

Appendix 2. Additional methods, results, and discussion.

METHODS

MPAs were either long-established (24-35 years) or recent (less than 10 years). All recent MPAs allowed fishing (Table 1), so the effect of age group on compliance levels could only be tested in MPAs that allowed fishing, and preliminary analysis revealed no effect. Hence MPA age (Table 1) was excluded from the linear mixed-effect model.

To obtain additional information on factors influencing compliance we asked participants what they thought was driving compliance and noncompliance, ranking these responses according to the number of mentions.

RESULTS

Table A2.1 summarizes the salient factors that respondents thought influenced compliance (i.e., why fishermen follow MPA rules) and noncompliance (i.e., why fishermen break MPA rules).

Table A2.1. Three highest-ranked factors considered by respondents to influence compliance and noncompliance. n= number of mentions by respondents.

Rank	Compliance	Noncompliance
1	Afraid of sanctions (n=57)	Better/easier fishing in protected area (n=49)
2	Complying brings benefits (individual, communal, or environmental) (n=52)	Financial hardship (n=23)
3	Complying is the right thing to do (n=16)	Unlikely to get sanctioned (n=21)

DISCUSSION

The factors influencing compliance that were identified by respondents revealed that there is some degree of purposeful, voluntary compliance (Table A2.1). Voluntary compliance is preferable to coerced compliance because it can: 1) indicate that natural resource users are assertive about the benefits of regulating use of natural resources, 2) provide a buffer when costly enforcement is suspended, and 3) confirm effective governance and management (Arias, 2015). Some respondents believed that compliance involves environmental, personal, or communal benefits (Table A2.1). The fact that most respondents believed that fishing illegally in MPAs could be better or easier than fishing outside of them (Table A2.1), suggests that MPAs, despite varying amounts of illegal fishing, could contain higher fish biomass than the non-protected areas. Even though voluntary compliance is preferred, a degree of enforcement is typically necessary (Arias, 2015; Braithwaite & Braithwaite, 2001; Tyler, 2003) to maintain deterrence and compliance (Table A2.1). We therefore consider that if the deficit of enforcement efforts detected in most of these sites were to continue, or deteriorate further, fishers who might be complying voluntarily could defect in the face of flagrant noncompliance. This is supported by our results, which suggest

that effective government efforts to combat illegal fishing can relate positively to perceived compliance (Figure 1). Furthermore, patrol efforts (either formal or informal) tend to be more effective in smaller areas (Ban et al., 2011), and this might explain why perceived compliance was lower in larger MPAs (Figure 1).

We were also interested in knowing what respondents thought was influencing noncompliance. Respondents cited poverty and better fishing in MPAs as the main reasons for noncompliance (Table A2.1). Coastal communities in Costa Rica are predominantly poor (Morales-Aguilar, 2013). Scarcity of food or income could induce some people to fish illegally in MPAs, mostly if they believe that there are more fish in them than outside (Table A2.1). It is worth noting that, in Cahuita and Gandoca-Manzanillo, both in the Caribbean, people do not rely entirely on fishing, and fishing in Costa Rica's Caribbean is much less productive than the Pacific (FAO, 2011). This low dependence on fishing can help explain the higher compliance in these two Caribbean sites. In contrast, the communities adjacent to MPAs with low perceived compliance (e.g., Caballo, Golfo Dulce, and Santa Rosa) rely substantially on fishing (Marín-Cabrera, 2012; Solis et al., 2012). This is particularly true at the small island of Caballo, where fishing is the only livelihood. These facts support the results of our model, which shows that fishers perceive lower levels of compliance than non-fishers (Figure 1). It is likely that compliance levels were negatively affected by a high dependence on declining fisheries, and a lack of livelihood options. Similar conclusions have been drawn by previous studies. Peterson and Stead (2011) suggested that the main causes for noncompliance with MPAs in Rodriguez, an island in the Western Indian Ocean, were lack of food and limited livelihood opportunities. Similarly, Karper and Lopes (2014) found that artisanal fishermen that depended more on fisheries had stronger intentions to break rules in a Brazilian MPA. Thus, declining or collapsed fisheries can give rise to illegal fishing and other types of noncompliance, and a high dependence on fisheries exacerbates the problem (Brashares et al., 2014; Gettleman, 2015).

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