do you spend most of your time fishing with other people?	Fishing Demographics	98	0.72	-0.80	0.43	-0.09	1.32	0.19	0.14

What is your occupation?	*Removed*	87	7.84	0.21	0.84	0.02	1.28	0.20	0.12
Do you currently or have you ever had a job a natural science-related field?	Basic Demographics	98	0.09	2.16	0.03	0.21	1.31	0.19	0.13
Do you currently or have you ever had a job in an environmental-management related field?	Basic Demographics	99	0.06	0.30	0.76	0.03	1.44	0.15	0.15
Do you consider yourself (political orientation)	*Removed*	91	2.23						
Approximately what is your annual household income?	Basic Demographics	91	3.99	-0.63	0.53	-0.07	-2.47	0.02	-0.25
What is your race?	Basic Demographics	93	4.72						

APPENDIX C: CODE USED FOR STATISTICS CONDUCTED IN R

Wilxcox Rank Sum Tests

```
setwd("~/MAF/FALL 2014/THESIS")
fish=read.csv("thesisdata.csv")
part<-subset(fish,fish$Participate==1)
nopart<-subset(fish,fish$Participate==0)
wilcox.test(part$KnowPart,nopart$KnowPart, na.rm="TRUE")
wilcox.test(part$ObPart,nopart$ObPart, na.rm="TRUE")
wilcox.test(part$WillingTime,nopart$WillingTime, na.rm="TRUE")
wilcox.test(part$PCPresFishery,nopart$PCPresFishery, na.rm="TRUE")
wilcox.test(part$PCKnow,nopart$PCKnow, na.rm="TRUE")
wilcox.test(part$PCPresArea,nopart$PCPresArea, na.rm="TRUE")
wilcox.test(part$ProtFish,nopart$ProtFish, na.rm="TRUE")
wilcox.test(part$Overshare,nopart$Overshare, na.rm="TRUE")
wilcox.test(part$InClub,nopart$InClub, na.rm="TRUE")
wilcox.test(part$JobEM,nopart$JobEM, na.rm="TRUE")
```

Partial Least Squares Models

```
#Values Attitudes Model 2 - corrected
fish=read.csv("indicatorscores.csv")
Values=c(0,0,0)
Attitudes=c(1,0,0)
Participation=c(0,1,0)
fish_path=rbind(Values,Attitudes,Participation)
colnames(fish_path)=rownames(fish_path)
innerplot(fish_path)
fish_blocks=list(9,c(4:5),1)
fish_modes=c("A","A","A")
fish_pls=plspm(fish,fish_path,fish_blocks,modes=fish_modes)
fish_pls
```

```
plot(fish_pls)
fish_pls$unidim
plot(fish_pls,what="loadings")
fish_pls$outer_model
fish_pls$crossloadings
#innermodel
fish_pls$inner_model
#rsq coefficients of determination
fish_pls$inner_summary
#redundancy
fish_pls$inner_summary
#Goodness of fit
fish_pls$gof
#bootstrap validation
fish_val=plspm(fish,fish_path,fish_blocks,modes=fish_modes,boot.val=TRUE,br=200)
fish_val$boot
#plot of model
Paths=fish_pls$path_coefs
arrow_lwd=10*round(Paths, 2)
plot(fish_pls,arr.pos=0.35,arr.lwd=arrow_lwd)

#Values, Beliefs, Norms Model # 2  - corrected
setwd("~/MAF/Spring 2015/Thesis yo")
library(plspm)
fish=read.csv("indicatorscores.csv")
Values=c(0,0,0,0)
Beliefs=c(1,0,0,0)
Personal.Norms=c(0,1,0,0)
Participation=c(0,0,1,0)
fish_path=rbind(Values,Beliefs,Personal.Norms,Participation)
```

```
colnames(fish_path)=rownames(fish_path)
innerplot(fish_path)
fish_blocks=list(9,11,c(7:8),1)
fish_modes=c("A","A","A","A")
fish_pls=plspm(fish,fish_path,fish_blocks,modes=fish_modes)
fish_pls
plot(fish_pls)
fish_pls$unidim
plot(fish_pls,what="loadings")
fish_pls$outer_model
fish_pls$crossloadings
#innermodel
fish_pls$inner_model
#rsq coefficients of determination
fish_pls$inner_summary
#redundancy
fish_pls$inner_summary
#Goodness of fit
fish_pls$gof
#bootstrap validation
fish_val=plspm(fish,fish_path,fish_blocks,modes=fish_modes,boot.val=TRUE,br=200)
fish_val$boot
#plot of model
Paths=fish_pls$path_coefs
arrow_lwd=10*round(Paths, 2)
plot(fish_pls,arr.pos=0.35,arr.lwd=arrow_lwd)

#model 10
fish=read.csv("indicatorscores.csv")
Attitudes=c(0,0,0,0,0,0,0,0,0,0,0)
```

```
Knowledge=c(0,0,0,0,0,0,0,0,0,0,0)

Values=c(0,0,0,0,0,0,0,0,0,0,0)

Beliefs=c(0,0,0,0,0,0,0,0,0,0,0)

Perc.Out=c(0,1,1,1,0,0,0,0,0,0,0)

Perc.BC=c(0,0,0,0,0,0,0,0,0,0,0)

DemFish=c(0,0,0,0,0,0,0,0,0,0,0)

Dem.Bas=c(0,0,0,0,0,0,0,0,0,0,0)

Personal.Norms=c(0,0,0,0,0,0,0,0,0,0,0)

Subjective.Norms=c(0,0,0,0,0,0,0,0,0,0,0)

Participation=c(1,0,0,0,1,1,1,1,1,1,0)

fish_path=rbind(Attitudes,Knowledge,Values,Beliefs,Perc.Out,Perc.BC,DemFish,Dem.Bas,Pe
rsonal.Norms,Subjective.Norms,Participation)

colnames(fish_path)=rownames(fish_path)

innerplot(fish_path)

fish_blocks=list(4:5,13,9,11,12,10,15,14,7:8,6,1)

fish_modes=c("A","A","A","A","A","A","A","A","A","A","A")

fish_pls=plspm(fish,fish_path,fish_blocks,modes=fish_modes)

fish_pls

plot(fish_pls)

fish_pls$unidim

plot(fish_pls,what="loadings")

fish_pls$outer_model

fish_pls$crossloadings

#innermodel

fish_pls$inner_model

#rsq coefficients of determination

fish_pls$inner_summary

#redundancy

fish_pls$inner_summary

#Goodness of fit
```

```
fish_pls$gof
#bootstrap validation
fish_val=plspm(fish,fish_path,fish_blocks,modes=fish_modes,boot.val=TRUE,br=200)
fish_val$boot
#plot of model
Paths=fish_pls$path_coefs
arrow_lwd=10*round(Paths, 2)
plot(fish_pls,arr.lwd=arrow_lwd)
```

Participant versus Non-Participant Comparisons

```
#select participants
participants=fish[fish$Part=="Y",]
#participants plspm
part_fish_pls=plspm(participants,fish_path,fish_blocks,modes=fish_modes)
#select non participants
nopart=fish[fish$Part=="N",]
#non participants plspm
nopart_fish_pls=plspm(nopart,fish_path,fish_blocks,modes=fish_modes)
#apply plspm.groups bootstrap
part_boot=plspm.groups(fish_pls,fish$Part,method="bootstrap")
#see the results
part_boot
#apply plspm.groups premutation
part_perm=plspm.groups(fish_pls,fish$Part,method="permutation")
#see the results
part_perm
```

WORK CITED

Ajzen, Icek. (1991) . The theory of planned behavior. *Organizational behavior and human decision processes 50*(2), 179-211.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of experimental social psychology, 22*(5), 453-474.

Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. (2009). Citizen science: a developing tool for expanding science knowledge and scientific literacy. *BioScience, 59*(11), 977-984.

Bamberg, Sebastian, and Guido Möser. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behavior. *Journal of environmental psychology 27*(1), 14-25.

Cohn, J. P. (2008). Citizen science: Can volunteers do real research? *BioScience, 58*(3), 192-197.

Couvet, D., Jiguet, F., Julliard, R., Levrel, H., & Teyssedre, A. (2008). Enhancing citizen contributions to biodiversity science and public policy. *Interdisciplinary science reviews, 33*(1), 95-103.

Delaney, D. G., Sperling, C. D., Adams, C. S., & Leung, B. (2008). Marine invasive species: validation of citizen science and implications for national monitoring networks. *Biological Invasions, 10*(1), 117-128.

Fischer, F. (2000). *Citizens, Experts, and the Environment: The Politics of Local Knowledge.* Durham, NC: Duke University Press.

Fitzpatrick M, Preisser E, Ellison A, Elkinton J. (2009). Observer bias and the detection of low-density populations. *Ecology Applications, 19,* 1673-79.

Johnston, R.J., Holland, D.S., Maharaj, V., Campson, T.W. (2008). Evaluation of Fish Tags as an Attenuated Rights- Based Management Approach for Gulf of Mexico Recreational Fisheries. Environmental Defense Fund.

Kluckhohn, C. (1951). *Values and value-orientations in the theory of action: An exploration in definition and classification*.

Lucy, Jon, and Kay Davy. (2000). Benefits of angler-assisted tag and release programs. *Fisheries 25*(4), 18-23.

Loftus, Andrew J., et al. (2000). Overview of angler-based tagging programs and management issues. *Fisheries 25*(4), 8-13.

Manfredo, M.J. (2008). Norms: Social Influences on Human Thoughts about Wildlife. In M.J. Manfredo (Ed.), *Who Cares About Wildlife? Social Science Concepts for Exploring Human-Wildlife Relationships and Conservation Issues* (pp 111-141). New York, NY: Springer Science + Business Media.

Manfredo, M.J., Teel, T.L. (2008). Integrating Concepts: Demonstration of a Multilevel Model for Exploring the Rise of Mutualism Value Orientations in Post-Industrial Society. In M.J. Manfredo (Ed.), *Who Cares About Wildlife? Social Science Concepts for Exploring Human-Wildlife Relationships and Conservation Issues* (pp 191-219). New York, NY: Springer Science + Business Media.

McGuire, J.R. (1992). An examination of environmental attitudes among college students (Unpublished master's thesis). The Pennsylvania State University, University Park.

Ong, Tah Fatt, and Ghazali Musa. (2011). An examination of recreational divers' underwater behavior by attitude–behavior theories. *Current Issues in Tourism* 14(8), 779-795.

Pereira, Jennifer. (2000). Profile of the BOAT/US Clean Water Trust Fish Tag and Release Program. *Fisheries-American Fisheries Society 25*(4), 14-15.

Robson, C. (2011). *Real World Research*: *A Resource for Users of Social Research Methods in Applied Settings.* Chichester, West Sussex: John Wiley & Sons Ltd.

Rotman, Dana, et al. (2012). Dynamic changes in motivation in collaborative citizen-science projects. *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*. ACM.

Rockeach, M. (1973). *The nature of human values.* New York: Free Press.

Sanchez, G. (2013). *PLS Path Modeling with R.* Trowchez Editions. Berkeley, 2013.

Shirk, J.L., Heidi L. Ballard, Candie C. Wilderman, Tina Phillips, Andrea Wiggins, Rebecca Jordan, Ellen McCallie, Matthew Minarchek, Bruce V. Lewenstein, Marianne E. Krasny, Rick Bonney. (2012). Public Participation in Scientific Research: A Framework for Deliberate Design. *Ecology and Society*, *17*(2):29.

Silvertown, J. (2009). A new dawn for citizen science. *Trends in ecology & evolution, 24*(9), 467-471.

Stern, P. C., & Dietz, T. (1994). The value basis of environmental concern. *Journal of social issues, 50*(3), 65-84.

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human ecology review*, *6*(2), 81-98.

Vaske, Jerry J., Maureen P. Donnelly (1999). A Value-Attitude-Behavior Model Predicting Wildland Preservation Voting Intentions. *Society and Natural Resources: An International Journal. 12*(6), 523-537.

Wingate, P. J. (2000). The lack of benefits in the public tagging of freshwater fish. *Fisheries. 25*(4), 26-27.