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Local perspectives on marine reserve creation in the Bahamas

Kenneth Broad [a,*], James N. Sanchirico [b]

[a] University of Miami, Rosenstiel School of Marine and Atmospheric Science, Abess Center for Ecosystem Science and Policy, 4600 Rickenbacker Cswy, Miami, FL 33149, USA
[b] Department of Environmental Science and Policy, University of California at Davis, Davis, CA 95616, USA

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ABSTRACT

In 2000, the Bahamian government initiated the process of developing a network of marine reserves with the goal of setting aside about 20% of their coastal marine environment. Here, we use information from more than 200 interviews, 600 household surveys, and participant observation conducted from 2001 to 2005 in five Bahamian settlements to examine the influence of different socioeconomic factors on individual and community support of a hypothetical no-take marine reserve in their local area. We developed hypotheses regarding socioeconomic characteristics of household and individual perspectives of the marine environmental conditions and current management, and tested and confirmed these using various statistical and multivariate regression methods. We also compared across community variation in responses to within community differences. Policy implications of these findings are discussed.

1. Introduction

The importance of healthy coral reefs for the sustainability of the wider ecosystem and for maintenance of viable recreational, fisheries, and tourism activities is widely accepted. More controversial, however, are the appropriate management mechanisms, where the typical tools such as closed seasons, size and bag limits, gear restrictions are used simultaneously or in isolation. The diversity of management tools stems in large part from the mixed results – both in ecological and socioeconomic outcomes – of different institutional regimes [1,8,15,5]. The "ecological" solution most actively promoted by the natural science community for improving the health of coral reefs is to create networks of marine reserves or no-take areas [17,23,3,2,18]. Social scientists, on the other hand, highlight the need for more in-depth studies of the relationship between socioeconomic variables and local perspectives concerning environmental resources before endorsing one particular management approach. Mascia [16], in a survey of 42 protected area managers in the wider Caribbean, found that Caribbean Marine Protected Areas are usually established with incomplete information regarding local biological and socioeconomic conditions, with socioeconomic assessment occurring less frequently than biological assessment.

The relationship between socioeconomic variables and perspectives on marine resource management has been given relatively little attention in designing conservation strategies and ecotourism development [31,25,7,9,28,26,24,11]. Although individual actors' perspectives and household and community level socioeconomic variables are not a complete set of factors to account for in conservation policy design, they are essential components for a number of reasons. Without an extremely robust enforcement system in place, compliance (and thus ecological success) for a no-take area, for example, is likely to rely on voluntarism of members of local communities. Respect for regulations is tightly coupled with the acknowledgement of a potential or existing environmental problem, identification of the sources of that problem, and the perception of the relative importance of the problem in relation to other concerns. It is increasingly claimed by practitioners and scholars that local community support is needed for successful management outcomes [14,4,21]. A logical conclusion, therefore, is that in developing workable and effective policy scenarios, *perspectives and socioeconomic conditions matter.*

In order to better understand the influence of different socioeconomic factors on individual and community support of a marine reserve in a local area (defined as a "no-take" area), we examined socioeconomic characteristics of households and individual perspectives of the marine environmental conditions and management options in six communities ("settlements" as they are locally referred to) in the Bahamas. Our study utilized information from more than 200 interviews, 600 household surveys, participant observation, and participatory mapping of resource use, conducted from 2001 to 2005.

Based on the responses to survey questions and ethnographic observations of the themes that emerged from the residents when discussing marine resource issues, we developed and tested a set of hypotheses. These are detailed in Table 1, along with the expected

* Corresponding author. Tel.: +1 (305) 421 4851.
E-mail addresses: kbroad@rsmas.miami.edu (K. Broad), jsanchirico@ucdavis.edu (J.N. Sanchirico).

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Table 1
Hypotheses relating to fundamental drivers for support of marine reserve creation

	Hypothesis	Variable	Expected sign
A. Environmental conditions	Individuals who perceive the local environmental conditions to be in poor condition are more likely to support the creation of a marine reserve	Rating of local environmental condition (poor, fair, good)	Negative
B. Current threats to marine environment	Individuals who perceive the top threat to the local environmental conditions to be non-fishing, such as pollution and natural causes, are less likely to support the creation of a marine reserve	Responses to open-ended question on the top impact to local marine environment	Negative
C. Fishery management	Individuals who perceive that current fishery management is appropriate are less likely to support creation of a marine reserve	Perspective on enforcement of fishing regulations (too low, appropriate level)	Negative
D. Income	Households that have higher incomes are more likely to support marine reserve creation	Household income (000s)	Positive
E. Community reliance on fishing	Communities that are more reliant on fishing for their livelihoods are less likely to support marine reserve creation	Indicator variable for Sandy Point, Southern Eluethera, and Tarpum Bay	Negative
F. Community reliance on tourism	Communities that are more reliant on tourism for their livelihoods are more likely to support marine reserve creation	Indicator variable for Bimini and San Salvador	Positive

sign between the variables (described below) and whether there is support for marine reserve creation. Policy implications from the results of each hypothesis test are also discussed.

Studying perspectives on the environmental and management options, and communities' actual reliance on marine resources in the Bahamas, which is an archipelago of more than 400 islands spanning more than 600 miles (see Fig. 2), is timely. First, this chain of islands is home to an extensive network of coral reefs and marine resource-dependent communities in terms of direct (commercial and subsistence fishing) and indirect (tourism, including recreational fishing and diving) contributions to household livelihoods. Second, in recognition of the importance of the marine environment and in step with management trends globally, the Bahamian government initiated in 2000 a process of developing a network of marine reserves with the goal of setting aside about 20% of their coastal marine environment (see Ref. [30] for a marine reserve list and explanation of selection criteria). Finally, the planning process has been contentious, with the settlements often objecting to the government-designated areas for closures and to the lack of local input in picking these areas for potential closure (see, for example, Ref. [29]).[1] The government has made efforts, though hampered by budgetary limitations, to foster participatory meetings. As of March 2007, none of the government-proposed marine reserves have been submitted to Parliament for approval (although several National parks that include marine areas promoted by the non-profit Bahamas National Trust, a group chartered by law to manage the national park system, have been established – see http://www.thebahamasnationaltrust.org/parks.php for details).

2. Methods

2.1. Survey description

The household surveys comprised four main sections. In the first, respondents provided general demographic and economic information, such as their age, number of years they had lived in their settlements, number of members of their household, type and ownership characteristic of their dwellings, number of bedrooms, their occupations and those of other household members, and the percentage that each contributes to the household income. In the second section, they answered questions about how their households use the marine environment; what types of activities they engage in (e.g., swimming, fishing, walking, and socializing); and the frequency with which household members visit different marine habitats, including local reefs, beach, sea grass, mangroves, and the deep sea. Another section, which was not utilized in this analysis, asked questions regarding the nature and type of fishing operations (gear, areas, and factors affecting fishing location choices). Finally, we included a series of questions intended to elicit respondents' perspectives on marine management, the state of the local marine environment, the principal current threats to their communities and the marine environment, and whether a marine reserve should be created off of their settlement.

The survey instrument consisted of open-ended and bounded response questions. The in-person survey took approximately ½ hour to 1½ hours to complete, where individuals who identified themselves as fishing more than 10 trips per year took the longest time to complete the survey.[2]

2.2. Sampling

During the period 2001–2005, we surveyed 604 households from North and South Bimini, San Salvador, and two settlements on both Eleuthera and Abaco in person (see Fig. 1). The settlements in the "Out" or "Family" Islands were chosen for the sample because (1) this is where the bulk of proposed marine reserves were to be located, and (2) there is a concerted effort emanating from the national government to increase tourism development in these areas. Furthermore, we selected settlements with the aim of covering a range of characteristics, including dependency on tourism; small-scale fishing; and remoteness from Nassau, Freeport, and the United States.[3] An additional driving force behind choosing these settlements was their proximity to ecological research sites, where the surveys are part of a larger US National Science Foundation project investigating the design of marine reserve networks in the Bahamas.[4]

[1] The Department of Marine Resources (DMR), located within the Ministry of Agriculture and Marine Resources, is the government entity responsible for the management of the Bahamian fishery and the implementation of the latest series of proposed marine protected areas. DMR interacts with local communities primarily through their network of fisheries officers stationed in the Family Islands, and more formally through community meetings with members of settlements adjacent to proposed protected areas. A second organization, The Bahamas National Trust (BNT), is an influential quasi-governmental group mandated with the conservation of "the natural and historic resources of The Bahamas". They currently administer the existing land and sea parks and have initiated the creation of new parks (that ultimately must be declared by the government to become official). Both DMR and BNT are partners in the National Implementation Support Partnership (NISP) that was signed in 2004 in order to further the commitment to expand the natural protected area system in the Caribbean made under the 1994 Barbados Program of Action.

[2] A graphical user interface within Excel was developed to minimize errors when inputting the survey information into electronic format.

[3] The two major urban areas (Nassau and Freeport), that contain about 50% of the total Bahamian population of more than 300,000, were excluded, as was the major commercial fishing port in Eleuthera, because of the study focus on the outer "Family Islands" settlements.

[4] For additional details on this larger project, see http://bbp.amnh.org.

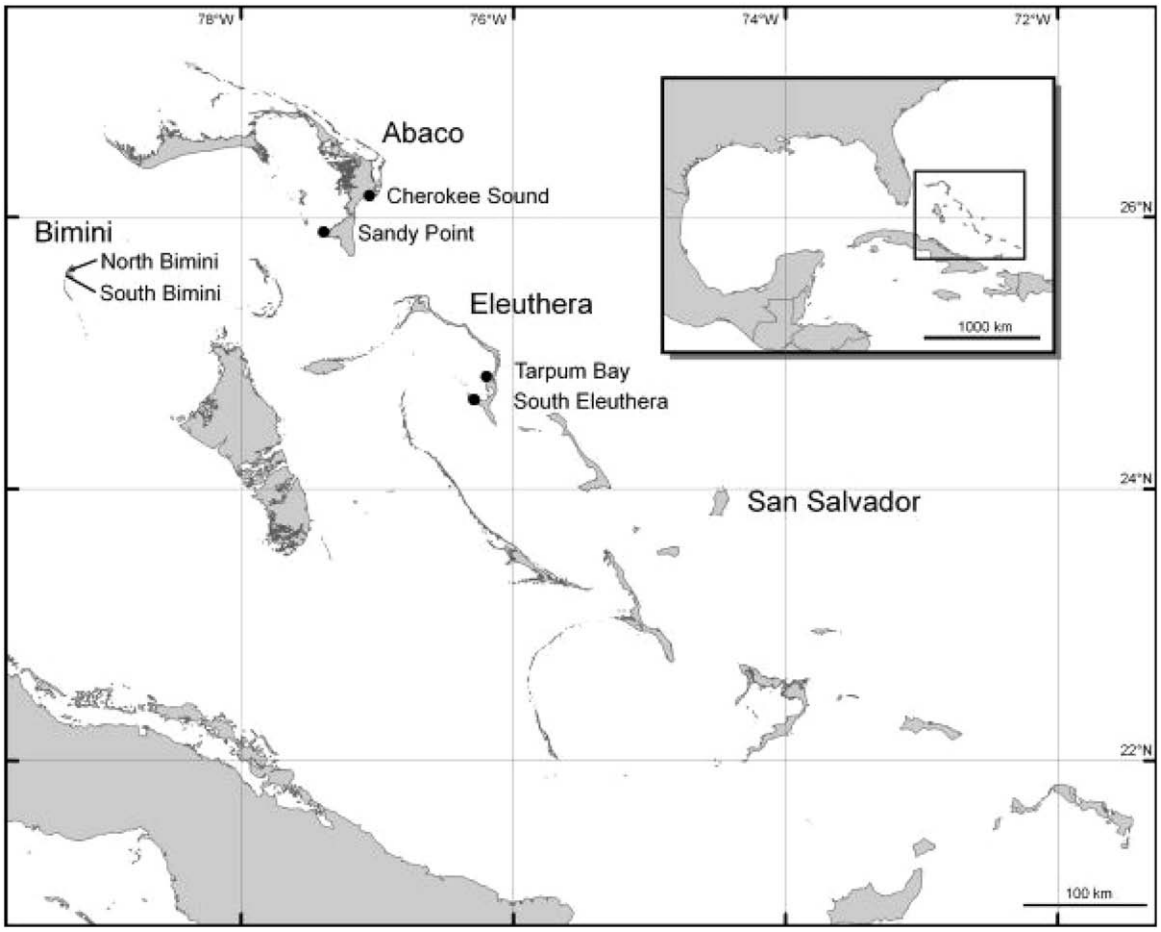

Fig. 1. Map of the Bahamas.

With only limited information available for each of the six settlements from the 2000 census, a probability sampling strategy survey was not feasible. However, in each settlement we collected data on a set of characteristics such as local geography (residence), age, and sex as a means to ensure a representative sample. When feasible, we ensured adequate representation of households across the different quadrants by referring to detailed maps of the dwellings in each settlement.

We sought to minimize potential biases inherent in samples of convenience (surveying people in a certain area) and samples of cooperation (surveying people who are willing) by undertaking numerous intercept strategies in each of the settlements. For example, surveyors attended church functions, town meetings, dinners, schools, etc. and built relationships with members of diverse groups to gain access for sampling.

In each settlement, the methods were tailored to the local situation. For example, in some settlements, door-to-door surveying at different times of the day proved to work well, and in other cases, this method was not acceptable. In addition, before the survey instrument was applied, surveyors spent from one to four weeks interacting with the community. Participant observation was useful because it helped the surveyors become familiar with the community dynamics and its general characteristics and established a degree of trust with the local populations. They also interviewed local authorities, NGOs, and created a network of key informants. Sampling biases were also likely to be minimized in some of the smaller settlements, where, for example, in Sandy Point, Abaco, the sample included approximately 45% of the households.

Local small-scale fishers were purposefully oversampled so that surveyors could better understand their decisions about where, when, and for what species they fish. Typically, large-scale commercial fisheries are focused on lobster, conch, and Nassau grouper, while smaller-scale fishers also target a range of other reef and pelagic species. We then adjusted the data to account for this oversampling, by taking a random sample of the commercial fishers surveyed from each settlement.[5] The number of fishers randomly chosen from the sample to include in the smaller sample ranged from five in San Salvador to 14 in Sandy Point, Abaco.

3. Results

3.1. Descriptive statistics

While the information collected in the surveys is extensive and includes detailed information on critical habitats, catch data, etc., only the relevant variables for this analysis are summarized (see Table 2). These variables include household-level information, individual survey–respondent information, use of the marine environment and knowledge of marine issues, and perspectives of the impacts on the marine environment. After randomly selecting the fishers to include in the estimation – and excluding Cherokee,

[5] The total number to include from each settlement was determined by equating the ratio of the number of fishers surveyed in each settlement over the number of households surveyed to the ratio of the (expected) number of fishers in settlement divided by the total number of households in the settlements.

Table 2
Descriptive Statistics

Demographic Variables	N	Mean	Std. Dev.	Min.	Max
Age	485	46.00	17.06	18.00	93.00
Number of children	485	3.30	3.35	0.00	15.00
Education (0 = primary, 1 = high school, 2 = college, 3 = graduate)	485	0.79	0.66	0.00	3.00
Marriage status (=1 yes)	485	0.51	0.50	0.00	1.00
Female (=1 yes)	485	0.49	0.50	0.00	1.00
Tourist employee in hhd (=1 yes)	485	0.54	0.50	0.00	1.00
Commercial fisher in hhd (=1 yes)	485	0.19	0.39	0.00	1.00
Household income (000s)	485	23.03	12.13	0.00	72.82
Respondents' mother from settlement (=1 yes)	485	0.507	0.501	0.00	1.00
Generational resource occupations (=1 yes)	485	0.15	0.36	0.00	1.00
Heard of the marine reserve (=1 yes)	485	0.63	0.48	0.00	1.00
Marine reserve meeting (=1 yes)	485	0.13	0.34	0.00	1.00
Marine users (=1 if freq. > 1 trip per week)	485	0.499	0.501	0.00	1.00
Settlement variables					
Tarpum Bay and Rock Sound, Eleuthera	485	0.24	0.43	0.00	1.00
Southern Eleuthera	485	0.10	0.29	0.00	1.00
Sandy Point, Abaco	485	0.13	0.34	0.00	1.00
San Salvador	485	0.27	0.45	0.00	1.00
North and South Bimini	485	0.27	0.44	0.00	1.00
Hypotheses					
Local marine condition	432	2.42	0.67	1.00	3.00
Enforcement (low or correct level)	422	0.374	0.485	0.00	1.00
Fishing reliance	485	0.462	0.499	0.00	1.00
Tourism reliance	485	0.538	0.499	0.00	1.00
Non-fishing impacts	485	0.674	0.469	0.00	1.00
Dependent varaiable					
Create new marine reserve (=1 yes, =0 no)	485	0.67	0.47	0.00	1.00

Abaco, surveys, which were too small a sample for the econometric analysis – the sample size for the analysis was 485 (out of the 604 total households surveyed).

Analysis of the descriptive statistics for the entire sample shows that there is considerable variation in the continuous variables. More specifically, the mean age in the sample was 46 years old, 54% of the households had members employed in tourism related industries, and 19% had a commercial or guide/charter fisher living in the home.

Thirty-three percent of the sample has only a primary education (the sample mean was below 1, where one corresponds to a high school education). Households had a mean size of more than three members, with an average household income approximately equal to $23,000. In the sample, 64% of households owned their house with an average of 2.7 bedrooms.

Researchers have pointed out the importance of local cultural norms being passed on through the generations and how this shapes the identity of settlements. Variables that proxy this process in the data include whether the respondent's mother was from the settlement (closeness to local knowledge, norms), whether the parents and/or grandparents were fishers or worked in natural resource-related occupations (fishing, agriculture, mining), and how long respondents have lived in the settlement. In the sample, 50% of the respondents' mothers were from the settlement and 15% had at least one parent and grandparent who worked in fishing and natural resource occupations. While not listed in Table 2, the mean number of years individuals had lived in the settlement where the survey was administered was 33 years. The sample analyzed here is almost exclusively made up of Bahamians of African descent (primarily brought to the Bahamas by British Loyalists as slaves).

Table 2 also shows the distribution of the sample of 485 across the five settlements. For example, 27% of the sample comes from San Salvador. The qualitative fieldnotes along with the survey were used to rank relative differences in important physical and sociological characteristics at the settlement level. For marine conservation, the socioeconomic dimensions over which there is potentially important heterogeneity are stages of tourist development, reliance on natural resource extraction, traditional characteristics, and infrastructure development. Table 3 presents the results of this exercise.[6]

Of particular note in Table 3 is the range of diversity within one relatively small and homogenous country (in terms of language group, fishing techniques, political and religious affiliations, etc.). For example, San Salvador has a high dependency on coral-reef tourism (through Club Med) and a low reliance on commercial fishing.[7] Most residents surveyed worked in the resort and revealed that the resort was importing most of their fish from Nassau. Sandy Point, on the other hand, has greater reliance on fishing and an informal economy. And, Bimini, which is famous for big game fishing and is also the closest settlement to the United States, is more reliant on tourism.

Table 3 is used to define variables that capture communities that are heavily reliant on fishing (Sandy Point, Tarpum Bay, and Southern Eleuthera) and communities that are more reliant on tourism (Bimini and San Salvador). The specific indicator variables are fishing reliance, where these three settlements account for 46% of the sample, and tourism reliance with 53% of the sample. Given the set of communities surveyed, it turns out that the fishing reliance indicator variable is equal to 1 minus the tourism reliance indicator variable.

Respondents also indicated whether they had heard of the marine reserve concept and/or attended a local meeting on creating a marine reserve. Table 2 shows that over 60% of the respondents had heard of the marine-reserve concept, and 13% had attended a meeting on marine reserves.

3.1.1. Hypothesis testing

To test hypothesis A, a variable is defined that is equal to 1 if the respondent rated the local environment poor; 2 if the rating was fair; and 3 if the rating was good. Table 2 shows that the mean in the sample, excluding the "don't know" responses, is 2.42. If this hypothesis is correct, individuals that rate the local environment in better condition should be less likely to support reserve creation and this variable will be negatively correlated with reserve creation.

We classified responses[8] to open-ended questions asking what the current, top local threats to the health of the marine environment are, dividing them into fishing and non-fishing impacts that include pollution, natural disasters, storms, etc. Table 2 shows that approximately 67% of our sample listed non-fishing impacts as the major threat. Hypothesis B states that those who view the greatest impacts coming from non-fishing activities are less likely to support the implementation of a regulation that is perceived as controlling fishing pressure. A negative correlation between reserve creation and listing non-fishing impacts as your top threat is expected.

With respect to hypothesis C, we used a respondent's rating on the level of enforcement of fishing regulations as a proxy for their perspective on local fishery management. The variable is equal to 1 if the respondent believes that the level of enforcement is adequate and equal to zero if the belief is that enforcement is poor. Because

[6] Bimini and San Salvador are actually islands but due to their small population size are considered as single settlements in the analysis.

[7] In the past, residents of San Salvador were much more heavily reliant on subsistence fishing and farming. During the survey period, subsistence fishing was a relatively minor source of food. However, residents still talk about their option to switch back to fishing and farming if necessary, as they did during crises such as occurred post-September 11, 2001 when Club Med shut down for over a year. Interestingly, Club Med imports most of their seafood from exporters in Nassau or from abroad.

[8] Respondents were not prompted with a list of possible answers.

Table 3
Table summarizing settlement characteristics relevant to our analysis. The comparisons are relative to each other

	Fishing reliance (commercial, subsistence, guide)	Tourism reliance	Urban distance (from Nassau, Freeport, or USA)	Development impact (large-scale resort, cruise ship port, housing enclaves)
Bimini	Low–medium	High	Low	High
Cherokee	Medium	Medium	Medium	Medium
Sandy Point	High	Low	High	Low–medium
San Salvador	Low	High	High	High
Southern Eleuthera	High	Medium	High	Low
Tarpum Bay	Medium–high	Medium	High	Low

some respondents did not feel comfortable answering this question, the sample size in Table 1 is slightly lower for this variable. In this smaller sample, 37% of the respondents classified enforcement as at adequate levels. Based on the hypothesis, the expected sign on this variable is negative as respondents who think that the current fishing regulations are being enforced are less likely to support additional regulations on the fishers.

Hypothesis D focuses on the level of household income, where households that have higher incomes are posited to be more likely to support marine reserve creation. A positive correlation between reserve support and income is therefore expected. Hypotheses E and F are related to each other, where a negative relationship is expected between communities that are more reliant on fishing and those that are not. The opposite hypothesis is stated for communities that are more reliant on tourism, where a positive correlation is anticipated.

3.1.2. Pairwise correlations

Table 4 illustrates the Spearman rank correlation coefficients between whether an individual responded favorably to the idea of creating a marine reserve off of their settlement and the variables capturing the different hypotheses. The statistical significance is illustrated by stars for variables at the 10(*), 5(**), and 1(***) percent levels. In looking at the first column of the table, statistical support for each of the hypothesis is evident. For example, those who are more likely to rate the environment as healthy are less likely to support marine reserve creation. Furthermore, individuals who perceive that the fishing regulations are currently being enforced are less likely to support marine reserve creation.

The other columns illustrate the pairwise correlations between the different hypotheses (variables) and illustrate some interesting findings. First, the results show that those who rate the environment healthy are more likely to view the level of enforcement of fishing regulations as acceptable, are less likely to come from households with higher income levels, are more likely to list non-fishing impacts as the top threat, and are more likely to come from tourism-dependent communities.

The pairwise correlations also illustrate that the individuals who respond that the level of enforcement of fishing regulations is adequate, list the top threat as stemming from non-fishing activities and are more likely to come from lower income households.

3.1.3. Multivariate regression

While simple pairwise correlations provide support for our hypotheses, the set of variables that best explains the variation in responses is difficult to discern. Therefore, a multivariate regression (probit) model is estimated with the dependent variable being whether the individual supports reserve creation or not. The independent variables are the hypothesis variables in Table 2.

Table 5 illustrates the multivariate regression result that predicts a 75% acceptance rate of marine reserves with these regressors when the observed frequency is 73%. Again, statistical support for our hypotheses is found and the regression results are consistent with the pairwise correlations. Income is, however, no longer statistically significant but the sign is consistent. That is, higher income households tend to support marine reserve creation, all else equal.

A similar regression with tourism reliance rather than fishing reliance was undertaken. The coefficient on tourism reliance is positive and statistically significant at the 1% level. Because of how the fishing and tourism-reliant indicator variables are defined in our study, it is not surprising that none of the other coefficients change between the two regressions.

The variable on general local condition was removed from the regression, which increases our sample size from 390 to 422, to test the robustness of the other hypotheses on a larger sample. There is no change in the expected signs, but now household income is significant at the 5% level. This difference is likely due to the larger

Table 4
Pairwise correlations

	Create new MR	Local Env. conditions	Enforcement of fishing Regs	HH income (000s)	Top impact non-fishing	Fishing reliance	Tourism reliance
Create new MR (no = 0, yes = 1)	1						
Local marine conditions (poor = 1, fair = 2, good = 3)	−0.1561** $N = 432$	1					
Enforcement of fishing Regs (too lax = 0, acceptable = 1)	−0.1941*** $N = 390$	0.2196*** $N = 390$	1				
Household income (000s)	0.1141** $N = 432$	−0.1527** $N = 432$	−0.1030** $N = 390$	1			
Top impact non-fishing (fishing = 0, non-fishing = 1)	−0.1645*** $N = 432$	0.1180** $N = 432$	0.1963*** $N = 390$	0.0163 $N = 432$	1		
Fishing reliance (no = 0, yes = 1)	−0.1560** $N = 432$	−0.1780** $N = 432$	0.0676 $N = 390$	0.0013 $N = 432$	0.1049** $N = 432$	1	
Tourism reliance (no = 0, yes = 1)	0.1560** $N = 432$	0.1780*** $N = 432$	−0.0676 $N = 390$	−0.0013 $N = 432$	−0.1049** $N = 432$	−1.00*** $N = 432$	1

Note: The stars represent the statistical significance of the pairwise Spearman rank correlation coefficients at the respective levels $^{*}p < 0.10$ (10% level), $^{**}p < 0.05$ (5% level), and $^{***}p < 0.001$ (1% level). The sample size, N, varies according to the variable (number of respondents to the questions) and is provided in the table.

Table 5
Probit regression on marine reserve creation

Variables	Coefficient estimate	Robust standard errors
Local Env. conditions	−0.30984**	0.116432
Enforcement of fishing Regs	−0.37187**	0.148164
Household income (000s)	0.0084	0.00644
Top impact non-fishing	−0.32845**	0.157028
Fishing reliance	−0.50943***	0.143113
Constant	1.827225***	0.360496

Note: The dependent variable is the individual's response to whether a marine reserve should be created (1 if yes, 0 if no). The stars represent the statistical significance of the probit estimates at the respective levels $^{*}p < 0.10$ (10% level), $^{**}p < 0.05$ (5% level), and $^{***}p < 0.001$ (1% level). The sample for the regression includes the 390 households that responded to the local environmental condition and enforcement question. The log pseudo likelihood function is 206 with a Wald Chi-square statistic of 40.59.

sample size and the omission of general local condition variables, where the two variables are negatively correlated. To further check for robustness, we tested our hypotheses on the full sample of surveys (not the random subset that corrects for the oversampling of fishing households). Again, the results are consistent with the findings in Table 4.

3.2. Within and across settlement variability

Up to now, our analysis has pooled all of the settlements to get a big picture view of the support for reserve creation. The survey, however, also permits investigation into potential differences across the settlements, an issue of importance for designing a network of protected areas [6]. For example, do all households that have a commercial, guide or charter fisher within fishing-reliant communities provide consistent responses when it comes to the support for marine reserve creation? Are all households with an employee in the tourism sector in tourism-reliant communities similar in their perspectives?

Using simple Spearman pairwise rank correlations, we investigated these questions to help shed further light on the aggregate results discussed above. Table 6 shows the rank correlation coefficients and statistical significance. We did not find a statistically significant relationship between fishing households in Tarpum Bay or Southern Eleuthera and support for reserve creation. Sandy Point, on the other hand, has a strong (1%) negative signal that is consistent with their rating of the local environmental conditions and enforcement. Interestingly, fishing households within predominantly tourism-dependent communities (Bimini and San Salvador) showed support for reserve creation at the 5% significance level.

With respect to the households in fishing dominant settlements (Sandy Point and Tarpum Bay) with tourism occupations, our analysis revealed a negative correlation that was statistically significant at the 10% level. San Salvador tourism households were also much more likely to rate the local environment higher, while Bimini tourism households were more likely to rate the local environmental condition as lower. Another interesting result is the strong positive correlation between Sandy Point residents with ties to the tourism sector and response that non-fishing impacts are the top threat.

4. Discussion

The hypotheses we tested in this study address whether residents from five settlements in the Bahamas support the placement of a marine reserve in their local area, and how this level of support is related to perspectives (i.e., of state of the marine environment, threats to this environment, and the efficacy of current management approaches), as well as to the more concrete, or material aspects of life in these coastal settlements (i.e., economic status, reliance on fishing, and/or tourism). This section highlights the hypotheses and discusses policy implications of the results.

4.1. Hypothesis A

The study found that individuals who perceive the local environmental conditions to be in poor condition are more likely to support the creation of a marine reserve. A next step, from a research perspective, would be to compare these perspectives to objective measures of ecological health of the local environment. Besides comparing the measures to expressions of local ecological knowledge, this type of research could help target educational campaigns to correct for biases in local perspectives and, as importantly, to educate natural scientists on the specifics of a local environment that may be less apparent given their methods and the constraints on the time they are able to spend in the field.

While it is beyond the scope of this paper to calibrate the results presented with ecological data, further investigation into the data of those respondents who did not feel comfortable to answer the question regarding the local environmental condition could also be used by the government to better target educational campaigns. To that end, we undertook a multivariate regression (probit) analysis, where the dependent variable is equal to 1 if they answered the question and zero if they did not feel comfortable answering (“don’t know”). In the sample, 89% were able to rate the local environmental conditions. The regressors included are the demographic variables in Table 2. Statistical evidence points to

Table 6
Spearman rank correlation coefficients of fishing and tourism households within each of the settlements

	Create new MR	Local Env. conditions	Enforcement of fishing Regs.	HH income (000s)	Top impact non-fishing
Fishing households					
Tarpum Bay	0.0030	−0.0032	0.0527	0.0241	0.0936
Southern Eluethera	0.0400	0.0107	−0.0201	0.0282	−0.0741
Sandy Point	−0.1555***	−0.0977**	−0.0916*	0.0766	−0.0199
San Salvador	0.0999**	0.0218	0.0394	−0.0180	0.0153
Bimini	0.1131**	−0.1096**	−0.1520***	0.0957	−0.1203**
Tourism households					
Tarpum Bay	−0.1226**	−0.1516***	0.0588	0.0508	0.0551
Southern Eluethera	0.0088	0.0316	0.0804*	0.0172	0.0350
Sandy Point	−0.0803*	−0.0154	0.0031	0.0500	0.1026**
San Salvador	0.0102	0.2385***	0.0596	0.0281	0.0172
Bimini	0.0615	−0.0965**	−0.1159**	0.0583	−0.0802*

Note: The stars represent the statistical significance of the pairwise correlations between the column and row variables at the respective levels $^{*}p < 0.10$ (10% level), $^{**}p < 0.05$ (5% level), and $^{***}p < 0.001$ (1% level). The sample size for all columns except the enforcement question is 432 and the enforcement question has a sample size of 390.

individuals with higher education levels, a household member working in the tourism industry, or respondents whose mother was born in the settlement as more likely to answer the question. Female respondents, on the other hand, were overwhelming more likely to respond "do not know" than their male counterparts, after controlling for age, income, and education, etc. One implication for government planners could be to target local information and educational campaigns to this sub-population by planning meetings at times suited to their circumstances and to design informational brochures that appeal to female audiences.

The fact that individuals who perceive their local environment to be in good condition *do not* see marine reserves playing a critical role in protecting these areas from future degradation is also notable. Qualitative explanations expressed by locals during fieldwork included "if it ain't broke, don't fix it", a lack of trust in regulatory agencies to do a good job managing, and a prioritization of other community problems that supersede marine conservation issues. Relatedly (and surprisingly), in an open-ended question eliciting identification of problems faced by the community, neither overfishing nor any problem related to the marine environment made it onto the list. (see Fig. 2).

4.2. Hypothesis B

Results indicate that the people who perceive the top threat to the local environmental conditions to be non-extractive, such as pollution and natural causes, are less likely to support the creation of a marine reserve. Again, while intuitive in a similar way to the above hypothesis (i.e., why take action on something not considered to be a problem?), this finding does identify some gaps in understanding the role played by marine reserves beyond reducing fishing pressure, and thus points to potential foci for educational efforts. In particular, residents did not consider the role of marine reserves as a tool to conserve biodiversity, including increasing resilience against non-fishing shocks such as climate change [13].

To get a better sense of a respondent's perspective on the top threat, we further analyzed the data associated with those individuals who identified natural rather than anthropocentric drivers under the non-fishing category. The analysis revealed that life-long residents of the settlements tended to point to environmental drivers (e.g., natural events such as storms, climate variability, species fluctuations, and other environmental processes) as the top impact on the marine ecosystem. Many of the older settlement residents described their having experienced many periods of environmental/resource fluctuations that are not explained by local human influences (e.g., the *Diadema* die-off in 1980s, the shifting of fish-spawning aggregation sites, and hurricane damage altering ecosystem properties). This finding along with the one that recent immigrants into the communities tended to be less favorable to marine-reserve creation, points to specific community and age cohorts to target for educational, and participatory discussions about marine management. In many of the study settlements, elderly community members still command respect and can directly influence community behavior. Identification of these specific groups can help target outreach and educational efforts.

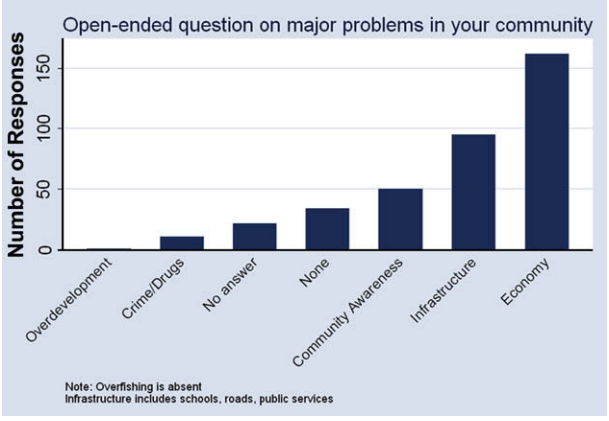

Fig. 2. Responses to question on major problems in your community. Note: This question was coded to fit into these general categories and was not asked in Bimini or Cherokee.

4.3. Hypothesis C

Our findings support the hypothesis that individuals who perceive that current fishery management are appropriate are less likely to support creation of a marine reserve. This result is somewhat more ambiguous than the others. Drawing on the fieldwork data, plausible explanations can be identified. The most obvious – which again resonates with the above results – is that things are working well, so why change them. Another often-mentioned issue was that a lack of enforcement of *existing* rules is the norm (Table 2 shows that only 37% of the respondents thought local enforcement was adequate), so why bother adding more rules and regulations, especially ones that require some degree of sophistication to comply with and to enforce – i.e., clear demarcation of boundaries in open water. This point was related to repeated comments during interviews, indicating the variability among resident in terms of their trust in the different regulatory agencies. Most relevant were residents' claims that these agencies were inconsistent in their treatment of different fishing groups (i.e., Bahamians versus Americans) and settlements (due to kinship ties or geographic favoritism).

Another less-frequently posited opinion was that local communities were best suited to decide and to self-enforce regulations. In fact, several examples of this self-regulation, albeit on a limited spatial scale, were observed over the course of the study. These included no fishing in certain areas considered vital for ecosystem health or recreation, public criticism for improper methods, and protection of areas where juvenile conch and lobster were relocated for growing out to legal size.

Finally, as was illustrated with the pairwise correlations, individuals who feel that the enforcement of fishing regulations is adequate are more likely to respond that the local environmental conditions are good. This reinforces the idea that perspectives on local environmental conditions and fishery management are shaping ideas about the merits of marine reserves, even though marine reserves may have much broader objectives.

4.4. Hypothesis D

This hypothesis, which posits that households with higher incomes are more likely to support marine reserve creation, was supported (though the statistical signal is not as strong as in the other tests of our hypotheses). While income is only one measure of wealth, other multivariate indices of wealth developed during the analysis (e.g., assets, dwelling characteristics, debt, etc.) produced similar results to using income exclusively. This finding is supported by other studies that explain that it is not until an individual's basic needs are fulfilled (i.e., drawing on Maslow's hierarchy of needs concept) that they can afford the material and ensuing psychological luxury to address environmental concerns [10]. Economists have also developed conjectures (e.g., Kuznet curve), at both the national and household scales, arguing that economic

development is a pre-requisite for groups to begin to prioritize environmental issues [12].

The findings illustrated in Fig. 2 support this more general point. Results from the study settlements reveal that residents prioritize socioeconomic concerns well above environmental ones. Clearly these issues are more salient to their everyday lives, with poorer households being affected more acutely by development limitations (infrastructure, crime, health care access, etc.).

4.5. Hypothesis E

Results support the hypothesis that communities more reliant on fishing for their livelihoods are less likely to support marine reserve creation. It is no surprise that one is less likely to support something that potentially reduces one's household income. Of note is that even though commercial fishers make up only a proportion of settlement occupations, ethnographic data indicates they are highly esteemed individuals for a variety of reasons. Fishing is also a tradition that is strongly valued in these settlements, and in addition to selling their catch, commercial fishers also distribute catch to family and friends.

Demographic generational trends derived from family history data collected during the survey indicate that in most of the study settlements there is a decreased reliance on fishing, where over 60% of the male respondents said their grandfather was either working in fishing, agriculture, or forestry and only about 20% of these respondents were doing the same. Thus it could be predicted that the influence of fishers overall will diminish in the future. However, there is significant variability among the settlements in terms of reliance on fishing. Furthermore, these differences could be used by regulators to choose sites that will be least negatively impacted for marine reserve placement or to target development efforts (e.g., alternative occupations).

Given the results on fishing-reliant communities, it is logical to infer that fishing households within these communities are the strongest opponents to marine reserve creation. However, the pairwise comparisons in Table 6 illustrate that this is not the case. Instead, we observe considerable variation among the fishing-reliant communities (Sandy Point, Southern Eleuthera, and Tarpum Bay). As a means to further illuminate the complexity between community and household perspectives, Table 6 also includes the fishing households in the tourism-reliant communities.

The pairwise correlations in Table 6 show that fishing households in Sandy Point are more likely to be against marine reserves, rate their local environment poor, and the enforcement of fishing regulations as poor. The fishing households in Tarpum Bay and Southern Eleuthera do not yield a statistically significant correlation either way. The lack of a statistical signal is just as significant as the presence of one, as it indicates the diversity of opinions and therefore lack of a strong correlation.

At first glance, the results in Table 6 seem to imply an inconsistency between the community-wide perspectives and households whose occupation (fishing) contributes to the community-wide perspective. The fieldwork along with our analysis of the occupations of grandparents and parents, however, shows that the fishing-reliant communities have a longer history in fishing than the other communities, and this history as passed down from one generation to the next can explain this discrepancy. Thus even though few members of the settlement are active commercial fishers, there exists a palpable, collective identity of a traditional fishing settlement and support for this endeavor is strong.

Table 6 also supports the conclusion that the fishing households in Bimini and San Salvador, the two communities not as reliant on fishing, are more likely to support reserve creation. In this case, the fieldwork and further analysis of the survey responses showed that in Bimini and San Salvador many of the fishing-dependent households are operating guide and charter operations for the tourists.

4.6. Hypothesis F

Consistent with the results of the previous hypothesis test, analysis reveals that communities that are more reliant on tourism for their livelihoods are more likely to support marine reserve creation. Interviews revealed that there was widespread awareness that tourists were drawn to "pretty" reefs and beaches, and that an ample and steady supply of fresh fish is necessary to feed these tourists. Thus these residents linked marine reserves to both preservation of key ecosystem features and charismatic species, as well as to enhancing overall biomass to be caught and fed to the tourists.

While a downward trend in fishing occupations is evident, analysis of the trend in tourism occupations shows the opposite. In fact, while 10% of the respondents said their grandfather or grandmother worked in the tourism industry, over 30–40% responded that they currently work in tourism related industry. This upward trend of involvement of both men and women in the tourist industry leads one to the conclusion that there will likely be increasing support (or at least less resistance) to marine reserve implementation efforts.

Again, it should be emphasized that not all tourism-reliant households unequivocally associate degraded marine environment with fishing pressure. One interesting example, for instance, is the strong positive correlation between Sandy Point residents with ties to the tourism sector and response that non-fishing impacts are the top threat (see Table 6). Many residents in Sandy Point are employed by a large cruise ship company that owns an island nearby their settlement, and they experience firsthand the local environmental impacts of the cruise ship activities.

Understanding perspectives in the communities on marine reserves is an important factor in the development and implementation of current and future management plans. The data we gathered clearly points to the potential difficulty of applying a one-size-fits-all conservation approach to coral-reef management and the corresponding need to understand during the planning processes the site-specific socioeconomic characteristics.

For managers thinking about how to take into account local perspectives at the start of a regulatory decision-making process, results of the study from the five Bahamas settlements reveal that some populations may be more likely than others to embrace a marine reserve in their local waters. In the Bahamas, this population of affected stakeholders includes the wider community and not just commercial fishers. In particular, results show that females, fishing households, and older residents are candidate target groups for increasing dialogue concerning marine resource management. Results also point to coupling economic growth policies with reserve creation, as a means to increase current incomes. And, if these development policies focus on increasing tourism infrastructure, then the results show that these policies are likely to lead to greater acceptance of marine reserves in the future as communities become more reliant on tourism.

While this study has focused on marine reserves – because that is currently the major focus of regulatory and conservation groups in the Bahamas – it is also important to emphasize that just because individuals are not supportive of a marine reserve in their area does not imply that they do not support any or all conservation efforts. In fact, during interviews, many alternative regulatory mechanisms were suggested. These include changes in timing of existing seasons to better match biological processes, differential size limits, and closure areas for commercial cash fishing versus subsistence consumption. Of particular note were respondents' suggestions to implement different catch limits for tourists versus locals,

reflecting resentment of foreign fishers – often in the form of US tourists – who target certain spawning aggregations in Bahamian waters and take lobster from local underwater traps (''condos'') that are not legally owned but are considered private property by Bahamian custom.[9]

A clear message from the study sample is the inherent complexity and diversity of factors that can explain perspectives and can lead to local community members' acceptance or rejection of management efforts. Since universal rules are not features of the ecological domain, where research has continually pointed to the nuances of trophic dynamics and dependencies on local conditions and scales [19], the fact that the human dimension of this problem exhibits the same characteristics should not be surprising to conservation planners.

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