Drivers of long-term support for marine protected areas in The Bahamas

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ABSTRACT

Marine protected areas (MPAs) are a critical tool for fisheries conservation and require public support to function effectively. Although much research highlights ways to develop public support for MPAs, less is known about how and why support for MPAs persists over time. We contribute to this literature with a case study on Andros, The Bahamas by examining how support for MPAs established in the early 2000s has persisted and changed over two decades. We interviewed 162 residents with fisheries and tourism related livelihoods between May and June of 2019. Our results indicated long-term support for MPAs was primarily predicted by: 1) access to alternative sources of income outside fishing, 2) attendance at MPA scoping meetings, 3) age, and 4) level of formal education. Support for future MPA establishment was positively predicted by support for previous MPAs, concern about overfishing, the perception among residents that MPAs were established for the right reasons, and residence within tourism-associated settlements. These results suggest public engagement in MPA establishment and preserving fishing livelihoods, or providing viable alternatives, will promote long-term public support for future MPAs.

1. Introduction

Marine ecosystem health underlies sustainability of fishing communities in coastal areas around the world (Eriksson et al., 2019; Lamberth and Turpie, 2003). A healthy marine system aids in promoting a healthy human community by supporting marine species that are used for food, recreation, and other economic purposes (Colléter et al., 2014; Miller et al., 2006). Marine species also provide numerous ecosystem services, including regulation of food web dynamics, recycling of nutrients, maintenance of marine sediments, and control of diseases (Holmlund and Hammer, 1999). Conversely, damaged marine ecosystems can threaten the well-being of nearby human communities by reducing local access to food and raw materials, removing a source of economic income, and even threatening human health (Eriksson et al., 2019; Fleming et al., 2006; Frumkin and Haines, 2019; Gurney et al., 2014). Fishery health is also positively correlated with economic health in fishing-dependent communities, both in terms of overall employment and income of affected families (Allison et al., 2009; Westlund et al.,

2017).

Marine protected areas (MPAs) represent a critical tool used to protect marine ecosystems, fisheries, and communities reliant on them (Broad and Sanchirico, 2008; Eriksson et al., 2019). An MPA is a "clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (IUCN, 2008). Around the globe, MPAs have been used to reduce stress on marine ecosystems, especially from overfishing, and help promote employment within local communities (Dalton et al., 2015; Eriksson et al., 2019). A variety of studies indicate populations of marine species respond well to MPAs when MPAs are designed and managed using empirical information about habitat use among focal species (Christie, 2004; Edgar et al., 2014; Knip et al., 2012; Williams et al., 2009).

However, MPA establishment is often controversial, with efficacy depending heavily on community support. Controversies over MPA establishment frequently revolve around economic difficulties for

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fishers via localized reductions in access to resources (Broad and Sanchirico, 2008; Cinner et al., 2007; Kamat, 2014). Opposition is especially prominent in areas where food security depends on the community's ability to fish (Chaigneau and Daw, 2015; Westlund et al., 2017). When MPAs are placed in areas with high conservation value, these negative economic consequences may be short term (Burgess et al., 2013; Coffman and Kim, 2009; Howarth et al., 2015; Mizrahi et al., 2019); however, in areas where residents have little access to alternative livelihoods, even short term negative consequences can undermine public support and negatively impact residents (Kamat, 2014; Santos and Brannstrom, 2015). Unfortunately, MPAs located in areas of high human impact can have the greatest conservation value, and the largest negative impact on humans (Devillers et al., 2015; Mizrahi et al., 2019). Catch restrictions also impact efficacy and community support. These restrictions often vary considerably, ranging from restrictions on single species for single seasons to complete bans on all fishing activities (Jones, 2014). MPA establishment is further complicated by governance disagreements and enforcement issues. Governance issues often arise when local communities are not given standing and therefore lack influence in MPA planning decisions (Christie and White, 2007; White et al., 2005). Lack of enforcement sometimes creates 'paper parks' allowing governments to claim environmental wins without furthering conservation (Pieraccini et al., 2017; White et al., 2005). These scenarios are worsened when planners fail to consider societal, economic, and cultural impacts, undermining community support (Christie and White, 2007). For instance, Karimunjawa Island fishers experiencing negative impacts on income and food security from local MPAs began resisting the Indonesian government's regulations (Westlund et al., 2017). Similar responses occurred among fishing-reliant villages in Taiwan, the Philippines, and Reunion Island where restrictions were met with unrest and lack of cooperation (Chaigneau and Daw, 2015; Thomassin et al., 2010; Wu and Tsai, 2016). However, in other instances, efforts to collaborate with local communities during MPA development made MPAs more successful (Dalton et al., 2015; Wise, 2014). In a variety of geographic and socio-cultural contexts, community support and stakeholder engagement has proven central to MPA success in restoring populations of focal marine species (e.g., Philippines: Chaigneau and Daw, 2015; Australia: Yates et al., 2019). Specifically, if locals benefit through direct employment or community economic growth, protected areas are more likely to succeed in restoring biodiversity to marine communities (Basurto, 2013). Similar patterns emerge in studies of terrestrial protected areas in Guatemala and Mexico (Solorzano and Fleischman, 2018). Public resistance and policy stalemates sometimes emerge even when extensive public engagement is used, such as with MPA establishment around the Channel Islands (Davis, 2005). For these reasons, we need to better understand the key factors shaping community support during MPA establishment.

Emerging research has responded to this need, and suggests several socio-cultural factors shape community support for MPAs. Knowledge of MPA rules and benefits, education level, access to alternative sources of income (non-marine-resource dependent sources such as tourism), ability to comply with MPA rules among fishers while still providing for themselves and their families, reliance on tourism for economic gain, and reliance on commercial fishing tend to predict community support for MPAs (Broad and Sanchirico, 2008; Chaigneau and Brown, 2016; Hayes et al., 2015; Masud and Kari, 2015). General education level along with specific knowledge about the ecological status of the area that needs protecting, the options available for enacting protection, and the most likely outcomes of each option can positively influence community support (Hayes et al., 2015; Lundquist and Granek, 2005). Residents reliant on tourism for their livelihoods, tend to be less concerned about MPA-related restrictions, and more likely to support MPAs (Chaigneau and Brown, 2016). However, those who rely heavily on harvesting marine life an MPA seeks to protect (e.g., commercial fishers) are less likely to be supportive and compliant because of the perception that an MPA will reduce their ability to provide for their families (Said

et al., 2018). Similarly, people who expect negative economic impacts due to establishment of MPAs are less likely to show support (Eriksson et al., 2019).

Research has therefore identified a number of factors that seem to play important roles in influencing community support for MPAs—yet, we do not yet understand how these patterns persist or change over time. Prior studies have typically been conducted during the planning stages and early establishment of MPAs, with limited follow-up research to address community support after MPA establishment. We began addressing this gap with a case study conducted across 8 communities (often referred to as settlements among local residents) on North Andros, The Bahamas. We tested several hypotheses about sources of support for both past MPA establishment and establishment of future MPAs. Based on previous studies (Broad and Sanchirico, 2008; Chaigneau and Brown, 2016; Eriksson et al., 2019; Hayes et al., 2015), we hypothesized that those who (1.1) had access to alternative sources of income, (1.2) were well-informed about MPA rules and regulations, (1.3) perceived overfishing to be an important problem, (1.4) resided in a tourism-associated settlement rather than a fishing-dependent settlement, (1.5) had higher levels of formal education (1.6) and attended MPA information meetings, would be more likely to have supported past MPA establishment. We hypothesized that those who (2.1) had supported previous MPAs, (2.2) had access to alternative sources of income, (2.3) perceived themselves to be well-informed about MPA establishment and conservation law, (2.4) perceived overfishing to be an important problem, (2.5) complied with conservation authorities, (2.6) thought that MPAs would be established with community wellbeing in mind, (2.7) maintained a positive relationship with conservation authorities, (2.8) resided in a tourism-associated settlement rather than a fishing-dependent settlement, and (2.9) had higher levels of formal education, would be more likely to support future establishment of MPAs.

2. Study area

A variety of protected areas have been established on Andros, including national parks and marine protected areas (Fig. 1). The Bahamas government established five national parks (three of which would go on to be designated as MPAs) on Andros in 2002 to protect the barrier reef, freshwater blue holes, mangrove nurseries, and land crab (*Cardisoma guanhumi* and *Gecarcinus lateralis*) habitat (The Bahamas National Trust et al., 2018). Since the early 2000s, several new parks have been designated as MPAs to combat overfishing and depletion of natural resources on Andros. These include the Green Cay Protected Area, designated in 2004, and the Joulter Cays Protected Area, designated in 2015. More recently, authorities have proposed identifying additional locations for marine protection (The Bahamas National Trust et al., 2018). Prior to MPA establishment, the Bahamas National Trust, the management agency overseeing Andros's MPAs, held community meetings to gather local input and provide information to Androsians. Fisheries regulation enforcement on Andros is poor. Prior studies suggest limited compliance with MPA regulations associated with inadequate enforcement and cultural norms supporting local harvest of protected resources for household use (Silvy et al., 2017). MPA establishment has coincided with numerous studies showing rapid decline in culturally and economically significant fish populations (e.g., queen conch, spiny lobster, and Nassau grouper) throughout the Bahamas (Ehrhardt and Deleveaux, 2007; Hayes et al., 2015; Higgs, 2021; Stoner et al., 2009; Stoner and Davis, 2010).

Andros provides a good case study for learning about long-term support for MPAs because communities are dependent on marine resources, experienced extensive past establishment of MPAs, and work with the national government to promote the area as an ecotourism hub. Andros (5,957 km^2) is the largest in The Bahamas, with low human population density (1.2/km^2 [7,490 people in 2010]; The Commonwealth of The Bahamas, 2012). Andros's multiple communities are treated as one entity politically (Hayes et al., 2015). We conducted
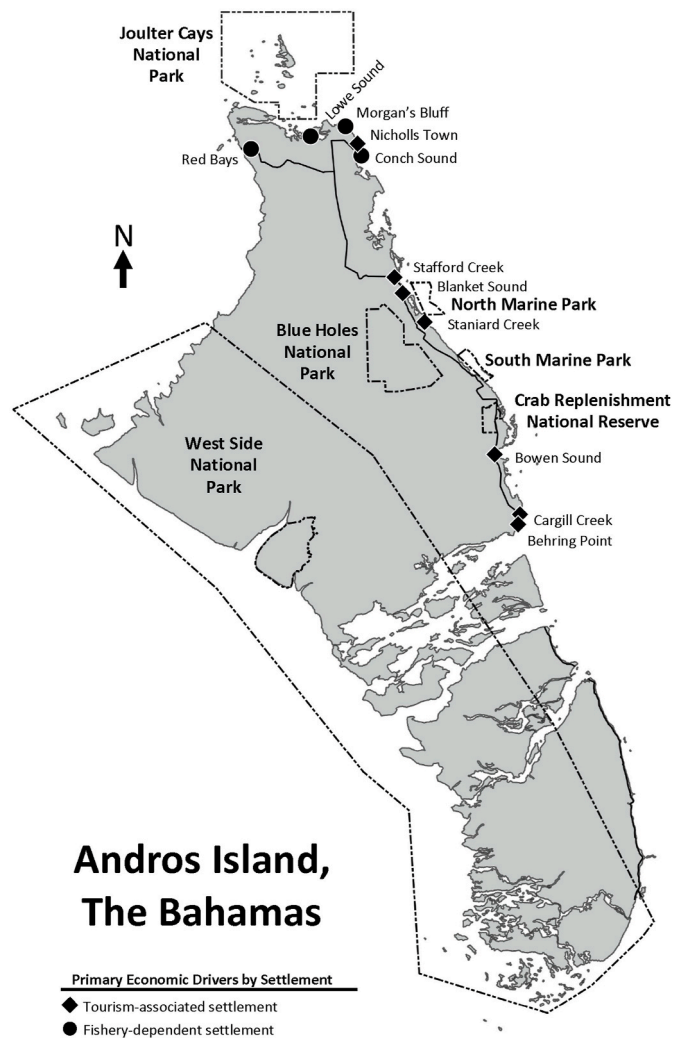
Fig. 1. Map of Andros, The Bahamas, showing the study region in northern Andros, the major highways, and the six national parks (boundaries shown by dotted lines).

surveys in the following communities: Red Bays, Lowe Sound, Conch Sound, Morgan's Bluff, Nicholls Town, Stafford Creek, Staniard Creek, and Cargill Creek/Behring Point. The communities consist of residents that rely on fishing and tourism for income. Primary tourism activities include bonefishing, SCUBA diving, birdwatching, deep-sea fishing, sailing, and kayaking. These tourist activities bring about $43.6 million in revenue each year (Hayes et al., 2015). Approximately 85% of the locals obtain income from fishing, crabbing and sponging, and other locals sell handmade products such as straw baskets or wood carvings to tourists (Hayes et al., 2015). A Budget Communication by The Bahamas Prime Minister described a need to grow the Andros economy, mostly in tourism development, while making sure that the natural resources are "not to be spoiled in the name of advancement" (Christie, 2014).

3. Methods

3.1. Sampling

Given limited census data availability for the settlements in our study area (Fig. 1), simple random sampling of the population was not feasible. Thus, we followed Broad and Sancharico (2008) by collecting data on individual respondents (i.e., age, sex), households (e.g., location, livelihoods), and communities (e.g. primary source of employment) that would facilitate a representative sample. Similarly, we

sampled from all regions of settlements by referencing detailed maps of dwellings in settlements. We minimized geographic biases by intercepting residents in diverse locations including their homes, neighborhood streets, fishing docks and boat ramps, workplaces, and churches (Broad and Sanchirico, 2008). We minimized non-response bias by achieving 96.7% cooperation; in total 162 residents participated in our interviews. This was possible due to the demographic diversity of our interview team, and long-term relationships built through 8 years of community research (e.g., Casola et al., 2021; Hayes et al., 2015; Shapiro et al., 2016; Valdez et al., 2019), and 18 years of ecological research (e.g., Giery et al., 2015; Langerhans et al., 2007) on Andros.

3.2. Instrument development

We developed a questionnaire to evaluate drivers of support for past MPAs and support for establishing future MPAs on Andros. To assess support for previously established MPAs among Androsians, respondents were asked "Are you aware of some of the marine parks and conservation areas on Andros?"; answers were coded as yes (1) or no (0). Respondents who answered yes, were then asked "How strongly did you support or oppose the creation of existing marine parks at the time they were established?" (hereafter referred to as "support for past MPAs"). Answers ranged from strongly opposed (1) to strongly supported (6). To assess future support for MPAs among Androsians, respondents were asked "Would you support or oppose the creation of more marine parks on Andros?" (hereafter coded as "support for future MPAs"). Answers were coded from strongly oppose (1) to strongly support (6).

To test each of our hypotheses, respondents were asked a series of questions about their livelihoods, communities, and demographics. Specific survey questions and their corresponding hypotheses and definitions are listed in Table 1. When asked about their highest level for education, some respondents indicated attending an "all-age school." Based on the respondent's education level reached in all-age school, results were coded as the equivalent stage of a typical public school (e.g. primary school or high school; Table 1). We recorded education level because education, both about conservation and on a broader scale, may be positively correlated with support for MPAs (Bennett and Dearden, 2014). We recorded age because age has been shown to negatively correlate with knowledge and perceptions about conservation subjects (Afonso et al., 2019). Sex was included because sex-based differences in social status and roles exist in Caribbean societies (Henry and Wilson, 1975). Moreover, previous research has shown that sex plays a role in support for MPA introduction, with women being more likely to support establishment than men (Hoelting et al., 2013).

Finally, we included a fixed effect in our analysis reflective of the primary source of income within each settlement: fishery-dependent economy or tourism-associated economy. The former group included commercial fishing-dependent communities – Red Bays, Conch Sound, Lowe Sound, and Morgan's Bluff. In this context, "commercial" refers to small-scale artisanal fishing, often sold to residents in Nassau or Andros (Silvy et al., 2017). The latter group included all other communities engaged in the study—Stafford Creek, Staniard Creek, Cargill Creek/-Behring Point, and Nicholls Town—all of which rely on tourism and tourism-related fishing (e.g. bonefishing) more than commercial fishing (Silvy et al., 2017). Table 1 provides a summary of all variables with definitions and summary statistics.

Our survey instrument takes advantage of a retrospective pre-post study design. This design relies on respondent recollection, requiring them to remember their opinions prior to the beginning of a program (MPA establishment in this study) and asks them to respond to questions regarding their initial opinions (Geldhof et al., 2018; Howard et al., 1979a, 1979b; Howard and Dailey, 1979). On Andros, true pre-post data about MPAs was not available and a retrospective pre-post design was the only option to evaluate how support for MPAs has changed over time. A retrospective pre-post study design has a number of advantages, inducing cost and time savings, the ability to evaluate programs when

Table 1

Survey questions, corresponding hypotheses, reference numbers, definitions and summary statistics. Item-specific coding listed in Variable Type column.

Question & Reference Number	Hypotheses Addressed	Variable Type	Mean (SD)
(1) How strongly did you support or oppose [already-established MPAs] at the time they were established?	2.1	Ordinal Scale (1 = *strongly opposed* to 6 = *strongly supported*)	4.61 (1.71)
(2) Did you attend any Marine Parks planning meetings at that time?	1.6	Binary Indicator (0 = *no*, 1 = *yes*)	0.35 (0.47)
(3) How familiar are you with the conservation rules associated with the Marine Parks around Andros?	1.2 & 2.3	Ordinal Scale (1 = *not at all familiar* to 6 = *very familiar*)	3.65 (1.78)
(4) Does your family have access to alternative sources of income, not dependent on fishing within Marine Parks around Andros?	1.1 & 2.2	Binary Indicator (0 = *no access*, 1 = *access*)	0.80 (0.40)
(5) How would you describe your community's compliance with the rules associated with Marine Parks around Andros?	2.5	Ordinal Scale (−2 = *very low compliance* to 2 = *very high compliance*)	0.32 (1.23)
(6) How would you describe your community's relationship with conservation authorities?	2.7	Ordinal Scale (−2 = *very poor* to 2 = *very good*)	0.73 (1.00)
(7) Do you believe the Marine Parks around Andros were established for the right reasons?	2.6	Binary Indicator (0 = *no*, 1 = *yes*)	0.92 (0.27)
(8) Has your family experienced an increase or decrease in economic income due to the Marine Parks around Andros?		Ordinal Scale (−2 = *large decrease* to 2 = *large increase*)	0.12 (1.03)
(9) How important of a challenge is overfishing to your community?	1.3 & 2.4	Ordinal Scale (−2 = *not at all important* to 2 = *very important*)	0.65 (1.43)
(10) Are you male or female?		Binary Indicator (0 = *Male*, 1 = *Female*)	0.33 (NA)
(11) What is the highest level of formal education you have completed?	1.5 & 2.9	Ordinal Scale (0 = *Primary School*, 1 = *High School*, 2 = *College*, 3 = *Graduate Studies*)	1.04 (0.73)
(12) What year were you born?		Continuous (Age)	48.19 (15.46)
(13) Would you support or oppose creation of more Marine Parks on Andros?		Ordinal Scale (1 = *strongly oppose* to 6 = *strongly support*)	4.38 (1.70)
(14) Settlement Economy	1.4 & 2.8	Binary Indicator (1 = fishery-dependent economy, 0 = tourism-associated economy)	0.50 (NA)

pre-implementation data were not collected, and a reduction in response-shift bias where respondent's conceptualization of a program (MPAs in our study) changes over time because of learned knowledge or lived experience (Geldhof et al., 2018; Howard et al., 1979a, 1979b; Howard and Dailey, 1979). This design also has potential drawbacks including introduction of recall bias, where accuracy of memories declines over time (Hill and Betz, 2005; Schwartz and Sprangers, 2010). Further, acquiescence bias, where respondents provide answers they believe are desired by researchers, may be more problematic for retrospective pre-post than true pre-post study designs (Sibthorp et al., 2007).

3.3. Analysis

To test our competing hypotheses for drivers of support for past MPAs, we used model selection and multimodel inference (e.g., Burnham et al., 2011; Grueber et al., 2011). We constructed ordinal logistic regression models that contained all of the possible combinations of the relevant variables (interactions between variables were not tested) with forced inclusion of the demographic variables (age, sex, education and type of settlement economy) in all models. The response variable for all models in this set was how strongly the respondent supported or opposed already-established MPAs at their time of establishment. This approach produced 16 possible models, which were ranked using Akaike information criterion (AIC_c to correct for small sample size). We conducted model averaging for all models within two ΔAIC_c of the best model (Burnham and Anderson, 2002). The sample size was 111 respondents, and variance inflation factors (VIFs) for each term were low (VIF <4) indicating low multicollinearity.

A similar process was used to evaluate the factors influencing support for future MPAs. We ran a set of ordinal logistic regression models that contained all of the possible combinations of the relevant variables with forced inclusion of the demographic variables and level of past support for MPA establishment in all models. The response variable for all models in this set was how strongly the respondent supported or opposed the creation of more Marine Parks on Andros. This produced 256 possible models, which were ranked using AIC_c; all models within two ΔAIC_c of the best model were then model averaged (Burnham and Anderson, 2002). The sample size was 113 respondents, and variance inflation factors (VIFs) for each variable were low (VIF <4). In addition to model averaged coefficients, standard errors, and *p* values, we calculated odds ratios for each variable that model averaging indicated was important for both sets of models to interpret the relative effect sizes of each variable on MPA support. Variable inclusion in all models was based on the results of AIC_c ranking and subsequent model averaging. Odds ratios are presented for all variables in both models as a consistent way to evaluate effect sizes.

4. Results

The average participant in this study was 48 years old (*SD* = 15.5), had completed high school, and identified as male (67% male). Exactly 50% of the participants lived in a fishery-dependent settlement and 50% lived in a tourism-associated settlement. Age distributions were very similar between the two type of settlements with an average of 49 (*SD* = 15.3) years old in fishery-dependent settlements compared to 47.5 (*SD* = 15.8) years old in tourism-dependent settlements. Most (74.5%) of the 162 Androsians interviewed were aware of the existence of MPAs on the island, but only 63.4% believed they could name the locations of any specific MPAs, and only 44.7% correctly identified an MPA near Andros. Respondents reported moderate support for the MPAs at the time of their establishment (mean = 4.61 on a scale of 1–6), and moderate support for the establishment of new MPAs (mean = 4.38 on a scale of 1–6). Additional summary statistics can be found in Table 1.

Table 2

Ordinal logistic regression models within two ΔAIC_c of the top model predicting support for established MPAs on Andros.

Model[a]	AIC_c	ΔAIC_c	Akaike Weight
2/4/3/10/11/12	325.15	0.00	0.29
2/4/3/9/10/11/12	325.25	0.10	0.28
2/4/3/10/11/12/14	325.56	0.41	0.24
2/4/3/9/10/11/12/14	326.04	0.89	0.19

[a] Numbers correspond to variable reference numbers described in Table 1.

The top four models examining support for past MPAs based on AICc are shown in Table 2, all four models were within two ΔAICc of the top model. Results averaged across all top models suggest the most important factors influencing past support for MPAs are access to alternative sources of income (odds ratio = 3.83) and attendance at MPA information meetings (3.20). Education (odds ratio = 2.01) and age (odds ratio = 1.04) were also important but less so. Results supported hypotheses 1.1 and 1.5, as access to alternative sources of income (β = 1.34) and overall education level (β = 0.70) both positively correlated with support for past MPAs (Table 3). Results also supported hypothesis 1.6, as attendance at MPA information meetings positively predicted support for past MPAs (β = 1.16). Older individuals had higher support for past MPAs (age: β = 0.04). Hypotheses 1.2, 1.3, and 1.4 were not supported as we did not find evidence via model averaging that familiarity with MPA rules, concern about overfishing in the community, or type of settlement economy influenced prior support for established MPAs. We also found no evidence that sex influenced support for past MPAs (Table 3).

In our assessment of the factors influencing support for future MPAs, we found 15 models within two ΔAIC$_c$ of the top model (Table 4). Model averaged results suggest the most important factor influencing support for future MPAs is the belief that MPAs were being established for the right reasons (odds ratio = 6.80). Perceived importance of overfishing (odds ratio = 1.65), pervious support for MPAs (odds ratio = 1.43), and type of settlement economy (odds ratio = 0.36) were also important but less so. Results supported hypotheses 2.1, 2.4, 2.6, and 2.8 as previous support for MPA establishment (β = 0.35), concern about overfishing in the community (β = 0.50), the belief that MPAs were being established for the right reasons (β = 1.92), and type of settlement economy (β = −1.02) all predicted support for future MPA establishment (Table 5). We did not find support for hypotheses 2.2, 2.3, 2.5, 2.7, and 2.9. We also found no evidence that any of the demographic variables (age, education, and sex) influenced support for future MPAs.

5. Discussion

This study extends previous research indicating community engagement promotes support for MPAs (Eddy et al., 2002; Lundquist and Granek, 2005; Mizrahi et al., 2019; Solorzano and Fleischman, 2018; Westlund et al., 2017) by suggesting that support may persist over long time periods. Previous research suggests stakeholder engagement helps build a sense of ownership and support among residents and may result in higher levels of compliance with MPA regulations (Cinner et al., 2005; Granek and Brown, 2005; Lundquist and Granek, 2005). Our results align well with these past studies by suggesting engagement during the planning and establishment phases leads to increased support for MPAs over the long term. Our results suggest community engagement may be influential regardless of other factors impacting MPA success.

Table 3
Model averaged parameter estimates, standard errors, and *p* values for model terms predicting support for established MPAs on Andros (N = 111).

Variable[a]	β	Std. Error	*p* value	Odds Ratio
(2) Attendance at MPA Meetings	1.16	0.4	0.007	3.20
(3) Familiarity with MPA Rules	0.08	0.12	0.49	1.19
(4) Access to Alternative Sources of Income	1.34	0.48	0.006	3.83
(9) Perceived Importance of Overfishing	0.08	0.13	0.53	1.20
(10) Sex [b]	0.70	0.48	0.15	2.02
(11) Education	0.70	0.32	0.03	2.01
(12) Age	0.04	0.02	0.02	1.04
(14) Settlement Economy [c]	−0.18	0.43	0.66	0.83

[a] Numbers correspond to variable reference numbers described in Table 1.
[b] Reference Level: Female.
[c] Reference Level: Fishery-dependent Economy.

Table 4
Ordinal logistic regression models within two ΔAIC$_c$ of the top model predicting support for future MPAs on Andros.

Model[a]	AIC$_c$	ΔAIC$_c$	Akaike Weight
1/7/8/9/10/11/12/14	338.97	0.00	0.12
1/6/7/8/9/10/11/12/14	339.06	0.09	0.12
5/6/7/8/9/10/11/12/14	339.62	0.65	0.09
1/3/4/7/8/9/10/12/14	340.08	1.11	0.07
1/3/6/7/8/9/10/11/12/14	340.30	1.33	0.06
1/2/6/7/8/9/10/11/12/14	340.38	1.41	0.06
1/2/5/7/8/9/10/11/12/14	340.47	1.51	0.06
1/4/7/8/9/10/11/12/14	340.54	1.57	0.06
1/2/7/8/9/10/11/12/14	340.64	1.67	0.05
1/5/6/7/8/9/10/11/12/14	340.64	1.67	0.05
1/2/5/6/7/8/9/11/12/14	340.64	1.67	0.05
1/6/7/9/10/11/12/14	340.84	1.87	0.05
1/3/6/7/9/10/11/12/14	340.89	1.92	0.05
1/2/3/7/8/9/10/11/12/14	340.92	1.95	0.05
1/3/5/7/9/10/11/12/14	340.94	1.97	0.05

[a] Numbers correspond to variable reference numbers described in Table 1.

Table 5
Model averaged parameter estimates, standard errors, and *p* values for covariates predicting support for future MPAs on Andros (N = 113).

Variable[a]	β	Std. Error	*p* value	Odds Ratio
(1) Previous Support for MPAs	0.35	0.13	0.006	1.43
(2) Attendance at MPA Meetings	−0.05	0.19	0.75	0.66
(3) Familiarity with MPA Rules	0.05	0.09	0.63	1.17
(4) Access to Alternative Sources of Income	0.09	0.29	0.75	1.76
(5) Perceived Compliance with Conservation Regulations	0.07	0.14	0.62	1.26
(6) Relationship with Conservation Authorities	0.16	0.22	0.49	1.41
(7) Established for the Right Reasons	1.92	0.75	0.01	6.80
(8) Change in Income Due to MPA Establishment	0.37	0.24	0.13	1.54
(9) Perceived Importance of Overfishing	0.50	0.14	0.0002	1.65
(10) Sex [b]	0.06	0.48	0.90	1.06
(11) Education	0.05	0.30	0.88	1.04
(12) Age	−0.007	0.01	0.54	0.99
(14) Settlement Economy [c]	−1.02	0.43	0.02	0.36

[a] Numbers correspond to variable reference numbers described in Table 1.
[b] Reference Level: Female.
[c] Reference Level: Fishery-dependent Economy.

For example, Androsians were given little power during MPA planning, and there is little evidence to show MPAs around Andros have bolstered fish populations, yet many Androsians who were present at MPA meetings and believe MPAs were established for the right reasons still report high levels of support for MPAs. Beyond initial support for MPAs, this study suggests past support generated via initial community engagement is predictive of support for the establishments of new MPAs in the future. On Andros, the majority of the MPAs and other National Parks were established in 2002, suggesting these community support mechanisms may have long-term effects as evidenced by a nearly 20-year legacy. Thus, strong community engagement during MPA establishment may pay dividends during the future creation of MPAs decades later within the same region. Future research is needed to further unravel the mechanisms influencing long-term support for MPAs.

This study suggests that the drivers of support for MPAs can change over time, as the factors influencing support for the establishment of existing MPAs were not the same as those influencing support for future MPAs. The most profound example of this phenomenon within our results is the fact that the most important factor influencing support for future MPAs is the belief that MPAs were being established for the right

reasons, yet this factor was not important in predicting initial support for MPAs. This suggests trust in authorities may be a critical factor bridging initial and future support and aligns well with previous literature suggesting public trust in management agencies increases the perceived benefits derived from MPAs and the legitimacy of management decisions (Cvitanovic et al., 2018; Diedrich et al., 2017; Turner et al., 2016). Other examples of drivers of support for MPAs changing over time include the impact of education and the perception of overfishing among residents. Residents with higher levels of formal education exhibited stronger support for previously established MPAs but not for the creation of new ones. This change may reflect education level driving understanding of MPA impacts prior to establishment (Leisher et al., 2012; Thomassin et al., 2010), and personal experience becoming more important in the years after establishment. Our results support this interpretation given residents who were concerned about overfishing supported MPAs irrespective of personal education level after living with MPAs for nearly two decades. This interpretation also aligns with multiple social science and fisheries studies within the region. Long-term residents on Andros have reported major declines in near shore fisheries (Casola et al., 2021), and their observations have been confirmed by long term studies concluding major fisheries of economic importance, including the queen conch, spiny lobster, and Nassau grouper, have experienced declines over the past two decades (Ehrhardt and Deleveaux, 2007; Hayes et al., 2015; Higgs, 2021; Stoner et al., 2009, 2019; Stoner and Davis, 2010). Moreover, during our interviews multiple respondents stated that previously established MPAs provided a means of environmental education for their children, reinforcing the idea that residents are directly learning from their experience of living with MPAs.

Building MPA support within communities with economies solely focused on commercial fishing may be more difficult than in other communities. Within this case study, settlements with tourism-associated economies were found to have greater support for future MPAs. This may be explained by residents in settlements with a stronger tourism focus and less reliance on commercial fishing being more inclined to protect marine habitats because of the direct connection to their livelihoods. This pattern also aligns well with previous studies suggesting communities which rely heavily on commercial fishing are less compliant with MPA regulations and suggests MPA establishment that attends to developing alternative livelihood pathways may be more successful than establishment efforts that do not (Broad and Sanchirico, 2008; Hayes et al., 2015; McLeod et al., 2009; Westlund et al., 2017). Future research should further explore the connection between diversity in economic structure, income, and MPA support to identify pathways for building support within fisheries dependent communities.

Young cohorts of fishers on Andros may explain why our age-related results counter patterns in the literature. Specifically, previous research suggests younger fishers and divers support MPAs more than their older counterparts (Bennett et al., 2020), and research within the general populace suggests age is negatively related with support for protected areas (Fiallo and Jacobson, 1995). On Andros, however, MPA support increased with age. We propose two possible explanations for this phenomenon. First, on Andros anglers actively harvesting commercial fish and lobster tend to be young, potentially due to the growing importance of diving relative to hook-and-line and net fishing (Casola et al., 2021). Thus, comparatively younger residents may tend to be more reliant on fishing incomes for their livelihoods on Andros relative to areas examined in prior studies (Bennett et al., 2020). Second, long-term residents on Andros have reported major declines in near-shore fisheries (Casola et al., 2021; Hayes et al., 2015). If older Androsians recognized the decline, they may also understand the need for protection, as opposed to younger Androsians who have not directly observed the long-term changes. These results highlight the need to account for age cohort dynamics when assessing public support for MPAs.

This study suggests stakeholder engagement paired with educational efforts may facilitate community support for MPAs. Establishing MPAs with the community's best interests in mind must be paired with delivering on key promises, such as protecting overexploited fisheries, to avoid damaging support for future MPAs. Although concerns about negative economic impacts of MPAs or displacement from traditional fishing grounds can be reduced through public engagement during establishment (Wise, 2014), failure to follow through with benefits for fishers may hurt prospects for future MPA establishment over the long term. Trust in MPA authorities depend on these perceived benefits and engagement (Cvitanovic et al., 2018; Diedrich et al., 2017; Turner et al., 2016), and this study suggests trust is the most important predictor of whether a community living in proximity to MPAs will support new MPAs.

Future research is needed to address several limitations of this study. Notably, we adopted a retrospective pre-study design, and this method raises concerns about recall bias (Bell et al., 2019). Long-term panel research could address this limitation. Similarly, future research in other socio-cultural contexts is needed to determine the degree to which inferences about long-term drivers of MPA support identified in this study extend to other locations particularly those where most fishers are older and diving for fish is less prevalent.

6. Conclusions

Ultimately, this study provides a snapshot of drivers influencing support for MPAs at their time of establishment and support for establishment of new MPAs in the future. Factors shaping community support for MPAs changed over time; however, community engagement during MPA establishment both generated initial support MPAs, and laid the foundation for MPA support decades later. Belief that MPAs were being established for the right reasons, an indicator of trust in management agencies, was the most influential factor driving support for future MPA establishment despite not predicting support for historical MPAs when they were established. Our findings align well with previous studies, by suggesting community engagement and access to alternative sources of income promote support for MPAs at their time of establishment. Complementary to other studies, our results suggest demographic (e.g., age) and economic factors also play a role in building support, and these factors may vary between communities with different economic strategies. For example, this study found settlements with tourism-associated economies had greater support for future MPAs than settlements relying more heavily on commercial fishing. Further inquiry into the drivers of support for MPAs may lead to more informed management decisions and increase compliance and support among impacted stakeholders and the public. This study suggests public engagement during MPA establishment and preserving income generated from fishing are needed to promote long-term public support for future MPAs.

Declaration of competing interest

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

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