DiscoverTURFs

A global assessment of Territorial Use Rights in Fisheries to determine variability in success and design

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Team Members
Gina Auriemma | Kristen Byler | Katie Peterson | Alana Yurkanin

Faculty Advisor
Dr. Chris Costello

DiscoverTURFs: A global assessment of Territorial Use Rights in Fisheries to determine variability in success and design

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Gina Auriemma

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Kristen Byler

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Katie Peterson

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Alana Yurkanin

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The Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Final Report is authored by MESM students and has been reviewed and approved by:

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Dr. Christopher Costello

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Abstract

Over one third of all assessed global fisheries are overexploited, despite extensive management strategies aimed at reducing overall fishing effort. Territorial Use Rights in Fisheries (TURFs) are a widely implemented management strategy that provides a well-defined user group exclusive and secure access to a specified area of water. This strategy is capable of providing fishers with incentives to harvest sustainably. Although numerous factors are hypothesized to lead to TURF success, it is still unclear what contributes to their effectiveness. Utilizing survey responses and published literature, we conducted the first global analysis categorizing where TURFs are located, how they are designed, and which factors contribute to their success. We identified over 1,000 TURFs in 41 countries around the world. Using detailed, site-specific information on 103 TURFs, we analyzed which design features contribute to a TURF's ability to successfully meet its stated management objectives. The most significant factor in predicting the likelihood of meeting general TURF objectives was the presence of co-management, where community and government involvement in the management of the TURF is approximately equal. Interestingly, when focusing exclusively on fisheries objectives, species mobility and the duration of tenure were the most significant design features associated with success. While our results identified design characteristics that should be critically considered in TURF implementation, we also discovered the complexities and site-specific variability inherent in TURF management. These complexities, coupled with the key design features identified in our analysis, are what enables TURFs to be a flexible solution to problems facing small-scale fisheries around the world.

List of Abbreviations

API	Application Programming Interface
CCA	Community Conservation Area
CMT	Customary Marine Tenure
EDF	Environmental Defense Fund
EU	European Union
FAD	Fish Aggregating Device
GIS	Geographic Information Systems
GNI	Gross National Income
HDI	Human Development Index
ITQ	Individual Transferable Quota
KML	Keynote Markup Language
LMMA	Locally Managed Marine Area
MPA	Marine Protected Area
NGO	Non-Government Organization
NTZ	No-take Zone
OLS	Ordinary Lease Squares
QA/QC	Quality Assurance and Quality Control
RBFM	Rights Based Fisheries Management
ROL	Rule of Law
SES	Social-Ecological System
TAC	Total Allowable Catch
TURF	Territorial Use Rights in Fisheries
USD	United States Dollar
WGI	World Governance Indicator

Executive Summary

Over one third of all assessed fisheries are overexploited (FAO, 2010) despite extensive efforts to manage global fisheries. To address the issue of overfishing, many traditional and ecosystems-based management strategies are frequently applied. While these strategies may foster increased species abundance and biodiversity (Halpern, 2003; Palumbi, 2004; Hilborn et al., 2006; Grafton, 2006), they do not in and of themselves alter the incentives of fishers in a way that reduces the race to fish.

To address the race to fish, Rights-Based Fisheries Management (RBFM) has emerged as a management strategy aimed at providing fishers with incentives to sustainably use resources (Christy, 1982; Cancino et al., 2007; Uchida et al., 2011; Gelcich et al., 2008; Wilen et al., 2012). Three common forms of RBFM are: Individual Transferable Quotas (ITQs), fishing cooperatives, and Territorial Use Rights in Fisheries (TURFs). TURFs assign access to the resources within a geographic area, and are the focus of this research paper.

For the purposes of this analysis, we define a TURF as an area in which individuals or communities are given some level of exclusive access to marine resources within a defined boundary. While the popularity of establishing TURFs has increased in recent decades, the concept is not new. Many fishing villages all over the world have had some form of established customary marine tenure for centuries to defend their marine territories and ensure exclusive access to their vital marine resources (Johannes 1978). Despite the widespread implementation of TURFs around the world, information on TURFs is lacking, except in a few well-researched countries or regions. In fact, few analyses seek to compile data across all TURFs, so it is still unclear what factors contribute to their effectiveness.

There is a spectrum of assumptions, some conflicting, in the literature describing the variables responsible for a TURF's success, including size, tenure length, species mobility, the presence of no-take zones, the use of co-management, and geographic enclosure. However, testing the validity of these hypotheses is challenging due to an unclear understanding of what success is and how it is measured. Many of these factors are often considered to beget biologically, economically, or socially successful TURFs, but they do not necessarily lead to effective, holistic management (Ostrom, 1990; Bonzon et al., 2010). Determining whether a TURF, or any fishery for that matter, is successful is inherently dependent on the objectives associated with that particular fishery.

While RBFM, and in particular TURFs, have the potential to curb the decline of overfishing by motivating fishers to stop their race to fish, critics of RBFM contest that exclusive property rights do not guarantee sustainability or stewardship, and that equity and fairness can be questionable or not addressed at all during the process of allocating and establishing rights (Bromley, 2011). Furthermore, there is concern that RBFM may be considered a silver bullet solution, and too often applied where other types management may be more appropriate (Smith et al., 2008; Ban et al., 2008).

In order for any kind of fisheries management to be implemented effectively around the world, it is critical to identify which strategies are most likely to succeed in any given location. To our knowledge, there is no comprehensive analysis that has explored the general hypotheses about TURFs – both positive and negative -- at a global scale, or provided basic summary statistics to understand where TURFs are located and how they operate. We conduct an empirical global analysis aimed at identifying TURFs around the world, determining how they operate, and identifying common trends and patterns. In addition, we explored characteristics associated with effective enforcement and provide a qualitative discussion of the considerable variation observed in TURF management. Fish Forever, a collaboration between Rare, Environmental Defense Fund, and the Sustainable Fisheries Group at the University of California, Santa Barbara, seeks to implement TURFs around the world to address overfishing in small-scale fisheries. The results of this project address several gaps in the published literature on TURFs, which will be a significant contribution to Fish Forever, and our results can be used to inform several pilot TURF programs.

We collected data at levels of resolution ranging from site-specific TURFs to general trends in TURF management at the country level. We collected data by first creating and widely distributing a survey that targeted academics, non-profit personnel, and government officials with first-person information on site-specific TURF information. We also used available databases and the literature for examples of TURF management. In addition to collecting management and design characteristics for individual TURFs, we kept track of physical locations and areal extents where possible.

Through our data collection efforts, we identified TURFs in 41 countries around the world, which we believe is the most comprehensive global cataloging of TURFs. We also identified 11 countries that do not currently have operational TURFs, but are either in the process of developing TURFs (e.g. Algeria, Senegal, Cape Verde, Sierra Leone, Liberia, South Africa), individuals or organizations have expressed interest in instituting TURFs (e.g. Kenya, Mozambique, Colombia, Malaysia), or the countries' government has laws allowing TURFs that are not yet being implemented (e.g. Thailand). Among the 41 countries, we found 11,762 individual TURFs (though 75% of these are oyster leases allocated to individuals along the coast of Louisiana, United States). Specific location data were only obtained for 1,133 TURFs.

We found that TURFs have a widespread geographic distribution, with presence in countries spanning a range of income levels and government stability, indicating that TURFs operate under a diverse suite of governmental settings and locations. Among the 41 countries with TURFs, we identified 66 distinct TURF systems and collected data on 43 of these distinct systems in 33 different countries. Utilizing survey responses and available peer-reviewed and grey literature, in-depth information were gathered for 103 individual TURFs in 29 distinct countries.

What factors drive the success of a TURF? For the purposes of our analysis, success was defined according to a ranking of meeting stated objectives across fishery, conservation, economic, and social categories. An additional analysis was conducted on the TURFs that specifically reported fisheries objectives, using a scale of meeting its stated objective as the criteria for success. When all reported management objectives were considered, co-management was a significant predictor of the likelihood of successfully meeting stated objectives, which is consistent with the predominant hypotheses in the literature (Christy, 1982; Ostrom, 1990; Costanza et al., 1998; Dietz et al. 2003; Evans et al., 2011; Gutierrez et al., 2011; Cinner et al., 2012). While previous studies have examined co-management in fisheries with various management strategies, several researchers have identified trends between co-management and TURFs. In an analysis on co-management and fisheries management strategies, Gutierrez et al (2011) found that among the 130 co-managed fisheries analyzed, those that were TURFs were particularly successful according to their success metric. When we analyzed the likelihood of success in terms of fisheries objectives only, co-management was no longer a significant predictor of TURF success, implying that co-management may be more integral in achieving social or economic objectives. This result, however, may be due to data limitations inherent in our analysis and it should be noted that in many instances, fisheries objectives can overlap or beget other objectives; for example, increasing stock biomass can improve catch size and consequently increase fishery revenues. Achieving these fisheries and economic objectives can in turn achieve social objectives, as livelihoods improve. Despite the interconnectedness of objectives, our results from the statistical analysis on TURFs with stated fisheries objectives differed from the results of the statistical analysis on all forms of management objectives.

Economic theory, supported by empirical evidence, dictates that as a resource user's property rights become more secure, investments in sustainable harvesting are encouraged (reviewed in Costello & Kaffine, 2008). In the case of fisheries, the security of the property right is related to duration of that right, or tenure. A fisher will have a greater incentive to harvest sustainably if they are guaranteed access to potentially higher catches in the future, as fish stocks recover. Our statistical analysis supports this hypothesis, as we found that short tenure length has a negative effect on the likelihood of achieving fisheries objectives specifically. However, through our literature review, we identified several TURF

systems where short tenure lengths may actually be beneficial to the user (MRAG, 2009). Furthermore, it is important to note that there are many ways in which territorial use rights can be granted. Rights to harvest resources in a given area can be granted to individuals or a group, such as a fishing cooperative. In cases where a fishing cooperative is granted a government concession to manage a particular area, there are frequently additional use rights granted to individual fishers within the cooperative. An additional component of our analysis revealed that the level of government involvement in management and the age of a TURF have the greatest effect on the duration of tenure.

Among the seven hypotheses we tested, we did not detect that TURF success was significantly affected by the presence of a no-take zone (NTZ) or the areal extent (size) of the TURF either across all or fisheries-specific objectives. It is posited that as fishing pressure is relieved through the establishment of an NTZ, fish size and abundance will increase inside of the reserve, allowing TURFs to experience spillover effects that directly benefit fishers and additionally compel fishers to comply with spatial closures (Poon & Bonzon, 2013). It is also hypothesized that the size of a TURF will significantly impact success, as many authors have pointed to the effectiveness of smaller TURFs that allow for a clearly identified and exercisable right of exclusion of others and a create a greater sense of ownership over the resources within the territory (Christy 1982). However, in contrast to the previous hypothesis, large TURF size could also be beneficial depending on the life history of the target species. Research suggests that TURFs should be large enough to incorporate larval dispersal patterns (White & Costello, 2011), such that use by others outside of the TURF boundary does not significantly diminish the value of the resource within (Christy, 1982). While these hypotheses describe characteristics that may contribute to effective TURF implementation and management, a significant effect was not seen in our analysis.

We tested what factors are related to TURF areal size, and found that TURFs that manage species with low mobility adult life stages are associated with smaller TURFs. As TURFs are a space-based management mechanism, they are an ideal tool for managing benthic or low-mobility species that are more likely to remain within the boundaries of the TURF throughout their life history. In our analysis on success, our results indicate that TURFs managing low-mobility species are more likely to reach their fisheries objectives. However, even species that are completely immobile in the adult life stage often have expansive larval dispersal patterns. A surprisingly large number of the TURF case studies analyzed specifically managed medium or high mobility species, sometimes in addition to low mobility species.

Additionally, TURFs that are partially bounded by land are hypothesized to be more successful, as it is easier to monitor from shore and exclude outsiders from entering the TURF. In our analyses on success, we used the extent to which a TURF is enclosed within a geographic feature as a proxy for the amount of land boundary. In an analysis examining the direct relationship between geographic enclosure and TURF success, we found that this had a significant effect on success of fisheries objectives specifically. This result was supported by case studies in the literature that identified land boundary as a vital factor in TURF success.

In an analysis that examined the direct relationship between enforcement and TURF success, we found that effective enforcement was highly significant in the likelihood of having a successful TURF. This relationship elicited the need for an analysis to investigate what specifically makes enforcement "effective." We found that the most significant factors in effective enforcement are the kinds of boundary that a TURF has, and what institutions are involved in management. Boundaries that are not explicitly clear have a negative effect on effective enforcement, while co-management was shown to positively contribute to enforcement.

Our project compiled the first comprehensive database of TURF design characteristics and objectives, in addition to identifying the locations of currently operating TURFs around the world. While TURF design may be complex and variable, some of the overarching hypotheses found in the literature about management and success hold true. Our analysis offers valuable insight into key variables that should be considered during the development of a TURF; however, the presence or absence of these characteristics

do not necessarily guarantee success or failure. There are many management solutions that can improve small-scale fisheries around the world, and TURFs will not be appropriate under all conditions.

Analyses aiming to uncover relationships between management interventions and success are limited by scope and the difficulty inherent in comparing systems spanning diverse cultural and ecological landscapes (Poteete & Ostrom, 2008; Evans et al., 2011). Future research should focus on the development of a comprehensive analytical framework. Finally, our understanding of TURF success would greatly benefit from large scale field-based studies.

TURFs offer a viable solution to many of the problems facing small-scale fisheries around the world. While our knowledge of what is necessary for successful implementation is currently limited, our analysis advances the general knowledge of TURFs and reveals some important factors in TURF success. Given more data, more detailed studies can continue to refine this understanding. Such advancements are critical in order to ensure that managers are able to make better-informed decisions in their efforts to reduce habitat degradation, food insecurity, and overfishing worldwide.

1.0 Introduction

1.1 The Issue of Managing Overfishing

Over one third of all assessed nearshore and offshore fisheries are considered overexploited (FAO, 2010) despite extensive efforts to manage global fisheries. Some rigorous fisheries management techniques have yielded positive results for many large-scale fisheries (Costello et al., 2012), but traditional top-down management has proven ineffective for many small-scale fisheries, especially those in developing nations (Wilen et al., 2012). The status of most small-scale fisheries remains unknown even though they comprise the vast majority of total global fisheries. Studies indicate that 64% of small-scale, unassessed fisheries are overexploited (Costello et al., 2012). Currently, small-scale fisheries provide approximately half of all global fish catches and employ nearly 150 million people worldwide (FAO, 2012). As fish stocks continue to decline, human population and seafood demand continues to increase, which threatens the livelihood of hundreds of millions of people that rely on small-scale, artisanal fisheries for food and income (Gutierrez et al., 2011). There is also an estimated $50 billion annual economic loss due to inefficient management, particularly in small-scale fisheries (FAO, 2009).

Diverse management strategies are employed around the world to reduce overfishing. Typical management techniques focus on reducing fishing effort by instituting controls on fishing mortality, such as catch limits, vessel or license limits, fishing seasons, and size restrictions (Wilen, 2006). While this may be a cost-effective management approach that reduces mortality, it incentivizes fishers to capitalize on other means of increasing their fishing effort to improve their catch. For example, if a fishing season is shortened, a fisher may improve the efficiency of their fishing gear with technological improvements to maintain their catch, rendering the effort-limiting restriction of a shortened fishing season ineffective (Pomeroy, no date; FAO, 2002).

Employing a more ecosystem-based management approach, no-take zones (NTZs) are often used to control or eliminate fishing effort to a specific area with the goal of promoting resilient and healthy marine ecosystems (Hilborn et al., 2006; Grafton, 2006). In some cases, marine reserves enhance fisheries by facilitating the protection of key habitat for target species (Grafton, 2006). While these strategies may increase species abundance and biodiversity (Halpern, 2003; Palumbi, 2004; Hilborn et al., 2006), they do not alter the incentives of fishers and do not necessarily eliminate the race to fish (Grafton, 2006).

1.2 Rights Based Fisheries Management

Overexploitation is often attributed to a lack of property rights (Gordon 1954; Hardin, 1968). The "open access" conditions of a fishery generate perverse incentives that encourage misuse even under strict regulation, as fishers are compelled to exhaust the resource before another fisher exhausts it (Gordon, 1954). Within the last several decades, Rights-Based Fisheries Management (RBFM) has emerged as a management technique capable of incentivizing sustainable resource use (Christy, 1982; Cancino et al., 2007; Uchida et al., 2011; Gelcich et al., 2008; Wilen et al., 2012). Sometimes referred to as catch shares, RBFM provides fishers with the exclusive right to extract marine resources while actively excluding unauthorized users (Wilen et al., 2012). With secure access, or property rights, fishers have an incentive to protect resources in order to maximize the benefits of future returns (Grafton et al., 2006). Thus, in contrast to open access, RBFM can dramatically improve the revenue of a fishery while providing numerous ecological benefits (Wilen et al., 2012).

There are three widely used forms of RBFM: Individual Transferable Quotas (ITQs), fishing cooperatives, and Territorial Use Rights in Fisheries (TURFs). Fisheries utilizing ITQs grant individuals the right to harvest a specific species according to a biologically determined catch limit (Arnason, 2012). ITQs offer the advantage of economic efficiency (Yagi et al., 2011), but because they are generally allocated uniformly over space and time, they are not easily applied to multi-gear, multi-species fisheries

(Wilen et al., 2012; Cancino et al., 2007). Cooperatives on the other hand, do not assign use rights to individuals but rather a well-defined group of fishers (Deacon, 2012). Cooperatives allow members to collectively design and coordinate various aspects of fisheries management and have proven to be a diverse and effective management strategy (Deacon, 2012; Ovando et al, 2013). Unlike ITQs and cooperatives that manage harvesting rights to a particular species, TURFs allocate exclusive use rights within a clearly defined spatial boundary (Cancino et al., 2007; Wilen et al., 2012). These RBFM strategies are not mutually exclusive and can be applied separately or in combination, providing tremendous flexibility when applying RFBM to local conditions.

1.3 Territorial Use Rights in Fisheries

Territorial Use Rights in Fisheries (TURFs) assign access to the use of a geographic area through a space-based rights structure. TURFs are capable of internalizing many of the externalities left unaddressed by other rights based management systems such as ITQs, allowing TURFs to facilitate the recovery of overexploited fisheries and manage the environment for long-term sustainability (Wilen et al., 2012; Cancino et al., 2007). While many researchers have offered loose definitions for a TURF (Christy, 1982), there is no clear, single definition available (Spagnolo, 2012). For the purposes of this analysis, we define a TURF as an area in which individual or communities are given some level of exclusive access to marine resources within a defined boundary (Box 1).

Box 1. Definition of TURF Used in Study
An area in which individuals or communities are given some level of exclusive access to marine resources within a defined boundary.

Traditionally, many fishing villages defended their territories to ensure exclusive access to their vital marine resources. While these customary TURF-like systems (see Box 2) have been in place for centuries, many countries are just now beginning to incorporate territorial use rights into formal fisheries management laws (Christy, 1982; Cancino et al., 2007; Spagnolo, 2012). Although government involvement varies considerably, TURFs are often managed in accordance with local needs, allowing managers and community members to develop site-specific regulations based on local knowledge and customs. For this reason, TURFs have become an increasingly popular management strategy. They are often thought of as a tool to empower local communities by encouraging active participation in management, fostering a sense of stewardship, and even providing new sources of revenue and income (Christy, 1992). The observed success of traditional marine tenure implies that TURFs can generate incentives for fishers to assume responsibility for the impacts of overexploitation as well as the benefits of conservation.

1.4 TURF Hypotheses in the Literature

Despite the widespread implementation of TURFs around the world, it is still unclear what factors contribute to their effectiveness. TURFs are most frequently characterized as small-scale fisheries, which are typically resource and data limited. Most of the studies conducted on TURFs thus far have focused on systems in a few countries or geographic regions, such as Japan, Chile, or Oceania. Nonetheless, based on anecdotes, first principles, and models, researchers have identified several overarching design characteristics that are purported to contribute to effective TURF implementation and management. Here we present several common hypotheses relating to successful TURF management.

In order for TURFs to be successful, members must receive benefits not realized by non-members.

Simply assigning property rights for a given area to a user group does not necessarily preclude non-members from receiving equal benefits (Uchida et al., 2011). Poor enforcement or excludability

mechanisms can easily erode any preferential benefits of membership if non-members are not adequately prevented from poaching. Even with effective exclusion, property rights in and of themselves do not ensure that members will experience benefits greater than the status quo (i.e. the situation prior to property rights assignment). Proper incentives must be in place in order for member fishers to clearly perceive direct benefits from their actions on the state of the resource and future profits (Uchida et al., 2011). Once appropriate steps are taken to provide clear evidence of privilege associated with membership, the TURF will effectively manage the resource.

TURFs require effective internal governance capable of resolving common pool, distributional, and enforcement effects within the TURF.

In cases where a cooperative or community group are granted use rights to a specific marine area, the cooperative is effectively forced to accept a system-wide perspective in order to manage the entire ecosystem within the defined area (Wilen et al., 2012). However, assigning rights to a group produces internal coordination costs that produce collective-good externalities. In order to overcome these externalities, sufficient internal governance is required (Wilen et al., 2012). In principal, internal governance can arise from either top-down or bottom-up processes, but it is presumed that bottom-up management will more effectively establish self-governance rules that meet local needs and encourage local buy-in (Wilen et al., 2012).

TURFs that are co-managed equally by fishers and government are likely to be more successful.

Co-management is often pointed to as a solution to many of the world's fisheries problems, as fishers, scientists, and governments can effectively cooperate in the management of fish stocks to prevent the tragedy of the commons (Ostrom, 1990; Costanza et al., 1998; Dietz et al., 2003; Evans et al., 2011). Local knowledge, adaptive capacity, and engaged participation by fishers can be bolstered by the legal and institutional capacity of governments capable of overseeing and enforcing the territory (Gutierrez et al., 2011; Christy, 1982). This interplay between local-level knowledge and governmental capacity is often highlighted as being critical factors in TURF success and is supported by individual case studies of co-management success across a range of ecological, economic, and social conditions (Ostrom, 1990; Costanza et al., 1998; Dietz et al., 2003; Gutierrez et al., 2011). However, other empirical evidence suggests that co-management policies can also lead to reduced resilience in traditionally managed marine ecosystems (Gelcich et al., 2006). Effective community-based governance is believed to be most frequently associated with bottom-up mechanism as opposed to top-down institutional processes (Wilen et al., 2012). In this way, developing nations that lack top-down governance may be more likely to favor TURF development (Wilen et al., 2012).

TURFs that assign use rights for a longer period of time are likely to be more successful.

Economic theory dictates that as a resource user's property rights become more secure, investments in sustainable harvesting are encouraged (reviewed in Costello & Kaffine, 2008). Therefore, use rights (henceforth referred to as tenure) need to be allocated for a sufficiently long period of time such that fishers are able to see returns on their investments towards sustainable fishing practices (Costello & Kaffine, 2009). Shares allocated in perpetuity and/or for long periods of time with a strong assurance of renewal will produce secure rights believed to encourage sustainable fishing practices (Wilen et al., 2012; Poon & Bonzon, 2013).

TURF management is most appropriate for fisheries targeting lower mobility species.

Area-based management approaches are ideal for benthic and sedentary species such as shellfish (Defeo & Castilla, 2005). Since adult movement is limited beyond the boundaries of the TURF, fishers can internalize long-term benefits associated with responsible fishing practices. TURFs are particularly suitable for stocks that consist of "smaller micro-stocks" (Prince, 2003), where fishers can aptly track fishing impacts on the resource inside the TURF, and internalize most of the long-term benefits of conservation behaviors (Poon & Bonzon, 2013). Targeting lower mobility species allows

the TURF to cover more of a species' range, conferring more secure property rights over the resource and encouraging sustainable fishing practices (White & Costello, 2011).

TURFs with no-take zones are more likely to be successful.

The benefits of pairing TURFs and reserves or no-take zones are increasingly lauded in the literature as an effective mechanism to increase catch and fish size (Perez de Oliveira, 2013; Afflerbach et al., in progress). As fishing pressure is relieved, fish size and abundance typically increases inside of a reserve area allowing neighboring TURFs to experience spillover effects that directly benefit fishers (Halpern, 2003). As fishers observe the benefits associated with no-take reserves, fishers may be more compelled to comply with and self-enforce spatial closures, effectively reducing external enforcement costs (Poon & Bonzon, 2013). In cases where coordination among TURF users is incomplete, strategically placed marine reserves between TURFs can avert spatial externalities by buffering the impacts of adjacent TURFs, therefore increasing fishery profit and abundance while reducing conflict (Costello & Kaffine, 2010). The proximity of reserves to TURFs will determine the benefits to TURF-users given that the effects of adult fish spillover are local (Halpern et al., 2010).

Physically larger TURFs are less successful as a result of increasing enforcement difficulty.

Several authors have pointed to the effectiveness of smaller, localized, and distinguishable TURFs in fisheries management, as they allow for a clearly identified and exercisable right of exclusion of others. Smaller TURFs also create a sense of ownership over the resources within the territory and the benefits gained (Christy 1982). Indeed, a relatively small size and scale has emerged as a "key design principle or contributing factor toward successful local-level or community-based management of the commons" (McCay et al., 2014), especially across vast coastlines.

TURFs that encompass the entire geographic extent of the target species' life history range are more successful.

In contrast to the previous hypothesis, large TURF size can be beneficial depending on the life history of the target species. Research suggests that TURFs should be large enough to incorporate larval dispersal patterns (White & Costello, 2011), such that use by others outside of the TURF boundary does not significantly diminish the value of the resource within (Christy, 1982). Indeed, TURFs that are too small can reduce stock ownership to near zero as the benefits of sustainable fishing within the area are not fully internalized by TURF owners. The area should nonetheless be demarcated, identifiable, and defensible (Christy, 1982), and so exceedingly large TURFs can lose value as they become too logistically complicated and expensive to enforce.

TURFs lacking physical geographic enclosure are less likely to be successful.

A clearly defined and defensible TURF boundary is typically associated with improved compliance and enforcement because the territory is easily identified and monitored (Christy, 1982). Boundaries can be delineated by public knowledge, buoys, or distinctive land features, but it can be difficult for outsiders to recognize TURF boundaries when restrictions are not clearly publicized. Additionally, large TURFs bounded by offshore buoys may not be easily monitored from shore, requiring additional investment in off-shore patrols (Wilen et al., 2012). In contrast, land features can create very clearly defined and easily enforced TURF boundaries. TURFs located within enclosed geographic features such as bays, coves, lagoons, or straits have fewer boundaries exposed to open water. Therefore, TURFs located in well-enclosed areas are expected to be easier to monitor and enforce compared to TURFs located on open coastlines (Wilen et al., 2012).

TURFs with effective enforcement are more likely to be successful.

Effective enforcement is widely recognized as being critical to the success of TURFs by ensuring that the exclusive use-rights are secure (Villena & Chavez, 2005; Poon & Bonzon, 2013). Enforcement can occur through a legal framework, as with direct government involvement, but may also be carried

out by other social institutions such as self-regulation by fishers and adherence to social norms and pressures (Lobe & Berkes, 2004; Satria & Adhuri, 2010; Cinner, 2005; Uchida & Baba, 2008). Effective enforcement likely depends on the spatial and socio-ecologic conditions in which the TURF is implemented and will be most effective when it is in the fishers' self-interest to comply with all rules (Christy, 1982).

1.5 TURF Success

As exemplified in the above hypotheses, there is a spectrum of assumptions in the literature concerning the variables responsible for a TURF's success, some of which conflict with one another. Testing the validity of these hypotheses is challenging due to an unclear understanding of what success is and how it is measured.

The socio-ecological and economic theories of collective governance may provide useful insight into factors that can be attributed to TURF success (Ostrom, 2009). These factors may include the size of the cooperative, the degree of social cohesion, leadership, education, the equal allocation of rights within a community, the type of resource (i.e. sedentary), and the presence of protected areas, among others (Ostrom, 1990; Ostrom, 2009; Gutierrez et al., 2011). Many of these factors are purported to generate biologically, economically, or socially 'successful' TURFs, however implementing any one or all of these factors does not always lead to meeting TURF objectives.

Beyond the social metrics associated with cooperative management, there is a host of traditional biological and economic metrics used to define successful fisheries. For instance, fisheries are often considered biologically or ecologically successful if management is able to prevent overexploitation, allow stock recovery, prevent or reduce by-catch, or protect important habitat (Poon & Bonzon, 2013). Economic goals often include increased profits or revenue, cost reductions, or job growth (Poon & Bonzon, 2013). However, the complexity of factors affecting TURF management may result in conflicting definitions of success. For instance, a TURF may provide substantial improvements in fish stocks and ecosystem health, but communities may suffer from inequitable distribution of rights leading to deleterious social conflicts.

Determining whether a TURF, or any fishery for that matter, is successful is inherently dependent on the objectives associated with that particular fishery. Conventional wisdom suggests that TURFs are primarily designed to fulfill fisheries goals, but this is not always the case. For instance, in the Indo-Pacific a long history of customary marine tenure does not necessarily coincide with well-formed fisheries objectives (see Box 2 for further explanation). In some cases, users will strive to maximize net economic revenue, while others may strive to attain social objectives such as to maximize employment opportunities (Christy 1982). Objectives related to TURF management vary significantly over fisheries, conservation, economic, and social goals (see Table 1 for a sample of representative management objectives).

Table 1. A sample of management objectives of TURFs

TURF Name	Objectives	Reference
Port-Cros National Park (prud'homie de Le Lavandou, France)	"…with the aim of preserving the area's natural heritage (by protection and restoration), promoting scientific research, educating the public, and serving as an example (e.g. conservation management) and reference site."	(Cadiou et al., 2009)
Prud'homie de Cannes, France	"To organize the fishers to defend themselves from the aristocracy."	(Arceo et al., 2013)
Hamaguri Clam Fishery in Ibaraki Prefecture, Japan	"Originally… to manage conflicts over fishing grounds, to stabilize market prices, and to sustain income from fishing. In the early 1980s, the central and prefectural governments promoted such bottom-up, local level management as a way to achieve resource conservation as well as social and economic sustainability of commercial fisheries at the local level."	(Takahashi et al., 2006)
Integrated Fisheries Foundation, Netherlands	"By spreading the economic risks posed by limited availability of fisheries resources over several species that require different gears, the IFF hopes to avoid intensive capital investments in high-tech vessels and gears and to maintain low-impacts on marine ecosystems."	(Grieves, 2009)
Os Miñarzos Marine Reserve of Fishing Interest, Lira Cofradia, Spain	"To protect and favour the regeneration of fishing resources." "To promote artisanal fishing and sustainable development." "To promote this fishing and environmental values of the Galician coast." "To facilitate the development and application of fisheries management models, with the participation of fishers and shellfishers in their design and implementation." "To conserve and protect the flora and fauna of the marine environment and their diversity." "To encourage environmental awareness about the marine environment."	(Perez de Oliveira, 2013)
Koster-Väderö Fjord Shrimp Fishery, Sweden	"The stated aims of the national park include long-term protection and conservation of the area's marine ecosystems, habitats, and species while ensuring sustainable use of the area's biological resources."	(Kvarnback & Liljenstrom, 2010)
Surveys of 6 Fijian villages	Conservation of fishery resources, raising community funds, ceremonial purposes, and the closure of traditional fishing grounds to non-native fishers (Indo-Fijian).	(Anderson & Mees 1999, Govan, 2009)
Ben Tre Clam Fishery, Vietnam	Develop a sustainable clam fishery that effects protection of broodstock and effective exploitation of the resource.	(Luu et al., 2010)
Unionpadu (Shared for 4 total padus in padu system), Kerala, India	Social: "redistribute the catch fairly among fishers." There are goals for "equity." Establish "collective responsibility for (padu) maintenance," and "provide mechanisms for conflict resolution and rule making." Economic: "Fishers want to cash in on profits from the lucrative shrimp fishery."	(Lobe & Berkes, 2004)
Huentelauquén, Chile	Formally: Sustainable "Loco" Fishery: Huentelauquén applied the AMERB for their traditional activity, the fishery of *Concholepas concholepas* ("loco"), in accordance with the official objective of the AMERB. Due to reduced catches of loco, fishers also added the collection of kelp, using their AMERB to control access to the entire coast surrounding their fishing community, beyond the limits of their AMERB. Informally: A clear expectation to gain new sources of income. In time, is used as a tool for territorial exclusion of other fishers beyond limits of respective AMERBs.	(Aburto et al., 2013)
Puertecillo, Region VI, Chile	MEABR policy was first formulated in the early 1990s ''to find mechanisms that would reverse the generalized overexploitation of benthic resources in Chile'' (G. San Martin personal communication).	(Gelcich, 2006)

Box 2. Customary Marine Tenure and TURFs

Territorial use rights have long been applied in many indigenous communities under institutions commonly referred to as customary marine tenure (CMT). Ruddle et al. (1992) notes CMT can be defined as the following: *"In 'customary marine tenure,' 'customary' refers to an institution that has continuous links with the past as it adapts to handling contemporary issues; 'marine' refers to the institution as dealing with reef, lagoon, coast, and open sea, including islands and islets within this overall seaspace; and 'tenure' refers to a social process of activities in maintaining control over territory and access to resources (Hviding 1989; 1991)."*

CMT is a common way of managing marine resources, particularly in traditional fishing communities in the Pacific Islands (Johannes, 2002). Communities often institute exclusive access to fishing grounds, coupled with management tools that may involve spatial or temporal fishing closures in certain areas under the term, "taboo" (though the name varies depending on the cultural group) (Govan, 2009). Pacific Island communities have described relationships between people and their land and sea using words that imply the "duty of care that people have for each other, future generations, and the environment," such as *vanua* (Fiji), *fenua* (Tuvalu), *enua* (Cook Islands), and *puava* (Marovo, Solomon Islands) (Govan, 2009).

Research on CMT, coupled with theory on property rights, has helped lay the groundwork for present day TURF theory as a means to help sustain fisheries. While "CMT" and "TURF" have sometimes been used interchangeably, many argue that the two management regimes are in fact quite different from one another. Ruddle et al. (1992) note that the CMT concept "goes beyond the implication of such concepts as TURF, that the utilization of fishery resources is the only concern of such institutions." Some posit that studies on whether traditional management regimes are meant to conserve resources are inconclusive, as evidence suggests that pre-colonial Pacific Islanders significantly depleted terrestrial and marine resources, while others suggest that resource shortages made island communities aware of their ability to deplete resources and therefore develop conservation practices that regulate use (Cinner, 2005).

The history of CMT institutions in the Pacific Islands is complex, as many traditional resource management strategies were eroded in the 20th century due to impacts of colonization and centralization from western economic and governance models (Johannes, 1978; Govan, 2009). As of the late 1990s, however, newly formed management systems - commonly referred to as "Marine Management Areas" (MMAs), Community Conservation Areas (CCAs), or Locally Managed Marine Areas (LMMAs) - represent a resurgence of traditional management approaches. A perceived potential to meet both conservation and community goals has led communities, governments, and NGOs to revitalize CMT approaches as an integral part of national and regional marine conservation planning (Johannes, 2002; Cinner, 2005).

The South Pacific has seen MMAs increase in the last decade in at least 500 communities spanning 15 countries and territories, with management strategies ranging from traditional regimes to complex multi-stakeholder structures involving government agencies and NGOs (Govan, 2009). Many of these systems are referred to as Locally Managed Marine Areas (LMMAs), however the names span a variety of acronyms depending on the sponsor and region (e.g. VBRMA, CBRM, CBFM, VFMP, etc.) (Govan, 2009). The objectives of these protected areas are diverse, however Govan (2009) suggests that the main goal is in a community's desire to "maintain or improve livelihoods, often related to perceived threats to food security or local economic revenue." Depending on the support of legislation in a given country, MMAs may incorporate varying levels of government involvement. While some systems involve the reintroduction or reinforcement of exclusivity in access to marine resources, not all MMAs utilize this strategy. As such, while most LMMAs involve some form of "managed access" regime, not all LMMAs necessarily operate as TURFs, as levels of exclusivity in management are highly variable depending on country, region, and/or community-level decisions, traditions, and feasibility.

1.6 Criticisms of RBFM

While RBFM and TURFs specifically have the potential to curb the decline of overfishing by motivating fishers to stop their race to fish, there is still some general criticism against RBFM. There is concern that exclusive property rights do not guarantee sustainability or stewardship and that equity and fairness is questionable when establishing rights (Bromley, 2011). The potential for lowered fishing capacity may also result in fewer jobs and less income distribution for fishers (Bromley, 2011). Pomeroy (no date) raises the concern that rights-based management may amount to the substitution of private interests for public interests.

Although RBFM can be applied in a number of different ways, some remain concerned that RBFM is often considered a silver bullet solution, and can neglect to incorporate other complementary management techniques (Smith et al., 2008; Ban et al., 2008). Some of the main causes of unsustainable fishing practices include inappropriate incentives, high demand for limited resources, poverty, limited knowledge of the biology of the fishery, ineffective governance, and interactions between fishery sectors and other aspects of the environment (Hannesson, 2002; FAO, 2002). In some instances, RBFM alone may not address all of these factors, especially socio-economic issues that require the resources, time, and political changes that are beyond the scope of fisheries management (Allison et al., 2012). Bromley (2011) advocates that instead of allotting use rights to fishers, overfishing should be addressed with traditional effort and mortality controls that are accompanied by more strict rules and sanctions that limit effort to sustainable levels.

1.7 The Need for a Global Analysis of TURFs

For fisheries management to be effective and extrapolated globally, it is critical to identify which strategies are most likely to succeed under any given set of circumstances. To our knowledge, there is no comprehensive analysis that has explored the general hypotheses about TURFs – both positive and negative – at a global scale. Similarly, few studies have provided basic summary statistics to better understand where TURFs are located and how they operate. Thus far, the conversation about TURF management has been broad and hypothetical, predominantly drawing from economic theory and specific case studies about a handful of TURFs.

While the body of literature on TURFs is growing, few have attempted to compare TURFs systems from around the world. Those that have tend to focus on specific regions or specific components of TURF management. For instance, numerous studies have investigated how TURFs compare to other forms of RBFM (Yagi et al., 2012; see Costello 2012). Others have focused comparisons on the two best-studied TURF systems, Japan and Chile (Cancino et al., 2007; Wilen et al., 2012). Still others have highlighted a sub-set of case studies within a specific geographic region (Pomeroy et al., 2001; Nielsen et al., 2004; Cinner 2005; Lobe & Berkes, 2004; Govan, 2009; Spagnolo, 2012). Those that have attempted to analyze TURFs, and TURF-like systems, globally have focused specifically on TURF reserves (Afflerbach et al., in progress), TURFs in developing nations (Jardin & Sanchiro, 2012), cooperatives (Ovando et al., 2013), and co-management fisheries (Guitierrez et al., 2011). There is still a limited understanding about where TURFs are located, which design characteristics, if any, are common among TURFs, and under which circumstances TURFs are successful at a global scale.

This study conducts an empirical global analysis aimed at identifying TURFs around the world, determining how they operate, and identifying common trends and patterns. Specifically, this study explores characteristics associated with management success, as defined by the ability of TURFs to meet their stated management objectives. While we are unable to address all of the assumptions commonly cited in the literature, this analysis does test several predominant hypotheses related to management success. Using a broadly distributed survey and available peer-reviewed and grey literature, we tested seven hypotheses (Table 2).

In addition, we explored characteristics associated with the effectiveness of enforcement and other attributes of TURFs. Using information gleaned from the literature review, we provide a qualitative discussion of the considerable variation observed in TURF management.

Table 2. Summary of predominate TURF hypotheses

Hypothesis	Justification from Literature
TURFs that are co-managed equally by fishers and government are more likely to be successful.	Local knowledge, adaptive capacity, and engaged participation by fishers can be bolstered by the legal and institutional capacity of governments capable of overseeing and enforcing the territory (Gutierrez et al., 2011; Christy, 1982).
TURFs with longer duration of tenure are likely to be more successful.	Property rights are more secure when access to a resource is allocated for a sufficiently long period of time that fishers are able to internalize the long-term benefits of sustainable fishing practices, encouraging stewardship of the resource (Poon & Bonzon, 2013)
TURFs are more successful for fisheries targeting lower mobility species.	Area-based management approaches are ideal for benthic and sedentary species (Defeo & Castilla, 2005). Targeting lower mobility species also allows the TURF to cover more of the range of a species, conferring for more secure property rights over the resource, which also encourages sustainable fishing practices (White & Costello, 2011).
TURFs with no-take zones are more successful.	Fish size and abundance typically increases inside of a reserve area allowing neighboring TURFs to experience spillover effects that directly benefit fishers (Halpern, 2003).
TURFs lacking physical geographic enclosure are less likely to be successful.	Land features can create very clearly defined and easily enforced TURF boundaries. TURFs located within enclosed geographic features such as bays, coves, lagoons, or straits have fewer boundaries exposed to open water. Therefore, TURFs located in well-enclosed areas are expected to be easier to monitor and enforce compared to TURFs located on open coastlines (Wilen et al., 2012).
Physically larger TURFs are less successful as a result of increasing enforcement difficulty.	Smaller TURFs allow for a clearly identified and exercisable right of exclusion of others. They can also create a sense of ownership over the resources within the territory and the benefits gained (Christy 1982).
TURFs with effective enforcement are more likely to be successful.	Effective enforcement is widely recognized as being critical to the success of TURFs by ensuring that the exclusive use-rights are secure (Villena & Chavez, 2005; Poon & Bonzon, 2013).

1.8 Project Significance: Fish Forever

This project will be a significant contribution to Fish Forever by addressing important areas of research that have thus far remained relatively unexplored. Fish Forever is a collaboration between the University of California, Santa Barbara Sustainable Fisheries Group, Rare, and the Environmental Defense Fund (EDF) that was developed with the goal of implementing TURFs around the world. This research will allow for improved communication among stakeholders, provide Fish Forever with a report that evaluates the characteristics and design features of TURFs, and explore how TURFs contribute to improvements in fisheries management.

Additionally, our results may be used to inform several pilot TURF programs. While Fish Forever specifically seeks to help communities establish TURF-reserves (TURFs that include no take zones [NTZs] in their design), our research will serve to better understand the efficacy and complexity of all TURFs, regardless of whether they include an NTZ. Doing so will establish a more comprehensive

analysis that allows for a better understanding of factors and design components associated with TURF success.

2.0 Methods

2.1 Data Collection

Data were gathered at various levels of resolution, including country-level, TURF system-level, and the individual TURF case-study level. We first identified countries that have at least one functioning TURF. These data were gathered through literature review, survey distribution, and personal communication. Countries were also identified by reviewing supplementary databases provided by EDF and researchers (Afflerbach et al., in progress; Ovando et al., 2013). Relevant grey and peer-reviewed literature as well as government and non-government organization websites were identified through general Google, Google Scholar, and Web of Science searches. Keywords varied dependent on the country and region, but generally included the country's name and terms such as "TURFs", "territorial use rights", and "customary marine tenure". In some cases, despite targeted searches, we were unable to identify TURFs in certain countries (e.g. China, Russia, Argentina, etc.); however, this does not necessarily imply TURFs are not present in these and other countries not identified in this analysis.

Once all known countries containing TURFs were identified, country-level data were obtained from various international databases for all sovereign nations. For each country, we obtained per capita Gross National Income (Atlas method), World Governance Indicator scores, and income level from the World Bank, in addition to Human Development Index scores from the United Nations Development Programme, and the length of each country's coastline from the United States Central Intelligence Agency World Factbook. While additional country indicators are available, we focused our analysis on these indicators for numerous reasons. GNI was chosen as an economic indicator, as opposed to similar indicators such as Gross National Product, because the World Bank uses per capital GNI to define a country's development status (i.e. high versus low income). The World Bank annually generates an assessment of six unique World Governance Indicators (WGI), which provide a standardized metric to assess multiple governance characteristics. Other indicators that assess governance are not as easily standardized among countries and across indicators. The Human Development Index (HDI) was chosen because it is a frequently reported metric that may be useful for comparisons with the available literature. Finally, we included the length of each country's coastline as a country-level indicator because this variable varies widely among countries and may be an important determinant in TURF size and the number of TURFs present in a given country. In all cases 2012 estimates were used, except in rare cases where a 2012 estimate was not provided, in which case the next most recently available estimate was used. TURFs also exist in non-sovereign territorial states such as American Samoa and Taiwan; these territories were excluded from analysis whenever territory specific data was not available.

For the purposes of this analysis, we define TURF systems as one or more TURFs that operate under a similar management structure or legal framework. Many countries have multiple systems that operate independently of one another. Therefore, simply discussing TURFs at the country-level is not sufficient to understand the full complexity of how TURFs operate in any given country. Using government websites and available peer-reviewed and grey literature, we gathered system-level data on 43 distinct systems in 33 countries (Table 3).

Data for this project were collected in a two-pronged method – 1) we created and widely distributed a survey, and 2) we utilized available databases and the literature for case-studies on TURF management. For supplemental information and support, we conducted a handful of targeted first-person interviews with fisheries experts having a comprehensive understanding of a specific TURF and managed region. From our data collection efforts, 103 TURF case-studies were outlined for use in this study. To help

facilitate literature review, supplementary information from EDF, Ovando et al. (2013), and Afflerbach et al. (in progress) were used. We collected 19 useable survey responses (Figure 1).

2.1.1 Survey

2.1.1.1 Survey Design

During our initial literature review, we identified significant gaps in the published literature and biases in readily available case studies. For example, TURFs that were primarily discussed in detail are skewed towards Japanese and Chilean fisheries. To gain a more comprehensive understanding of trends in TURF management and design, we developed a survey to glean information from unpublished sources, specifically individuals with first-person involvement with a particular TURF.

The survey was guided by the following initial research questions developed in Spring 2013:

1. Do most TURFs measure success in terms of ecological, social, or economic objectives?

2. Are there certain design and management features or characteristics shared by TURFs?

3. Do fishers engage in cooperative behaviors?

4. What enforcement mechanisms are effective at maintaining exclusive access among defined users?

The initial draft survey sought information on TURF design and management characteristics, user rights, measures of success, enforcement, fisher behaviors, as well as general information about the respondent for quality assurance and control purposes. This draft was sent out to ten experts in our network for revisions and suggestions. Most of the recommendations suggested making the survey as short as possible to increase prospective responses. Although we reduced the number of survey questions as recommended, the final version had a total of 55 multiple-choice and fill-in-the-blank questions and required approximately thirty minutes for a respondent with intimate knowledge of the TURF to complete.

The survey was also designed to comply with the Human Subjects Protocol required by the Office of Research at the University of California, Santa Barbara. To comply with the protocol, our survey did not ask any personal information beyond name, type of involvement in the TURF, and e-mail address to potentially follow up with questions. When the survey was approved by the Office of Research, we transcribed the survey questions into SeaSketch, an online platform with a GIS component enabling respondents to provide spatial information by drawing polygons as a component of completing the survey. Another version translated by a native Spanish speaker was also posted onto SeaSketch.

2.1.1.2 Survey Distribution

Our survey specifically targeted academics, non-profit personnel, and government officials with site-specific information on TURFs. We identified three methods to reach these audiences including: 1) e-mailing our direct network of fisheries contacts using snowball sampling to further distribute to their contacts; 2) identifying academics from the literature with information and contacts useful to our study and having a 15-minute phone conversation asking them to take our survey and help us with distribution; and 3) advertising our survey on the web on a variety of outlets including Listservs, Linked-In groups, Twitter, and various other websites by forming collaborative relationships. Two weeks after initial contact was made, a follow up e-mail was sent to encourage participation in the survey.

In order to contribute spatial data for our research, respondents were required to create an account with SeaSketch to take our survey. The survey was available in English and Spanish, and could accommodate information-sharing for someone with information on one or multiple TURFs. In the event that creating an account with SeaSketch deterred people from taking our survey, we also created a version of our survey through Adobe FormsCentral, which did not require a sign-in and did not collect spatial data, but collected answers to all other survey questions.

We incentivized our respondents to take our 30-minute survey by offering an entry into a random drawing for one of two prizes as well as a guaranteed $5 for every TURF entered in the survey. Prizes included a $100 cash prize and registration to the Second World Small-Scale Fisheries Congress in Merida Mexico, an over $300 value, provided by the research network, Too Big To Ignore. Survey data collection lasted from October 18th, 2013 until January 15th, 2014, although surveys had to be completed by December 31, 2013 to be eligible for the prize drawing.

For help with survey distribution within the academic community, we contacted fisheries experts (e.g. H. Uchida, N. Pascal, S. Jupiter, etc.) via e-mail and phone calls and encouraged them to disseminate the survey to their list of relevant contacts.

2.1.1.3 Survey Response

Once a survey was completed, a point person completed our quality assurance and control (QA/QC) procedure, by verifying response information and contacting respondents with follow-up questions concerning unclear or missing information. All responses were backed up on a password-protected computer. Responses were then entered into a centralized database where data from other collection methods would also be stored.

If a survey respondent chose to be paid $5 for every TURF entry, payment was made via PayPal or the United States Postal Service within five business days of the response. As a courtesy to all those who have contributed data or helped distribute our survey, an additional email will be sent out to announce the launch of our interactive map of TURFs hosted on our website, DiscoverTURFs.com.

2.1.2 Literature Review

While disseminating our survey, we also conducted a search of the published literature to supplement survey responses, given the time constraints of our project. In addition to our extensive searches in Google Scholar and Web of Science, Ovando et al. (2013) and EDF Catch Share Design Center helped to identify relevant literature. We utilized our survey as a framework for deriving information from the literature to standardize data collection as much as possible and to ensure it was as consistent as possible with the survey responses.

The data gathered from the literature have many caveats when compared to the data collected from the survey, including:

- Survey respondents indicated that they were well acquainted with a particular TURF, and usually had first or second hand experience with the TURF. Data collected from the literature was a third-person interpretation of a particular author's first or second hand account of the TURF.
- Most survey respondents were involved in fisheries disciplines, whereas the literature we utilized was written by authors of a broader range of disciplines. For example, some case studies used for site-specific data were written by sociologists, government agencies, conservation ecologists, and economists. The author's discipline thereby affected their perspective of subjective qualities of a particular TURF, especially in prioritizing TURF objectives and if the TURF was meeting those objectives sufficiently.
- Our own interpretation of the literature may be biased. Although we worked together to decide which data to collect, the literature on TURFs often expounded on the nuances of management. It is highly unlikely that any two team members would read the same paper and fill out our survey framework with exactly the same answers. Furthermore, data collection efforts were divided into regions, and each team member was responsible for gathering data from their respective region. The purpose of this was to allow team members to recognize trends in each region and allow for more accurate QA/QC of survey responses in their region. If we had enough data to include regions as a possible variable in our regressions, this would allow us to control for potential regional effects and personal biases. However, we were unable to include this as possible predictor

variable as it required the estimation of too many coefficients to be included in any regression models. Furthermore, we were reluctant to include inferential data regarding subjective information when collecting the data from the literature. Information on subjective variables, such as level of TURF success, were only included if explicitly stated in the literature.

For supplemental information, a handful of interviews were conducted with fisheries experts (e.g. H. Uchida, N. Pascal, S. Jupiter, etc.). Experts were contacted via e-mail and engaged in a 15-minute conversation. These interviews sought information on site-specific TURFs and country-level TURF characteristics.

Finally, some site-specific data were also gathered from supplementary information provided from Afflerbach et al. (in progress). We retrieved information for relevant variables directly from the database and also obtained information for other variables of interest from the literature cited in the database.
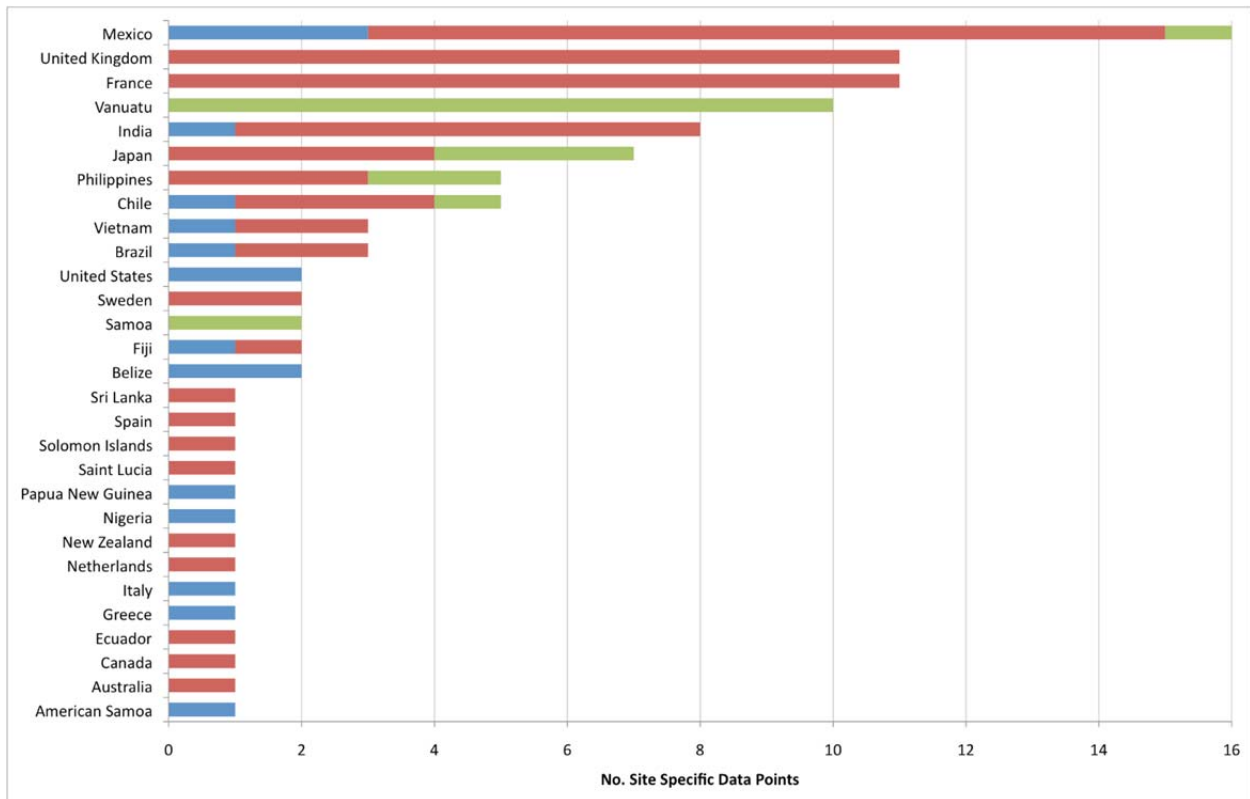
Figure 1. Site-specific data collected by source type
Red bars indicate data collected from literature, green bars indicate data collected from Afflerbach et al. (in progress), blue bars indicate data collected from SeaSketch survey.

2.1.3 Spatial Data

In addition to collecting management and design characteristics for individual TURFs, the physical location and areal extent was also obtained where possible. Spatial data were gathered from multiple sources using various media. Surveys taken in SeaSketch allowed users to draw either a point or polygon to represent the physical location of a given TURF; these files were downloaded from the SeaSketch server and converted to ArcGIS shapefiles. Spatial files were also gathered from government websites and personal contacts when available. The Chilean[1], Brazilian[2], New Zealand[3], and Galician (Spanish)[4]

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[1] *Subsecretaria de Pesca y Acuicultura. Gobierno de Chile* (Chilean Government). http://www.subpesca.cl/servicios/603/w3-article-79986.html

governments all host websites displaying downloadable spatial data with TURF locations. In some cases, individuals familiar with our survey sent relevant GIS files (e.g. FEDECOOP TURF group in Baja, Mexico[5] and Quintana Roo TURF group in Yucatan, Mexico[6]). Finally, paper maps from the literature were used to create electronic spatial files by either creating a Keynote Markup Language (KML) file of the approximate location using Google Earth or georeferencing the image in ArcGIS (see Section 2.1.3.1).

While data were collected at varying levels of spatial resolution, all data were standardized to a single point representing the location of the TURF (if data were available as polygons, the point was drawn in the center of the polygon). A total of 1,133 points were identified in 32 countries (Table 3). These points represent the number of TURFs with available spatial data and does not necessarily represent the total number of TURFs in a given country. We also identified three fisheries, one each in Algeria, Colombia, and South Africa, that were not included because they are not currently functionally operating as TURFs.

2.1.3.1 Georeferencing and Area Calculations

In cases where we were unable to obtain GIS data for a given TURF, we used image files of paper maps from the literature in order to create GIS data. Detailed GIS shapefiles representing the administrative boundaries of individual countries were obtained from DIVAGIS.org. For a given TURF, an image file of a paper map was uploaded into ArcGIS 10.1 software. Using ground control points, the image was aligned to match the geographic extent of the administrative boundaries of the specified country. In all cases more than three ground control points were used, allowing the ArcGIS software to calculate residual error associated with georeferencing each map. Care was taken to ensure residuals remained as low as possible. The accuracy of the georeference varied dependent on the spatial resolution of the paper map available. In cases where the administrative boundaries did not supply sufficient spatial resolution to show ephemeral barrier islands or wetland areas present in the paper map, LandSat satellite imagery was used to facilitate the georeferencing.

Once the paper map was properly aligned with the administrative boundaries, a polygon was drawn to represent the boundary of the TURF(s) displayed in the paper map. All management areas shown in the map were also drawn. Each polygon was saved as a unique shapefile; once all polygons were drawn, they were merged into a single shapefile containing all polygon data available (n = 176). All polygons were converted into a single point to be included in the larger available database of all known TURF locations.

Whenever possible, polygons were drawn for each TURF with site-specific, case-study information. In cases where shapefiles were obtained from government websites, these polygon data were used preferentially over polygons drawn from georeferenced images. Polygons were drawn for all TURFs in which paper maps were identified, regardless of whether the TURF was represented as a site-specific data point for analysis. Therefore, while only 75 of the 103 site-specific data points had either reported or calculated area information, we were able to obtain area data for a total of 224 individual TURFs in 29 countries. Once all available polygon data was merged into a single file, we used ArcGIS software to calculate the area of each polygon. Area calculations were done using a world Cylindrical Equal Area projected coordinate system. To determine the accuracy of ArcGIS area calculations, we compared all reported area values available against the calculated values. Reported area values came from literature, survey responses, and areas reported through acquired shapefiles and KML files. A paired student's t-test revealed no significant difference between reported and calculated areas (p = 0.2003, n = 49).

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[2] Cadastro Nacional de Unidades de Conservação (CNUC), Brazilian Ministry of the Environment. Accessed from: http://www.mma.gov.br/areas-protegidas/cadastro-nacional-de-ucs/dados-georreferenciados

[3] National Aquatic Biodiversity Information System (NABIS). New Zealand Government. http://www.nabis.govt.nz/Pages/default.aspx

[4] *Recursos Marinos y Pesquerias* (http://recursosmarinos.udc.es/gis/cartografia/descargas) and SIGREMAR (http://ww3.intecmar.org/Sigremar/). *Xunta de Galicia* (Galician Government, Spain).

[5] Provided by Eréndira Aceves Bueno

[6] Provided by Stuart Fulton

Table 3. Location and number of TURFs identified

TURF systems represent one or more TURFs that operate under a similar management structure or legal framework; many countries have multiple systems that operate independently of each other. The number of TURFs reported indicates the number known and does not necessarily represent all TURFs present in a given country; parentheses indicate the number of TURFs for which spatial data were gathered. The number of site-specific data points gathered for each country is reported; these data were used in the site-specific data analysis. The number of TURF systems identified is reported; the number of TURF systems in which data were gathered is shown in parentheses.

	No. of TURFs		No. with Site-Specific Data	No. of TURF Systems	
Africa					
Benin	-		0	1	(0)
Cameroon	-		0	1	(0)
Ghana	-		0	1	(0)
Nigeria	-	(1)	1	1	(1)
Asia					
India	9	(9)	8	3	(1)
Japan	976	(28)	7	1	(1)
Oman	-		0	1	(0)
Korea, Rep.	294	(0)	0	1	(1)
Sri Lanka	1	(1)	1	1	(1)
Taiwan	15[#]	(0)	0	1	(1)
Vietnam	22	(14)	3	3	(2)
Europe					
Finland	many*		0	1	(1)
France	34	(34)	11	2	(2)
Greece	-	(1)	1	1	(0)
Italy	24	(23)	1	2	(2)
Malta	1^	(1)	0	1	(1)
Netherlands	1	(1)	1	1	(0)
Spain	229	(94)	1	11	(2)
Sweden	2, many*	(2)	2	2	(2)
Turkey	-		0	1	(0)
United Kingdom	28	(11)	11	1	(1)
Indo-Pacific					
American Samoa	8	(8)	1	2	(1)
Australia	2	(1)	1	1	(1)
Cook Islands	-		0	1	(0)
Fiji	385**	(13)	2	1	(1)
Indonesia	3, many*	(1)	0	3	(3)
New Zealand	25	(25)	1	2	(2)
Papua New Guinea	86[§]	(1)	1	2	(2)
Philippines	8, many*	(8)	5	1	(1)
Samoa	59[§]	(2)	2	2	(2)
Solomon Islands	113[§]	(2)	1	1	(1)
Vanuatu	44[§]	(11)	10	1	(1)
Latin America					
Belize	2	(2)	2	1	(1)
Brazil	30[†]	(21)	3	1	(1)
Chile	793	(768)	5	1	(1)
Ecuador	2	(2)	1	1	(1)
Mexico	500[¥]	(24)	16	1	(1)
North America					
Canada	1	(1)	1	1	(1)
Grenada	1^	(1)	0	1	(1)
Saint Lucia	1	(1)	1	1	(1)
Table 3 continued from previous page					
United States	8,063***	(21)	2	3	(1)
Totals	**11,762**	**(1,133)**	**103**	**66**	**(43)**

As of January 2014, there were 20 pending TURF applications in Taiwan.
* It is know that many TURFs exist in these countries, but numbers are not known.
^ We considered both Malta and Grenada as single TURFs; both countries have individual fixed fishing gear sites that are spread along the entire coastline of the country. Each fixed gear location is considered a zone within the larger TURF. Grenada has 97 fixed haul sites operating on a first come first serve basis; Malta has up to 130 offshore sites leased annually.
** There are 385 marine qoliqolis registered in Fiji, however the degree of exclusivity under which each operates as a TURF is unknown. Some qoliqolis have joined together to create a network of Locally Managed Marine Areas (LMMAs) operating under varying rules of exclusivity.
§ Number of LMMAs; not all LMMAs necessarily operate as TURFs, but exact number with exclusive access is unknown. Numbers reported as of 2009.
† The exact number of Marine Extractive Reserves in Brazil is not known, but there are approximately 30.
¥ There are more than 500 TURFs in Mexico; however the exact numbers are unknown. There are 217 TURFs in the Baja Peninsula.
*** There are 8,043 oyster lease sites in the Gulf Coast of Louisiana, USA. These are annual leases allocated by the Louisiana Department of Wildlife and Fisheries to individuals or groups for exclusive access within a particular area to harvest oysters. See http://oysterlease.wlf.la.gov/oystermap/map.html and http://www.wlf.louisiana.gov/fishing/oyster-program

2.1.3.2 Geographic Features

In order to test hypotheses associated with boundary delineation, all TURFs with high-resolution, polygon spatial data were visually assessed to define categories according to their geographic type (e.g. bay, lagoon, estuary, etc.). For conceptual purposes, if a TURF is simplified to a rectangular shape, TURFs that are offshore or surround entire islands have four water boundaries. Conversely, TURFs located along a straight coastline only have three water boundaries, as the land forms one of the TURF boundaries. TURFs that fill an entire bay, or other enclosed area, will only have one water boundary, as the remainder of the TURF is surrounded by land. Land boundaries are assumed to be easier to recognize and enforce, indicating the degree of enclosure may influence TURF design characteristics and success.

For the purposes of analysis, TURFs were binned into four broad categories according to the degree to which the TURF is enclosed (Figure 2). In some instances, a single TURF has multiple, physically separated fishing grounds or encompasses areas with varying degrees of enclosure. For instance, a TURF may predominantly border an open shoreline, but a portion of the TURF may extend inland into a more enclosed estuary or lagoon. Therefore, when assigning a TURF to one of the binned categories, we chose the enclosure category with the least enclosed physical boundary. In the example above, the TURF with an unenclosed shoreline area and fully enclosed lagoon area would be classified as not being enclosed.

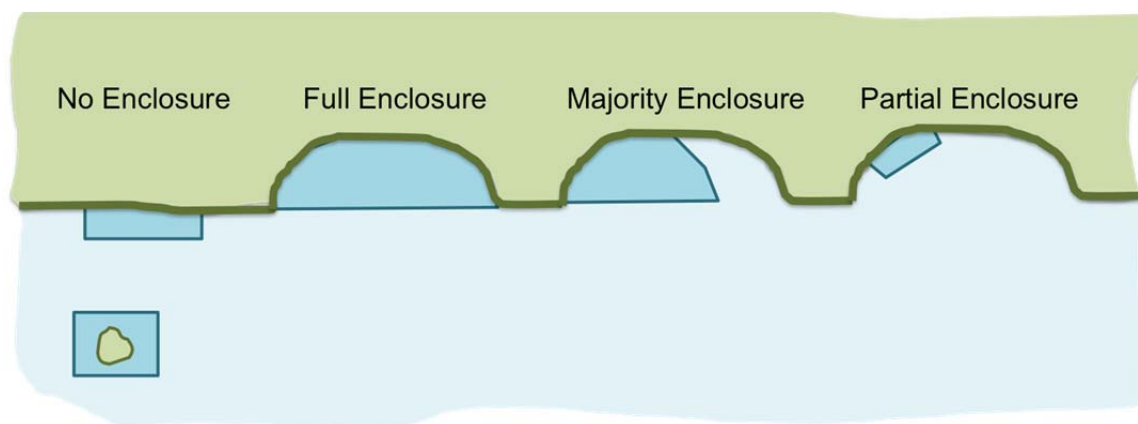**Figure 2. Degree of geographic enclosure.**
Dark blue areas represent TURFs.

2.2 Data Analysis

We compiled a TURF database using responses from the survey, information from other fisheries databases, and case studies on particular TURFs gathered from the published literature. This database allowed us to test which of our hypotheses confers TURF success, primarily using multivariate binary

logit regression that included focal variables and in some cases, additional predictor variables that we felt could potentially have an effect. In some instances, where data were limited, a univariate regression was run between the dependent variable and focal variable. The analyses used for each hypothesis are described in Table 4.

However, as there is no universally agreed upon definition of success, especially when management objectives differ considerably, we were forced to develop a proxy for TURF success. We executed this by using a survey question that asked respondents to indicate on a scale from 1 to 5 how well they felt the TURF was meeting its top two management objectives. Due to data limitations, we generalized the ranked data into a binary indicator determining whether the TURF was meeting its objectives or not. We averaged the self-reported ranked values for all objectives, no matter the category, and transformed it into a binary variable where scores of 3 or below were considered "unsuccessful" and scores above 3 were considered "successful".

During initial data exploration, we recognized that most TURFs had fisheries-related objectives. This prompted us to include a regression analysis on only the TURFs with fisheries objectives to determine if the predictor variables had a different effect. By specifically separating stated fisheries objectives from stated social, conservation, or economic objectives, we tested whether our hypotheses regarding TURF success would hold true under different contexts. Ideally, we would have run separate analyses on the other objectives categories, but the sample sizes for each of these were far too low for any statistical tests. However, we acknowledge that some fisheries objectives overlap with other objectives; for example, the goal of improved catch per unit effort is closely tied to the economic goal of improving fishery revenues. Furthermore, as we asked respondents to identify the top two objectives of the TURF, TURFs with fisheries objectives often also have other objectives, further limiting the conclusions that can be drawn from this regression.

Our survey also asked respondents to rank how effectively a TURF was enforcing exclusivity along its boundaries. Thus, we ran regressions that explored the relationship between enforcement effectiveness and design characteristics, as well as the relationship between effective enforcement and a TURF's ability to meet stated management objectives. The direct relationship between effective enforcement and TURF success was analyzed through univariate binary logit regressions, where effective enforcement predicted the likelihood of achieving all stated objectives (aggregated objectives) and also where it predicted the likelihood of achieving fisheries objectives. Further, TURF characteristics that predict the likelihood of effective enforcement were also examined through a multivariate binary logit regression wherein effective enforcement was used as the dependent variable.

We also explored the relationships between other crucial TURF attributes. Using regression analysis, we tested design characteristics related to the tenure length of use rights, the level of government and community involvement in management, and TURF size, wherein these factors were the dependent variables of separate regression analyses. Although the tenure length and co-management variables were included in the success regressions, these data were also utilized as dependent variables to identify interactions with other TURF characteristics.

Due to limited responses and missing data across variables, the sample size was too low to have enough statistical power to run regressions using the raw data. To improve the statistical power of our analysis, we transformed our dependent variables of interest into binary variables using methodology similar to that employed for our aggregated objectives dependent variable. Using these transformed variables, we employed a binary logit regression analysis, with the exception of TURF size. TURF size was left as continuous data to allow us to use an ordinary least squares regression. We also transformed the predictor variables of interest into binary or continuous data as appropriate. The transformations for each variable are described in more detail in Appendix 1, which includes all changes made to the dataset and any relevant assumptions we made to justify transformations.

The generalized binary logit model is:

$$\ln(p/(1-p)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n$$

We used this model for all regression analyses except TURF size. Coefficients on significant variables were exponentiated to determine the odds ratio of each variable on the predicted outcome.

The generalized ordinary least squares regression model for TURF size is:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon$$

We tested many combinations of predictor variables to determine the best fit model. We reported the full model with as many relevant variables that had sufficient observations to avoid omitted variable biases, rather than utilizing simpler models that included fewer variables. This econometric approach to regression analysis was chosen because we lacked the ability to control variables in an experimental setting and relied heavily on observational data. This approach allowed us to obtain the most unbiased estimate of the effects of the predictor variables of interest. While our final models do not contain all the possible variables that could have an effect on the dependent variables, we were not able to include these due to data limitations.

Table 4. Success hypotheses and corresponding tests

Hypothesis	Focal Variable	Regression
TURFs that are co-managed equally by fishers and government are more likely to be successful.	Co-management	All objectives multivariate binary logit
		Fisheries objectives multivariate binary logit
TURFs with longer duration of tenure are likely to be more successful.	Short tenure	All objectives multivariate binary logit
		Fisheries objectives multivariate binary logit
TURFs are more successful for fisheries targeting lower mobility species.	Low mobility	All objectives multivariate binary logit
		Fisheries objectives multivariate binary logit
TURFs with no-take zones are more successful.	NTZ	All objectives multivariate binary logit
		Fisheries objectives multivariate binary logit
TURFs lacking physical geographic enclosure are less likely to be successful	Not geographically enclosed	All objectives univariate binary logit
		Fisheries objectives univariate binary logit
Physically larger TURFs are less successful as a result of increasing enforcement difficulty.	Number of fishers (as a proxy for size)	All objectives univariate binary logit
		Fisheries objectives univariate binary logit
TURFs with effective enforcement are more likely to be successful.	Enforcement	All objectives univariate binary logit
		Fisheries objectives univariate binary logit

3.0 Results

3.1. TURF Characteristics and Locations

We identified TURFs in 41 countries around the world (Figure 3). For the purposes of this analysis, Taiwan and American Samoa are considered countries despite being territories of China and the United States, respectively. In addition, we identified 11 countries that do not currently have operational TURFs,

but are either in the process of developing TURFs (e.g. Algeria, Senegal, Cape Verde, Sierra Leone, Liberia, South Africa), individuals or organizations have expressed interest in instituting TURFs (e.g. Kenya, Mozambique, Colombia, Malaysia), or where a national government has laws allowing TURFs but are yet to be implemented (e.g. Thailand). The European Union (EU) has also expressed interest in providing a TURF provision in the Mediterranean Sea under the Common Fisheries Policy (Spagnolo, 2012). Additionally, extensive freshwater TURF systems are present in Bangladesh, Cambodia, Peru, Sweden, and Finland; however, these systems are beyond the scope of this analysis. TURFs may be present in countries not identified here.

Among the 41 countries, 11,762 individual TURFs were identified (note that 8,043 of these are oyster leases allocated to individuals along the coast of Louisiana, United States). Specific location data were obtained for 1,133 TURFs (Table 3). These figures simply represent the number of TURFs *identified* and does not represent all TURFs present in all 41 countries.

TURFs have a cosmopolitan distribution, with presence in countries spanning a wide range of income levels and government stabilities. Figure 4 shows the distribution of per capita Gross National Income (GNI) and government effectiveness in 38 and 40 of the 41 countries identified as having TURFs, respectively (the World Bank did not provide data for the Cook Islands; GNI was not calculated for non-sovereign territories including Taiwan and American Samoa). Based on per capita GNI (USD) the World Bank classifies countries as low-income (< $1,035), lower middle-income ($1,035-$4,086), upper middle-income ($4,086-$12,616), and high-income (> $12,616). These classifications are used in lieu of the terms *developed* and *developing*, which are sometimes used to describe high and low-middle income countries, respectively. Of the 38 countries for which 2012 GNI is available, one is low-income, 12 are lower middle-income, eight are upper middle-income, and 17 are high-income countries. The 38 TURF countries identified have a higher mean 2012 per capita GNI ($18,965) then the global aggregate ($10,138).

The World Bank provides global data on six Worldwide Governance Indicators (WGI) and ranks countries into the percentile in which their scores fall. Government effectiveness "reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies"[7]. Of the 40 countries with government effectiveness scores (includes Taiwan and American Samoa), the majority (67.5%) falls within the upper 50th global percentile. While we are unable to compare these data against countries that do not have TURFs, they indicate that TURFs operate under a diverse suite of governmental settings and geographic locations.

3.1.1 TURF Systems

While only 41 countries were identified as containing TURFs, 66 distinct TURF systems were identified, of which data were collected on 43 systems in 33 different countries (Table 3). As described above, for the purposes of this analysis, a TURF system is defined as one or more TURFs that operate under a similar management structure or legal framework within the same country. Not all TURF systems have legal standing, but most are at least recognized by their national or regional government. There is large temporal variation in the establishment of TURF systems. Many marine areas functionally operated as TURFs for centuries but only recently have governments formalized their presence. This wide variation in TURF system implementation is summarized in Figure 5. This timeline extends back to 1000 A.D.; however systems of customary marine tenure likely existed long before this in many areas around the world (Box 2).

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[7] http://info.worldbank.org/governance/wgi/index.aspx#home

3.1.2. Site-specific TURF Characteristics

Utilizing survey responses and available peer-reviewed and grey literature, in-depth information was gathered for 103 individual TURFs in 29 distinct countries (Table 3, Figure 6) (See Appendix 3 for a full list of the 103 case studies analyzed in this study). For any given category analyzed, not all 103 site-specific data points could be used due to incomplete data (see above). However, it is useful to visualize the range of answers gathered among all 103 TURFs with available in-depth information. TURFs analyzed ranged considerably in terms of the number of fishers, mobility of the species managed, length of use right assignment, and the level of government involvement in TURF management (Figure 7). In accordance with hypotheses made in the TURF literature, it is assumed that TURFs with fewer fishers involved will decrease cooperation costs and improve the operation of the TURF (Yagi et al., 2011; Wilen et al., 2012). The majority of the TURFs analyzed had fewer than 200 fishers.

Low mobility species are presumed to be most appropriate for TURF management (Defeo & Castilla, 2005). Of the TURFs analyzed, most managed solely low mobility species (n = 41), although 29 TURFs managed medium or high mobility species (Figure 7b). An additional 20 TURFs managed multiple types of species, each with different mobility types, all of which included at least one medium or high mobility species.

Use rights can be allocated in a variety of different ways with varying tenure lengths. For instance, rights can be granted in the form of a lease or concession for an area of water. Conversely, fishers can simply be granted licenses or permissions from a management authority. In either case, there is only one level of primary use rights allocation. However, in some cases there can be a secondary level of use rights assignment. For example, a fishing cooperative may obtain a primary use right in the form of a concession from the government, the cooperative then has the right to assign additional licenses to individual fishers. Therefore, there can be variable tenure lengths in a single TURF if both primary and secondary use rights are assigned. Figure 7c shows the variation in the length of use rights. In this case, we considered the secondary use right; however, in cases where there is no secondary use right, the length of the primary use right was used. We used the secondary use right in this analysis, as it directly influences individual fishers' behaviors. Their harvesting practices often depend on the length of time they are guaranteed access to a particular resource, not necessarily the length of time the government assigns concession to a cooperative, for instance. Despite the influence of duration of tenure length on fisher behavior, the majority of TURFs analyzed allocate use rights that are short in duration (less than 3 years).

Government can play different roles in TURF management and is often variable between national, regional, and local governments. Of the 103 TURFs analyzed, most either had high or limited government involvement, as only 20 TURFs reported equal parts government and community involvement, or co-management (Figure 7d). However, these data are likely skewed based on over-representation by several countries in both the high and limited government categories. Unlike the parameters discussed above, government involvement is typically consistent among all TURFs in a given country. Of the 103 TURF analyzed, 23 were located in France, India, or the United Kingdom and were classified as having high government involvement. Conversely, 10 of the TURFs located in Mexico have limited government involvement.
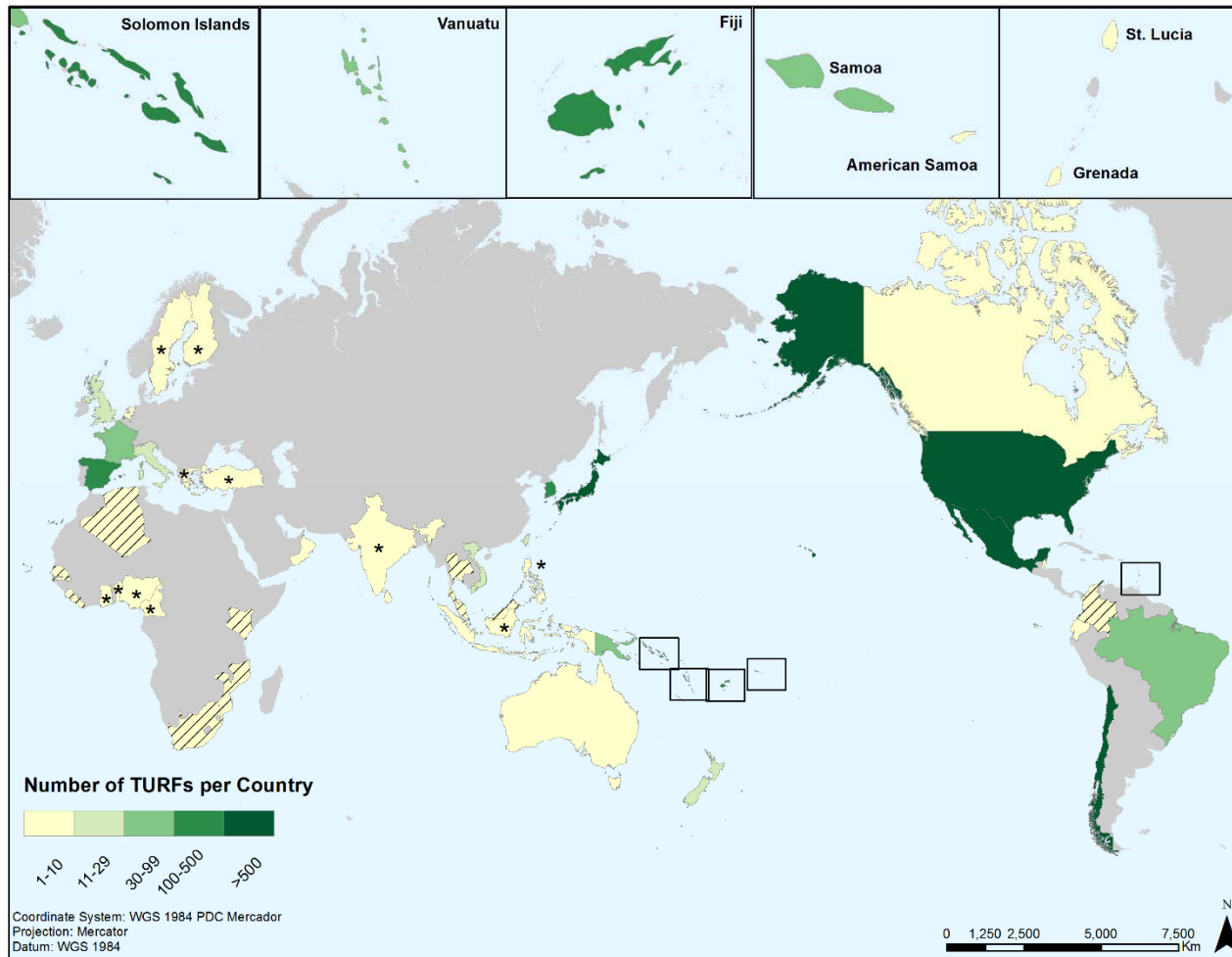
Figure 3. Global distribution of TURFs

Darker colors indicate a larger number of TURFs identified within the country. Numbers represent TURFs identified through this analysis and do not necessarily reflect the true number of TURFs located in each country. Crosshatched countries represent countries that do not currently have operating TURFs but either have pilot projects in progress or have expressed interest in implementing TURFs. *The exact number of TURFs in Sweden, Finland, Indonesia, the Philippines, Cameroon, Benin, Nigeria, Ghana, Turkey, Greece, and India is not known but are expected to be higher than represented by the shading shown here.
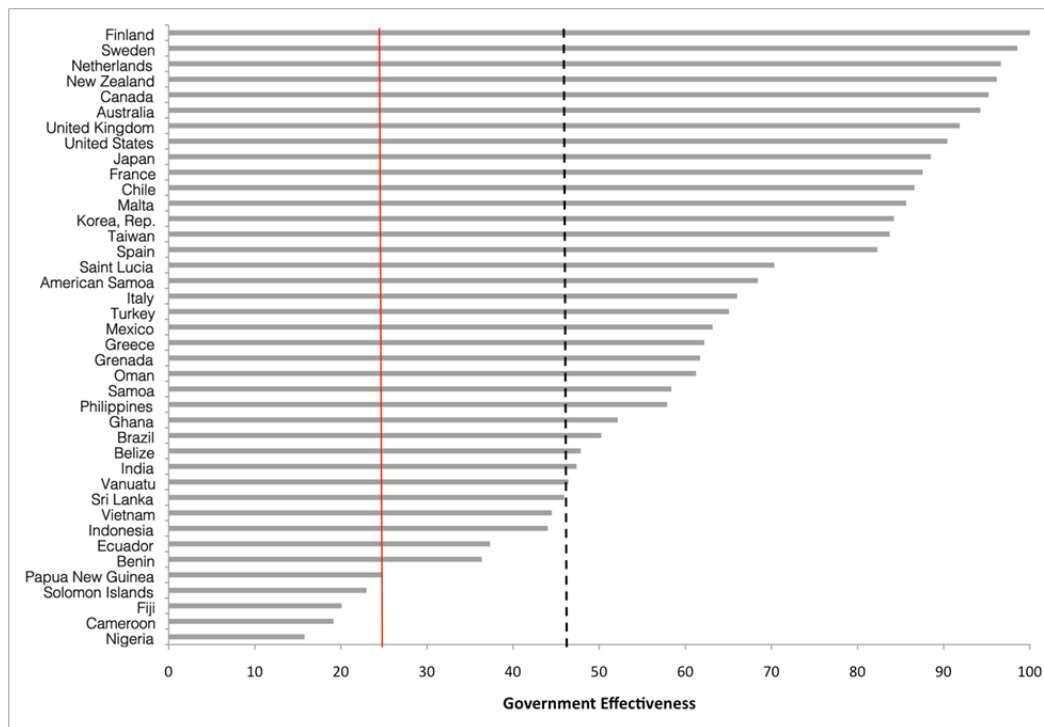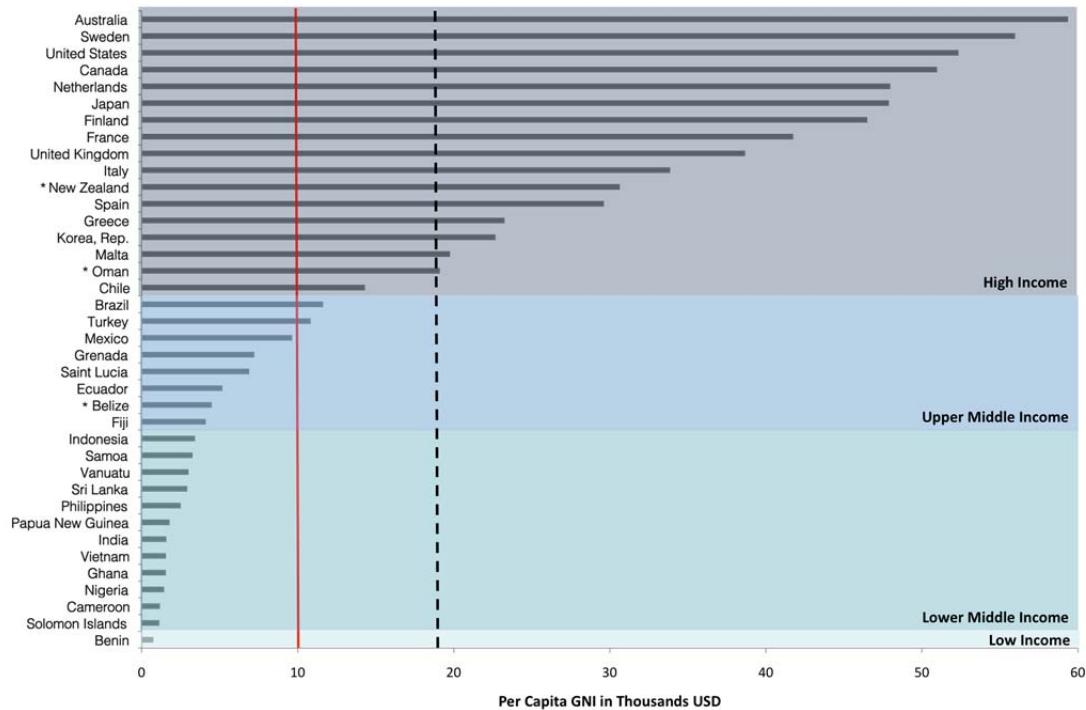
Figure 4. Range in per capita Gross National Income (a) and government effectiveness (b) among countries identified as having TURFs

(a) GNI values as of 2012 displayed in 2012 USD; shading indicates World Bank income brackets; red line is the 2012 global aggregate per capita GNI ($10,138); black dotted line is the 2012 average per capita GNI for the TURF countries listed ($18,965). (b) Government effectiveness is a World Bank World Governance Indicator represented as a global percentile; the red line indicates the global 25th percentile; black dotted line indicates the 25th percentile of the TURF countries listed. *2012 GNI value was not available, therefore the 2011 value was used.
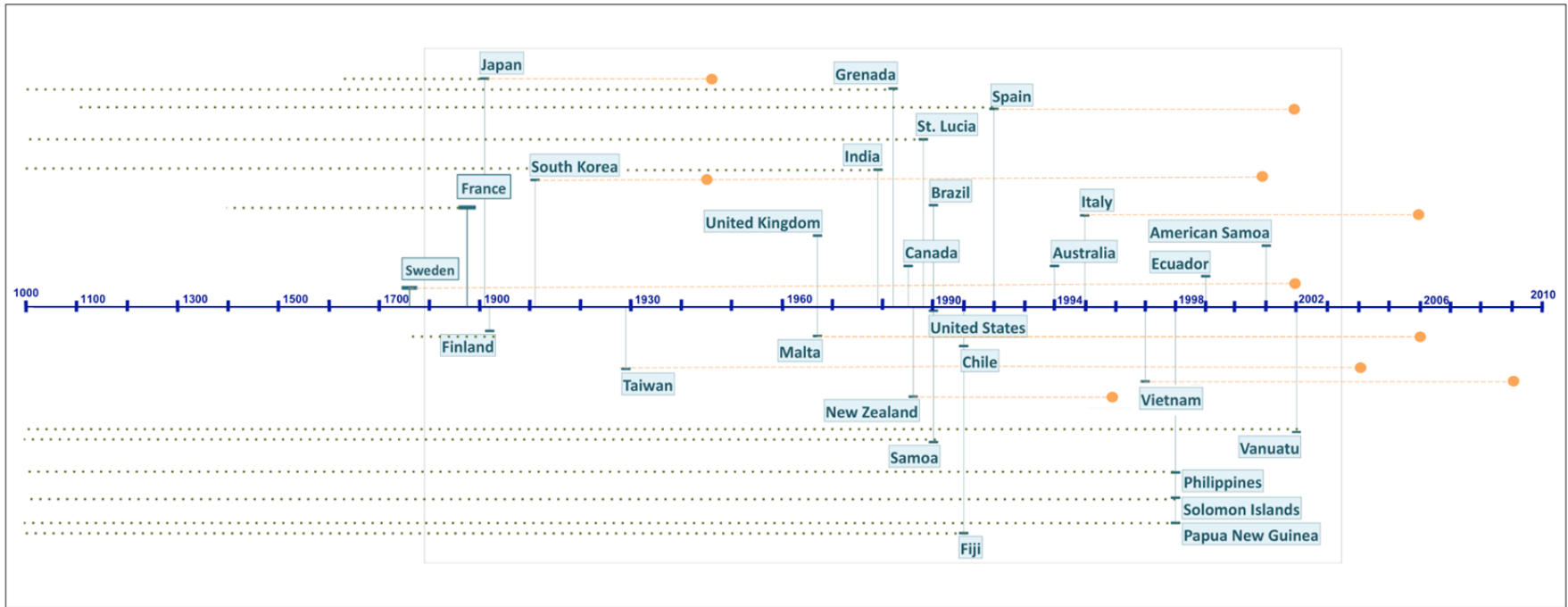
Figure 5. Timeline displaying the history of TURF systems relative to their date of legal formulation

The country label is placed on the date of the earliest known legal basis for TURF implementation. The dotted green lines extending back in time signify a historic basis for TURFs in a given country; the timeline was only extended back to 1000A.D., but TURFs may have operated informally prior to this date. Orange dashed lines extending forward in time signify countries that have passed some form of legal reform to their TURF system; orange dots indicate the actual date of legal reform.
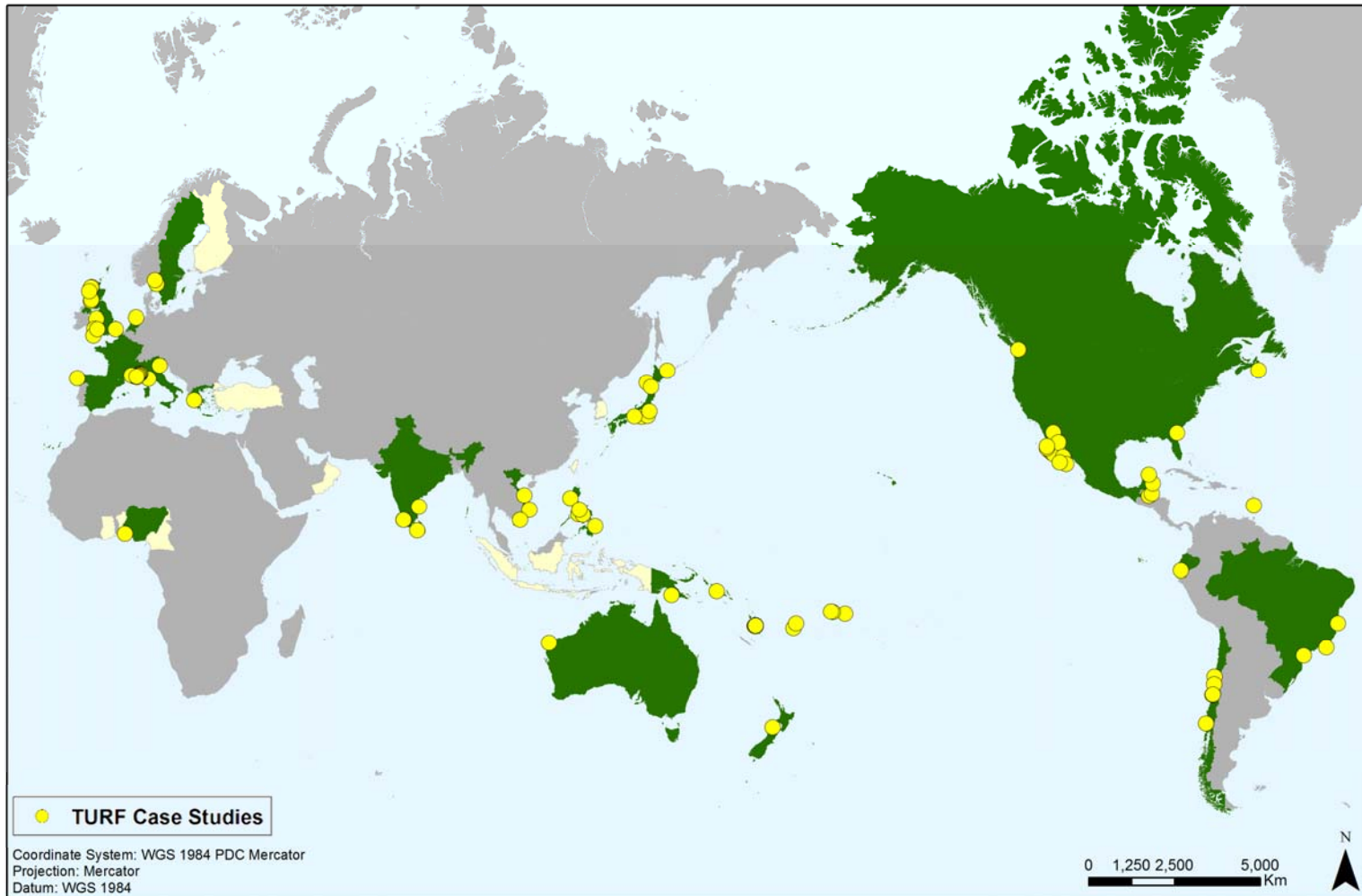
Figure 6. TURF case studies identified with site-specific information included in the dataset (N=103)
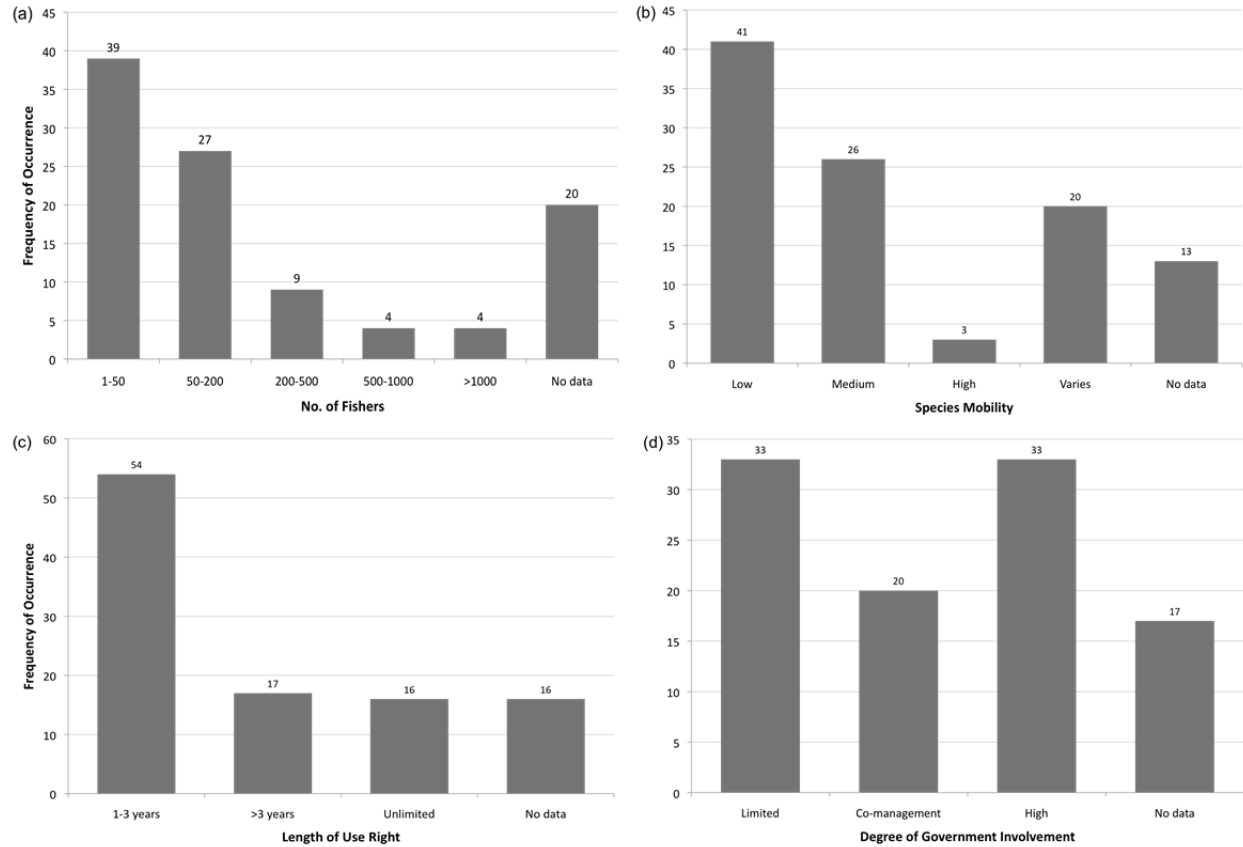
Figure 7. Site-specific TURF variation (N=103)
Graphs show the frequency with which a particular categorical response was chosen for (a) number of fishers, (b) species mobility, (c) length of use right, or (d) degree of government involvement. Data comes from survey responses and literature review. Categories left blank are indicated as No data.

While only 75 of the 103 TURFs analyzed had information on the area and geographic location of the TURF (i.e. how enclosed the TURF is by land features, see Section 2.1.3.2), detailed spatial data were gathered for an additional 149 TURFs in 25 countries. Therefore, TURF size and amount of geographic enclosure were analyzed for 224 TURFs in total. There are orders of magnitude differences in the size of TURFs, ranging from 0.01 km^2 to over 138,000 km^2 (Figure 8a). The majority (51%), however, are less than 10km^2 in size (Figure 8b). We also observed variation in the degree of geographic enclosure among TURFs analyzed (Figure 9), although most TURFs are located in areas with no enclosure (i.e. offshore, surrounding islands, or adjacent to an open shoreline).
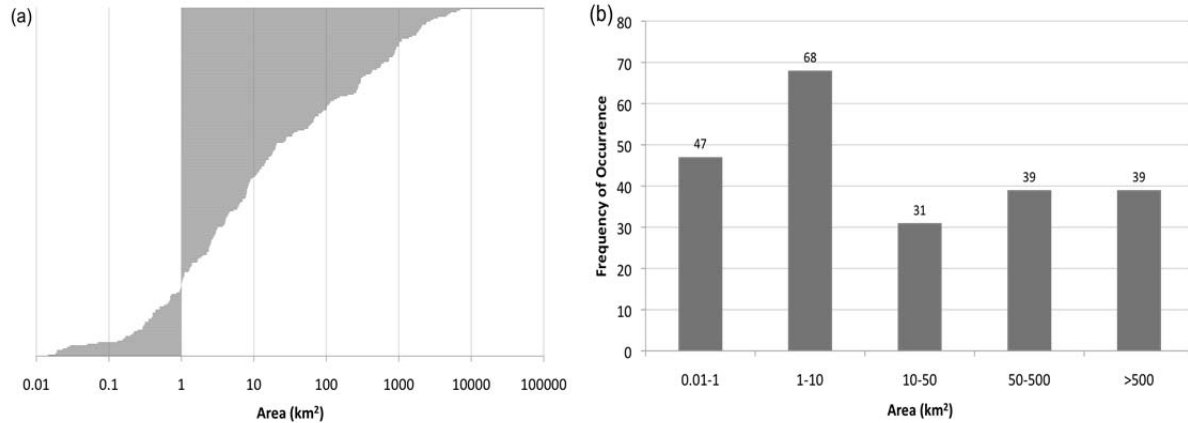
Figure 8. Variation in TURF size (N=217)
(a) Logarithmic range of TURF sizes centered above and below 1 km^2; each horizontal bar represents a unique TURF. (b) Number of TURFs present within specified size ranges.
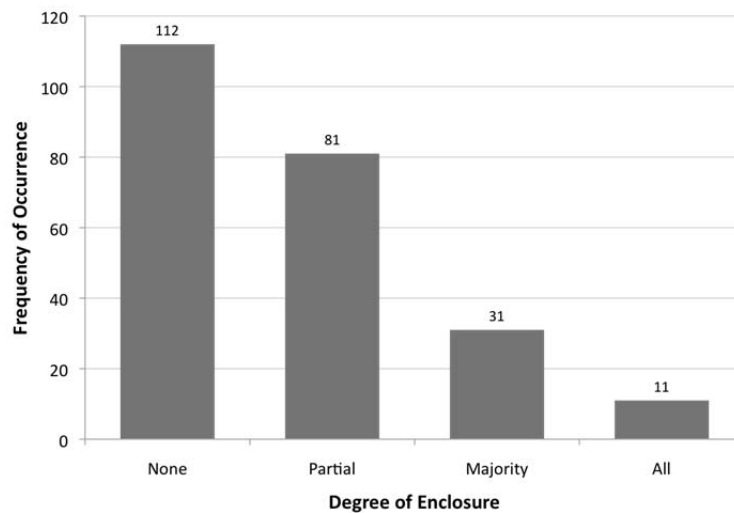
Figure 9. Degree of geographic enclosure by land boundaries

3.2 Identification of TURF Regimes

In researching TURFs around the world, we qualitatively identified trends and common themes in basic TURF design and management. While we observed a great deal of complexity and site-specific variability in TURF design, we were able to identify four broad design categories, or TURF regimes (Figure 10). All of the TURF case studies analyzed fall within one of these four regime types. To our knowledge, no studies have identified and categorized design trends on a global scale. It is useful to understand that while TURFs are frequently managed in a very site-specific fashion, there are still overarching trends in design.
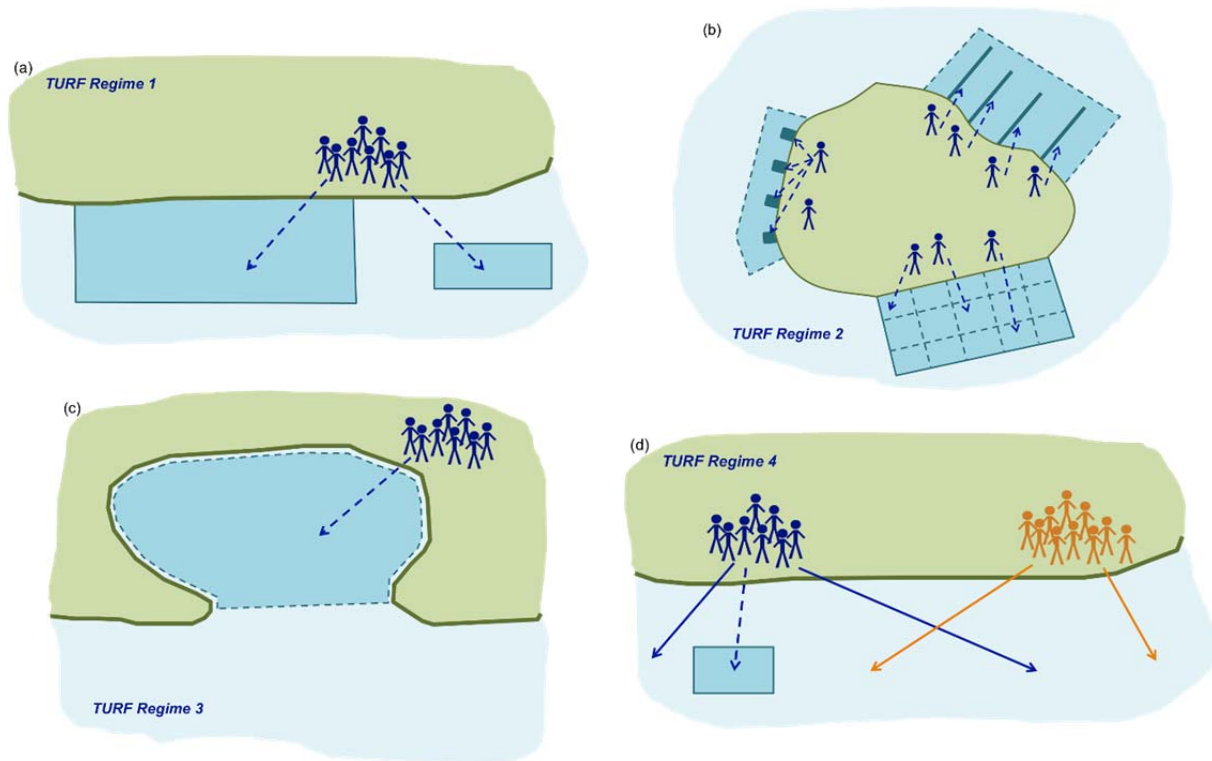
Figure 10. TURF Regime Types
(a) TURF Regime 1 – Classic TURFs. (b) TURF Regime 2 – Divided TURFs. (c) TURF Regime 3 – ITQ TURFs.
(d) TURF Regime 4 – Taboo TURFs. The dark blue areas represent the TURFs. Solid TURF boundary lines indicate
firm, well-established boundaries as dictated during the creation of the TURF; dotted TURF boundary lines indicate
soft boundaries that occur by virtue of how the system is operated, but not established as a formal boundary during
TURF implementation. Dark blue fishers represent the user group with exclusive access to the TURF. Arrows
extending from fishers indicate where the users have access to resources; dotted lines indicate exclusive access
while solid lines indicate unrestricted access. Multiple arrows coming from the same user group indicates the fishers
are able to move freely within the TURF area(s). TURF regime 2 (b) displays the three different ways in which a
Divided TURF can operate; they are drawn on the same figure for presentation purposes only.

Regime 1- Classic TURFs

In its simplest form, a TURF encompasses a single area of water with a clearly defined boundary in which
a single, well-defined user group is assigned exclusive access to a single marine resource (Figure 10a).
We define this type of TURF as a Classic TURF, which can be complicated by multiple fishing grounds,
more than one distinct user group, or when multiple species are targeted within the TURF. The third
volume of the Environmental Defense Fund's (EDF) Catch Shares Design Manual describes four "TURF
types" based on variation in complexity of user groups and resource complexity (Figure 11; these "TURF
types" differ from the TURFs regimes identified in this analysis). In brief, a single user group can have
access to a single biological resource resulting in the least complex TURF type (Figure 11, Type 1; Poon
& Bonzon, 2013). Adding complexity, multiple user groups may access a single biological resource
(Figure 11, Type 3) or a single user group may access multiple biological resources (Figure 11, Type 2).
A fourth and most complex TURF type occurs when multiple user groups target multiple biological
resources (Figure 11, Type 4); when multiple user groups are involved coordination between groups is
often necessary (Poon & Bonzon, 2013). All four of these TURF types described by EDF fall within the
category of a Classic TURF regime as described in the current analysis.

FIGURE A | *Four TURF Types According to Resource and User Complexity*
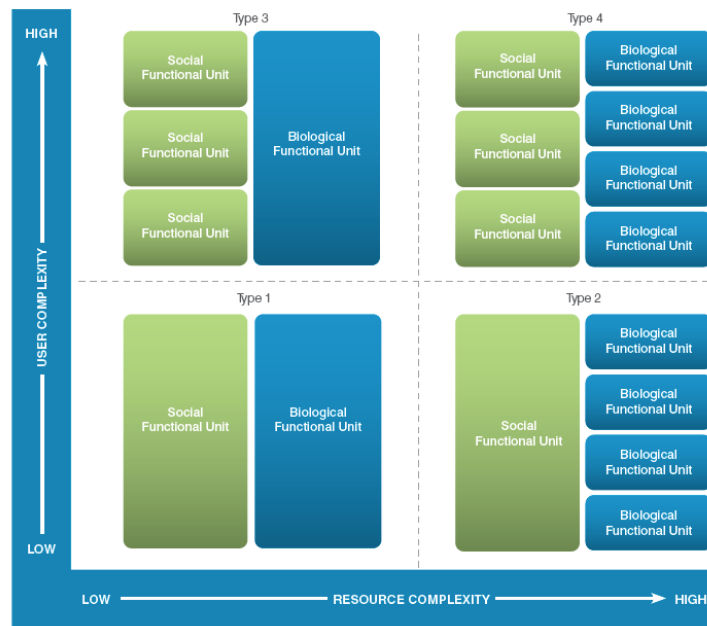
Figure 11. EDF Catch Share Design Manual TURF types based on user and resource group complexity

In some cases, a single TURF can have multiple, physically separated fishing grounds. We consider this a single TURF as long as there is a single user group that can equally access all available fishing grounds. In some cases, a particular user group is excluded from one of the fishing grounds or some specific area of the TURF. In this case a second level of exclusion is created over a specific area, which under our definition, would result in the creation of a second TURF.

In Classic Regime 1 TURFs, users are able to access all areas within the TURF at some point in time (excluding no-take zones). In some cases, spatial rotations are implemented, which direct users to rotate access to preferred fishing grounds, but *all* users are able to access the *entire* TURF area at some point in the fishing season. Spatial rotations do not imply an additional level of ownership over a specific area within the TURF, but rather provide equal access to preferred fishing grounds by all members in the TURF. Fixed gear fisheries can also operate within Classic TURFs but differ from the way fixed gears are utilized in Divided, Regime 2 TURFs (see below). The informal Maine lobster fisheries provide a salient example. Lobster traps act as a fixed gear when in use, but fishers are able to move their traps to different fishing areas and are not restricted to specific zones within the TURF (Acheson, 1975).

Therefore, a Classic TURF is one in which all resource users has access to the entire TURF area at some point during the fishing season. This was by far the most common TURF regime encountered and occurred around the world.

Regime 2- Divided TURFs

In some cases, TURFs are subdivided into many smaller areas or zones in which individuals may be granted additional property rights to a specific zone within the larger TURF (Figure 10b). There is a great deal of variation within this regime type, but most utilize fixed gears or fish aggregating devices (FADs). Unlike Regime 1, fixed gears or fishing zones remain permanent, meaning fishers are not able to move around freely within the TURF area, but are bound to specific rules of tenure. In some ways, divided TURFs can be thought of as multiple small TURFs within a larger TURF. This regime type is best explained by examples.

In the South Sulawsi region of Indonesia, local fishers utilize a traditional *rompong* rights system. *Rompongs* are FADs that are situated within a one-hectare area or zone (Satria & Adhuri, 2010). Individual fishers own these one-hectare areas in perpetuity, but many *rompongs* will operate within a larger area and only certain users are allowed to enter the fishery (Satria & Adhuri, 2010). Therefore, we consider the larger area to be the TURF with a primary level of exclusivity that is further divided into smaller zones with an additional level of private ownership.

The Languedoc-Roussillon region of the French Mediterranean also have fisheries that operate as divided TURFs. Exclusive fishing rights are granted to *prud'homies*, or fishers' organizations, that only allow *prud'homie* members to fish within their territory (Grieves, 2009; Arceo et al., 2013). Most of the *prud'homies* in the Lagnuedoc-Roussillon region apply an annual lottery in which members are allowed to choose zones within the *prud'homie* territory (Grieves, 2009). Through the lottery, members are granted temporary, sole ownership over their individual fishing zone(s) (Grieves, 2009).

The Caribbean island nation of Grenada has a series of 97 fixed gear sites, or hauls, distributed along the entire coastline of the country (McConney, 2003). Seine net fishers must tie up their nets within a haul in order to fish. Only local fishers are able to access the hauls and exclusivity follows a complicated set of rules governed by social norms (McConney, 2003). Access to a given haul occurs on a first come first serve basis and fishers enjoy exclusive access to their haul as long as they continue to fish the site (typically a few days). In this system, the gear becomes stationary by virtue of the permanent haul sites, but users are able to move freely among haul sites within the TURF area. Malta operates similarly to Grenada, but has 130 FADs that the government leases out to Maltese fishers annually (MRAG, 2009). Through a lottery system, fishers are granted exclusive access to a single FAD for one year, at which point a new lottery re-assigns FAD ownership (MRAG, 2009). In both cases, fishers are able to move within the TURF (albeit at variable temporal scales), but the gear remains fixed.

Regime 3- ITQ TURFs

Fisheries managed by Individual Transferable Quotas (ITQs) assign individuals the right to harvest a particular species according to a biologically determined quota (Arnason, 2012). Since property rights are assigned to a species not an area, ITQs typically have no boundaries and simply encompass the entire accessible range of the target species. However, some species are limited to a specific geographic region based on their distribution and life history characteristics. Therefore, there are cases when a species managed by ITQ is confined to a specific area such as a bay or lagoon (Figure 10c). Under this circumstance, the ITQ fishery functionally operates as a TURF since access is made exclusive through quota permits and fishing occurs within a clearly defined boundary. We identified ITQ TURFs in New Zealand (Mincher, 2008) and similarly, limited entry systems that operate as TURFs in Australia (Kangas et al., 2008), but recognize that this TURF regime likely applies to many fisheries around the world.

Regime 4- Taboo TURFs

As the name suggests, a taboo TURF is an area of water in which fishing is forbidden or taboo except under very special circumstances (Figure 10d). This TURF regime is common in the Indo-Pacific in which villages have operated taboo area for centuries (Govan, 2009). While each taboo TURF operates differently, typically the waters surrounding the taboo area are open to fishing, potentially even by neighboring villages. During times of celebration, the village chief will open the taboo area exclusively to local village members (Govan, 2009). Taboo areas are typically opened to supply a feast to commemorate sacred events.

3.3 Regressions

3.3.1 Success

Objectives of TURFs and associated measures of "success" differ across TURF systems. We utilized a binary logistic regression model to identify what contributes to achieving TURF objectives, our proxy for success. The variables we included were based on the hypotheses reported earlier that describe what contributes to success in a TURF. However, we utilized the number of fishers in the TURF as a proxy for size (referred to as "Size proxy" in equations below), as number of fishers was highly correlated with size in a Pearson's product-moment correlation test ($r^2 = 0.55$, p-value of 0.02). The only predictor variable included that was statistically significant ($p < 0.05$) is, co-management, where an equal level of government and community involvement in the TURF was found to positively impact the likelihood of TURF success (Table 5). The relationship of co-management with success is re-confirmed in testing all three levels of co-management against success, where both limited and high government involvement negatively impact the likelihood of TURF success (although limited government involvement and equal government involvement are the only variables with significance, see Table 5). The following is the full, best fit model used to predict the probability of successfully meeting objectives:

$$Probability\ of\ successful\ TURF, \ln\left(\frac{p}{1-p}\right)$$
$$= 0.382 + 0.646(NTZ) - 1.323(Short\ Tenure) + 2.042(Co\text{-}Management)$$
$$+ 0.154(Low\ Mobility) - 0.0008(Size\ proxy)$$

Due to lacking data, enforcement effectiveness and geographic enclosure were not included in the above regression, though hypotheses indicate that these may be indicators of TURF success. These predictor variables were run in a univariate regression against TURF success across aggregated objectives. Geographic enclosure was not significant across all objectives; however, enforcement effectiveness, using the following model, was highly significant and had a positive effect on TURF success:

$$Probability\ of\ successful\ TURF, \ln\left(\frac{p}{1-p}\right) = -1.61 + 3.624(Enforcement)$$

Of the TURFs analyzed, the majority had a management objective that was explicitly fisheries related (i.e. when asked to identify the TURFs management objectives as either fisheries, social, conservation, or economic, fisheries was chosen most frequently). Most commonly, hypotheses associated with TURF success are discussed in the context of fisheries management, and therefore, we ran a separate regression focused on TURFs with a stated fisheries objective, which reduced the sample size to 23. Using the same predictor variables, we analyzed how well a TURF ranked in terms of meeting its stated fisheries objective. While co-management was no longer a significant variable we observed a significant negative relationship between tenure length and success, and a significant positive relationship between TURFs targeting low mobility species and success. The following is best fit model to predict the probability of successfully meeting fisheries objectives:

$$Probability\ of\ successful\ fisheries\ objectives, \ln\left(\frac{p}{1-p}\right)$$
$$= 0.808 - 0.751(NTZ) - 2.97(Short\ Tenure) + 2.197(Co\text{-}Managment)$$
$$+ 2.726(Low\ Mobility) - 0.002(Size\ proxy)$$

Due to data limitations, enforcement effectiveness and geographic enclosure were not included in the above regression, though hypotheses indicate that these may contribute to TURF success. These predictor variables were run univariately against TURF success across fisheries objectives. A TURF that is not enclosed geographically had a statistically significant negative effect on the likelihood of achieving fisheries objectives success, and similar to aggregated objectives success, enforcement effectiveness is statistically significant and had a positive effect on fisheries objectives success:

$$Probability\ of\ successful\ fisheries\ objectives, \ln\left(\frac{p}{1-p}\right) = -2.08 + 3.784(Enforcement)$$

$$Probability\ of\ successful\ fisheries\ objectives, \ln\left(\frac{p}{1-p}\right) = 0.811 - 1.79(Not\ Enclosed)$$

3.3.2 Enforcement

As discussed in the above section, due to data limitations, enforcement was not included as a predictor variable in the full models of the success regressions. Instead, it was run in a univariate binary logit against each dependent variable (Table 5). Both univariate regressions results show that effective enforcement is highly significant in predicting the likelihood of successfully meeting all stated objectives in a TURF, as well as meeting fisheries objectives. There is a positive effect of effective enforcement in both regressions.

An additional regression analysis was conducted to determine the variables that would contribute to the likelihood of effective enforcement. The presence of soft boundaries had a significant negative effect in achieving effective enforcement. Co-management was also statistically significant, and increases the likelihood of achieving effective enforcement. The country-wide Rule of Law[8] variable was also significant, but was found to negatively impact the likelihood of having effective enforcement. The following is the best fit model to predict the probability of effective enforcement:

$$Probability\ of\ effective\ enforcement, \ln\left(\frac{p}{1-p}\right)$$
$$= 1.85 - 3.91(Soft\ Boundaries) + 4.012(Co\text{-}Management)$$
$$+ 0.67(Government\ Enforced) - 0.001(Number\ of\ Fishers)$$
$$- 1.25(Rule\ of\ Law)$$

Table 5. Results from analyses of TURF success indicators The all objectives success regression tested the effect of predictor variables on whether a TURF was successfully meeting its stated fisheries, social, economic, and/or social management objectives. The fisheries objectives success regression tested the effect of predictor variables on whether a TURF was meeting its stated fisheries management objective. The enforcement effectiveness regression tested the effect of predictor variables on whether a TURF was ranked as having effective enforcement. Significant variables are indicated (. = $p<0.1$, * = $p<0.05$, ** = $p<0.01$, *** = $p<0.001$).

Dependent Variable & Test	Predictor Variable	Coefficient	St. Error	p-value
All Objectives Success Multivariate binary logit 29 degrees of freedom	NTZ	0.6464	0.932	0.488
	Short Tenure	-1.323	1.018	0.197
	Co-management	2.04	1.001	0.041*
	Low mobility	0.154	0.93	0.868
	Size proxy[9]	-0.0008	0.00009	0.409

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[8] Rule of Law is a World Bank World Governance Indicator that, "Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."

[9] Due to data limitations, number of fishers was used as a proxy for size in success regressions as number of fishers was a larger data set and highly correlated with TURF size in a Pearson's product-moment correlation test.

Table 5 continued from previous page.

Dependent Variable & Test	Predictor Variable	Coefficient	St. Error	p-value
Fisheries Objectives Success Multivariate binary logit 22 degrees of freedom	NTZ	-0.751	1.469	0.609
	Short Tenure	-2.97	1.523	0.051 .
	Co-management	2.197	1.487	0.139
	Low mobility	2.726	1.483	0.066 .
	Size proxy[10]	-0.002	0.001	0.117
All Objectives Success Univariate binary logit 28 degrees of freedom	Enforcement	3.624	1.081	0.0008***
Fisheries Objectives Success Univariate binary logit 21 degrees of freedom	Enforcement	3.784	1.310	0.004**
All Objectives Success Univariate binary logit 31 degrees of freedom	Not geographically enclosed	-0.093	0.744	0.212
Fisheries Objectives Success Univariate binary logit 23 degrees of freedom	Not geographically enclosed	-1.791	0.905	0.048 *
Enforcement Effectiveness Multivariate binary logit 31 degrees of freedom	Soft Boundary	-3.914	1.456	0.007**
	Co-management	4.013	1.946	0.039*
	Government Enforced	0.670	1.569	0.669
	Number of Fishers	-0.001	0.002	0.502
	Rule of Law	-1.256	0.651	0.054 .

3.3.3 Design Features

In addition to the hypotheses tested to determine what design features contribute to TURF success, we analyzed what other attributes of TURFs predict the likelihood of a TURF implementing key design features. Due to data availability, we focused on analyses for three key design features: tenure length, the level of government and community involvement in management, and the areal size of the TURF.

3.3.3.1 Tenure Length

Short tenure length was identified as a significant predictor of achieving stated fisheries objectives, as described above. To identify the relationship between this design characteristic and other design characteristics of TURFs, a binary logit regression was employed to predict the probability of selecting a

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[10] Due to data limitations, number of fishers was used as a proxy for size in success regressions as number of fishers was a larger data set and highly correlated with TURF size in a Pearson's product-moment correlation test.

shorter tenure length as part of a TURF design. The predictor variables we identified as potentially having an impact were co-management level, the age of the TURF, the number of fishers using the TURF, and whether the TURF host country was above the average global government stability score. The statistically significant variables in this regression were the age of the TURF and high government involvement. For the remaining variables included in the model, we fail to reject the hypothesis that they have an effect on the probability of selecting short tenure length when designing TURFs. Regression coefficients and p-values are shown in Table 6. The following is the best fit model to predict the probability of a short tenure length:

$$Probability\ of\ short\ tenure\ length, \ln\left(\frac{p}{1-p}\right)$$
$$= -0.29 - 0.856(Co\text{-}Management) - 2.209(High\ Government\ Involvement)$$
$$+ 2.649\ (TURF\ Age) - 0.0007(Number\ of\ Fishers)$$
$$+ 1.405(Voice\ \&\ Accountability\ Score)$$

3.3.3.2 Level of Government Involvement

As co-management was identified as a significant predictor of overall TURF success, a binary logit regression was employed to predict the probability of choosing co-management level in TURF management. The predictor variables included: whether the TURF management strategy was written into law, the age of the TURF, the number of fishers, if a community leader was active in TURF management, and if the country the TURF is located in has an above average global GNI. When the full model was run, a host country's status relative to the global average GNI and number of fishers were statistically significant ($p < 0.1$). Although there is a weak relationship with these variables and co-management, for all variables we were unable to reject the null hypotheses that they have an effect on selecting the level of government in TURF management, given 95% confidence intervals. Regression coefficients and p-values are shown in Table 6. The following is the best fit model to predict the probability of co-management:

$$Probability\ of\ co\text{-}management, \ln\left(\frac{p}{1-p}\right)$$
$$= -25.25 - 0.361(Legal\ TURF) - 1.099(TURF\ Age)$$
$$+ 0.007(Number\ of\ Fishers) + 22.02(Community\ Leader) + 2.038(GNI\ Score)$$

3.3.3.3 TURF Size

An ordinary least squares (OLS) regression was employed to predict the size of a TURF based on the following predictor variables: number of fishers, mobility of the target species, and the amount geographic enclosure. The number of fishers in the TURF and targeting low mobility species had significant relationships with the size of TURFs. This model describes 43% of the variation in TURF size, with a model p-value of 0.016. To model TURF size, we used the following OLS regression equation.

$$TURF\ Size = TURF\ Size$$
$$= 123.890 + 0.017(Number\ of\ Fishers) - 67.588(Low\ Mobility)$$
$$- 31.417(Medium\ Mobility) + 0.001(Coastline\ Length)$$
$$- 10.648(Entirely\ Within\ Geographic\ Feature)$$
$$- 10.455\ (Within\ Part\ of\ Geographic\ Feature)$$
$$+ 30.789\ (Not\ Enclosed\ within\ Geographic\ Feature)$$

Table 6. Results of design characteristic regressions Significant variables are indicated (. = p<0.1, * = p<0.05, ** = p<0.01, *** = p<0.001).

Dependent Variable & Test	Predictor Variable	Coefficient	Standard Error	p-value
Short Tenure Length Multivariate binary logit 38 degrees of freedom	Co-management	0.8558	0.7390	0.2469
	High government involvement	-2.2094	0.7479	0.0031 **
	TURF age	2.6494	0.7819	0.0007 ***
	Number of Fishers	-0.0007	0.0007	0.2789
	Above/below global average of Voice & Accountability Score	1.4048	1.0263	0.1711
Co-management Multivariate binary logit 41 degrees of freedom	Legal TURF	0.3613	1.414	0.7983
	TURF age	-1.099	0.9166	0.2304
	Number of Fishers	0.0066	0.0037	0.0796 .
	Community leader	22.026	3098	0.9943
	Above/below average global GNI	2.038	1.113	0.0671 .
TURF Size Ordinary Least Squares 38 degrees of freedom	Number of Fishers	0.0172	0.0081	0.0400 *
	Low mobility	-67.5875	31.4234	0.0379 *
	Medium mobility	-31.4167	28.0871	0.2702
	Length of coastline	0.0011	0.0018	0.5528
	TURF entirely enclosed in geographic feature	-10.6482	48.6183	0.8278
	TURF partially enclosed in geographic feature	-10.4546	46.6304	0.8238
	TURF not enclosed within geographic feature	30.7894	44.6425	0.4946

4.0 Discussion

This global analysis of TURFs is the first of its kind, providing a foundation of information that reveals the variety of characteristics, locations, and potential trends seen in TURFs across the globe. These data clearly indicate that TURFs are a widely utilized management strategy capable of achieving multiple management objectives, but are frequently met with varying levels of success. Territorial use rights are not a strategy reserved for developing nations in the tropics, as is sometimes assumed, but are found across latitudes and income classes. Moreover, TURFs are not a recent phenomenon. While the name and associated economic theory are relatively young (Christy, 1982), TURFs have been utilized for centuries in many countries around the world. There is also a great deal of variety and complexity associated with TURF management, which unfortunately complicates analysis; however, we argue that this complexity allows for a great deal of plasticity, which in turn provides managers with a diverse toolkit of management solutions that can lead to a successful TURF.

4.1 Indicators of Success

The prevailing TURF literature provides several key factors that are purported to be associated with successful TURF management. These hypotheses are largely based on the tenets of economic theory associated with property rights (e.g. Christy 1982; Villena & Chavez, 2004; Wilen et al., 2012; Uchida et al., 2011), models (e.g. Costello & Kaffine, 2008; Kaffine & Costello, 2011; White & Costello, 2011; McCay et al., 2014), and select case studies (e.g. Pomeroy et al., 2001; Nielsen et al., 2004; Cinner 2005; Lobe & Berkes, 2004; Govan, 2009; Spagnolo, 2012). However, most of these hypotheses lack empirical evaluation limiting our understanding of success at a global scale. Studies that attempt to evaluate interventions in the management of natural resources are notoriously challenging (Poteete & Ostrom, 2008; Evans et al., 2011; MacNeil & Cinner, 2013). There is an inherent trade-off between focusing on a few data-rich case studies and the evaluation of limited variables to satisfy a large sample size (Poteete & Ostrom, 2008). Here, we chose to include a large number of case studies (N = 103) spanning 29 countries around the world in order to focus our analysis on empirically testing six key variables that are commonly hypothesized to affect TURF success. While this approach limited our capacity to draw causal conclusions concerning TURF success, it did provide a greater dataset. This allowed us to test our hypotheses and to identify common trends and key variables that are expected to be important factors necessary for successful TURF design, implementation, and management.

4.1.1 Co-management and TURF success

When all reported management objectives were considered, the presence of co-management was found to have a statistically significant, positive effect on the likelihood of having a successful TURF, as predicted by the predominant hypotheses in the literature (Christy, 1982; Ostrom, 1990; Costanza et al., 1998; Dietz et al., 2003; Evans et al., 2011; Gutierrez et al., 2011; Cinner et al., 2012). This result is not surprising considering co-management represents a fundamental component of common property institutions (Dietz, 2003; Ostrom, 2009). Numerous studies have revealed the importance of co-management and collective action in fisheries management (Gutierrez et al., 2011; Evans et al., 2011; Cinner et al., 2012; MacNeil & Cinner, 2013; Ovando et al., 2013). Co-management is often associated with improved resource management through the use of local knowledge, a heightened sense of ownership that promotes long-term stewardship, and increased compliance through peer pressure in addition to improved monitoring and surveillance by fishers (Gutierrez et al., 2011). However, co-management can also lead to undesirable outcomes such as the concentration of benefits among wealthier users and the creation of new incentives to overexploit (Cinner et al., 2012; Allison et al., 2012).

While all currently available studies have focused on co-management in fisheries broadly, several researchers have identified trends in TURF specific co-management. Gutierrez et al. (2011) found that of the 130 co-managed fisheries investigated across the globe, those that were associated with TURFs managing benthic and demersal species were particularly successful. Similarly, the presence of clearly established boundaries was one of the factors associated with a beneficial perception of co-management among users (MacNeil & Cinner, 2013) and co-management success more generally (Gutierrez et al., 2011).

Interestingly, when the multivariate regression was run to specifically analyze the effects of our six focal variables on a TURFs ability to meet fisheries objectives alone, co-management was no longer a statistically significant predictor of TURF success. This implies a TURF's ability to meet fisheries objectives is less dependent on co-management as a TURF's ability to meet social, economic, and/or conservation objectives. However, we may have failed to detect an effect due to data deficiencies. Furthermore, as mentioned previously, there is considerable overlap between fisheries-specific objectives and all other objectives, which may have skewed our results. While the relationship was not significant, co-management did show a weak positive relationship with TURFs successfully meeting fisheries objectives. More research is needed to confirm the limited role of co-management in achieving fisheries objectives, but there is some support in the general fisheries co-management literature. For instance,

Table 7. Summary of results and additional research needs related to TURF hypotheses
See Tables 4 and 5 for detailed descriptions of results.

Hypothesis	Results		Summary of Findings	Additional Research
	All Objectives	Fisheries Objectives		
TURFs that are co-managed equally by fishers and government are more likely to be successful.	Supported	Weak Positive Trend	Co-management is important for TURF success across all (aggregated) objectives. Co-management did not have as strong of an effect on successfully meeting fisheries objectives.	Because fisheries objectives are strongly interconnected to economic, social and conservation objectives, more explicit distinctions between fisheries and other objectives would better elucidate the impacts of co-management on differing objectives.
TURFs with longer duration of tenure are likely to be more successful.	No effect	Supported	TURFs with long tenure length are important in successfully meeting fisheries objectives.	Differentiating the various levels at which use rights can be assigned would help determine the scale at which fisher behaviors are incentivized to sustainably harvest resources.
TURFs are more successful for fisheries targeting lower mobility species.	No effect	Supported	TURFs that target low mobility species are more likely to successfully meet fisheries objectives.	Only the mobility at the adult life-stage was considered in this analysis; incorporating dispersal and other life history characteristics would make this relationship more conclusive.
TURFs with no-take zones are more successful.	Weak Positive Trend	Weak Negative Trend	The presence of NTZs did not influence TURF success. TURFs with and without NTZs were equally likely to be successful or unsuccessful.	Better understanding of other management strategies that can offer similar benefits to NTZs (e.g. stock enhancement, spatial rotations) would enhance understanding of how additional design features impact success.
TURFs lacking physical geographic enclosure are less likely to be successful	Weak Negative Trend	Supported	TURFs that are enclosed within a geographic feature were more likely to be successful (unable to control for additional variables).	A larger sample size is needed to further validate this hypothesis in order to run a multivariate analysis that includes other potentially confounding or contributing variables.
Physically larger TURFs are less successful as a result of increasing enforcement difficulty.	No effect	No effect	Unable to detect an effect.	A larger sample size is needed to determine if size truly does not influence success or whether our analysis was simply unable to detect an effect.
TURFs with effective enforcement are more likely to be successful.	Supported	Supported	TURFs that were ranked as having effective enforcement were more likely to be successful for any of the stated management objectives.	A larger sample size is needed to further validate this hypothesis to run a multivariate analysis that includes other potentially confounding or contributing variables.

Cinner et al. (2012) found that in co-managed fisheries in the Indo-Pacific, livelihood and compliance outcomes were most strongly affected by institutional characteristics, yet had little impact on the ecological condition of the fishery (Cinner et al., 2012). Co-managed fisheries are generally capable of supporting social and ecological goals (Cinner et al., 2012), but it is still unclear whether fisheries objectives specifically are more frequently achieved under a co-management framework in TURFs.

Interestingly, when the multivariate regression was run to specifically analyze the effects of our six focal variables on a TURFs ability to meet fisheries objectives alone, co-management was no longer a statistically significant predictor of TURF success. This implies a TURF's ability to meet fisheries objectives is less dependent on co-management as a TURF's ability to meet social, economic, and/or conservation objectives. However, we may have failed to detect an effect due to data deficiencies. Furthermore, as mentioned previously, there is considerable overlap between fisheries-specific objectives and all other objectives, which may have skewed our results. While the relationship was not significant, co-management did show a weak positive relationship with TURFs successfully meeting fisheries objectives. More research is needed to confirm the limited role of co-management in achieving fisheries objectives, but there is some support in the general fisheries co-management literature. For instance, Cinner et al. (2012) found that in co-managed fisheries in the Indo-Pacific, livelihood and compliance outcomes were most strongly affected by institutional characteristics, yet had little impact on the ecological condition of the fishery (Cinner et al., 2012). Co-managed fisheries are generally capable of supporting social and ecological goals (Cinner et al., 2012), but it is still unclear whether fisheries objectives specifically are more frequently achieved under a co-management framework in TURFs.

The government can initiate co-management in TURFs through top-down mechanisms such as the formation of laws that encourage co-management. Examples of national TURF co-management programs were found around the world and include such countries as Spain (Macho et al., 2013), Italy (Spagnolo, 2007), Sweden (Popescu, 2010), Japan (Makino & Matsuda, 2005), Chile (Defeo & Castilla, 2005), Mexico (McCay et al., 2014), South Korea (Uchida et al., 2012), Taiwan (Chen, 2012), and many areas throughout the Indo-Pacific (Cinner et al., 2012; MacNeil & Cinner, 2013).

In many case studies analyzed, government initiated co-management has been successful. As an example, in 1995 the Italian government established the Italian Molluscs Management Consortia in the Adriatic Sea in response to failed top-down management (Spagnolo, 2007). Clam stocks crashed in the 1970s and despite a well-formed licensing scheme, overexploitation continued and the stocks failed to recover. This prompted the government to establish a decentralized management scheme with the goal of decreasing government involvement and increasing localized management (Spagnolo, 2007). By effectively reducing fishing effort through a successful buy-back program, the fisheries stocks have recovered allowing for documented increases in market prices, profitability, and landings since the establishment of the co-managed TURF system (Spagnolo, 2007).

We also uncovered examples in which TURF co-management schemes initiated by the government were not well-received and effectively weakened traditional territorial use rights systems (Gelcich et al., 2006; Brown et al., 1999). Chile has one of the most well-established and well-studied TURF co-management systems in the world, with nearly 1,000 TURFs operating along the lengthy Chilean coastline (SUBPESCA, 2014). The Chilean system is widely received as a success (Cancino et al., 2007; Wilen et al., 2012), with numerous examples in which co-management has in fact contributed to this success (Defeo & Castilla, 2005). However, even in this well-established system, co-management has not been universally beneficial (Gelcich et al., 2006). In the case of TURFs harvesting bull-kelp, a traditional and informal TURF system was in place long before government imposed co-management. Upon implementation of the superimposed co-management regime, the traditional management structure has been considerably weakened and has resulted in increased conflict among users (Gelcich et al., 2006).

While the Italian Mollusc Consortia are focused on a single resource and operates very similarly along the relatively short Adriatic coast, the Chilean co-management system operates uniformly over a very diverse range of resources and user groups over an extremely long coastline. Gelcich et al. (2006) argue that while the Chilean system has been successful in many cases, the system was established to fit a single social ecological system (SES). In some cases, the SES prescribed by the government does not fit well

with, and can even hamper, traditional management systems. These examples highlight the complexities of social ecological systems associated with fisheries and support the need to focus management on both the resource as well as the people that rely on it (Ostrom, 2009; Guiterrez et al., 2011).

In our review of the literature we also found examples of bottom-up mechanisms used to initiate co-management, such as the case in Brazil (Diegues, 2008). Many authors have expressed the importance of bottom-up governance in fisheries co-management generally (Castilla, 2000; Pauly et al., 2003). Some have argued that TURFs specifically are a strategy best suited for small-scale fisheries in developing nations (Wilen et al., 2012; Costello et al., 2012). This assumption is based on the fact that in order for TURFs to internalize externalities associated with common pool resources, effective internal governance is required. Since TURFs operate at the local level, self-governance or strong community involvement through co-management is thought to be necessary (Wilen et al., 2012). Developing nations often lack top-down institutions capable of supplying adequate internal governance and thus are more likely to establish the bottom-up, co-governance strategies necessary for proper TURF management (Wilen et al., 2012). Indeed, co-management in small-scale fisheries has been the model approach for instituting rights-based management in developing nations (Allison et al., 2012).

4.1.1.1 Co-management and Developing Nations

Although TURFs are often touted as a management strategy that is ideal for small-scale fisheries in developing nations (Wilen et al., 2012), our analysis demonstrated that nearly half of the countries identified as having TURFs are considered high-income, or developed nations by the World Bank (Figure 4a), and most fall above the 25th percentile for government effectiveness (Figure 4b). In the case studies analyzed, host countries with a Gross National Income (GNI) score above the global average were found to be more likely to institute TURFs with co-management, indicating developed countries were more likely to institute TURF co-management than developing nations. Specifically, our results indicate that a given TURF is 7.91 times more likely to engage in co-management when the host country's GNI rises above the world aggregate value. Since 1995, high-income, developed nations such as Sweden (Popescu, 2010), Italy (Spagnolo, 2007), and New Zealand[11] (Bess, 2001) have passed laws and/or created initiatives to encourage co-management through TURFs, indicating area-based rights do function as an effective management solution across all income classes. Although, one could infer that developed countries would be more likely to devote resources for researching and developing the framework for a co-managed TURF.

In this analysis, we were not able to compare countries with TURFs against countries (along the coast) without TURFs, making it difficult to understand if income class is associated with TURF implementation. Moreover, the observed results could also be biased from our data collection procedure; often developed countries have more formal fisheries management and consequently relevant literature is more readily accessible. Even still, our data indicate that TURFs are more frequently located in countries above the global average income. This does not mean that TURFs cannot be successfully implemented in developing, low-income countries, but these trends do warrant additional analysis to determine if TURFs are an appropriate strategy for fisheries management in low-income nations. It is possible that some level of government involvement or government effectiveness is required for TURFs to function adequately.

There is considerable support for the assertion that co-management and rights-based management may not be an effective blanket strategy for lower-income nations. Jardine & Sanchirico (2012) demonstrated that developing countries with catch share programs, including TURFs, tend to have higher governance ranking scores and stronger overall economies when compared to developing countries without catch shares. While Gutierrez et al. (2011) did not consider different income-classes in terms of GNI, they did report that countries with higher Human Development Index (HDI) scores were correlated with co-management success in fisheries. In the current analysis, HDI showed a similar trend to GNI among the countries identified as having TURFs, as average HDI scores of TURF countries fell above the global average. In investigating co-management in small-scale fisheries in developing nations in the Indo-

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[11] Refers to indigenous rights for Māori fishers, not ITQs discussed above.

Pacific, Cinner et al. (2012) found that TURFs actually has a strongly *negative* effect on users' compliance. Possible explanations for this counterintuitive result include unclear use rights assignments (typically associated with membership confusion due to marital arrangements) and inadequate surveillance and enforcement of the TURF by local fishers (Cinner et al., 2012).

Many other factors present challenges to small-scale fisheries, not all of which are directly tied to fisheries management. For instance, poverty, increasing population growth, and economic globalization can influence the effectiveness of fisheries management as well as individual fisher's incentives for resource use (Evans et al., 2011; Allison et al., 2012). In many cases, declining fish stocks and/or insecure rights are not the leading causes of poverty, and thus if efforts are taken to institute TURFs on the premise of changing fisher's incentives, they are unlikely to be successful as the underlying issue is not directly resolved (Allison et al., 2012). Fishers in developing nations do not always view declining fish stocks as the most immediate threat as other factors more imminently threatened their well-being, meaning these users are less likely to effectively steward the resource (Allison & Ellis, 2001; Allison et al., 2012). In developing nations in the Indo-Pacific, fish biomass was negatively correlated with an increased dependence on the marine resource (Cinner et al., 2012).

These trends are important to understand, as considerable effort and funding is currently being devoted to establishing TURFs in developing nations around the world (Grieve, 2009; World Bank, 2012). We identified 11 countries that have expressed some level of interest in instituting TURFs, either through third party organizational efforts or by national governments. All 11 countries identified fall below the average global income level and four fall within the low-income bracket. In contrast, only half of the countries with currently established TURFs fall below the global average income level and only one country, Benin, is considered low-income. However, it is important to note that examples of successful TURF co-management exist in many developing nations. These trends may simply indicate that TURF implementation may be more complex and require additional third party investment when instituted in developing countries, but does not necessarily imply TURFs will be less successful in low-income countries.

4.1.2 Success in the Context of Fisheries Objectives

While TURFs may be implemented and managed with a wide range of objectives in mind, spanning conservation, social, and economic goals, TURFs are most frequently considered a mechanism to achieve fisheries objectives. Fisheries objectives often center on goals such as increasing stock biomass or maintaining harvest rates at maximum sustainable yield. Given that the majority of the case studies in this analysis listed fisheries objectives as one of the two stated TURF objectives, we chose to separately analyze our seven hypotheses related to success against the ability of TURFs to specifically meet stated fisheries objectives.

Our results varied considerably when regressions were run to only consider fisheries objectives in comparison to regressions considering all forms of management objectives. As stated above, when all stated management objectives are considered, only co-management presents as a significant variable associated with TURF success; however, when we focused solely on fisheries objectives, co-management showed a weak, insignificant relationship with success. By focusing the analysis on fisheries objectives, several variables shown to be insignificant when associated with all forms of objectives, had statistically significant effects on the likelihood of TURF success. The presence of a short tenure length and low mobility species both had significant effects on a TURF's ability to meet their stated fisheries management objectives. While we were unable to include our measure of geographic enclosure in the multivariate analysis, when run univariately against success, geographically unenclosed TURFs also showed a significant relationship with TURF success – a finding that was not shown to have a significant effect when tested against all objectives. While the size of a TURF[12] was not a significant predictor of

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[12] Due to data limitations, number of fishers was used as a proxy for size in success regressions as number of fishers was a larger data set and highly correlated with TURF size in a Pearson's product-moment correlation test.

TURF success, a weak negative effect was detected indicating TURFs larger may experience greater challenges when trying to meet fisheries objectives

4.1.2.1 Duration of Tenure

For territorial use rights to sufficiently incentivize long-term stewardship, the use right must be long enough in duration to instill confidence in the user's ability see returns on their investments (Grafton et al., 2006; Costello & Kaffine, 2008; Ostrom, 2009; Wilen et al., 2012). Our results further support these assertions—short tenure lengths, less than three years in duration, negatively influence a TURF's ability to meet its stated fisheries objective(s). In other words, a longer tenure length gives sufficient time for fishers to internalize the long-term benefits of sustainable fishing practices and encourages fishers to abide by regulations designed to meet fisheries related management goals. Despite this negative effect, the majority of our TURF case studies allocate short use rights that are less than three years in duration.

It is important to note that there are many ways in which territorial use rights can be granted. Rights to harvest resources in a given area can be granted to individuals or a group, such as a fishing cooperative. In either case, rights granted in perpetuity offer the most security. However, governments are often reluctant to grant full control or ownership to an area in perpetuity, meaning governing bodies frequently offer concessions or leases for a specified period of time (Costello & Kaffine, 2008). Most commonly, cooperatives or groups are able to apply for concessions, which are usually renewable. Modeling exercises reveal that as long as the probability of renewal is high, even relatively short concession lengths can, under some circumstances, promote sustainable use (Costello & Kaffine, 2008; McCay et al., 2014). Presumably, even if property rights are imperfect or not fully secure, they can still provide some benefit (Wilen et al., 2012). However, in most cases, as concession length decreases it is more difficult to provide sufficient incentives to ensure stewardship (Costello & Kaffine, 2008). Factors such as the life history of the targeted species and the perceived likelihood of renewal are expected to greatly influence how tenure length will affect successful management (Costello & Kaffine, 2008; McCay et al., 2014). The effects of concession length on TURF management are well understood in the Mexican Baja California FEDECOOP Benthic Species TURF for lobster and abalone (Costello & Kaffine, 2008; Cunningham, 2013; McCay et al., 2014).

In cases where a fishing cooperative is granted a government concession to manage a particular area, there are frequently additional use rights granted to individual fishers within the cooperative. Therefore, while cooperative may receive a 20-year concession, individual fishers may only have guaranteed access to the area on an annual basis. This indicates that success may vary dependent on the scale at which tenure length is analyzed. Here, we analyzed the finest available scale of use rights allocation (i.e. down to individual allocation when available).

Interestingly, we identified several TURF systems in which short tenure lengths may actually be beneficial to the user. For instance, TURFs in Malta (MRAG, 2009) and the Languedoc-Roussillon region of France (Grieve, 2009) both function as Divided TURFs (TURF regime type 2, see Section 3.2). In both cases, fishers are allocated a specific area of water based on an annual lottery. Due to natural variation in the distribution of species within a landscape, some fishing areas will be more productive than others. In the instance that a fisher is granted an area with low productivity in a given lottery, the user will benefit from a short tenure (Grieve, 2009).

Our analysis reveals that the level of government involvement in management and the age of a TURF most commonly influence tenure length. TURFs that are older than 100 years are more likely to institute short tenure lengths when compared to younger TURFs. This is potentially an indicator that TURFs that have been implemented more recently have been designed in consideration of the prevailing economic theories associated with secure property rights. Counter-intuitively, our results indicate that TURFs with high government involvement are less likely to institute short tenure lengths, with strong statistical significance. This result is surprising considering national governments are often hesitant to assign long-term property rights (Costello & Kaffine, 2008). Perhaps government institutions are increasingly realizing the benefits of secure access rights. Alternatively, if governments remain heavily involved in the everyday management of the TURF, governing agencies may have a greater sense of authority and control when granting individuals access.

4.1.2.2 Species Mobility

Our results indicate that TURFs managing low mobility species are significantly more likely to reach their fisheries objectives. This corroborates one of the more frequently cited assumptions that sedentary or benthic species are most appropriate for area-based management (Christy, 1982; Allison & Ellis, 2001; Prince, 2003; Defeo & Castilla, 2005; Cancino et al., 2007; Poon & Bonzon, 2013). Specifically, Christy (1982) assumed that TURFs will be most effective when they manage sedentary species, species raised or confined to pens or cages, species attracted to fish aggregating devices, and diadromous species. Jardine & Sanchirico (2012) systematically tested these assumptions by analyzing the life history characteristics of targeted species in TURFs found in developing nations; they report strong support for Christy's original hypotheses. While this level of detail was beyond the scope of the present analysis, anecdotally, many of the case studies analyzed lend support to these findings. Many national TURF systems specifically manage benthic species including Galicia, Spain (Macho et al., 2013), the United Kingdom, and Italy's Adriatic Sea Clam Fishery (Spagnolo, 2007), Chile, and Ecuador. Additionally, some systems exclusively relied on spatially explicit fish aggregating devices (e.g. Malta [MRAG, 2009] and Indonesia [Satria & Adhuri, 2010]). It is possible that the observed relationship between low mobility species and success is confounded by the fact that sedentary species often fetch higher market prices (Cancino et al., 2007); our dataset did not allow us to test this hypothesis.

A surprisingly large number of the TURF case studies analyzed specifically managed medium or high mobility species, sometimes in addition to low mobility species. In a global analysis of TURFs managed in association with no-take reserves, Afflerbach et al. (in progress) was unable to detect a management preference for low mobility species. Certainly, in some cases higher mobility species can be effectively managed under a TURF system. For example, assuming the target stock is not faced with significant external pressures even if it moves beyond the bounds of the TURF, fishing within the TURF can still remain sustainable. However, more frequently, target species migrate and disperse outside of TURF boundaries at some point during their life cycle, which can substantially erode property rights (Janmaat, 2005; Kaffine & Costello 2011; White & Costello, 2011). These spatial externalities can be overcome through coordinated efforts between neighboring TURFs (Kaffine & Costello 2011; Poon & Bonzon, 2013). The sakuraebi (shrimp) fishery in Suruga Bay, Japan has become famous for its ability to successfully manage a migrating species through concerted coordination between neighboring fishing cooperatives in the form of income pooling (Uchida & Baba, 2008; Sakai et al., 2010). Coordinated profit sharing prevents competition, which has allowed market prices to increase, fisher income to increase, and shrimp stocks to remain healthy (Sakai et al., 2010; Uchida & Baba, 2008).

4.1.2.3 Geographic Enclosure

While we were unable to include our measure of geographic enclosure in our more robust multivariate analysis, we were still able to examine direct trends between geographic enclosure and TURF success by running a univariate analysis. When tested directly against a TURF's ability to meet fisheries objectives, a significant relationship emerged, indicating that TURFs located in areas that are more enclosed by shoreline geography are more commonly able to meet stated fisheries objectives. This is intuitive, because when TURFs are located within an enclosed area, at least part of the TURF boundary are delineated by land, which should make enforcement more effective and less expensive (Wilen et al., 2012). Conversely, a high degree of exposure to open water should limit the success of a TURF. A possible exception to this would be TURFs located in areas of relative isolation—such as some island nations in the central Pacific— where the probability of illegal fishing is diminished, as is noted with MPAs (Edgar et al., 2014).

Salient examples were identified among the case studies analyzed, both across all objectives and fisheries objectives specifically. The Gulmar Fjord in Sweden offers an example of successful TURF management, as exemplified by increased market prices and revenue coupled with effective habitat conservation strategies (Eggert & Ulmestrand, 2008). The TURF is located within a narrow fjord that is fully enclosed, leaving virtually no open water boundaries to monitor or enforce. Furthermore, the fjord's geography creates extreme weather events, which tend to deter illegal fishers (Eggert & Ulmestrand, 2008).

Geographic enclosure is also expected to affect the types of species harvested in a given TURF. For instance, some species may be confined to a bay, lagoon, or estuary due to oceanographic conditions such as currents, primary productivity, or salinity. Therefore, the amount of enclosure may be related to success due to a propensity for less mobile species to inhabit an enclosed area. The success of the sakuraebi (shrimp) fishery in Suruga Bay, Japan is in part related to the fact that the sakuraebi migration is restricted to the bay by virtue of the species' life cycle and the seafloor bathymetry (Uchida & Baba, 2008).

4.2 Additional Trends in TURF Management

Among the seven success hypotheses tested, we did not detect statistically significant effects of TURF size or the presence of a no-take zone. Due to difficulties associated with comparing variables across diverse case studies, countries, and regions (Poteete & Ostrom, 2008), data deficiencies may have inhibited our ability to detect significant relationships. Despite this challenge, we are still able to draw inferences as to why no effect was detected. Direct comparisons between single variables and success also yielded interesting and informative trends, although these tests did not allow us to control for potential confounding variables. Finally, regardless of success, we were also able to draw conclusions concerning why common design characteristics are frequently utilized under different circumstances.

4.2.1 No-Take Zones

TURFs with no-take zones (NTZs) were not found to significantly improve a TURF's success. Certainly, NTZs have been shown to increase species abundance, size, and biodiversity within the NTZ (Halpern, 2003), increase fecundity (Palumbi, 2004), and promote ecosystem resiliency (Grafton et al., 2005). Spillover effects are expected to allow TURF members to benefit from the presence of an NTZ (Halpern et al., 2010). TURFs coupled with NTZs are found around the world as demonstrated here and by others (Afflerbach et al., in progress). An increased sense of stewardship associated with secure property rights have been shown to influence a group's propensity to lobby for and/or support NTZs (Yagi et al., 2010; Perez de Oliveira, 2013; Arceo et al., 2013; Ovando et al., 2013). Furthermore, the presence of protected areas has also been found to be a significant predictor in the success of co-managed fisheries (Guiterrez et al., 2011).

We may not have detected a relationship between success and NTZ presence because there are other means by which a TURF can realize fisheries and conservation benefits. For instance, a recently formed TURF in the Netherlands has proven successful without having implemented an NTZ (Grieves, 2009). A pilot project started by the Integrated Fishery Foundation aimed to create a low-impact fishery capable of using diverse gear types to harvest species based on their local availability (Grieves, 2009). Consequently, fish were only targeted during specific seasons and in select habitats in order to obtain the highest catch at the lowest cost. By only targeting a given species at the 'best' time, this TURF created opportunistic closures that offered similar benefits to seasonal NTZs. Other means of achieving similar benefits to those realized by NTZs include stock enhancement and targeting seeding efforts (Takahashi et al., 2006; McAlister et al., 2010) and complex spatial rotation systems that preserve sensitive habitats (Takahashi et al., 2006; da Silva, 2004). Moreover, simply including NTZs may not guarantee TURF success (e.g. Stamieszkin et al., 2009). Monitoring, enforcement, and coordination costs may also increase with the implementation of an NTZ.

4.2.2 Size

We were unable to test the relationship between TURF success and areal size, but using the number of fishers as an indicator of size, a weak, albeit negative relationship was detected. However, we did analyze TURF areal size as the dependent variable against the number of fishers, species mobility, the length of the host country's coastline, and the geographic enclosure of the TURF. This analysis revealed a strongly significant relationship in which larger TURFs tended to have more fishers, hence the use of the number of fishers as a proxy for TURF size in the multivariate success analyses.

This analysis also revealed that species with low mobility adult life stages are more frequently associated with smaller TURFs. In some ways, this supports the work of Costello and Kaffine (2011) and White and

Costello (2011), which suggest that TURF size should be scaled to accommodate the full range of the target species to minimize spatial externalities that can diminish the security of property rights. That is to say, that TURFs that target more mobile species are typically larger in size, potentially in order to sufficiently ensure that users outside of the TURF boundary do not negatively impact the resource.

This interpretation, however, is fairly narrow in scope. Even species that are completely immobile in the adult life stage frequently have wide-ranging larval dispersal. We found no indication of TURFs designed explicitly to consider the target species' range, but instead were more commonly associated with administrative boundaries. White and Costello (2011) demonstrated that small TURFs attempting to manage mobile species (at any life stage) can severely limit a user's sense of ownership, potentially to the point of near open-access conditions. Additional controls such as income pooling and coordination between neighboring TURFs are area may be able to limit spatial externalities (Kaffine & Costello; 2011). Wilen et al. (2012) suggest a potentially more important question related to size and scale is determining at what point a TURF is large enough to internalize spatial externalities (inter-TURF) but small enough to manage transaction costs (intra-TURF).

There are numerous confounding social, biological, and economic factors that could influence TURF size, which were not included in our model due to data limitations. Potential factors include the financial capital of countries or relevant institutions invested in TURFs, the range of larval dispersal of target species, the gear type used in the fishery, the enforcement and patrol regime, and conflicting uses in coastal waters (i.e. development, oil and gas extraction, or recreation). Size is certainly a fundamental consideration in TURF design, but determining which characteristics are needed to strike a successful balance between keeping TURFs small enough to easily enforce yet large enough to minimize spatial externalities have proven challenging.

4.2.3 Enforcement Effectiveness

While we were unable to include our measure of enforcement effectiveness in our more robust multivariate analysis, we were still able to examine direct trends between enforcement and TURF success. TURFs with effective enforcement are more likely to be capable of meeting any of their stated objectives. This result is to be anticipated; however, it is important to keep in mind that the effectiveness of enforcement may not be due to high or stringent penalties. Instead, effectiveness may be fully reliant on social and institutional norms that create an environment in which monitoring TURF boundaries and activities are not even necessary (e.g. Cinner, 2005).

The significant relationship between effectiveness of enforcement and success affords a critical opportunity to investigate what specifically makes enforcement "effective". We detected a significant negative relationship between TURFs with "soft" boundaries and effective enforcement. In other words, TURFs with boundaries delineated by public knowledge or public maps (so called "soft" boundaries) are associated with reduced enforcement effectiveness. These findings were supported by several case studies in which conflict between neighboring communities arose out of confusion made by poorly marked or understood boundaries (Aswani, 2005; Hviding, 1998). In the United Kingdom, TURF are explicitly required by law to clearly mark all TURF boundaries, as infractions cannot be levied against intruders unless boundaries are clearly visible (Defra, 2013).

Variations in governing institutions are expected to influence enforcement. Indeed, co-managed TURFs were more frequently associated with effective enforcement. This is indicative of the balance between the government's capability to provide financing, infrastructure, and legal force, and the community's ability to discourage rule breaking while applying social pressures. Surprisingly, enforcement effectiveness was actually weaker in countries with effective rule of law[13] (ROL). On first inspection, a logical assumption would be that countries with higher ROL scores, and thus better national enforcement mechanisms, would host TURFs with more effective enforcement (Wilen et al., 2012). However, effective enforcement at the

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[13] Rule of Law is a World Bank World Governance Indicator that, "Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."

national level is not necessarily indicative of enforcement mechanisms at the local scale. Enforcement may be very effective locally, regardless of national trends, because of dedicated self-enforcement or social pressures. For example, success in the Ecuadorian mangrove cockle TURFs may be associated with the fact that fishers regularly patrol the TURF's on a rotating basis (Beirl, 2011). Similarly, the Mexican Vigia Chico spiny lobster cooperative is a community-based cooperative that has exclusive lobster harvesting privileges in an enclosed bay that is more easily patrolled locally due to its geography (Cunningham, 2013).

Enforcement effectiveness can also be complicated by many additional factors not incorporated into this analysis. In Galicia, Spain for instance, some TURFS have experienced major enforcement issues due to limited funding (Perez de Oliveira, 2013). In the recent past, the government hired a private company to patrol the TURF, which included both regular on-shore and boat patrol. This was very successful until recently, when budget cuts ended the availability of active surveillance for the TURF. Despite the Galician Service of Coastguards having since assumed enforcement responsibility, illegal fishing has been an increasing problem since funding was cut (Perez de Oliveira, 2013; pers. comm. with L. Perez de Oliveira). This example highlights the notion that local enforcement abilities are essential, as national enforcement entities may not have the ability to effectively monitor individual TURFs.

4.3 Data Caveats

In the present study, we defined a TURF simply as an area of water with clearly defined boundaries and some level of exclusive access. However, there are multiple factors that complicate our understanding of where TURFs are located, which likely implies that more countries than identified here have TURFs. First, there is no clear definition of a TURF (Christy, 1982; Spagnolo et al., 2012). We chose to leave the definition broad, but a more specific definition would certainly affect the number of countries identified as having TURFs. There are also complications related to the differences between formal, legally established TURFs and de facto TURFs that function solely based on word of mouth and social norms. It is very likely that de facto, informal TURFs can be found in most countries around the world. While some of these informal systems are discussed in the literature (Johannes, 2002), in most cases these TURFs are not well understood or documented.

There were also issues associated with limitations, biases, and language barriers in the peer-reviewed and grey literature. Some TURF systems are very well documented in the literature providing a wealth of easily obtained information (e.g. Japan, Chile, CMT in the Indo-Pacific). However, other regions are not well represented (e.g. West Africa, the Caribbean, the Western Indian Ocean) and in some cases, the available articles present limited information making it difficult to determine if these fisheries truly operated as TURFs. Many regions lacked recent literature making it impossible to determine if systems that operated 30-40 years ago are still functioning today. While in some cases government websites and documents proved informative, many countries do not supply English versions of government reports. In cases where government websites had English versions, they were often truncated and did not supply the same information available in the native language. Due to these limitations, this analysis may be bias towards countries with a higher frequency of peer-reviewed literature and availability of English versions of grey literature.

Finally, since a single, broadly accepted definition of a TURF is not available, fisheries that function as TURFs according to the definition used here may not be considered TURFs locally or in the available literature. In many cases the term 'TURF' was never associated with fisheries in a given country. Fisheries utilizing territorial use rights may be associated with keywords such as territorial rights, Customary Marine Tenure, Community-based Fisheries Management, fisheries cooperatives, co-management in fisheries, limited entry, or by a traditional local name. There is also the potential that fisheries are called TURFs when they do not actually exercise exclusive access. Managed access fisheries operate similarly to TURFs, but differ in that while they may manage entry into the fishery, access is not made exclusive (e.g. Madagascar, Thailand). The lack of consistent language associated with TURF management greatly complicates analysis.

5. Conclusion

To the best of our knowledge, this is the first comprehensive database of TURF locations, design characteristics and success objectives. We found that TURFs have been broadly implemented to reach a variety of success objectives.

While TURF design may be complex and variable, some of assumptions made in the literature concerning management success do seem to hold true. Our results lend further support to the importance of co-management in facilitating successful TURF management. Similarly, TURFs that manage low mobility species and/or institute long tenure lengths are more likely to meet their stated fisheries management objectives. We also found some support for the importance of effective enforcement, size, and the extent to which a TURF is enclosed by physical geographic boundaries. Other factors not addressed here are expected to be important determinants of success, such as secure funding, third-party organizational or academic support, and conflicts with competing forms of coastal development.

While this analysis offers valuable insight into key variables that should be rigorously considered in the development of a TURF, the presence or absence of these design and management characteristics do not necessarily lead to success. In any given situation, we identified numerous examples of TURF case studies that offered expectations to our overall findings and conventional wisdom on TURF management more generally. These case studies imply that the success of a TURF can be achieved in many different ways (Lobe & Berke, 2004; Pomeroy et al., 2001; Nielsen et al., 2004; Cinner, 2005; Govan, 2009; Spagnolo, 2012; Uchida & Baba, 2008).

There are many diverse solutions that can be applied to declining small-scale fisheries around the world, and TURFs will not be appropriate under all conditions. TURFs do, however, offer some inherent advantages. The simple presence of a clearly defined boundary allows for innovative management strategies that would be logistically and financially unfeasible under other forms of RBFM such as ITQs (Cancino et al., 2007; Yagi et al., 2012; Wilen et al., 2012). Governments may benefit from instituting TURFs, especially when strong community support allows for reduced administrative, enforcement, and management costs. While we were unable to directly measure TURF success in terms of empirical changes in social, economic, or ecological metrics, our review of available case studies clearly shows that: a) there are several key variables that influence a TURF's ability to successfully meet self-defined management objectives, and b) territorial use rights are applied under an incredibly diverse set of conditions and apply a wealth of creative and unique strategies to combat common issues in fisheries management.

Empirical analyses aimed at uncovering causal relationships between management interventions and success is challenged by scope and an inability to easily compare systems spanning diverse cultural and ecological landscapes (Poteete & Ostrom, 2008; Evans et al., 2011). Evans et al. (2011) summarize how these challenges can be overcome: 1) establishing a comprehensive analytical framework, 2) creating meta-databases, and 3) by conducting large-scale (big N) field-based studies. We have initiated the development of a comprehensive meta-database on global TURFs. These data can be built upon through innovative web-based mapping techniques capable of rapidly harnessing knowledge from practitioners around the world. We recommend that efforts should be taken to maintain and improve this initial database.

As our database is expanded, future research should focus on the development of comprehensive analytical framework. We recommend the use of the framework outlined by Ostrom (2009), which is capable of analyzing complex social-ecological systems, such as TURFs. Indeed, this framework has proven valuable in determining factors driving success in co-managed fisheries (Gutierrez et al., 2011; Evans et al., 2011; Cinner et al., 2012; MacNeil & Cinner, 2013). Allison and Ellis (2001) and Allison et al. (2012) argue that incorporating a livelihood approach to TURFs, especially in developing nations, is necessary to fully understand how TURFs will influence incentive structures in different cultures. Incorporating basic human rights considerations may strengthen TURF implementation (Allison et al., 2012).

Finally, our understanding of TURF success would greatly benefit from large-scale field-based studies. This of course is extremely challenging. For instance, marine protected areas (MPAs) have been extensively studied for decades and are supplemented by numerous data rich meta-databases (Lester et al., 2009; Edgar et al., 2014; MPAtlas; Protected Planet) -- despite this, only recently have researchers begun to uncover the socio-economic benefits MPAs offer at a global scale (Edgar et al., 2014). Edgar et al. (2014) benefited greatly from rigorous, robust, and geographically broad field surveys that allowed the authors to identify five key features that clearly increase conservation benefits. The TURF literature is in its infancy compared to our understanding of MPAs, but it is interesting to note that three of the five features identified as important characteristics for MPA success by Edgar et al. (2014), are also hypothesized as being crucial to TURF success--specifically, the presence of no-take areas, effective enforcement, and size. This implies that future TURF research could benefit greatly from applying lessons learned from the MPA literature. Implementation of new TURFs in multiple contexts by Fish Forever in the coming years affords a unique opportunity to understand how social, economic, and ecological dynamics change upon TURF implementation. We recommend that Fish Forever take care to design projects under an experimental framework in order to garner clear, empirical evidence of how TURF management interventions can benefit an area.

TURFs offer a promising solution to many of the problems facing small-scale fisheries around the world. While our knowledge of factors leading to their successful implementation is limited currently, our analysis offers a positive advancement in this field of study. As our database is expanded, more detailed studies can continue to refine this understanding. Such advancements are critical in order to ensure that managers are able to make better-informed decisions in their efforts to enhance prosperity of fisheries, fishing communities, and ecosystems worldwide.

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Appendix 1
Data transformations

The following table indicates the methods used to transform dependent and predictor variables for regression analyses and the assumptions made to justify these transformations.

Variable	Type of variable in final analysis	Transformation and/or assumption
TURF success (for all objectives)	Binary	Initially ranked data on a scale from 1 to 5, with 1 as strongly disagreeing that the TURF met management objectives and 5 as strongly agreeing that the TURF met management objectives. When ranks provided for both primary and secondary management objectives, ranks scores were averaged. These averaged ranks were then re-coded this so that if a value above 3 was reported, the variable equaled 1 for meeting objectives, and any other selection equaled 0 for not meeting objectives.
TURF success (for fisheries objectives)	Binary	Initially ranked data on a scale from 1 to 5, with 1 as strongly disagreeing that the TURF met fisheries objectives and 5 as strongly agreeing that the TURF met fisheries objectives. Re-coded this so that if a rank above 3 was selected, the variable equaled 1 for meeting fisheries objectives, and any other selection equaled 0 for not meeting fisheries objectives.
Enforcement	Binary	Initially ranked data a 1 to 5 scale, with 1 as strongly disagreeing that the enforcement of boundaries is effective, 5 as strongly agreeing the enforcement of boundaries is effective. Re-coded this so that if a rank above 3 was selected, the variable equaled 1 when the enforcement of boundaries was identified as effective, other selection equaled 0 to indicate ineffective enforcement.
Short tenure length	Binary	Initially, integer data with the length of tenure length entered. Binned this into short, long tenure lengths, where short tenure lengths last 1 to 3 years and long tenure lengths last more than 3 years. Re-coded variable so if the data fell into the short tenure length bin, the variable equaled 1, and any other selection equaled 0. This variable describes the length of use right chosen for the "lowest order", which is the type of tenure more closely associated with the user if possible. If a tenure is not present, then a concession is chosen; if there is not an official concession granted for a limited amount of years, than it is the community right/customary marine tenure/de facto exclusivity (generally assumption of perpetuity). The lowest order use right was not explicitly asked in the survey, so there may be some disconnect with these data.
Co-management level	Categorical	Initially, categorical data with no, limited, equal, high, and all government involvement as proxies for co-management. No government involvement or low government involvement coded as "limited co-management," "equal co-management" unchanged, and high or all government involvement coded as "high co-management."
Limited government involvement	Binary	Initially categorical data with no, limited, equal, high, and all government involvement as proxies for co-management. Created new variable vector by re-coding so that if limited government involvement was selected, the variable equaled 1, and any other selection equaled 0.
Co-management	Binary	Initially categorical data with no, limited, equal, high, and all government involvement as proxies for co-management. Created new variable vector by re-coding so that if co-management was selected, the variable equaled 1, and any other selection equaled 0.

Variable	Type of variable in final analysis	Transformation and/or assumption
High government involvement	Binary	Initially categorical data with no, limited, equal, high, and all government involvement as proxies for co-management. Created new variable vector by re-coding so that if high government involvement was selected, the variable equaled 1, and any other selection equaled 0.
Presence of NTZ	Binary	Initially an option from a "choose all that apply" question regarding fisheries regulations to reduce effort. Created new variable vector by re-coding so that if no-take zone was chosen among the options, the variable equaled 1, and any other selection equaled 0.
Target species mobility	Categorical	Initially categorical data from a list of various groups of target organisms, such as reef fish, bivalves, mollusks, groupers, etc. These were re-binned into low, medium, high, and variable mobility based on adult mobility and range patterns as described by Green et al. (in review). Observations were binned into the "variable" mobility bin if a combination of species with different adult ranges and mobility was indicated: for example, if "large pelagics" (high mobility) and "bivalves" (low mobility) were selected, then it would be coded as "variable".
Low mobility species	Binary	Initially from categorical variable from mobility of target species. Created new variable vector by re-coding so that if "low" mobility species was selected, the variable equaled 1, and any other selection equaled 0.
Medium mobility species	Binary	Initially from categorical variable from mobility of target species. Created new variable vector by re-coding so that if "medium" mobility species was selected, the variable equaled 1, and any other selection equaled 0.
High mobility species	Binary	Initially from categorical variable from mobility of target species. Created new variable vector by re-coding so that if a "high" mobility species was selected, the variable equaled 1, and any other selection equaled 0.
Variable mobility of species	Binary	Initially from categorical variable from mobility of target species. Created new variable vector by re-coding so that "variable" mobility was selected, the variable equaled 1, and any other selection equaled 0.
Amount enclosed within geographic feature	Categorical	No adjustment- run as categorical data with the following categories: TURF within entirety of geographic feature, TURF within most of geographic feature, TURF within part of geographic feature, and TURF not enclosed within geographic feature.
Entirely enclosed in geographic feature	Binary	Initially from categorical variable Amount enclosed within geographic feature. Created new variable vector by re-coding so that if "entirely enclosed" was selected, the variable equaled 1, and any other selection equaled 0.
Mostly enclosed in geographic feature	Binary	Initially from categorical variable Amount enclosed within geographic feature. Created new variable vector by re-coding so that if "mostly enclosed" was selected, the variable equaled 1, and any other selection equaled 0.
Partially enclosed in geographic feature	Binary	Initially from categorical variable Amount enclosed within geographic feature. Created new variable vector by re-coding so that if "partially enclosed" was selected, the variable equaled 1, and any other selection equaled 0.
Not enclosed in geographic feature	Binary	Initially from categorical variable Amount enclosed within geographic feature. Created new variable vector by re-coding so that if "not enclosed" was selected, the variable equaled 1, and any other selection equaled 0.

Variable	Type of variable in final analysis	Transformation and/or assumption
Soft boundary	Binary	Initially from categorical variable identifying TURF boundaries. Created new variable vector by re-coding so that if public knowledge or public map was selected, the variable equaled 1 to denote a "soft" TURF boundary, and any other selection equaled 0 to denote physical TURF boundaries or other.
Government enforced boundaries	Binary	Initially from categorical variable identifying TURF enforcement regimes. Created new variable vector by re-coding so that if government was selected among any options, such as "regular government boat patrol" or "random government boat patrol", the variable equaled 1, and any other selection that did not include the word government equaled 0.
Rule of Law	Continuous	No adjustment
TURF age	Binary	Initially categorical data with the following bins for the length of time that a TURF has been in place as a management strategy in that location with the following bins: less than one year, 1-2 years, 3-10 years, 11-20 years, 21-50 years, 51-100 years, or more than 100 years. Re-coded so that if more than 100 years was selected, the variable equaled 1 and any other option equaled 0. The 100 year cutoff was chosen because it represents a generational time lapse in management.
Legal TURF	Binary	Initially categorical data regarding legality of the TURF with the options of Yes the TURF is written into law, Yes the TURF is legally recognized but not written into law and No this TURF is not legally recognized. Re-coded so that the variable equaled 1 if Yes the TURF is written into law was selected and 0 if any other option was selected.
Above average Voice and Accountability Score	Binary	Average Voice and Accountability Score was 0, so this variable was re-coded so that if the country scored above 0, then the value equaled 1, and if the country scored below 0, the value of the variable equaled 0.
Above world aggregate GNI	Binary	Originally a continuous variable of country's gross national income, per capita. The 2012 World Aggregate per capita GNI determined by the World Bank was 10138.40, so this variable was re-coded so that if the country's GNI was above the aggregate, then the variable equaled 1, and if the country's GNI was below the aggregate, the value of the variable equaled 0.
Community leader	Binary	No adjustment- the variable equals 1 if community leader is involved in the management of the TURF and 0 if there is no indication that a community leader is involved in the TURF.
TURF size (km^2)	Continuous	No adjustment, areal size was either stated by survey respondent, stated in literature, calculated from shapefile, or calculated from georeferenced map.
Number of fishers (individual)	Continuous	Initially categorical data binned as 0-50, 51-200, 201-500, 500-1000, and more than 1000. Changed to continuous by entering the ceiling of the bin category, except when "more than 1000" fishers was selected. For these four observations the actual values were looked up. Due to high correlation between the number of fishers and size (see Results), number of fishers was used as a proxy for size in the Aggregated and Fisheries success regressions.
Length of coastline (km)	Continuous	No adjustment

Appendix 2
Country-Level Description

We identified TURFs in 41 countries. This appendix lists all of the countries for which country-level information is known. In some cases, a single county has multiple, independently operating TURF systems; therefore, some countries have multiple entries to explain these system level differences. The maps are used to display any location data that was obtained in this analysis; these points do not necessarily represent all the TURFs present in a given country. Similarly, the number of TURFs listed for a given country does not necessarily represent all the TURFs present in that country.
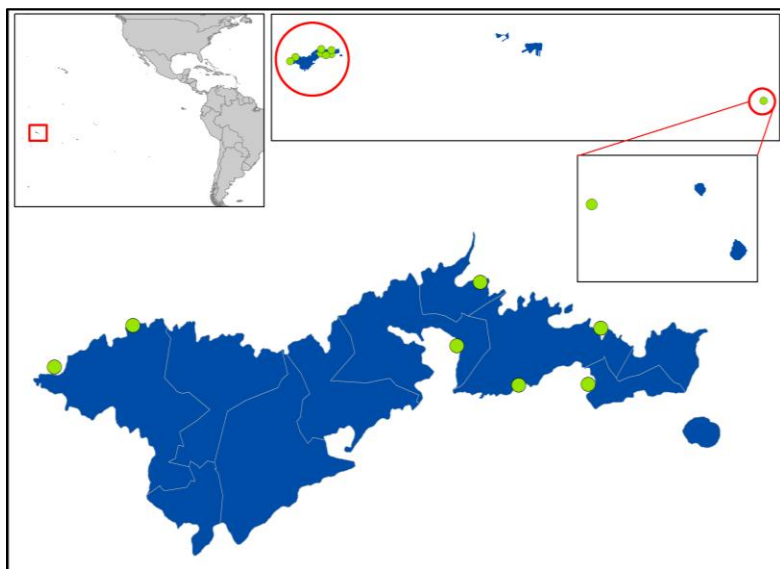

AMERICAN SAMOA
COMMUNITY-BASED FISHERIES MANAGEMENT PROGRAM (CFMP)

Number of TURFs:	12*
Date of Legal Standing:	2001
Local Name:	CFMP, Village Marine Protected Area (VMPA)
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Upper Middle Income

Overview
While American Samoa has a tradition of customary marine tenure over nearshore marine resources adjacent to villages, the Community-based Fisheries Management Program (CFMP) was established by the Department of Marine and Wildlife Resource (DMWR) to formalize those rights.[1] Once a village is approved by DMWR, representatives work with the village to establish a plan, as well as aid in technical assistance and advice, community workshops and training, and monitoring and implementation. The village is responsible for overseeing actions that protect and manage its marine area as agreed to in the plan. In most cases, communities implement village marine protected areas (VMPAs) to establish formal spatial restrictions in their nearshore waters. Generally, fishers from outside the community are either banned or require permission to fish in village waters, with violators subject to territorial citations through DMWR[2].

History
Historically and still today, many villages in American Samoa control use rights to their nearshore marine resources, with non-village members required to gain permission from a village mayor or council to fish in areas adjacent to the village. In 2001, the Department of Marine and Wildlife Resources (DMWR) formally established the CFMP to assist villages in managing their nearshore resources through voluntary co-management with the government[1]. The program was largely based on a similar program established in independent Samoa in 1995[1].

* As of 2012, 12 villages were enrolled in the Community Based Fishery Management Program, most of them managing through traditional bans or permission requirements for fisherman from neighboring villages to fish in the reef adjacent to their village.

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[1] Richmond, L., & Levine, A. (2012). Institutional Analysis of Community-based Marine Resource Management Initiatives in Hawaiʻi and American Samoa. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-35, 48 p. + Appendices.
[2] Levine, A. S., & Richmond, L. S. (2014). Examining Enabling Conditions for Community-Based Fisheries Co-management: Comparing Efforts in Hawaiʻi and American Samoa, 19(1).

AUSTRALIA

Number of TURFs:	Unknown
Date of Legal Standing:	1994
Country Development Status:	High Income

Overview

While no national TURF system was found to exist in Australia, other management systems like limited entry and Individual Transferable Quota (ITQ) fisheries have gained in popularity. In instances where the target species is bounded to a specific geographic region (e.g. a bay or estuary) based its distribution and life history characteristics, many limited entry or ITQ systems may operate as TURFs by nature of their geography and target species. The Exmouth Gulf Prawn Fishery, a limited entry system in Western Australia, is one example of this TURF-like regime. The fishery here is bounded by the geographic features of the gulf, within which, exclusivity is allocated to those who own permits to harvest prawns (in this case, one company owns 15 of the 16 total permits)[1].

[1] Kangas M, Sporer E, Donoghue SO, Hood S. Co-management in the Exmouth Gulf Prawn Fishery with comparison to the Shark Bay Prawn Fishery. In: Townsend, R, Shotton, R, Uchida, H, editors. Case Studies on Fisheries Self-Governance. Rome: FAO; 2008. p. 231–44.

BELIZE

Number of TURFs:	Unknown
Date of Legal Standing:	1940s
User Group Allocation:	Community
Primary Target Resource:	Lobster and conch
Country Development Status:	Upper Middle Income

Overview

Fisheries in Belize have been heralded as an example of successful co-management in TURFs within the Caribbean region, mostly owing to the high participation among fishers in the cooperatives. Nearly all (98%) of fishers in Belize are cooperative members. Despite this, the lobster and conch fisheries are not without problems, including overexploitation, disputes over territories, labor shortages, and increasing conflict with tourism activities. TURF effectiveness is also limited because the government lacks the capacity to enforce TURF regulations. Cooperatives are responsible for production, processing, and export of resources, which has improved earnings for fishers[1]. Areas under the management of Fishing Cooperatives are further divided into smaller zones that are exclusive fished by local Belizean fishers. Access to these zones is inherited through a patriarchal lineage or through apprenticeship[2].
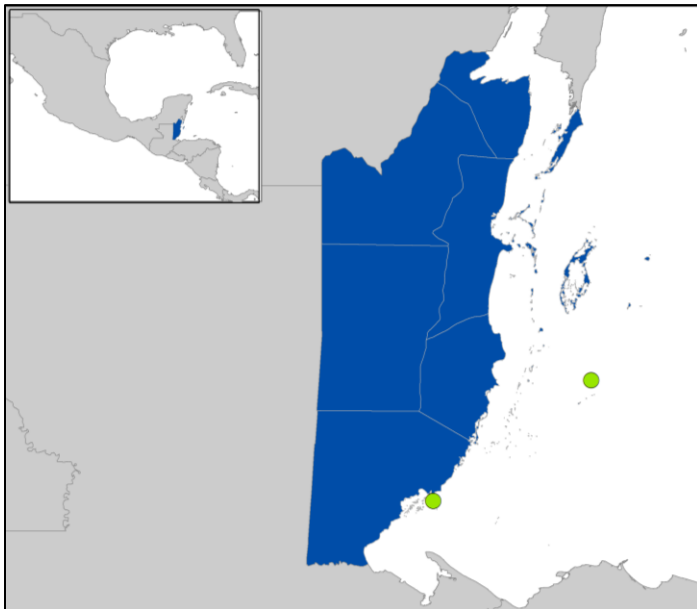
History

Although Belize has not had a long history of marine tenure, native Belizeans had controlled the lobster fishery for decades before any formal fisheries laws were implemented. In the 1940s, fishers began to form cooperatives to protect their rights and improve their earnings. Since then, native Belizeans have defended their territorial rights over the lobster and conch fisheries. The Belize Fishermen Cooperative Association was formed in 1970, which strengthened the capacity and power of the cooperatives in management decision making[1].

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[1] Brown, David N., and Robert S. Pomeroy. (1999) "Co-management of Caribbean Community (CARICOM) Fisheries." *Marine Policy* 23.6, 549-70. Print.
[2] King, Thomas D. "Folk Management among Belizean Lobster Fishermen: Success and Resilience or Decline and Depletion?" Human Organization 54.4 (1997): 418-26. Print.

BENIN
ACADJA

Number of TURFs:	Unknown
Local Name:	*Acadja*
Primary Target Resource:	None, many species targeted
Country Development Status:	Low Income

Overview

Acadjas are a traditional fishing method in Benin, although they have been known to lead to social conflict, creating feuds over fish and fishing rights[1].
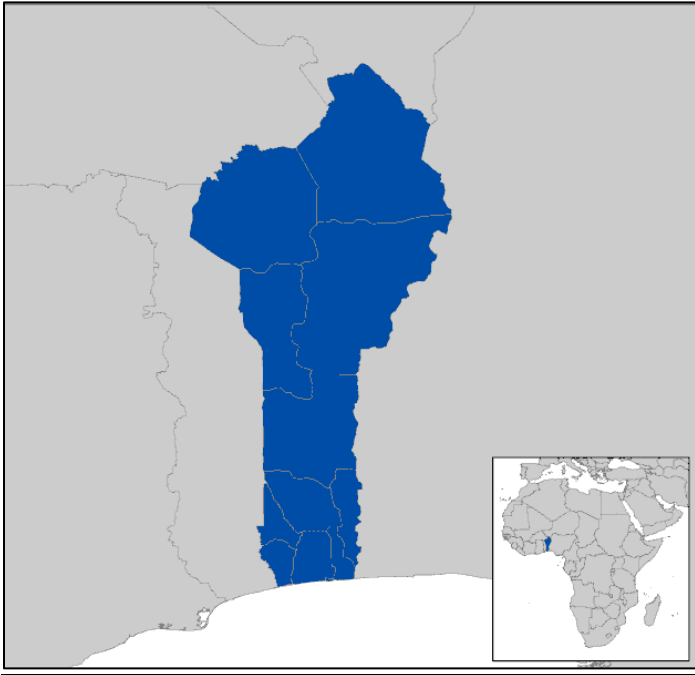
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[1] Olopade, O.A., Taiwo, O.I., Ajibade, D., Aluko, F. A. (2008). Community based fishery management: A case study of acadja method of fishing on the Badagry Creek, Ogun State, Nigeria. Journal of Agriculture and Social Research (JASR), 8(1), 28–33.

BRAZIL
MARINE-EXTRACTIVE RESERVE

Number of TURFs:	30*
Date of Legal Standing:	1990
User Group Allocation:	Community
Primary Target Resource:	Benthic species
Country Development Status:	Upper Middle Income

Overview

There are over 30 Marine Extractive Reserves (MERs) off the coast of Brazil that range in size from 600-830,000 hectares[1]. Establishing an MER in Brazil is a particularly formal and time-intensive process. Local communities or fishing cooperatives must apply for a concession from the Centre for Traditional Populations (CNPT) within the Brazilian Institute for the Environment (IBAMA), which is the federal agency that oversees extractive reserves[2]. Once CNPT receives the application, they conduct an assessment of the feasibility of the proposed MER, draft new laws must be passed to in order to establish the MER, and finally the President of Brazil must sign a presidential decree to officially establish the MER[2]. Successful concessions granted through the establishment of a MER last 50-60 years[2]. MERs are managed from the top down, as each MER is assigned an IBAMA government official who is primarily responsible for monitoring and enforcing the TURF[3].

*As of 2008

History

Traditionally, over 80% of Brazil's total catch came from artisanal fisheries. However, in an effort to gain a foothold in foreign markets, the Brazilian government encouraged the expansion of industrial scale fishing in the 1960s[2]. With the advent of the industrial fishing boom, coupled with the increased implementation of Marine Protected Areas (MPAs) that banned the fishing of certain areas, the artisanal fishing sector crashed. As MPAs became more popular, local fishers were unable to support themselves and were forced to relocate. Despite this, approximately 30 percent of protected areas in Brazil remained inhabited, and conflicts between community members seeking to use resources and managers were common[2]. In the 1980s, the Amazonian rubber tappers requested that the government establish extractive reserves instead of protected areas in an effort to achieve conservation goals while allowing traditional users to maintain their livelihoods. The CNPT was created within IBAMA and in 1989 MERs became designated conservation categories[3]. The increase of MERs over MPAs has largely contributed to the revitalization of the artisanal fishing sector. Simultaneously, industrial scale fishing caused fish stocks to plummet, making industrial fishing unprofitable. With that, artisanal fishing reemerged as the main form of fishing, accounting for 60% of Brazil's total catch today[1].

[1] Moura, R.L., Minte-Vera, C.V., Curado, I.B., Francini-Filho, R.B., De Castro Lima Rodrigues, H., Fraga Dutra, G., Correa Alves, D., & Bezerra Souto, F.J. (2009). "Challenges and Prospects of Fisheries Co-Management under a Marine Extractive Reserve Framework in Northeastern Brazil." *Coastal Management* 37.6: 617-32.
[2] Diegues, A.C. (2008). Marine Protected Areas and Artisanal Fisheries in Brazil. SAMUDRA. International Collective in Support of Fishworkers,
[3] da Silva, P. (2004) "From Common Property to Co-management: Lessons from Brazil's First Maritime Extractive Reserve." *Marine Policy* 28.5: 419-28.

CAMEROON
ACADJA

Number of TURFs:	Unknown
Local Name:	*Acadja*
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

Acadjas are a traditional fishing method used along the Western African coast, however, no specific case studies were found to provide further detail of their history in Cameroon[1].

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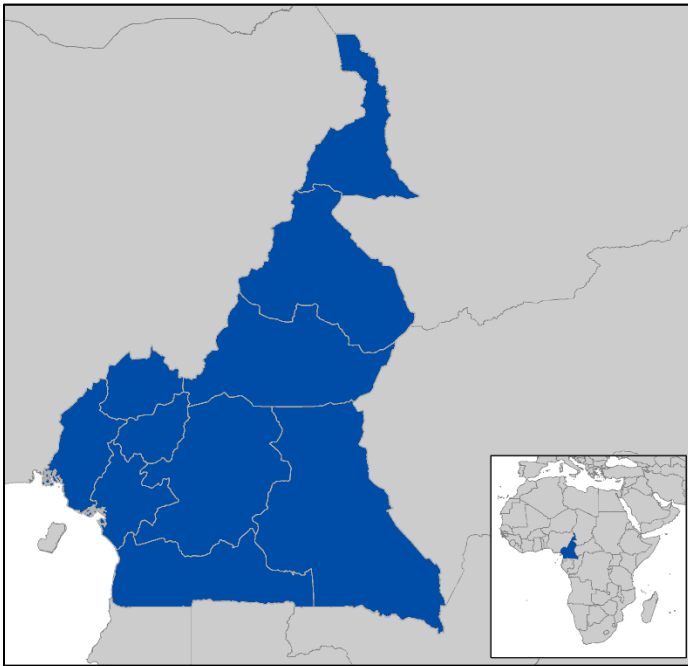
[1] Welcomme, R. L. (1972). An evaluation of the acadja method of fishing as practised in the coastal lagoons of Dahomey (West Africa). Journal of Fish Biology, 4(1), 39–55. doi:10.1111/j.1095-8649.1972.tb05651.x

CANADA

Number of TURFs: 2*
Date of Legal Standing: 1985
User Group Allocation: Cooperative or Community
Primary Target Resource: None, many species targeted
Country Development Status: High Income

Overview

Canada has a robust system of co-managed rights-based fisheries management. Most fisheries have Individual Transferrable Quota programs, and a few among these have zones where certain groups are allocated exclusive access to harvest in particular areas, such as in the Nova Scotia snowcrab fishery[1].

History

Informal, quasi-property rights in fisheries have been legal in Canada since 1977. The Fisheries Act of 1985 provides the legal authority to assign fishing zones states[1].

* As of 2008; more TURFs likely exist in Canada, but we are only aware of two.

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[1] Townsend R, Shotton R. (2008) Fisheries self-governance: new directions in fisheries management. In: Townsend, R, Shotton, R, Uchida, H, editors. Case Studies on Fisheries Self-Governance. Rome: Food & Agriculture Org; 2008. p. 90

CHILE
ÁREAS DE MANEJO Y EXPLOTACIÓDE DE RECURSOS BENTÓNICOS

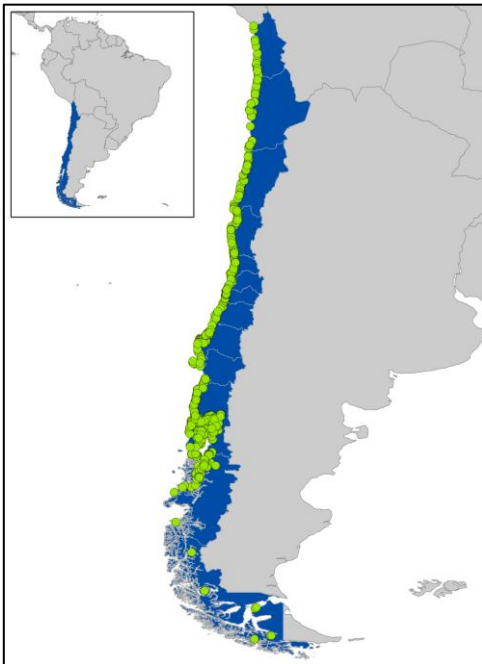|	
Number of TURFs:	793*
Date of Legal Standing:	1991
Local Name:	*Áreas de Manejo y Explotacióde de Recursos Bentónicos* (AMERB)
User Group Allocation:	Cooperatives
Primary Target Resource:	Benthic species (predominantly)
Country Development Status:	High income

Overview

In order to be granted a concession over a *caleta* adjacent to their residential area, artisanal fishers must register for a license from the National Fishers Registry, as well as to register their target species[1,2.]. With special permission form a TURF, unregistered fishermen are permitted to harvest finfish species within the TURF area[3]. Immediately following the second year of the TURF agreement, fishers must pay a fixed annual fee per hectare of seabed for the exclusive right to harvest the designated benthic resources, irrespective of region, target species, productivity, catch, or revenue. Fishing associations are also required by law to hire scientists from qualified universities or consultants to perform initial baseline studies describing the bathymetric characteristics and benthic communities found in the area. Before a TURF concession is granted, baseline studies must also include stock assessments as well as the socio-economic characteristics of the fishing community[1]. Finally, with the help of scientists and consultants, a one or two year management plan must be created based on findings of the baseline study. As an example of a regulation found in management plans, a TURF-level Total Allowable Catch (TACs) is set by the fishermen's association, and then allocated as individual quotas to the association members[4].

History

The AMERB system was formalized in 1991, although an informal system had been present for over 30 years[5]. Originally implemented to address the overexploitation of the Chilean abal.one, or loco, the AERB system now manages over 60 species. The reauthorization of the Fishery and Aquaculture Law extended the legislation to pelagic fishes.

*As of 2014

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[1] http://www.subpesca.cl/normativa/605/w3-article-764.html

[2] Cancino, J. P., Wilen, J. E., & Uchida, H. (2007). TURFs and ITQs: Collective vs. Individual Decision Making University of Rhode Island. *Marine Resource Economics*, *22*(5129), 391– 406.

[3] SUBPESCA, 2010b. Presentación de Informe "Estado de las pesquerías bentónicas Chilenas". Unidad de Recursos Bentónicos. División de Administración Pesquera de SUBPESCA. XXI Congreso Nacional CONAPACH, Noviembre 2010.

[4] Cancino, J. P., Wilen, J. E., & Uchida, H. (2007). TURFs and ITQs: Collective vs. Individual Decision Making University of Rhode Island. *Marine Resource Economics*, *22*(5129), 391– 406.

[5] Castilla, J.C., and DeFeo, (2001). Latin American benthic shellfisheries: emphasis on co-management and experimental practices. Reviews in Fish Biology and Fisheries 11: 1-30.

COOK ISLANDS

Number of TURFs: Unknown
User Group Allocation: Community
Primary Target Resource: None, many species targeted

Overview

The Cook Islands, like other states in the South Pacific, have a history of customary marine tenure that is still practiced today in many villages. More specifically, the Islands have had a revival in the establishment of traditional taboo or protected areas (often operating as periodic or temporary no-take zones limited to community upon opening), called *ra'ui*[1]. *Ra'ui* are traditional spatial restrictions used to control access to marine resources, however no specific case studies were found to provide further detail. The Cook Islands are widely distributed geographically in the Indo-Pacific, therefore, the map only displays the main islands.
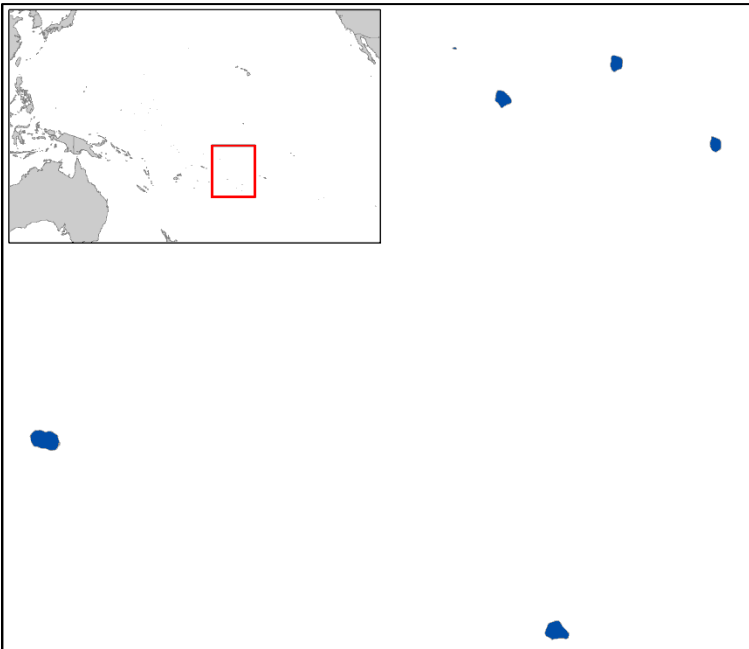
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[1] Govan, H., Tawake, W. A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Tafea, H., … Cohen, P. (2009). Community Conserved Areas : A review of status & needs in Melanesia and Polynesia.

Ecuador
Mangrove Cockle *Custodias*

Number of TURFs:	34*
Date of Legal Standing:	1999
Local Name:	*Custodia*
User Group Allocation:	Community
Primary Target Resource:	Cockles
Country Development Status:	Upper middle income

Overview

Custodias are concessions lasting ten years that are granted to communities for the sustainable use of mangrove resources and the ecological restoration and conservation of the mangrove habitat. Most *custodias* target mangrove cockles, a mollusk hand-collected from the mud among mangroves. Fishers belonging to the *custodia* are encouraged to self enforce, and in some instances, they rotate boat patrol responsibilities to ensure that the *custodia* boundaries are always being monitored. If fishers do not help enforce the *custodia* boundaries or follow management regulations, fishers can lose their harvesting privilege[1].

History

In Ecuador, deforestation of mangroves has increased with the development of shrimp aquaculture. In addition to habitat loss, the cockle fishery was simultaneously overharvested. To address these issues, in 1999, Executive Decree No. 1102 was passed, which recognizes the traditional rights of ancestral communities to mangrove areas. This allowed 34 coastal communities to apply for concessions, locally known as *custodias*[1].

* As of 2011

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[1] Beitl, C. M. (2011). Cockles in custody : the role of common property arrangements in the ecological sustainability of mangrove fisheries on the Ecuadorian coast, 5(2), 485–512.

FIJI
CUSTOMARY MARINE TENURE

Number of TURFs:	385*
Date of Legal Standing:	1991
Local Name:	*qoliqoli*
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Upper Middle Income

Overview

Traditionally, Fijians have managed the marine resources adjacent to their villages in what are called *qoliqolis*, or traditional fishing grounds. There are 410 *qoliqolis* in Fiji (385 of which are marine), which have been surveyed and registered by the Native Fisheries Commission so that the Comissioner may consult with *qoliqoli* owners when determining whether to issue a fishing permit in that area[1]. Commercial fishermen (fishing for trade or sale) are required to have a one year permit to fish in a given location. Fiji has been successful in implementing a Locally Managed Marine Area Network (LMMA), involving individuals, communities, traditional leaders, government, academics and NGOs to improve community-based marine conservation. The Fijian LMMA system (FLMMA) includes 217 project sites, with the goal of using local knowledge to develop and implement marine management plans for conservation, sociological and economic benefit[1]. LMMAs are typically delineated by the traditional fishing grounds of one or a network of *qoliqolis*, and while the Fisheries Department has "formally accepted the FLMMA model," LMMAs have no formal legal status in Fiji[2].
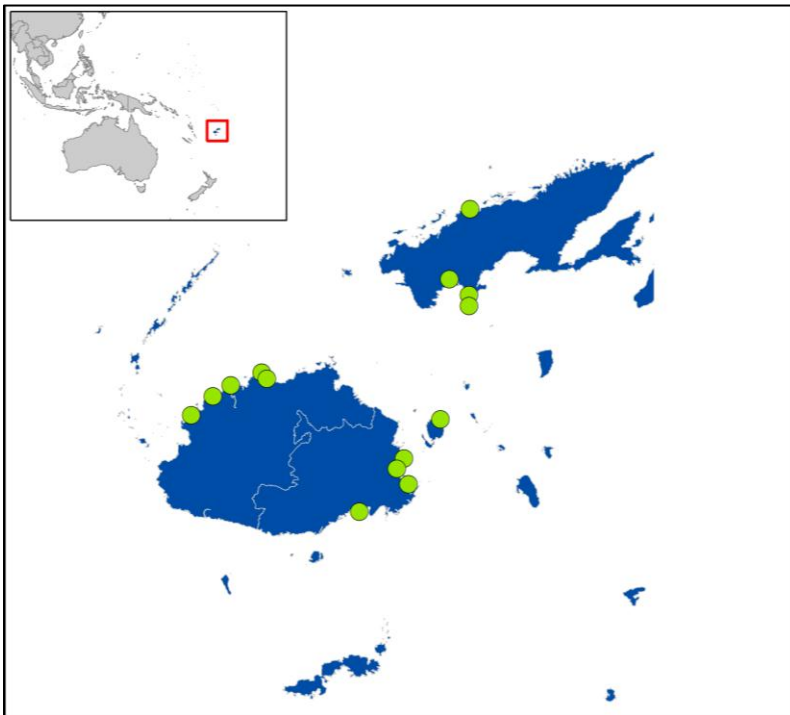
*385 marine *qoliqolis* reported as of 2009.

History

Fiji has a rich history of customary marine tenure through the management of traditional fishing grounds, or *qoliqolis*. The 1991 Fisheries Act enabled community involvement in management of coastal marine resources, requiring village consent for commercial and subsistence fishing in customary fishing areas and creating the position of community fish wardens[2]. In 1997, the first Fijian LMMA site was established in Ucunivanua–the success of which sparked the creation of the FLMMA network in 2001 to share methods and results[3].

[1] Govan, H., Tawake, W. A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Tafea, H., … Cohen, P. (2009). Community Conserved Areas : A review of status & needs in Melanesia and Polynesia.
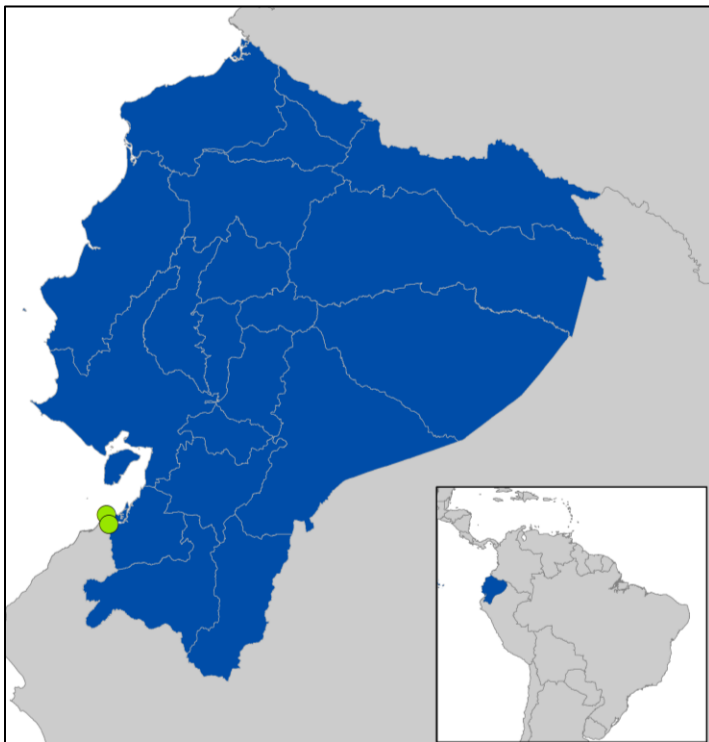
[2] Techera, E. (2009). Customary Law and Community-Based Fisheries Management across the South Pacific Region, (November), 279–292.

[3] United Nations Development Programme. (2012). Fiji Locally-Managed Marine Area Network, Fiji. Equator Initiative Case Study Series. New York, NY.
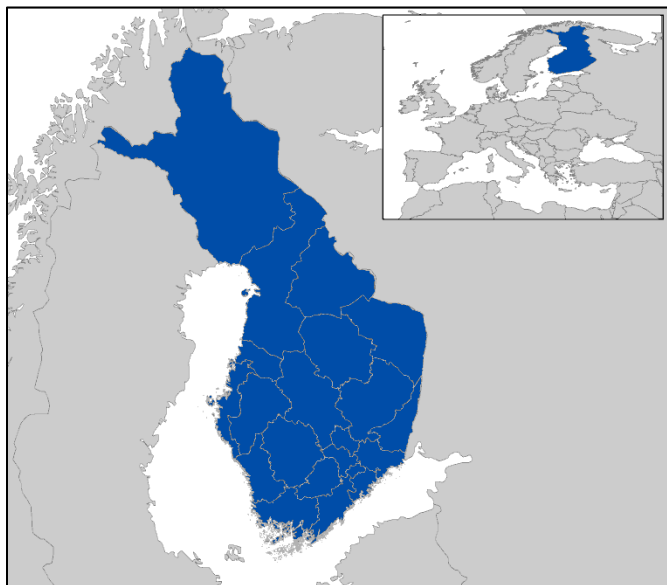
FINLAND
STATUTORY FISHERIES ASSOCIATIONS

Number of TURFs:	Unknown*
Date of Legal Standing:	1902
User Group Allocation:	Individuals or Community
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

In Finland, coastal waters and lakes can be privately owned, as water areas are simply considered an extension of a privately owned land parcel[1,2,3]. Therefore, all privately owned marine areas function as TURFs since the private owner has exclusive access to a specific area. Any marine area within 500m of the shoreline can be privately owned[1]. The government, municipalities, villages, or individuals can own private water areas. In many instances, all of the households within a municipality will jointly own the private waters adjacent to the city boundaries. In other cases numerous individuals in the area separately own small, fragmented parcels. In either case, Statutory Fishery Associations (SFAs) are frequently formed to aid in the collective management of coastal waters[1,2]. Fishing regulations are issued by Fisheries Regions, which are regional management organizations composed of SFA representatives, recreational, and commercial fishers. Together, Fisheries Regions and SFAs are able to develop local regulations that are more stringent then national regulations[1]. Private property owners may sell, transfer, rent or lease all or a portion of their property, which allows commercial fishers to gain access to coastal waters. In contrast, recreational fishing is largely unrestricted. Any Finnish citizen or permanent resident is allowed to fish in coastal waters recreationally without special permission from the owner. Not only do recreational fishers outnumber commercial fishers, recreational fish landing far exceed coastal commercial landings. Therefore, there is a great deal of competition for space and conflict among users[1].

History

Private ownership of coastal waters has a long history in Finland, dating back to 1766 when Finland was still a part of Sweden[2]. Traditionally, commercial fisheries were mostly operated by 'landless' people, or people who did not own parcels of land with adjoining water. But in 1902, the Finnish government passed legislation that strengthened the management and decision making powers of landowners while weakening the rights of the landless[2]. This resulted in a precipitous decline in the number of commercial fishers throughout the 20th century[2]. As the number of parcels increased, management became increasingly disorganized, despite the efforts of Statutory Fisheries Associations. Thus, in 1982 the government substantially reformed the Fisheries Act in order to promote regional fisheries management and sustainable fishing practices[1,2].

* There are as many TURFs as there are private coastal properties in Finland.

[1] Lappalainen, A., Salmi, P., & Varjopuro, R. (2002). Management of Baltic Coastal Fisheries: A Background Report (pp. 1–60). Helsinki. Retrieved from http://www.rktl.fi/www/uploads/pdf/raportti241.pdf

[2] Salmi, P. (2012). The social in change: property rights contradictions in Finland. *Maritime Studies*, *11*(1), 2. doi:10.1186/2212-9790-11-2

[3] MRAG, IFM, CEFAS, AZTI Tecnalia & PoIEM (2007); An Analysis of existing Rights Based Management Instruments in Member States and on setting up best practices in the EU, Parts I & II, European Commission, FISH/2007/03.

FRANCE
PRUD'HOMIES

Number of TURFs:	33*
Date of Legal Standing:	1859
Local Name:	*Prud'homies*
User Group Allocation:	Cooperative
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

Prud'homies, or fishing guilds, have existed for centuries and serve to protect the livelihoods of fisher and fishing communities along the French Mediterranean[1]. In order to fish within the territorial boundaries of a *prud'homie*, fishers must be an active member of the *prud'homie* and obtain commercial fishing licenses from the state[1]. While *prud'homie* leaders are given police power to enforce the *prud'homie* rules among its members, they do not have jurisdiction to sanction intruders, which is a large issue[2]. In some cases, *prud'homies* can apply to regional government committees to give their local rules and regulations legal force and allow *prud'homies* to legally sanction illegal fishers[1]. Fishers must abide by centralized national and European Union fishing regulations, but *prud'homies* are able to set additional regulations for their members. They have the power to regulate fishing activities, penalize offenders, control fishing activities (through licenses and lotteries), and resolve conflicts among users. However, overall *prud'homies* have limited involvement in decision-making at a governmental level and their power has largely diminished over time[1,3]. There are regional differences in management between *prud'homies* in the Languedoc-Roussilon region and the Provence-Alpes-Cote d'Azur and Corsica regions[1,2].
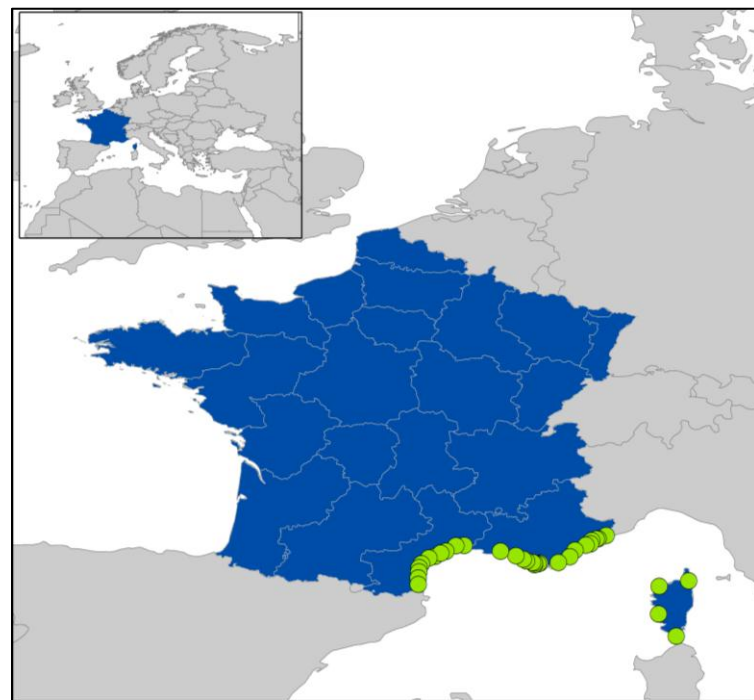
* As of 2012

History

Prud'homies were first formed the 14th century to oversee and organize the fishing activities in the territorial waters of coastal communities[2]. It was not until 1790 though that the State recognized the fishing organizations and not until 1859 that they were legally confirmed[3]. According to French law, the concept of *Droit de travail*, or the right to work and earn a living, must be preserved. Therefore, fairness and equal opportunity have always been and continue to be major considerations in *prud'homie* membership[1]. But over the years, fisheries management in France has become increasing centralized, with the implementation of blanket fisheries policies set by the French government and the European Union[2]. These policies have progressively weakened the traditional *prud'homie* system[3]. Even still, *prud'homies* continue to operate along the Mediterranean coast.

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[1] Grieve, C. (2009). Languedoc-Roussillon region of the French Mediterranean. In Environmental and Social Criteria for Allocating Access to Fisheries Resources (pp. 30–35). Pew Environment Group.
[2] Arceo, H. O., Cazalet, B., Aliño, P. M., Mangialajo, L., & Francour, P. (2013). Moving beyond a top-down fisheries management approach in the northwestern Mediterranean: Some lessons from the Philippines. *Marine Policy*, 39, 29–42. doi:10.1016/j.marpol.2012.10.006
[3] Spagnolo, M. (2012). What kind of management for Mediterranean fisheries? European Parliament, Brussels. doi:10.2861/45788

GHANA

Number of TURFs:	Unknown
Country Development Status:	Lower Middle Income

Overview

While no case-study data was found for TURFs in Ghana, their presence has been cited in the literature[1].

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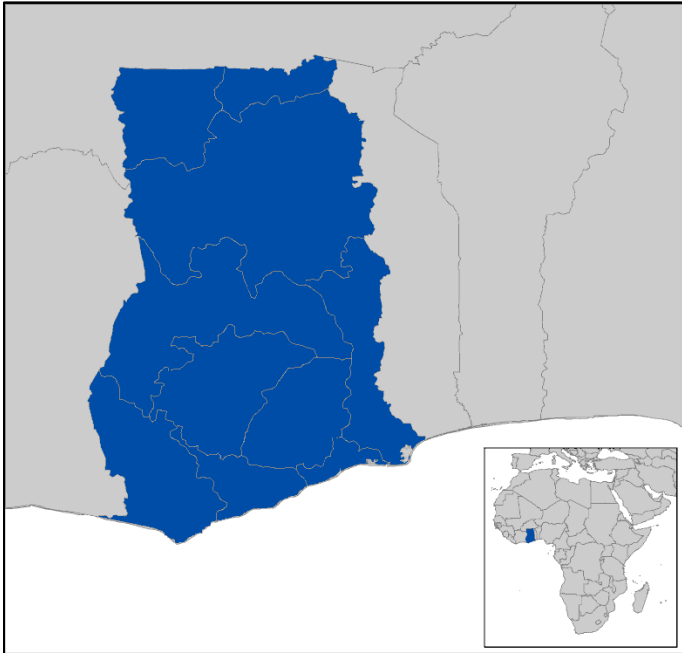
[1] The World Bank Group. (2012). Africa program for fisheries (pp. 2–12).

GREECE
LAGOON FISHERIES

Number of TURFs:	Unknown
User Group Allocation:	Cooperatives
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

Fishers Cooperatives can rent a lagoon area through a periodic auction process instituted by the Greek government[1]. Cooperatives are able to install barrier traps and are given management control over the lagoon area.

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[1] Tzanatos E, Dimitriou E, Katselis G, Georgiadis M, Koutsikopoulos C (2005) Composition, temporal dynamics and regional characteristics of small-scale fisheries in Greece. 73: 147-158.

GRENADA
GRENADA BEACH SEINE FISHERY

Number of TURFs:	1*
Date of Legal Standing:	1982
User Group Allocation:	Individuals
Primary Target Resource:	None, many species targeted
Country Development Status:	Upper Middle Income

Overview
TURFs in Granada operate on a first come first serve basis. In order to get the right to caste a net at one of the stationary "haul" stations, you must be the first group/boat to anchor in the haul and tie the stern line to the shore[1]. Only one boat may caste at a haul at a time (subsequent boats will take their turn in sequence). Each net has only one opportunity to cast their net at a time.
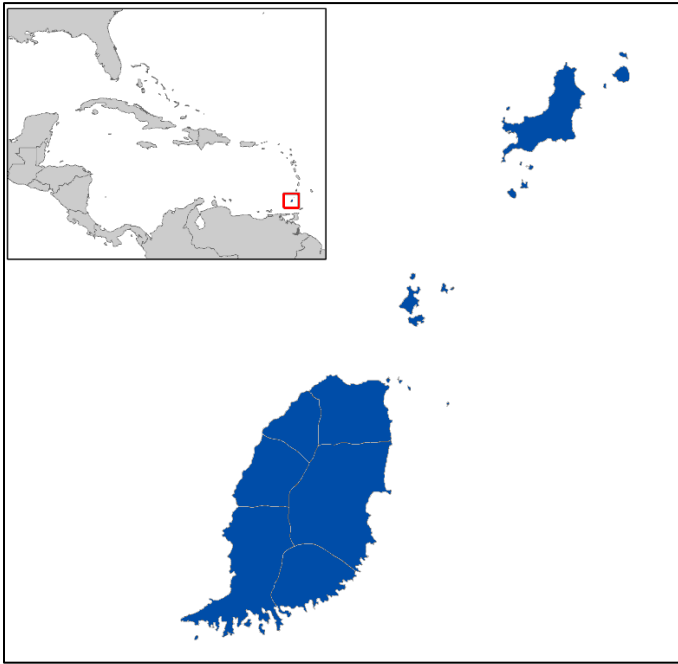
History
Seine net fishing is common throughout the Caribbean and is often a small-scale fishing operation[1]. In 1982, the government of Grenada began formalizing the seine net fishery, which had been operating as an informal system previously. From 1982 to 1997, the Fisheries Administration hosted consultations with the fishers to resolve conflict until reaching a place of national consensus on informal fishing rules.

* One TURF as of 1995. Within this TURF, there are 76 hauls where fishers stake their claim to fish. Since all hauls operate under the same rules and the same fisher groups, it is considered one TURF.

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[1] McConney, P. (2003). Grenada case study : Legalisation of beach seine traditional rules at Gouyave (pp. 1 – 64).

INDIA
STAKE NET FISHERY - *PADU* SYSTEM

Number of TURFs:	9*
Date of Legal Standing:	1979
Local Name:	*Padu*
User Group Allocation:	Community
Primary Target Resource:	Shrimp
Country Development Status:	Lower Middle Income

Overview

Within a community, eligible male fishers of a particular caste will be allotted a *padu*, or territorial area with a fixed gear for their stake net fishing efforts within a specific fishing ground[1]. Some *padus* will rotate access for *padu* locations, while others will have an annual lottery for *padu* position. *Padus* are located in estuaries near the mouth of the sea.
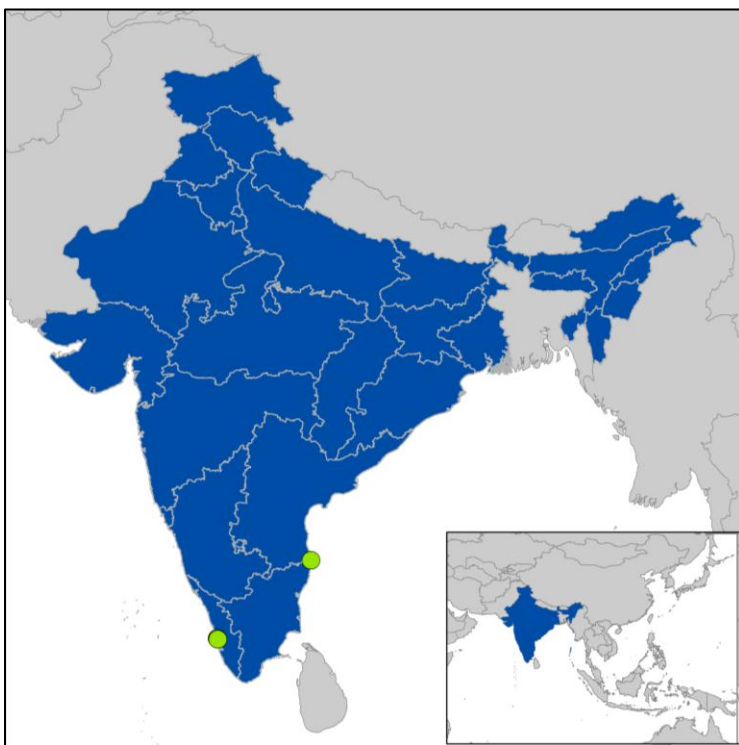
History

Padu is a system that has existed in India and Sri Lanka for at least three centuries[1]. In India, there is a presence of unlicensed and licensed *padu* systems, with licensed *padus* beginning around 1979. In 1974, state legislation required all fishers to have licenses from the state in order to fish. In 1987, a community of unlicensed fishers petitioned for their caste-based right to the stake net fishing grounds even though they were without licenses to fish. Unlicensed communities are registered with the State Registrar's office at the High Court and are governed by specific rules for their operation.

* As of 2004

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[1] Lobe, K., & Berkes, F. (2004). The padu system of community-based fisheries management: change and local institutional innovation in south India. Marine Policy, 28(3), 271–281. doi:10.1016/S0308-597X(03)00087-3

INDONESIA
CUSTOMARY MARINE TENURE

Number of TURFs:	3, many
Local Name:	*Sasi, Petuanan, Awig-Awig, Rompong, Seke*
User Group Allocation:	Varies
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

Generally, fisheries in Indonesia are open access; however, in some regions de facto marine tenure systems govern the commons. Customary laws differ depending on the region, but as a whole are recognized by formal laws that allow for the existence of TURF-like systems. For example, in Maluku, *sasi* (rules) and *petuanan* (boundaries) establish an area in which every community member has the right of access and usage of marine resources, while outsiders must seek permission from originating kin groups[1]. While *petuanan* and *sasi* are strong, it is not formally supported by government regulations or institutions. In South Sulawsi, a different type of system exists, where *rompongs* establish property rights to an individual or group of a 1 hectare area by building a Fish Aggregating Device of bamboo and coconut fronds[2]. An owner not operating his romping must allow others making a request to fish in his area. It is relatively unknown how many of these systems may exist in Indonesia, as traditional management systems may vary across and within regions dramatically.

[1] Harkes, I., & Novaczek, I. (2002). Presence, performance, and institutional resilience of sasi, a traditional management institution in Central Maluku, Indonesia. Ocean & Coastal Management, 45(4-5), 237–260. doi:10.1016/S0964-5691(02)00057-1

[2] Satria, A., & Adhuri, D. S. (2010). Pre-existing Fisheries Management Systems in Indonesia, Focusing on Lombok and Maluku. In K. Ruddle & A. Satria (Eds.), Managing Coastal and Inland Waters: Pre-existing Aquatic Management Systems in Southeast Asia (pp. 31–55). Springer Netherlands. doi:10.1007/978-90-481-9555-8

ITALY
ARTISANAL FISHERIES MANAGEMENT CONSORTIA

Number of TURFs:	10*
Date of Legal Standing:	2006
User Group Allocation:	Cooperative
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

TURFs have only recently been instituted in Sicily, Italy. In 2006, the Artisanal Fisheries Management Consortia (CO.GE.PA) program was developed to facilitate collective management in the multi-gear, multi-species artisanal fisheries of Sicily. TURFs are locally managed by Fishing Consortia, which are responsible for developing fisheries management plans with the assistance of all Consortium members and local research scientists. Upon approval of the management plan, the Ministry will institute a Ministerial decree providing legal force (*erga omnes*) to the regulations set by the Consortium. However, before a management plan can even be drafted, at least 70% of all the registered fishers in a given area must join the Fishing Consortium in order to demonstrate community support. Any fishing enterprise that is registered within the demarcated area can join the Consortium; however, assuming fishers hold a general license, fishers are not required to be a member of a Consortium to fish in the TURF. Although, all users must abide by the rules set by the Consortia since they are given legal force. There are currently 10 Consortia surrounding the islands of Sicily, representing over 1,400 vessels[1].

History

In 2006, the European Fishery Fund issued a regulation allowing collective action in fisheries management[1]. At which point, the Italian government and the European Fishery Fund instituted the CO.GE.PA program in areas all around the islands of Sicily.

* As of 2012

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[1] Spagnolo, M. (2012). What kind of management for Mediterranean fisheries? European Parliament, Brussels. doi:10.2861/45788

ITALY
MOLLUSCS MANAGEMENT CONSORTIUM

Number of TURFs:	14*
Date of Legal Standing:	1995
User Group Allocation:	Cooperative
Primary Target Resource:	Clams
Country Development Status:	High Income

Overview

In response to the near collapse of clam stocks in the Adriatic Sea, the Italian government established the Molluscs Management Consortium (CO.GE.MO). The program was developed with the intention of empowering local fishers and rebuilding clam stocks through a co-managed TURF system[1]. Territories were designated based on the administrative boundaries of the maritime districts along the Adriatic coast and Fishing Consortia were established in each district. To ensure community involvement, use rights are not granted to a Fishing Consortium until at least 75% of the registered fishers in the maritime district join the consortium. In order to gain access to a TURF, fishers must be registered within a maritime district that has a clam consortium in addition to holding a special license to operate a hydraulic dredge. Technically, a fisher need not be a member of a Consortium to harvest clams in the TURF, but all fishers are required to follow the regulations set by the Consortium[1]. Through a targeted buy-back program, the number of vessels operating dredges has been significantly reduced; currently there are approximately 700 dredges operating along the Italian Adriatic coast employing some 1500 fishers[1]. Over time, the Consortia have assumed full management responsibility and today there is limited government involvement. While results vary by Consortium, overall fishing effort has decreased, market prices and profitability have increased, and landings have increased due to stock recovery[1,2].

History

The Adriatic Sea clam fishery was established in the 1970s under a top-down centralized management regime. However, the licensing scheme implemented to manage the fishery failed to prevent overexploitation, and by the early 1990s the clam stocks nearly collapsed[2]. Recognizing the failure of previous top-down management, the Italian government launched a co-management system, which established a voluntary vessel buy-back program to reduce effort and created Fishing Consortia with clearly defined boundaries. In 1998, the government revised the program to further reduce the number of vessels while also increasing the management authority of the Consortia. Today, the Fishing Consortia are nearly completely self-governed[2,3].

* As of 2014

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[1] Spagnolo, M. (2012). What kind of management for Mediterranean fisheries? European Parliament, Brussels. doi:10.2861/45788

[2] Spagnolo, M. (2007). The Decommissioning Scheme for the Italian Clam Fishery: A Case of Success. Chapter 8. In: Fisheries Buyback (eds R. Curtis and D. Squires). Wiley-Blackwell, Ames, IA., pp. 157-176.

[3] Management Instruments in Member States and on setting up best practices in the EU, Parts I & II, European Commission, FISH/2007/03.
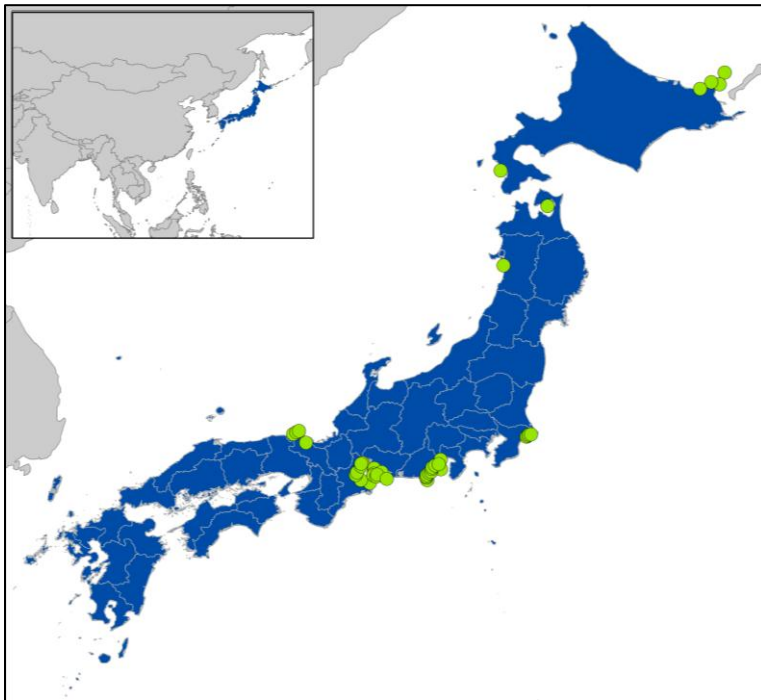
JAPAN

FISHERIES COOPERATIVE ASSOCIATIONS

Number of TURFs:	976*
Date of Legal Standing:	1901
User Group Allocation:	Cooperative
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

Japan hosts the world's most well established network of TURFs. Coastal fisheries are divided into Fisheries Cooperative Associations (FCAs) that manage multiple TURFs within their jurisdiction. There are regional and national coordinating committees that help facilitate cooperation between each FCA[86]. Although not legally recognized, FCAs are further subdivided into Fisheries Management Organizations (FMOs), which allow local fishers to institute additional regulations as needed[87]. As of 2007, FCAs managed 88% of the fisheries in Japan[3]. TURFs in Japan utilize a wide range of fisheries management techniques allowing for the protection of both sedentary and mobile species[88]. Strong government support coupled with local management flexibility contributes to the ability of many Japanese TURFs to protect their marine resources.

History

In the 17th century the Japanese government began to recognize villages as distinctive administrative units. This allowed fishers to establish guilds, or TURFs, in order to utilize and protect their village's shoreline. In 1901, when the Japanese government drafted the Meiji Fishery Law, individuals were given permits .that allowed for unlimited access to all the resources within a TURF. However, because these permits were tradable, soon all the rights were concentrated with a few individuals and the effectiveness of the TURF was diminished. To address this and other issues, following World War II, the Fishery Cooperative Law was revised, which with some amendments, is the current law governing TURFs in Japan today[1].

* As of July 2013

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[86] Makino, M., Matsuda, H., & Sakurai, Y. (2009). Expanding fisheries co-management to ecosystem-based management: A case in the Shiretoko World Natural Heritage area, Japan. *Marine Policy*, *33*(2), 207–214. doi:10.1016/j.marpol.2008.05.013

[87] Wilen, J. E., Cancino, J., & Uchida, H. (2012). The Economics of Territorial Use Rights Fisheries, or TURFs. *Review of Environmental Economics and Policy*, *6*(2), 237–257. doi:10.1093/reep/res012

[88] Cancino, J. P., Wilen, J. E., & Uchida, H. (2007). TURFs and ITQs: Collective vs . Individual Decision Making University of Rhode Island. *Marine Resource Economics*, *22*(5129), 391–406.

MALTA
KANNIZZATI FISHERY

Number of TURFs:	1*
Date of Legal Standing:	1965
Local Name:	Fisheries Management Zone
User Group Allocation:	Individuals
Primary Target Resource:	Dolphinfish
Country Development Status:	High Income

Overview
A TURF is used to manage the *kannizzati*, or dolphinfish, fishery in Malta, which uses Fish Aggregating Devices. The TURF is 7-25 nautical miles off the coast and allows a total of 130 concessions via a lottery system. The winners of the lottery each get access to one line where Fish Aggregating Devices can be placed[1].

History
In 1965, Malta became a member of the General Fisheries Commission for the Mediterranean, which was later ratified in 1999. The Maltese Fisheries Conservation and Management Act was established in 2001 and later amended in 2007, establishing conservation and management practices for fisheries. When Malta entered the EU in 2004, there was a major reform in fisheries legislation to ensure consistency with the EU's Common Fisheries Policy and to limit the number, size, and power of fishing vessels that enter the management zone.

* One TURF as of 2007. Even though each fisher gets their own right to a line of Fishing Aggregating Devices, this country was considered to have one TURF because the entire offshore area was under the same management rules and regulations and encompassed all locations in the lottery to fish.

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[1] MRAG, IFM, CEFAS, AZTI Tecnalia & PoIEM (2007); An analysis of existing Rights Based Management Instruments in Member States and on setting up best practices in the EU, Parts I & II, European Commission, FISH/2007/03.

MEXICO
FISHING CONCESSIONS

Number of TURFs:	Over 500*
Date of Legal Standing:	1936
User Group Allocation:	Cooperative or Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Upper Middle income

Overview

TURFs in Mexico are typically in the form of 20-year long concessions that are allocated to cooperatives. To varying degrees, cooperatives are responsible for the management and enforcement within the TURF. There are national fisheries regulations promulgated through *norms*, but cooperatives often employ additional regulations to improve fisheries performance. Cooperatives can limit duration of tenure for members, and any fisher in Mexico must apply for national fishing licenses that vary in length depending on the target species- license range from a single season to several years. Although the use right for fishers is short in duration, the process of license renewal is not difficult and applications are usually approved[1,2]. Coordination among cooperatives is common in Mexico, which is exemplified in the Pacífico Norte FEDECOOP TURFs along the Vizcaino Peninsula in Baja California. These nine TURFs coordinate harvesting and management responsibilities for the red rock lobster, and was the first community-based fishery to earn the marine Stewardship Council's certification of sustainability[1]. There are a few examples of fishing concessions granted to indigenous, traditional communities, such as is the case in the Seri Exclusive Fishing Zone. In these circumstances, the concession is allocated the community in perpetuity. There is often conflict and illegal fishing by fishers in the adjacent fishing ground, as the indigenous communities have less capacity for enforcement of TURF boundaries.[3]

History

The legal framework for cooperatives was passed in 1936, where fisheries law set aside certain species, such as lobster and abalone, for harvest by cooperatives in concessions. Despite this, concessions were not effective, because they lacked political power until the 1970s, when cooperatives became more involved in the processing and supply chain of their resources. Through increased fisher involvement in the development of regulations, TURF concessions transitioned from top-down nationally-managed fisheries tools to truly co-managed fisheries as cooperatives became increasingly involved in management and the development of fisheries regulations[1.]

*The exact number of concession is unknown, but is over 500

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[1] McCay, B. J., Micheli, F., Ponce-Díaz, G., Murray, G., Shester, G., Ramirez-Sanchez, S., & Weisman, W. (2014). Cooperatives, concessions, and co-management on the Pacific coast of Mexico. Marine Policy, 44, 49–59. doi:10.1016/j.marpol.2013.08.001

[2] Fraga, J., Jesus, A. (2008). Coastal and marine Protected Areas in Mexico (pp. 1–97). Retrieved from www.icsf.net

[3] Bourillón-moreno, L. (2002). Exclusive fishing zone as a strategy for managing fishery resources by the Seri Indians, Gulf of California, Mexico. University of Arizona.

NEW ZEALAND
MAORI *MATAITAI* RESERVES

Number of TURFs:	24*
Date of Legal Standing:	1996
Local Name:	*Mataitai* reserves
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

The Maori are the indigenous people of New Zealand who make up roughly 15% of the national population. With passage of the Fisheries Act of 1996, *Mataitai* reserves were created to develop policies that recognize traditional use and fisheries management systems of the Maori for non-commercial purposes[1]. Management is based on a territorial-use rights system, whereby indigenous *tangata whenua* ("people of the land"), a legally recognized unit of Maori local governance based on historic ties to a geographic area, hold exclusive management rights, including access, withdrawal, management, and exclusion, to part of the coast[2]. Small fishing areas correspond to traditional boundaries, and while Maori may not exclude recreational fishing, commercial fishing is prohibited unless permitted through regulation.
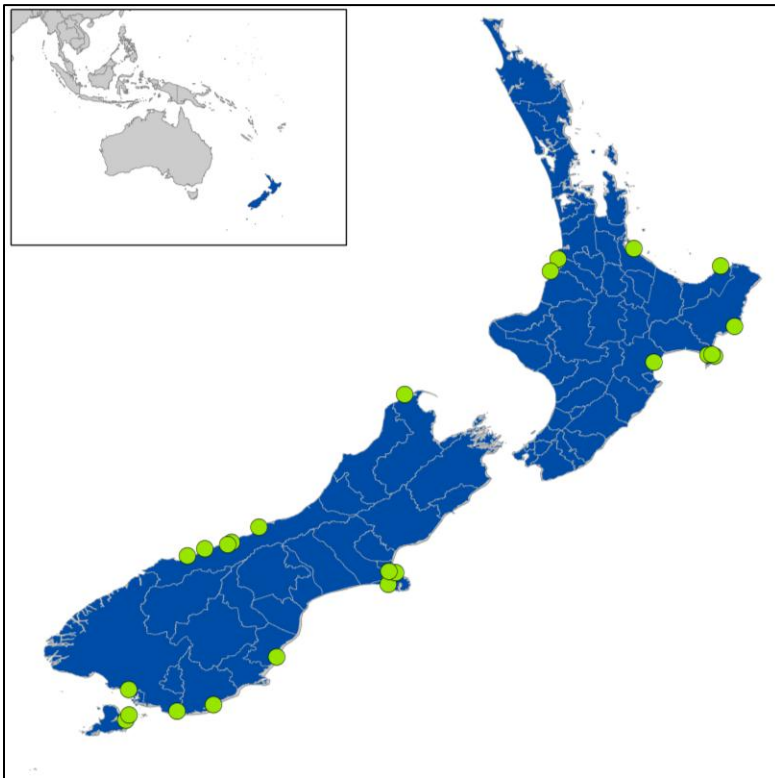
*As of 2014

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[1] New Zealand Ministry for Primary Industries. (2014). *Mataitai Reserves.* Retrieved from http://www.fish.govt.nz/en-nz/Maori/Management/Mataitai/default.htm
[2] Harte, M. (2003). Assessing the road towards self- governance in New Zealand's commercial fisheries, 323–334.

NEW ZEALAND
QUOTA MANAGEMENT SYSTEM

Number of TURFs:	Unknown
Date of Legal Standing:	1986
User Group Allocation:	Individual
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

New Zealand has adopted ITQs to manage many of its fisheries. As evidenced by the characteristics of ITQ systems where the target species is bounded to a specific geographic region (e.g. a bay or estuary) based on its distribution and life history characteristics, many ITQs may operate as TURFs by nature of their geography and target species. The Challenger Scallop Fishery utilizes an ITQ management structure, however the fishery is bounded by the geographic features of the bay, within which, exclusivity is allocated to quota holders only[1].

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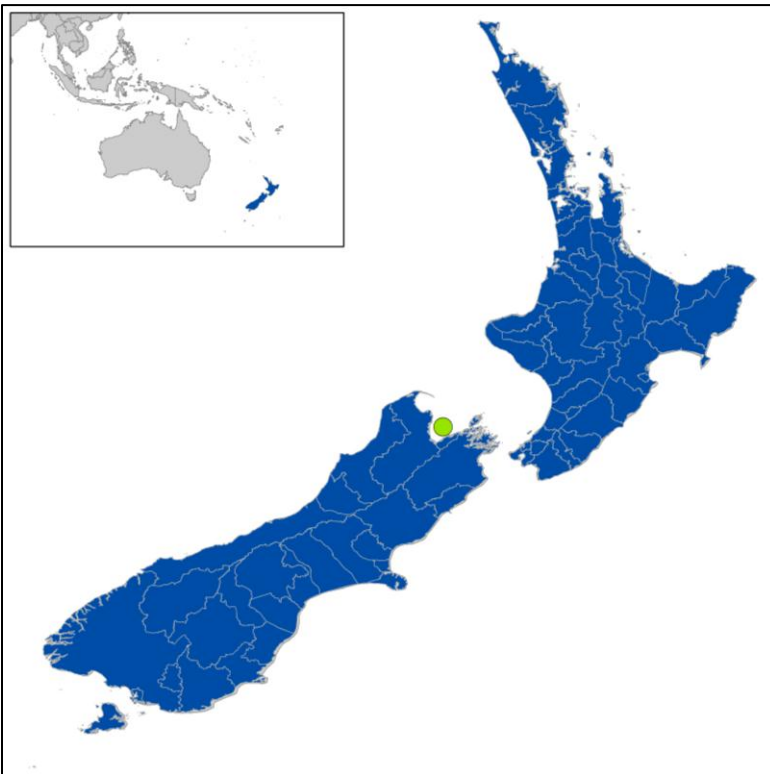
[1] Mincher R. (2008). New Zealand's Challenger Scallop Enhancement Company : from reseeding to self-governance. In: Townsend, R, Shotton, R, Uchida, H, editors. Case Studies on Fisheries Self-Governance. Rome: FAO. p. 307–22.

NIGERIA
ACADJA

Number of TURFs:	Unknown
Local Name:	*Acadja*
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

Acadjas are a traditional fishing method used in coastal lagoons and lakes along the Western Africa[1]. They take many forms of design, but typically are installed in shallow waters and made of dense branches stuck into the mud that are left to attract fish to new habitat.
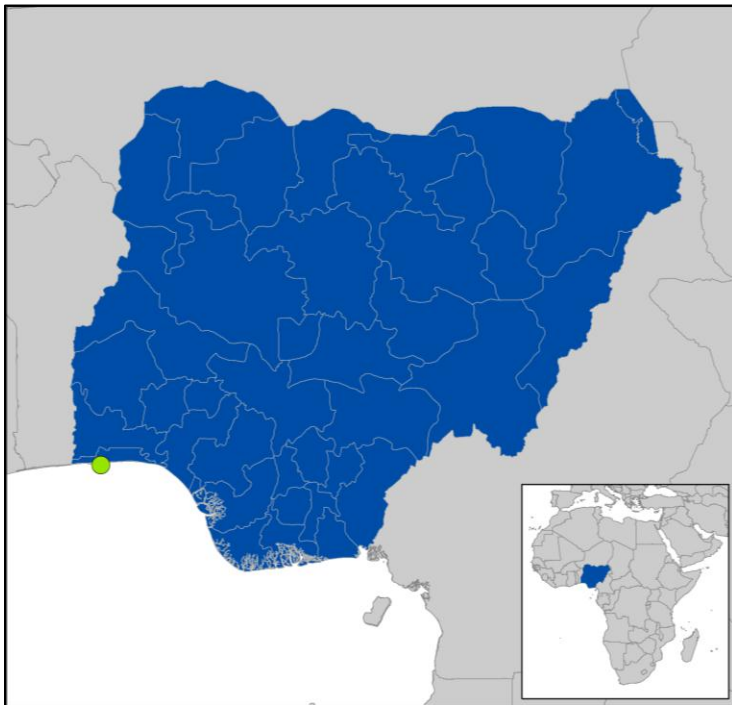
History

Acadjas were first used in the Lake Nokoue and Porto-Nov Lagoon in Nigeria in the early 1900s. They are currently not legally recognized[2].

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[1] Olopade, O.A., Taiwo, O.I., Ajibade, D., Aluko, F. A. (2008). Community based fishery management: A case study of acadja method of fishing on the Badagry Creek, Ogun State, Nigeria. Journal of Agriculture and Social Research (JASR), 8(1), 28–33.

[2] Welcomme, R. L. (1972). An evaluation of the acadja method of fishing as practised in the coastal lagoons of Dahomey (West Africa). Journal of Fish Biology, 4(1), 39–55. doi:10.1111/j.1095-8649.1972.tb05651.x

OMAN

Number of TURFs: Unknown

Overview
The presence of TURFs in Oman has been mentioned in the literature[1]; however, no further information has been found to give details for TURF history and operation in this country.

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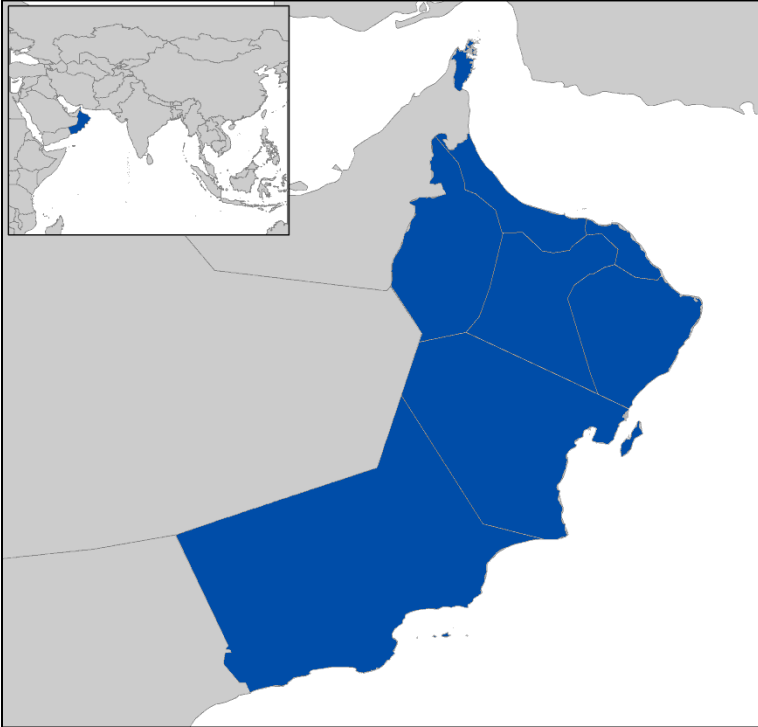
[1] Morgan, Gary. "Country Review: Oman." Review of the State of World Marine Capture Fisheries Management: Indian Ocean, Issue 488. Ed. Cassandra De Young. N.p.: Food & Agriculture Organization, 2006. 1-458. Print.

PHILIPPINES
LOCAL GOVERNMENT UNITS

Number of TURFs:	Unknown
Date of Legal Standing:	1998
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

In the Philippines, waters from the coastline out to 15km are under the jurisdiction of municipalities, or local government units (LGUs). Jurisdiction over coastal waters does not necessarily exclude non-municipal fishers from municipal waters, however it allows for the exclusion of commercial fishers and provides an enabling framework for LGUs to create legislation that allows for this exclusion[1]. The Fisheries Codes provides for local Fisheries and Aquatic Resources Marine Councils (FARMCs) to institutionalize the participation of fisherfolk in management of f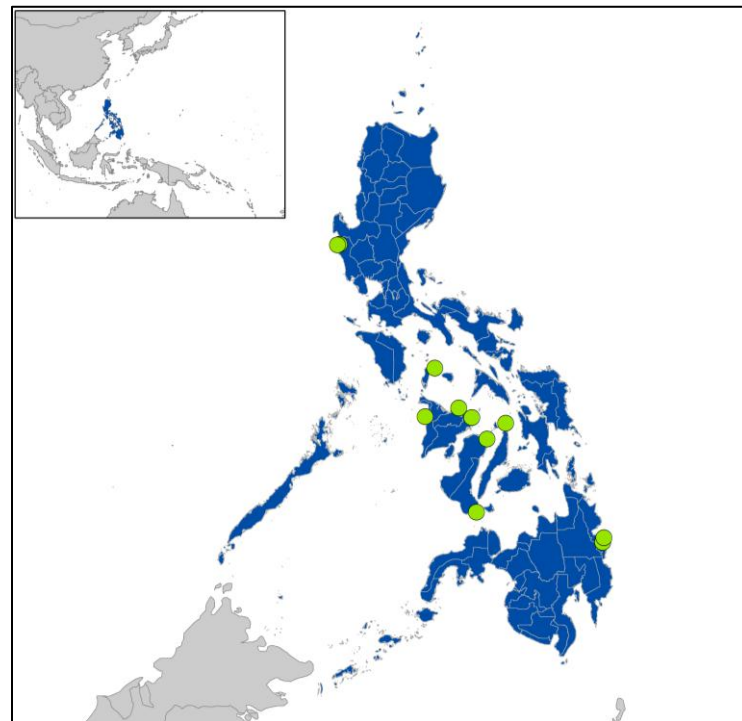ishing activities[2]. The LGU deputizes volunteer community fish wardens called *Bantay Dagat* for the enforcement of municipal waters[1].

History

The Constitution in the Philippines (1987) establishes the State's control over natural resources, including fisheries and marine resources, however, it also allows for small-scale utilization of natural resources[1]. After over a decade of lobbying, the Local Government Code (1991) decentralized certain responsibilities associated with fishery resources to local governments. The Fisheries Code of 1998 was established to expand municipal waters out to 15km, decentralize the management of municipal waters to LGUs, adopt MSY as a basis for fisheries management, and create FARMCs[1].

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[1] Vera, C., Cabaces, R., & Reyes, L. (2007). Asserting Rights, Defining Responsibilities.
[2] Mercado, A., & Philippine Locally-Managed Marine Area Network. (2011). Making Governance Work for Marine Conservation - Lessons from the Philippines: Zambales, Batangas and Romblon.

PAPUA NEW GUINEA
CUSTOMARY MARINE TENURE

Number of TURFs:	86*
Date of Legal Standing:	1998
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

As in many Pacific Island nations, customary marine tenure in Papua New Guinea can take many forms. Generally, outsiders are not permitted to fish in the fishing grounds adjacent to a village without permission. However, excludability can be quite complex, wherein some systems, individuals and family may have rights to different spaces, species and gears[1]. The 1998 Fisheries Management Act respects local and government laws as they relate to access and license holding restrictions, including customs and traditions of indigenous inhabitants[2].

History

While Pacific Island nations, colonial governments significantly weakened customary marine tenure institutions, in Papua New Guinea, German and British colonial administrations recognized traditional fishing rights[3]. Customary ownership of natural resources is recognized in the PNG constitution and the 1998 Fisheries Management Act, providing one of the most enabling legal environments for CMT in the South Pacific.

* As of 2009. Number of Locally Managed Marine Area (LMMAs); not all LMMAs necessarily operate as TURFs, but exact number with exclusive access is unknown.

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[1] Cinner, J. E. (2005). *The role of socioeconomic factors in customary coral reef management in Papua New Guinea* (Doctoral dissertation, James Cook University).

[2] Govan, H., Tawake, W. A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Tafea, H., … Cohen, P. (2009). Community Conserved Areas : A review of status & needs in Melanesia and Polynesia.

[3] Hyndman, D. (1993). Sea Tenure and the Management of Living Marine Resources in Papua New Guinea. *Pacific Studies*, *16*(4), 99–114.

REPUBLIC OF KOREA
SELF-CONTROL MANAGEMENT PROJECT

Number of TURFs:	294*
Date of Legal Standing:	1911
Local Name:	*Maul* Fisheries
User Group Allocation:	Cooperative
Primary Target Resource:	Clams and other sedentary species
Country Development Status:	High Income

Overview

In 2001, the South Korean government established the Self-control Management Plan (SMP) with the goal of encouraging fishing village cooperatives to manage their fisheries resources[1]. The program promotes community-based management in many different small-scale fisheries, including TURFs. Fisheries that assign territorial use rights are referred to as *maul* fisheries[1,2]. The program provides participating fishing village cooperatives with the financial, administrative, and technical government support needed to initiate a self-governance framework. After successfully applying to the program, fishing village cooperatives are granted a license from the Ministry of Marine Affairs and Fisheries. Generally, in order to be a recognized self-governance fishery and receive government support, cooperatives must create specific management regulations[2, 3]. Cooperatives are given the authority to determine fisher membership, allocate use rights to individual fishers, and establish regulations. Once fishing cooperatives have demonstrated successful management, fishers gain full management authority, and no longer have government support. The long-term goal of the SMP is complete self-governance[1]. Enforcement responsibilities are typically shared between the fishing village cooperative and the government; however, since regulations are established locally by the cooperative, most regulations do have legal deterrence[1]. Since its inception, the number of registered TURFs under the SMP has rapidly increased[2]. However, some argue decreasing fish stocks, labor shortages, and decreasing fisher income are causing many fishing communities to shift away from collective action towards privatization, which could diminish the success of the SMP[3]. Even still, many fishers favorably view the program indicating that the SMP has been successful[1,2].

* As of 2007
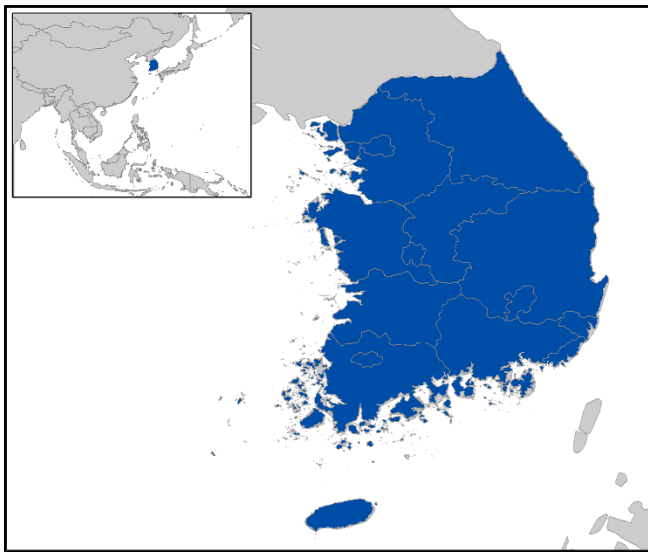
History

TURFs were initially introduced when Japan annexed Korea in 1910. In 1911, the Japanese government applied the Meiji Law to Korea, which had been successfully implemented several years prior in Japan. Following liberation in 1945, Korea maintained the general framework established by the Meiji Law. By 1953, the Fisheries Act of Korea officially encouraged cooperative fisheries management, but most fisheries still operated under strong top-down regional management. Due to increasing conflict between illegal fishers, internal conflicts among fishers, and growing conflict between local fishers and the central government, Korea began to slowly decentralize management by allocating rights directly to village fishery cooperatives[1]. In the 1980s, the Korean government began targeted revitalization programs to develop stronger, more cohesive fishing communities[4]. Following unsuccessful amendments in the 1990s[4], in 2001, the system was revised again creating the Self-control Management Program (SMP)[1].

[1] Lee, K. N., Gates, J. M., & Lee, J. (2006). Recent developments in Korean fisheries management. *Ocean & Coastal Management*, 49(5-6), 355–366. doi:10.1016/j.ocecoaman.2006.03.002

[2] Uchida, E., Uchida, H., Lee, J.-S., Ryu, J.-G., & Kim, D.-Y. (2012). TURFs and clubs: empirical evidence of the effect of self-governance on profitability in South Korea's inshore (maul) fisheries. *Environment and Development Economics*, 17(01), 41–65. doi:10.1017/S1355770X11000246

[3] Cheong, S.M. (2004). Managing Fishing at the Local Level: The Role of Fishing Village Cooperatives in Korea. *Coastal Management*, 32(2), 191–201. doi:10.1080/08920750490276254

[4] Cheong, S.M. (2003). Depleting Fish Resources, Declining Fishing Communities, and the State Revitalization Project in Korea. *Environmental Management*, 32(3), 382–390. doi:10.1007/s00267-003-0074-6
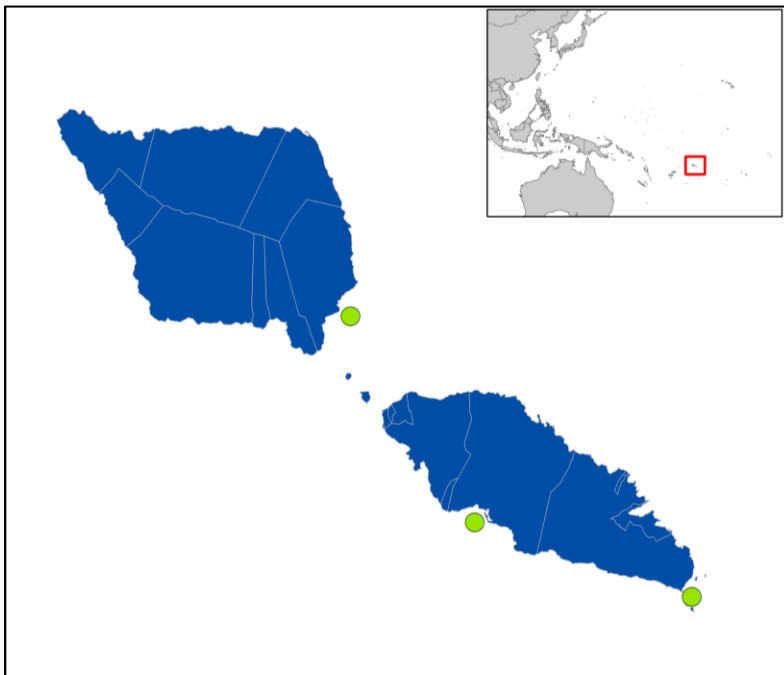
Samoa
Customary Marine Tenure

Number of TURFs:	85*
Date of Legal Standing:	1990
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

Samoa has a history of customary marine tenure, and more recently has had strong government investment in community-based fisheries management through mechanisms that allow for the establishment of more formal TURF systems. A national program called the Community-based Fisheries Management Program (CFMP) was initiated by the Fisheries Division to assist villages in establishing and implementing CFMPs. As of 2004, 83 villages had developed fisheries management plans through this program, whereby communities have formalized dedicated access to their waters and can enforce rules on outsiders with legal backing[1]. Another TURF system in Samoa, are two community-owned, co-managed MPA districts developed through the Samoa Marine Protected Areas Programme. Safata (a network of 9 villages) and Alpeita (a network of 11 villages), were developed by local communities working with the Samoa government and funded by the World Bank through IUCN[1].

History

Until passage of the Fisheries Act of 1988, waters off of Samoan villages were public property. While a history of customary marine tenure existed, coastal villages had no legal backing to prohibit outsiders from fishing in their waters, making management of marine resources difficult[2]. The Fisheries Act established the rights of nearshore fishing grounds to villages, turning village rules into by-laws enforceable under national law[2]. In 1990, the Village *Fono* Bill recognized the village *fono* (council of chiefs) as the authority over village fishing rights, and enabled traditional fines to be place on villagers that violated bylaws[1].

* As of 2004, 83 villages had developed CFMPs (though not necessarily all operate with exclusive access) and 2 multi-village MPAs had been established.

[1] Techera, E. (2008). Samoa: Law, custom and conservation. *Custom and Conservation*.
[2] Govan, H., Tawake, W. A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Tafea, H., … Cohen, P. (2009). Community Conserved Areas : A review of status & needs in Melanesia and Polynesia.

SOLOMON ISLANDS
CUSTOMARY MARINE TENURE

Number of TURFs:	Unknown
Date of Legal Standing:	1998
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

In Solomon Islands, a history of customary marine tenure means that "fishing for food" is generally free to anyone, but "fishing for money" generally requires permission from the chief or other representative or controlling group in a village[1]. Generally, Solomon Islanders acquire important primary entitlements at birth to land, marine resources, and in some instances there is a clear distinction between the power to "speak about" fishing resources (participate in decisions) and the rights to extract resources[1]. The Fisheries Act (1998) recognizes customary fishing rights and vests management with each of nine provincial assemblies. Provinces are responsible for registering customary fishing rights, boundaries, and fishers entitled to those rights[2]. Commercial fishing is subject to customary fishing rights, and requires compensation be paid to customary owners[2].

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[1] Hviding, E. (1998). Contextual flexibility: present status and future of customary marine tenure in Solomon Islands. *Ocean & Coastal Management*, *40*(2), 253-269.
[2] Govan, H., Tawake, W. A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Tafea, H., … Cohen, P. (2009). Community Conserved Areas : A review of status & needs in Melanesia and Polynesia.
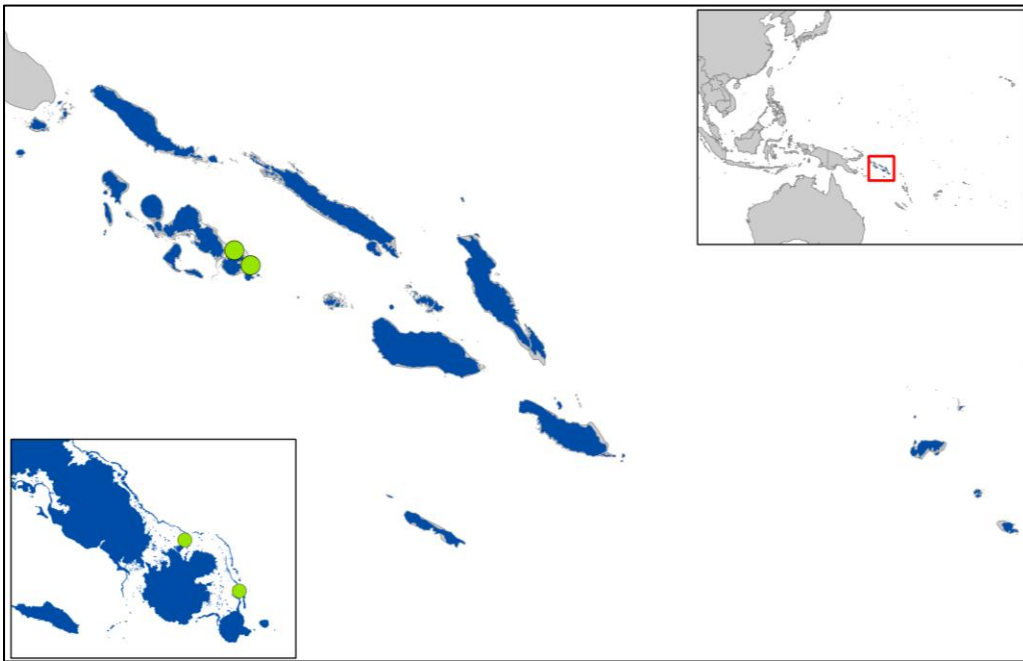
SPAIN
COFRADÍA

Number of TURFs:	229*
Date of Legal Standing:	Varies by Autonomous Community
Local Name:	*Cofradía*
User Group Allocation:	Cooperative
Primary Target Resource:	None, many species targeted
Country Development Status:	High Income

Overview

In Spain, territorial use rights are granted to Fishing guilds, or *cofradía*, who harvest and manage the resources within their territorial boundaries. IN order to harvest resources from a *cofradía's* fishing grounds, fishers must be a member of that *cofradía*[1,2]. Following the decentralization of the Spanish government in the 1970s, Autonomous Communities (AC) were formed and given the authority to manage their nearshore fisheries at a regional level. Each of the ten coastal ACs have *cofradías*. While there are 229 in total[1], we were only able to gather location data for *cofradía* in Galicia and Catalonia. Since management is regional, each AC institutes different policies with varying levels of region government involvement and legal recognition. For instance, in Galicia, rights for shellfish are granted through application, but in other regions, like Catalonia, use rights were informally established at time of *cofradía* implementation centuries ago (current legal standing is a formality)[1]. In most cases, it is compulsory for *cofradía* members to sell their catch at the local auction run by the *cofradía*. Violators of *cofradía* rules are typically punished in real-time at the auction, where violators are forced to either sell their catch last (at a lower price) or forfeit their catch entirely. In other cases, violators do not gain access to the collective services offered by the *cofradía* (e.g. ice, gear, etc.)[1].

The Canaries
Autonomous Community
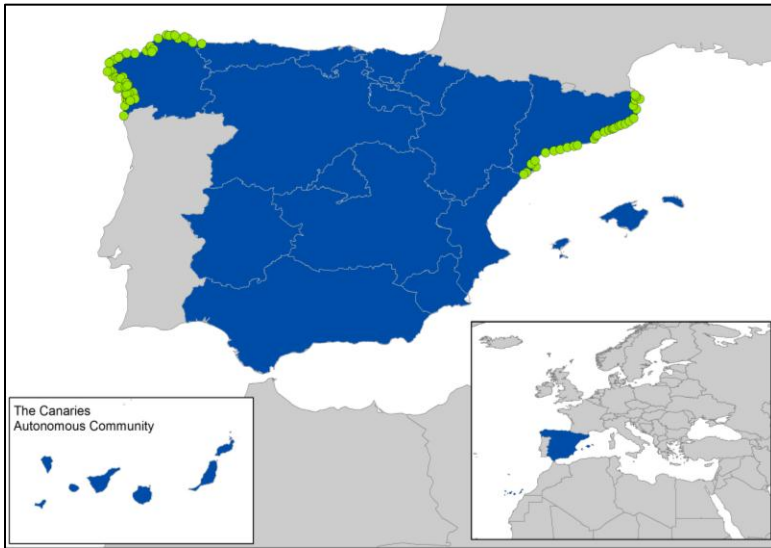
History

Cofradía were established in the 12 century as religious based economic associations. The boundaries were determined by the king in a tradeoff between the fishing communities and the Monarchy. At the time, coastal lagoon areas were heavily degraded and posed risks to human safety. Therefore, the King granted fishers the right to fish on the King's land and in return, the coastal communities were tasked with restoring the coastal areas[3]. Throughout history (especially surrounding the French Revolution), there were efforts to dismantle the *cofradías*, but even when they were considered illegal, they persisted[1,3]. In 1978, Spain shifted to a more decentralized government with the establishment of Autonomous Communities (ACs), which were given the right to manage coastal waters independently. Since, many ACs have legally formalized the *cofradías*.

* As of 2009

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[1] Franquesa, R. (2004). Fishermen guilds in Spain (Cofradias): Economic role and structural changes. IIFET Japan Proceedings, 1–14.

[2] MRAG, IFM, CEFAS, AZTI Tecnalia & PoIEM (2007); An Analysis of existing Rights Based Management Instruments in Member States and on setting up best practices in the EU, Parts I & II, European Commission, FISH/2007/03.

[3] Spagnolo, M. (2012). What kind of management for Mediterranean fisheries? European Parliament, Brussels. doi:10.2861/45788

Spain

Galician Shellfish Exploitation & Management Plan

Number of TURFs:	63*
Date of Legal Standing:	1992
Local Name:	*Cofradías*
User Group Allocation:	Cooperative
Primary Target Resource:	Shellfish and benthic resources
Country Development Status:	High Income

Overview

While Spain has a long history of territorial use rights in the form of fishing guilds or *cofradía*, the Galician government formalized TURFs in 1992 with the development of s co-management system for shellfish and benthic resource exploitation[1]. (Galicia is an Autonomous Community that is decentralized from the Spanish government and has the authority to manage fisheries independently.) Each year, the Galician government (*Xunta de Galicia*) launches a general marine resources exploitation plan, which includes closure time for all species managed in the region. Each *cofradía* (i.e. TURFs) must then prepare an annual management plan, which includes additional regulations pertaining to specific resources including goose barnacle, sea urchin, razor clam, poliquetes, and other shellfish and benthic resources[1,2]. Once the government approves the management plan, *cofradía* are granted exploitation rights to their territory for the remainder of the year. Each *cofradía* hire technical assistants to help manage the shellfishery and marine guards to help patrol and enforce. Individual shellfishers must be a *cofradía* member and obtain special shellfish permits from the government[1]. Within Galicia there are about 3500 on-boat shellfishers and 5000 on-foot shellfishers, most of which are women and all of which are professional fishers (part-time employment is prohibited)[1]. Overall, the program is considered a successful example of co-management[3,4].
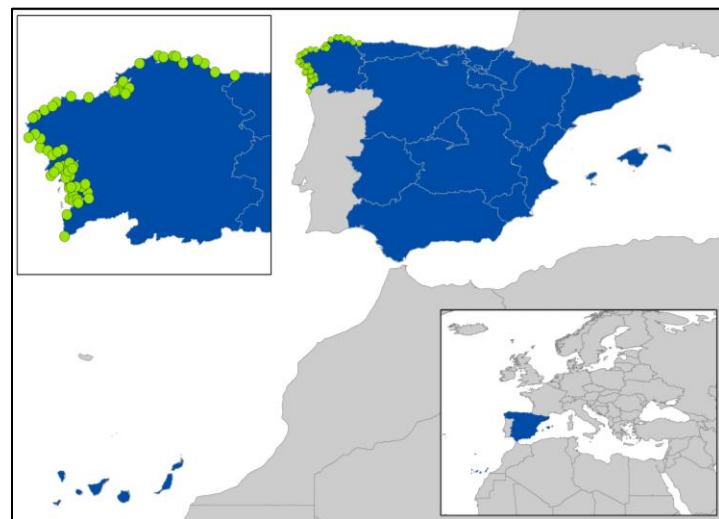
* As of 2014

History

Extensive shellfish harvesting first began in Galicia in the 1960s (Frangoudes et al., 2008). Although licenses were required, there was no limit to the number of licenses that could be issued and soon shellfisheries became overcrowded and shellfish stocks began to suffer[1]. Even though informal TURFs, or *cofradía*, have existed in the region since the 14th century, TURFs became formal in 1992 when the Galician government introduced a co-management system for shellfish and other sedentary resources[3]. The program began as a three-year pilot project, which ended in success. Consequently, the program was expanded to include 11 *cofradias* by 1996. The program has continued to expand since[1].

More information: http://recursosmarinos.udc.es/gis/cartografia/descargas (in Spanish and Galician); http://ww3.intecmar.org/Sigremar/

[1] Macho, G., Naya, I., Freire, J., Villasante, S., & Molares, J. (2013). The Key Role of the Barefoot Fisheries Advisors in the Co-managed TURF System of Galicia (NW Spain). *Ambio*, 42(8), 1057–69. doi:10.1007/s13280-013-0460-0

[2] Perez de Oliveira, L. (2013). Fishers as advocates of marine protected areas: a case study from Galicia (NW Spain). *Marine Policy*, 41, 95–102. doi:10.1016/j.marpol.2012.12.024

[3] Frangoudes, K., Marugán-Pintos, B., & Pascual-Fernández, J. J. (2008). From open access to co-governance and conservation: The case of women shellfish collectors in Galicia (Spain). *Marine Policy*, 32(2), 223–232. doi:10.1016/j.marpol.2007.09.007

[4] Molares, J., & Freire, J. (2003). Development and perspectives for community-based management of the goose barnacle (Pollicipes pollicipes) fisheries in Galicia (NW Spain). *Fisheries Research*, 65(1-3), 485–492. doi:10.1016/j.fishres.2003.09.034

SRI LANKA
STAKE NET FISHERY - PADU SYSTEM

Number of TURFs:	9*
Date of Legal Standing:	1958
Local Name:	*Padu*
User Group Allocation:	Community
Primary Target Resource:	Shrimp
Country Development Status:	Lower Middle Income

Overview
Within a rural fisheries society (RFS), one eligible male fisher from each family and of a particular caste will be allotted a *padu*, or territorial area with a fixed gear for their stake net fishing efforts within a specific fishing ground. There are four RFS that rotate access to fishing sites daily, with a yearly lottery to assign the fishers starting points. These *padus* are located near the mouth of an estuary.
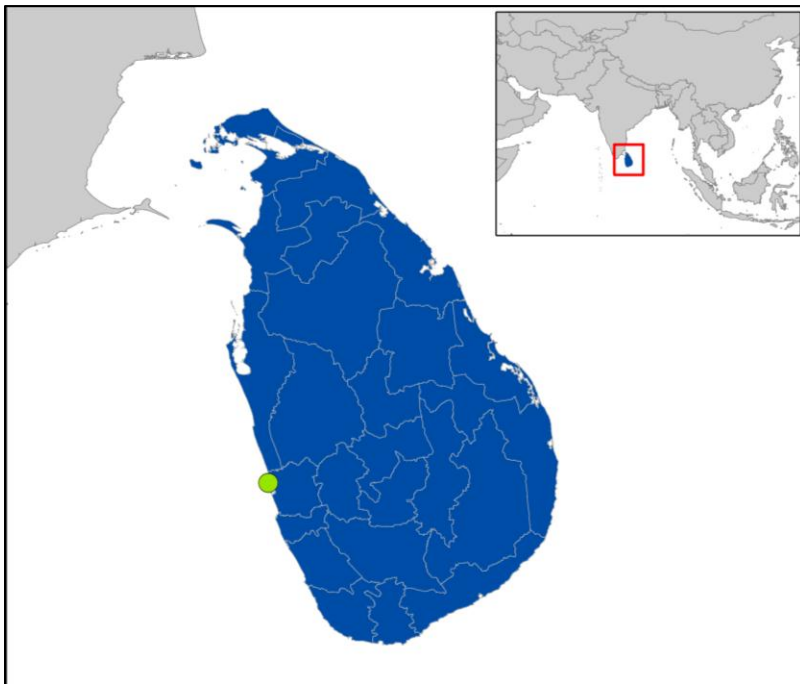
* As of 2004

History
Padu is a system that has existed in India and Sri Lanka for at least three centuries.[1] In Sri Lanka, The rights to the resources are only given to members of the rural fisheries societies (RFS), and descendants must apply to become members. There are four RFSs and they have been given legal status as of 1958, where recorded disputes among resource users began in the 1940s.[2]

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[1] Lobe, K., & Berkes, F. (2004). The padu system of community-based fisheries management: change and local institutional innovation in south India. Marine Policy, 28(3), 271–281. doi:10.1016/S0308-597X(03)00087-3

[2] Amarasinghe, U.S., Chandrasekara, W.U., Kithsiri, H. M. P. (1997). Traditional practices for resource sharing in an artisanal fishery of a Sri Lankan estuary. Asian Fisheries Science, 9, 311–323.

SWEDEN
CO-MANAGEMENT INITIATIVE

|	
Number of TURFs:	2*
Date of Legal Standing:	2004
Local Name:	*Samförvaltningsinitiativet*
User Group Allocation:	Individuals
Primary Target Resource:	Shrimp
Country Development Status:	High Income

Overview

Swedish law allows private ownership of lakes and coastal waters in conjunction with land parcels[1]. Owners are given full ownership over all resources the within their property, meaning outsiders must obtain permission to extract resources from private property. However, under Common Law, any Swedish citizen can recreationally fish with hook and line in any private property without prior permission. Since recreational fishing is extremely popular among Swedish citizens, the unregulated allowance of recreational fishing is a source of conflict among fishers[1,2]. Since parcels tend to be small in area, the Swedish government encourages co-management between private landowners to provide more comprehensive management, but individual property owners have full power to manage their water area as they see fit[1]. In addition to a long history of territorial use rights in private waters, the Swedish government recently established a Co-Management Initiative (CMI) to encourage flexible, precautionary, and sustainable fisheries management in public waters[3]. There are currently two marine TURFs under the CMI, both of which target shrimp fisheries in the Skagerrak strait.
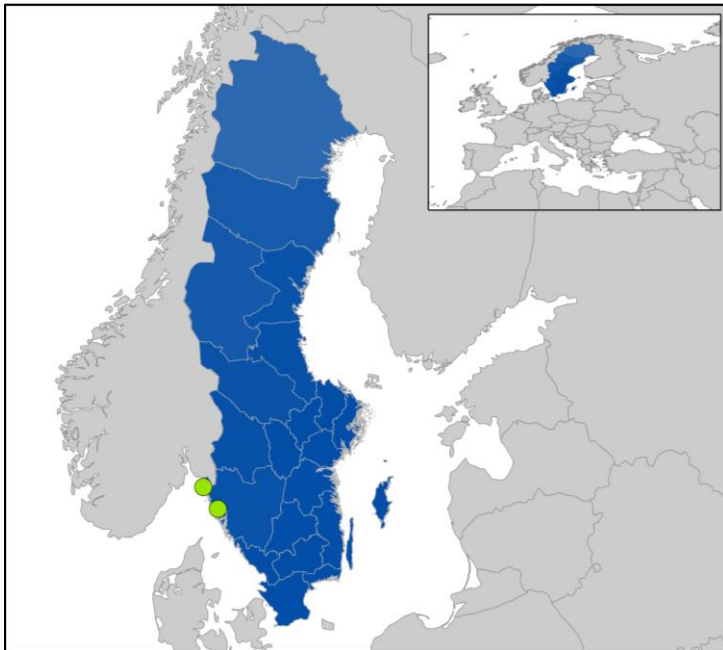
History

Swedish law first formalized the allocation of private property rights to marine areas and lakes in 1766[4]. The impetuous for decentralized private management was largely based on the impracticality of centrally managing more than 100,000 lakes throughout Sweden[2]. Private ownership and management of marine areas within 300m from shore continues today. Commercial fishing also occurs in public waters and in the early 2000s the Swedish government established a National Strategic Plan to encourage ecosystem-based management, develop employment opportunities in rural areas, and increase the profitability of the fishing sector, among other goals[1]. Thus in 2004, the Swedish Board of Fisheries initiated the Swedish Fisheries Co-Management Initiative as an experimental program to encourage co-management in public waters. Two marine fisheries under the initiative operate as TURFs.

*There are two TURFs within the Co-Management Initiative in public waters. There are also as many TURFs as there are private coastal properties in Sweden.

[1] Popescu, I. (2010). Fisheries in Sweden. European Parliament, Brussels. Retrieved from http://www.europarl.europa.eu/RegData/etudes/note/join/2010/438579/IPOL-PECH_NT%282010%29438579_EN.pdf

[2] Brady, M., & Waldo, S. (2009). Fixing problems in fisheries—integrating ITQs, CBM and MPAs in management. *Marine Policy*, 33(2), 258–263. doi:10.1016/j.marpol.2008.07.002

[3] Folkesson, M. (2010). Towards a Sustainable Fisheries Management: How to address uncertainty in order to achieve a sustainable development of regional fisheries management. Stockholm University.

[4] Salmi, P. (2012). The social in change: property rights contradictions in Finland. *Maritime Studies*, *11*(1), 2. doi:10.1186/2212-9790-11-2
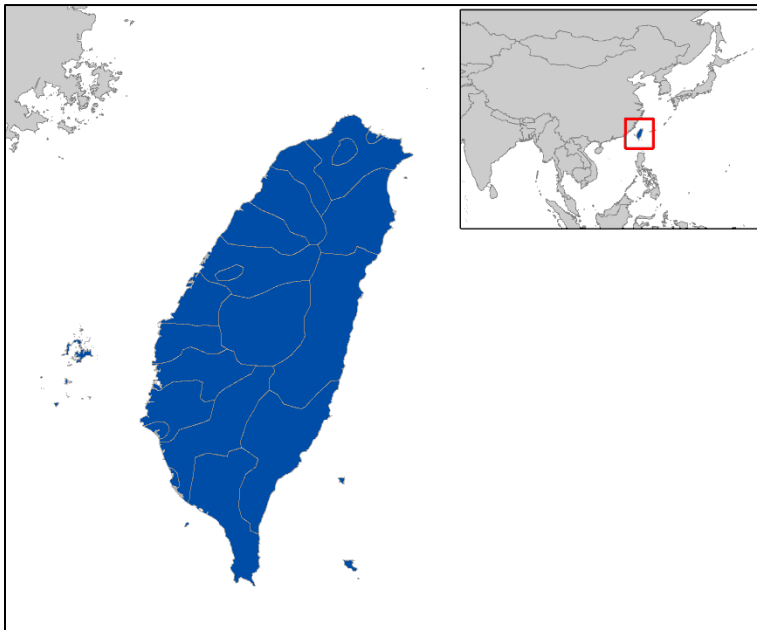
TAIWAN
EXCLUSIVE FISHERY RIGHTS

Number of TURFs:	15*
Date of Legal Standing:	1929
User Group Allocation:	Cooperative
Primary Target Resource:	None, many species targeted
Country Development Status:	N/A (territory of China)

Overview

In Taiwan, exclusive fishing rights are granted to local Fishermen's Association or Production Cooperatives (FAC)[1]. FACs must apply to the central government for exclusive fishing rights to a given area. If granted, FACs are given management authority and exclusive access to all the resources in a specified area for 10 years. Individual fishers must then apply to become an FAC member, which is typically granted assuming access fees are paid. The Fisheries Agency is responsible for reviewing applications and conducting regular audits of approved fisheries rights areas. The Agency has the authority to suspend or revoke fishing rights if FAC management is deemed insufficient. While conflict has been reduced, the system still suffers from many challenges including poor enforcement, low fisher participation, and limited government involvement. Enforcement has been particularly challenging. The Taiwanese Coast Guard is responsible for enforcing public waters, but they only enforce official government laws and do not enforce local community rules set by the fishers associations[2]. FACs do not have the legal authority to expel illegal fishers. These challenges indicate that Taiwan has not yet reached its goal of establishing a functional co-management system, but steps are actively being taken to improve the fishery rights system.

* 15 approved and 20 pending applications as of 2014

History

The fishery rights system in Taiwan was established in 1929 under the Fishery Act[1]. The TURF system was developed as a replicate of the Japanese system and thus allowed community-based co-management to replace the more traditional centralized top-down fishery management. However, the system was not very successful. Despite having exclusive access, fisheries associations did little to manage the resource in their TURF. At the same time, the government did not take the necessary actions to encourage active co-management. This led to criticism that the exclusive fishery rights systems was present on paper only. One of the biggest issues with the original Fishery Act was that it did not have proper mechanisms to deal with conflicts between fishers and developers, as land-use conflicts increased over time. In an effort to correct these failing, the Taiwanese Fishery Agency issued an administrative decree in 2004 to amend the fishery rights system with the aims of reducing conflict and establishing a more robust co-management system.

[1] Chen, C.L. (2012). Unfinished business: Taiwan's experience with rights-based coastal fisheries management. *Marine Policy*, 36(5), 955–962. doi:10.1016/j.marpol.2012.02.009

[2] Personal communication with Chung-Ling Chen

TURKEY
LAGOON FISHERIES

Number of TURFs:	Unknown
User Group Allocation:	Cooperative or Individual
Primary Target Resource:	None, many species targeted
Country Development Status:	Upper Middle Income

Overview

The Turkish government periodically leases lagoon areas to individuals or fisheries cooperatives[1].
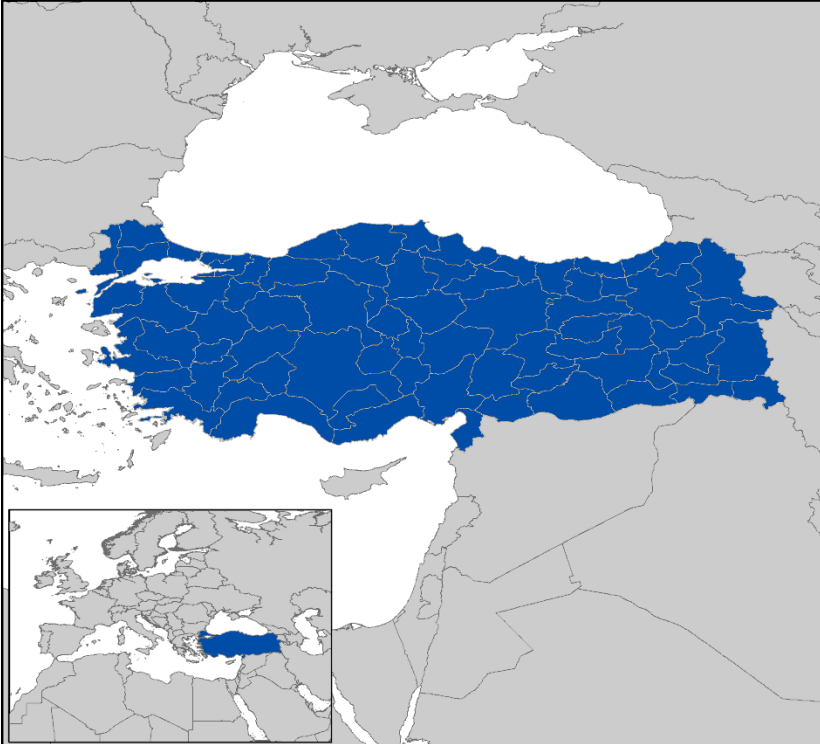
[1] Berkes, F. (1986). Local-level management and the commons problem: A comparative study of Turkish coastal fisheries. *Marine Policy*, 10, 215-229.

UNITED KINGDOM
SEVERAL FISHERY ORDERS

Number of TURFs:	28*
Date of Legal Standing:	1967
User Group Allocation:	Individuals
Primary Target Resource:	Shellfish
Country Development Status:	High Income

Overview

While not typically referred to as TURFs, the United Kingdom has a well-established territorial use right system that gives individuals exclusive ownership over an area of water through a government issued lease known as a Several Order. Any individual, cooperative, company, or responsible body can apply for a Several Order, which is typically granted for 5-10 years[1]. Several Orders are designed to manage shellfish species, specifically applying to the management of oysters, mussels, cockles, clams, scallops, queens, lobsters, and crabs. Grantees of Several Orders are authorized to maintain, harvest, and manage designated shellfish species as they see fit within their defined area[2]. In order to receive a Several Order, applicants are required to submit complete a management plan that outlines how cultivation will benefit the shellfishery and is subject to public review[1]. If approved, Grantees must comply with any specific regulations and restrictions set by the Ministry. The Ministry also reserves the right to impose additional regulations and prohibit harvest if a shellfishery is under threat of a disease outbreak. Illegal fishing has been a problem in some areas, but clear legal regulations are in place to enforce unauthorized activity[1]. Violators are liable for full compensation of damages and are subject to fines, forfeit of catch, and even imprisonment.
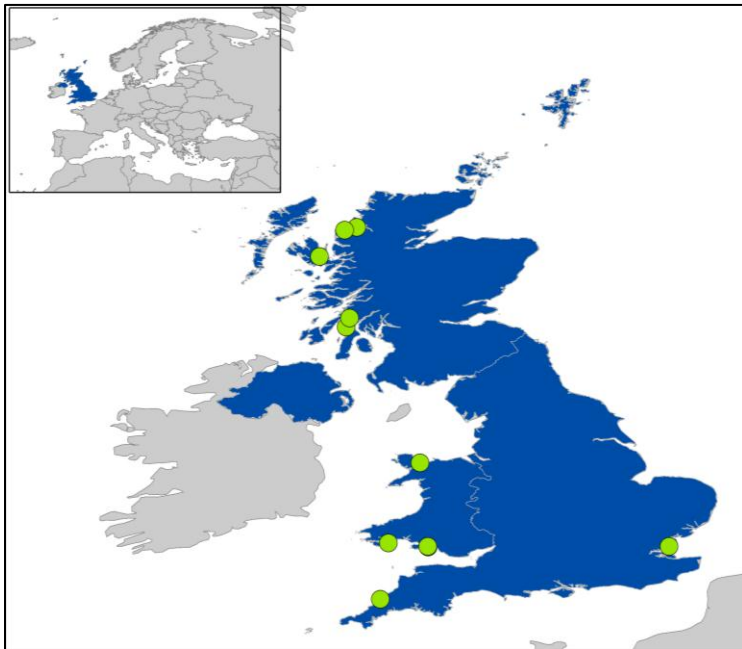
History

Several Orders were legally established under the Sea Fisheries (Shellfish) Act of 1967. The statute gave management authority to the Department of Environment, Food and Rural Affairs (Defra) in England, the Welsh Assembly Government (WAG) in Wales, and the Scottish Executive Environmental and Rural Affairs Department (SEERAD) in Scotland[1]; Northern Ireland is not included in the Sea Fisheries Act. Since the 19th century fisheries in the UK have been co-managed under 12 regional Sea Fisheries Committees (SFCs)[3]. With the Sea Fisheries Act of 1967, SFCs were granted authority to permit Several Order fisheries. Recently, England, Wales, and Scotland have each independently instituted major reform to the SFCs[3]; however, all three governments continue to issue Several Orders.

* As of 2006

More information: http://www.legislation.gov.uk/

[1] Laing, I., & Spencer, B. E. (2006). Bivalve cultivation: criteria for selecting a site (no. 136). The Centre for Environment, Fisheries & Aquaculture Science, Norwich.

[2] Defra & National Assembly for Wales (2003) Several and Regulating Orders for oysters, mussels, cockles, clams, scallops, queens, lobsters and crabs. Notes for guidance. Department for Environment, Food & Rural Affairs, UK government. 4pp.

[3] Phillipson, J., & Symes, D. (2010). Recontextualising inshore fisheries: The changing face of British inshore fisheries management. *Marine Policy*, 34(6), 1207–1214. doi:10.1016/j.marpol.2010.04.005

UNITED STATES

|	
Number of TURFs:	Over 8,060*
Date of Legal Standing:	1990
User Group Allocation:	Cooperative or Community
Primary Target Resource:	None, many species targeted
Country Development Status:	High income

Overview
TURFs in the United States fall into two categories: designated fishing territories for indigenous communities, and TURFs that are subdivided into smaller areas with the rights to set fixed gears within areas allocated to individuals. The oyster leases in coastal Louisiana are a textbook example of this. The state Department of Wildlife and Fisheries leases sections of oyster grounds to individuals or groups to harvest for one year. 8,043 leases were allocated in 2013, although some individuals own multiple leases[1]. (The orange triangle on the map represents the 8,043 oyster leases in Louisiana.) Although the lobster fisheries in New England are similar in their spatial structure, they are notorious for de facto territoriality- although anyone with a license can fish, they must be accepted into a group of lobster fishers, and are only allowed to fish within that group's traditional territory[2]. Georgia's crab fishery operates in a similar de facto fashion.
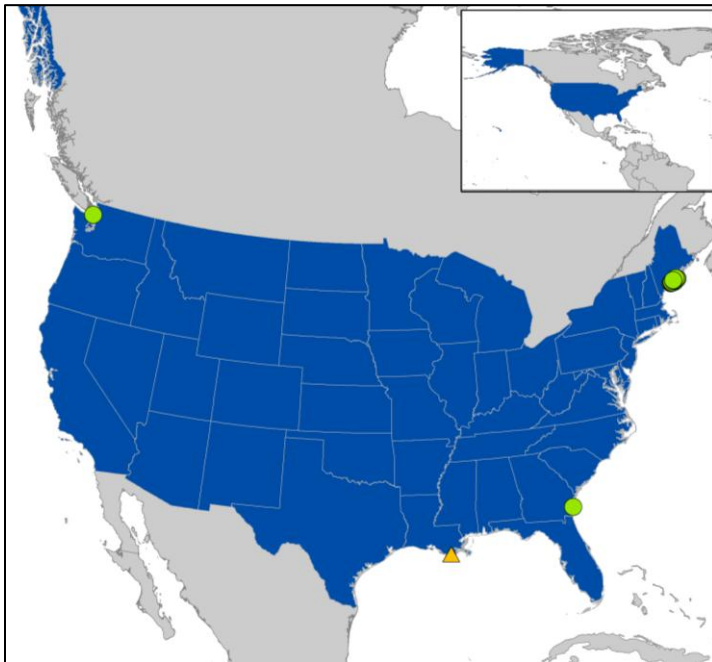
History
Catch shares became legal in the 1990 amendment of the Magnuson-Stevens Act. Although this legislation on catch shares includes TURFs, most fisheries implemented under this framework are Individual Transferrable Quotas[3]. However, TURFs have existed in the United States before there was national framework. Indigenous fishing communities often operate informally with territorial use rights, but these have become legally recognized, such as in the "Squamish Tribe usual and Accustomed Area"[4].

*The majority of the TURFs identified in the U.S. are in Louisiana. More TURFs are likely present throughout the U.S.

More information: http://www.st.nmfs.noaa.gov/economics/fisheries/commercial/catch-share-program/

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[1] http://www.wlf.louisiana.gov/fishing/oyster-program
[2] Acheson, J. M. (1975). The Lobster Fiefs: Economic and Ecological Effects of Territoriality in the Maine Lobster Industry. *Human Ecology*, *3*(3), 183-207.
[3] http://www.nmfs.noaa.gov/sfa/management/catch_shares/about/documents/noaa_cs_policy.pdf
[4] Survey response

VANUATU
CUSTOMARY MARINE TENURE

Number of TURFs:	unknown
Date of Legal Standing:	2002
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

Vanuatu has experienced a revival of community based resource management in one of the most supportive environments for allocation of fishing rights to customary owners in the Pacific[1]. Customary marine tenure is well-recognized both in communities and in national law, where rights to control and actions on traditional nearshore fishing grounds extends from the shoreline to the end of the reef adjacent to villages. Vanuatu's constitution (1980) recognizes legal ownership of this seabed and subsoil to the edge of offshore reef areas to Indigenous people[2], however communities are viewed as the legal owners of nearshore resources and generally manage their resources at the community level[3]. All community members are given access to fish the waters adjacent to a given community and full time residency is a common basis for fishing rights[2]. Non-community members require permission from a village chief or village council to extract resources from within a village's fishing grounds. Vanuatu is still in the early stages of developing a country-wide LMMA Network.
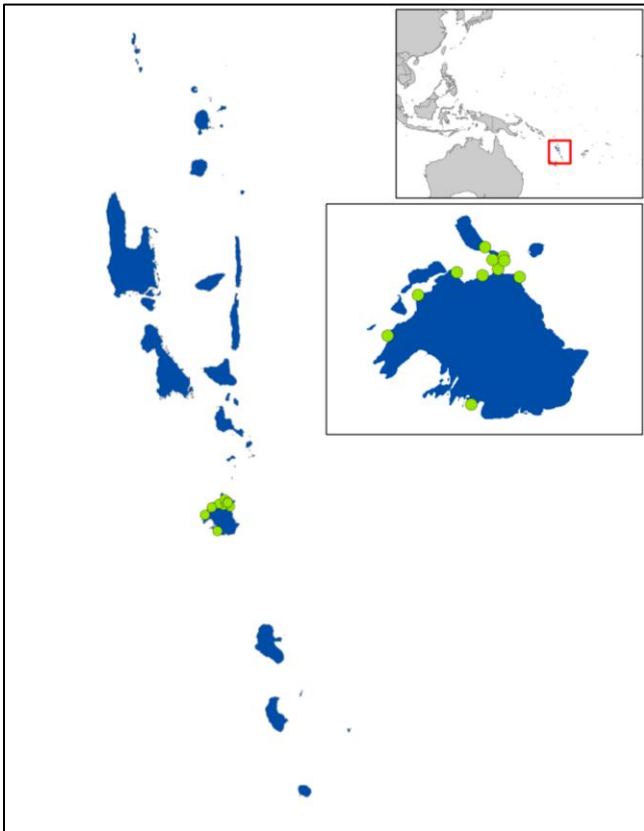
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[1] Govan, H., Tawake, W. A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Tafea, H., … Cohen, P. (2009). Community Conserved Areas : A review of status & needs in Melanesia and Polynesia.

[2] Techera, E. (2009). Customary law and community-based fisheries management across the South Pacific region. *Journal of Environmental Law*,*297*, 298.

[3] Leopold, M., Beckensteiner, J., Kaltavara, J., Raubani, J., & Caillon, S. (2013). Community-based management of near-shore fisheries in Vanuatu: What works?. *Marine Policy*, *42*, 167-176.

VIETNAM
BEN TRE PROVINCE CLAM FISHERY

Number of TURFs:	14*
Date of Legal Standing:	1997 (First cooperative established)
User Group Allocation:	Cooperative
Primary Target Resource:	Clams
Country Development Status:	Lower Middle Income

Overview

One TURF system operating in Vietnam is the Ben Tre Province Clam Cooperative system. At the provincial level, the Ben Tre Department of Agriculture and Rural Development (DARD) allocates areas where authorized clam management may be carried out and issues and may withdraw licenses to collectors. Three districts are responsible for setting targets for the fishery and organizes security patrols, within which the clam cooperatives themselves (there are 10 cooperatives and four small "clam groups") are responsible for security, harvesting and closing areas locally, ensuring laws are obeyed, and surveying[1]. Clams are collected by hand and rake. Nearly 13,000 households are involved in the fishery[2].

History

The Rang Dong Cooperative, the pioneering cooperative in Ben Tre, was established in 1997 by the Ben Tre Department of Agriculture and Rural Development (DARD)[2]. In 2009, Ben Tre's hard clam fishery became Marine Stewardship Council (MSC) certified, making it the first fishery in the Southeast Asian region to achieve the certification[2].

*14 cooperatives (10 cooperatives and 4 "clam groups") as of 2010

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[1] Luu, T. T., Holt, T., & Hough, A. (2010). Public Certification Report for Ben Tre Clam Fishery, Client: Ben Tre Department of Agriculture and Rural Development / WWF.
[2] International Sustainability Unit. (2011). Ben Tre Clam Fishery. *The Prince of Whales' Charitable Foundation.* Retrieved March 10, 2014, from http://www.pcfisu.org/marine-programme/case-studies

VIETNAM
TAM GIANG LAGOON TURFS

Number of TURFs:	7*
Date of Legal Standing:	2009
User Group Allocation:	Community
Primary Target Resource:	None, many species targeted
Country Development Status:	Lower Middle Income

Overview

In the Tam Giang Lagoon, 50 Fishing Associations (FAs) have been established and are recognized by higher level authorities, seven of which have been granted formal fishing rights by Provincial and District authorities[1]. For an FA to be granted formal fishing rights, 75% of the village must belong to the association and show the District a plan for fisheries management. In the Vinh Giang Fishing Association (the first established TURF), the lagoon space has been divided into sub-zones, including zones for fixed gear fishing, mobile gears, traffic areas, breeding areas, and seasonally protected zones[1]. Zoning is based on local knowledge of lagoon resources and is consistent with Provincial and District plans for fisheries. Organizations and individuals in and out of the Vinh Giang commune may register for exploitation of resources within the TURF, however users must be registered with the association and pay an annual fee[2].

History

In the late 1980's, Vietnam moved from a centralized, state-planned economic system to a decentralized system of individual land titling and a private sector oriented market. The 2003 Fisheries Law recognizes the role of community members in the management of their natural resources, and the law has been used to enact decisions enabling community management, as well as to formally transfer fishing rights to FAs[3]. In 2009, the "first TURF" in Vietnam was allocated to the Vinh Giang Fishing Association and since then, formal rights allocations have been granted to six other sites in the lagoon[1].

*7 TURFs as of 2012

[1] Marschke, M., & Armitage, D. (2012). Do collective property rights make sense? Insights from central Vietnam, 6(1), 1–27.

[2] Armitage, D., Marschke, M., & van Tuyen, T. (2011). Early-stage transformation of coastal marine governance in Vietnam? Marine Policy, 35(5), 703–711. doi:10.1016/j.marpol.2011.02.011

[3] Anh, N. T. K. (2012). Community-based Co-management in Vietnamese fisheries. The case of the Fisheries Associations in Tam Giang-Cau Hai Lagoon. University of Tromso Norway & Nha Trang University, Vietnam.

Appendix 3
TURF Case Study Information

List of all site-specific TURF case studies analyzed in this study (n = 103). A separate works cited for the case-studies is also included. Survey respondents are to remain anonymous, although all survey respondents were professional researchers and managers with extensive knowledge of the TURF for which they completed the survey.

Country	Name	Location	Source
American Samoa	Rose Atoll Marine National Monument	Rose Atoll	Survey Response
Australia	Exmouth Gulf Prawn Fishery	Exmouth Gulf, Western Australia State	Kangas et al., 2006; Townsend et al., 2008
Belize	Glover's Reef	Glover's Reef	Survey Response
Belize	Port Honduras	Port Honduras	Survey Response
Brazil	Mandira Marine Extractive Reserve	Cananéia, São Paulo State	Diegues, 2008
Brazil	Arraial do Cabo Marine Extractive Reserve	Arraial do Cabo, Rio de Janeiro State	da Silva, 2004
Brazil	Corumbau Marine Extractive Reserve	Prado & Porto Seguro, Bahia State	Survey Response
Canada	Nova Scotia Crab Fishery	Nova Scotia, Quebec Province	Townsend & Shotton, 2008
Chile	Guayacan AMERB[1]	Coquimbo, Elqui Province	Aburto et al., 2013
Chile	Puertecillo AMERB[1,2]	Pichilemu, Cardenal Caro Province	Gelcich et al., 2006
Chile	Huentelauquen AMERB[1]	Huentelauquen, Choapa Province	Aburto et al., 2013
Chile	Chaihuin (Sectors A, B, & C) AMERB[1]	Chaihuin, Valdivia Province	Survey Response
Chile	Navidad AMERB[1]	Navidad, Cardenal Caro Province	Afflerbach et al., in progress
Ecuador	Isla Costa Rica	Costa Rica (near Tembleque), El Oro Province	Beitl, 2011
Fiji	Kubulau District Fisheries Management Area	Kubulau District, Bua Province	Nainoca, 2011; Wildlife Conservation Society, 2012
Fiji	Navakavu LMMA3	Na Vasi, Viti Levu Island	Survey Response; O'Garra, 2009; Nainoca, 2011; Hubert, 2007; Beukering et al., 2007; Clarke & Jupiter, 2010

Country	Name	Location	Source
France	Bastia-Cap Corse Prud'homie	Bastia, Corse Province	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Cagnes-sur-Mer Prud'homie	Cagnes-sur-Mer, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Cannes Prud'homie	Cannes, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Toulon Prud'homie	Toulon, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Le Lavandou Prud'homie	Le Lavandou, Provence-Alpes Cote d'Azur	Arceo et al., 2013 Cadiou et al., 2009; Grieve 2009; Spagnolo, 2012
France	Martigues Prud'homie	Martigues, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Sanary Prud'homie	Sanary-sur-Mer, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	St. Raphaël Prud'homie	St. Raphaël, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	St. Tropez Prud'homie	St. Tropez, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Villefranche Prud'homie	Villefranche-sur-Mer, Provence-Alpes Cote d'Azur	Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
France	Port-Cros National Park4	Port Cros, Provence-Alpes-Cote d'Azur	Cadiou et al., 2009; Arceo et al., 2013; Grieve 2009; Spagnolo, 2012
Greece	Messologgi Lagoon Fishery	Messologgi Lagoon, Gulf of Patras, Western Greece Region	Survey Response
India	Pulicat	Pulicat, Tamilnadu, Tamil Nadu State	Survey Response; Rajagopalan, 2012
India	Kodipadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
India	Unionpadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
India	Muruganpadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
India	Panumbukadpadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
India	Ayapenpadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
India	Kunentherapadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
India	Thiyikadehpadu	Cochin Estuary, Vallarpadam Island, State of Kerala	Lobe & Berkes, 2004
Indonesia	Sasi Lola	Ohoirenan Village, Kei Besar Island, Maluku Province	Harkes & Novaczek, 2002; Thoburn, 2000; Ruttan, 1998; Satra & Adhuri, 2010

Country	Name	Location	Source
Italy	Cogevo Chioggia	Chioggia, Veneto Region	Survey Response
Japan	Walleye Pollack Fishery in Nishi Section	Hiyama District, Hokkaido Prefecture	Uchida & Watanobe, 2008
Japan	Sakuraebi (Shrimp) Fishery in Suruga Bay	Surauga Bay, Shizuoka Prefecture	Uchida & Baba, 2008 Sakai et al., 2010
Japan	Hamaguri Clam Fishery in Ibaraki Prefecture	Kashima Sea, Ibaraki Prefecture	Takahashi et al., 2006
Japan	Abalone Fishery in Chiba Prefecture	Chiba Prefecture	Takahashi et al., 2006
Japan	Mutsu Bay Sea Cucumber Fishery	Mutsu Bay, Aomori Prefecture	Afflerbach et al., in progress
Japan	Ise Bay Sandeel Fishery	Ise Bay, Mie and Aichi Prefectures	Afflerbach et al., in progress
Japan	Rausu Walleye Pollock Fishery	Rausu, Shiretoko Peninsula, Hokkaido Prefecture	Afflerbach et al., in progress
Mexico	Seri Exclusive Fishing Zone	Canal del Infiernillo, Tiburón Island, State of Sonora	Bourillón-Moreno, 2002
Mexico	San Felipe Marine Reserve/Actam Chuleb	San Felipe, State of Yucatán	Chuenpagdee et al., 2002
Mexico	Progreso FEDECOOP	Estero La Bocana, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	Punta Abreojos FEDECOOP	Punta Abreojos, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	Leyes de Reforma FEDECOOP	Playa Océano Pacífico, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	California de San Ignacio FEDECOOP	San Roque, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	Bahía Tortugas FEDECOOP	Bahía Tortugas, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	La Purísima FEDECOOP	Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	Emancipación FEDECOOP	Morro Hermoso, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	Pescadores Nacionales de Abulón	Isla Cedros, Vizcaíno Peninsula, State of Baja California Sur	McCay et al., 2014
Mexico	Loreto Bay National Park	Loreto, State of Baja California Sur	Stamieszkin et al., 2009
Mexico	Olazul Experimental Concession	La Paz, State of Baja California Sur	Survey Response
Mexico	Lobster fishing cooperatives of Vigía Chico	Vigía Chico, State of Quintana Roo	Survey Response

Country	Name	Location	Source
Mexico	Preio de Propiedad Federal SCPP Buzos de Puerto Punta Peñasco SC de RL	Puerto Peñasco, State of Sonora	Survey Response
Mexico	Isla Natividad Baja California Regional FEDECOOP	Isla Natividad, Vizcaíno Peninsula, State of Baja California Sur	Afflerbach et al., in progress
Mexico	Magdalena Bay Baja California Regional FEDECOOP	Magdalena Bay, State of Baja California Sur	Afflerbach et al., in progress
Netherlands	Integrated Fisheries Foundation	Wadden Sea (Dutch Waddenzee)	Grieve, 2009; Alma, 2008; Enemark, 2005; Geïntegreerde Visserij Website
New Zealand	Challenger Scallop Enhancement Company	Marlborough Sounds, South Island	Wincher, 2008
Nigeria	Acadja	Abeokuta, Ogun State	Survey Response; Olopade et al, 2008
Papua New Guinea	SeaSmart Fisheries Management Areas	Central Province	Survey Response
Philippines	Candelaria	Candelaria, Zambales Province	Mercado, 2011; Vera et al., 2007
Philippines	Community-based Fisheries Resource Management Project Malalison Island	Malalison Island, Antique Province	Agbayani et al., 2000; Pomeroy & Ahmed, 2006
Philippines	Hinatuan	Hinatuan, Surigao Del Sur Province	Vera et al., 2007
Philippines	Romblon	Romblon, Romblon Province	Afflerbach et al., in progress
Philippines	Concepcion	Concepcion, Iloilo Province	Afflerbach et al., in progress
Samoa	Safata Marine Protected Area	Safata District	Afflerbach et al., in progress
Samoa	Aleipata	Aleipata District	Afflerbach et al., in progress
Solomon Islands	Mbili Passage Puava	Mbili Passage (or Mboli???), Marovo Lagoon, Vangunu Island	Kinch et al., 2006
Spain	Os Miñarzos Marine Reserve of Fishing Interest[5]	Lira, Galicia	Perez de Oliveira, 2013
Sri Lanka	Negombo Estuary	Negombo, Western Province	Amarasinghe et al., 1997; Lobe & Berkes, 2004
St. Lucia	Soufrière Marine Management Area	Soufrière, Soufrière Quarter	Sandersen & Koester, 2000
Sweden	Gullmar Fjord Shrimp Fishery	Gullmar Fjord, Bohuslän Province	Eggert & Ulmestrand, 2008
Sweden	Koster-Väderö Fjord Shrimp Fishery	Koster-Väderö Fjord, Bohuslän Province	Grieve, 2009; Eggert & Ulmestrand, 2008; Popescu, 2010
United Kingdom	Loch Sligachan, Isle of Skye, Scallops Several Fishery Order	Sconser, Scotland	No. 280, 2013; Laing & Spencer, 2006; Defra, 2003

Country	Name	Location	Source
United Kingdom	Loch Ewe, Isle of Ewe, Wester Ross Scallops Several Fishery Order	Loch Ewe, Scotland	No. 830, 1997; Laing & Spencer, 2006; Defra, 2003
United Kingdom	Loch Crinan Scallops Several Fishery Order	Crinan, Scotland	No. 304, 2005; Laing & Spencer, 2006; Defra, 2004
United Kingdom	Loch Caolisport Scallops Several Fishery Order	Clachbreck, Scotland	No. 272, 2002; Laing & Spencer, 2006; Defra, 2005
United Kingdom	Little Loch Broom Scallops Several Fishery Order	Badluarach, Scotland	No. 186, 2002; Laing & Spencer, 2006; Defra, 2006
United Kingdom	Menai Strait Oyster and Mussel Fishery Order	Bangor, Wales	MacAlister, 2010; No. 705, 1962; Defra, 2007
United Kingdom	Lydstep Haven Mussel Fishery Order	Lydstep, Wales	No. 2946, 2013; Laing & Spencer, 2006; Defra, 2008
United Kingdom	Mumbles Oyster Fishery Order	The Mumbles, Wales	No. 2020, 2013; Laing & Spencer, 2006; Defra, 2009
United Kingdom	River Camel Mussel and Oyster Fishery Order	Rock, England	No. 1978, 2013; Laing & Spencer, 2006; Defra, 2010
United Kingdom	Swansea Bay (Thomas Shellfish Limited) Mussel Fishery Order 2012	West Cross, Wales	No. 1689, 2012; Laing & Spencer, 2006; Defra, 2011
United Kingdom	River Roach Oyster Fishery Order	Paglesham Eastend, England	No. 1979, 2013; Laing & Spencer, 2006; Defra, 2012
United States	Georgia blue crab fishery	Georgia State	Survey Response
United States	Suquamish Tribe Usual and Accustomed Area	Puget Sound, Washington State	Survey Response
Vanuatu	Takara	Takara Village (near Baofatu), Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Siviri	Siviri Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Tanoliu	Tanoliu Village (near Port Havannah), Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Mangaliliu	Mangaliliu Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Eratap	Eratap Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Piliura	Piliura Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Unakapu	Unakapu Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Laonamoa	Laonamoa Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vanuatu	Worasifiu	Worasifiu Village, Efaté, Shefa Province	Afflerbach et al., in progress

Country	Name	Location	Source
Vanuatu	Paonangisu	Paonangisu Village, Efaté, Shefa Province	Afflerbach et al., in progress
Vietnam	Rang Dong Fishery Cooperative	Thói Thuân Commune, Bình Đai District, Ben Tre Province	Luu et al., 2010
Vietnam	Vinh Giang Fishing Association	Phu Vang District, Thua Thien-Hue Province	Marsche & Armitage, 2012; Anh, 2012; Armitage et al., 2011
Vietnam	Ran Trao LMMA[3]	Van Hung Commune, Khanh Hoa Province	Survey Response

1 AMERB (*Áreas de Manejo y Explotacióde de Recursos Bentónicos*) is the name of the Chilean TURF system
2 Puertecillo AMERB is no longer active
3 LMMA (Locally-Managed Marine Area)
4 The Port Cros National Park is a TURF located within the Le Lavandou *prud'homie* (i.e. this is a TURF within a larger TURF)
5 The *Os Miñarzos* Marine Reserve of Fishing Interest is a TURF located within the Lira *Cofradia* (i.e. this is a TURF within a larger TURF)

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Appendix 4
DiscoverTURFs Interactive Map Database

Introduction
More data are needed to better understand the factors that lead to successful TURF implementation and management. The data gathered through this analysis provide an initial framework that can be built upon to better categorize indicators of success. While it is clear that TURFs exist around the world, the TURF literature is relatively limited and frequently biased toward a few well-studies countries or regions. By globally distributing our survey, we were able to identify TURFs in several countries that we would have not otherwise found in the literature. We believe the best way to gather accurate and comprehensive data on TURFs is to create an interactive, open access map database that can be expanded using the local knowledge from experts around the world.

Through the distribution and advertisement of our survey, as well as conversations with organizations, researchers, and managers around the world, we feel there is considerable support and interest in a global TURF database. The relatively high traffic on our DiscoverTURFs website (see below) also highlights the general interest in such a tool. If an initial map is created, users would be able to clearly see the benefits of such a database, which we believe will encourage active participation and improved data collection. Social media, Internet forums, newsletters, and listservs could act as effective means of advertising such a map and would encourage participation.

The actual development of a map is beyond the scope of this particular project; however, The Environmental Defense Fund and Fish Forever have expressed interest in potentially using the data gathered in this analysis to create, host, and maintain an interactive TURF map. Therefore, this Appendix proposes a general framework for how such a map could be developed. The specifics are dependent on the goals and needs of the host organization.

Designing a Map Interface
With the data collected through this analysis, data could be displayed on an interactive map at three different levels of resolutions:
> 1) <u>Country Level Data</u>- general information about how TURFs operate at a national level; data (with varying levels of information) are currently available for 41 countries.
> 2) <u>Case Study Data</u>- information about how a single TURF is designed and operated; data (with varying levels of information) are currently available for 103 TURF case studies in 29 countries.
> 3) <u>Location Only Data</u>- we identified the approximate locations of 1,133 TURFs around the world. No site-specific information is currently available for these TURFs.

While the design of a map interface could vary greatly, here we present one potential design. Upon entering the website, users would be presented with a map set to a global extent. All of the countries with TURFs would be highlighted in a bright color, directing users to click on a country of interest. By clicking on a country, the map would then zoom in and display the country of interest. Once zoomed to this resolution, all points representing known TURF locations would be visible. Points could be differentiated by shape and color for TURFs with that have case study information versus TURFs where only a location and/or name are known.

By clicking on a country, case study, or location point of interest, specific written information could be displayed in one of two ways:
> 1) Users could click on a country or point to reveal a pop-out text box containing written information, or

2) Users could click on a country or point and be directed to a separate webpage containing written information.

In order to easily see how information could be displayed, Figures 1, 2, and 3 provide examples at all three levels of data resolution using pop-out text boxes.

Contributing Information

In order to make the map interactive and up-to-date, users could be given the option to verify, edit, and/or contribute information. To facilitate this process, and to provide a level of quality assurance, users could be required to create an account and login in order to make any changes or suggestions. As part of the login process, users could provide personal information in order to confirm their credentials. The map operator would then need to vet all verifications, edits, and contributions before the data was added to the map.

Users could have the ability to "verify" the validity of the data presented in the map for each individual country or case study. For each independent verification, a green check mark (or some other symbol) could be added to the information displayed for a given country or case study. If users have edits or wish to contribute additional information, they could login and follow a link to send contributions to the map operator. For those TURFs where only a location and/or name is known, users could be given the opportunity to contribute information by taking a survey. Similarly, if a TURF is not present on the map at all, users could follow a link in order to take the survey and add a new TURF to the map. Users could be directed to an abbreviated version of the survey created for this analysis.
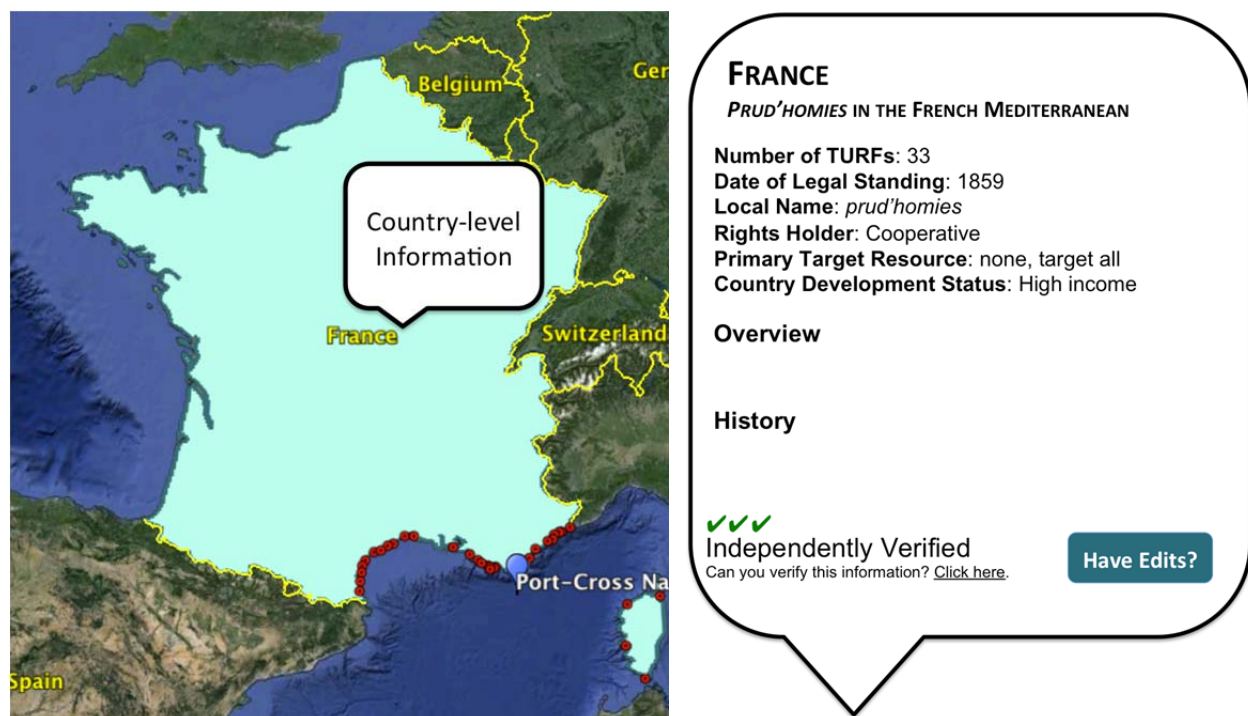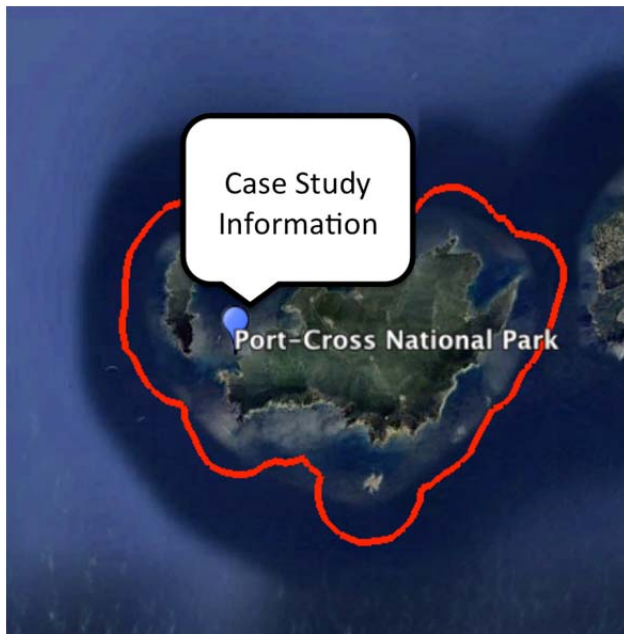

Figure 1. Potential option for how country-level data could be displayed. This example is based on the country level data that is currently available in Appendix 1 of this report.
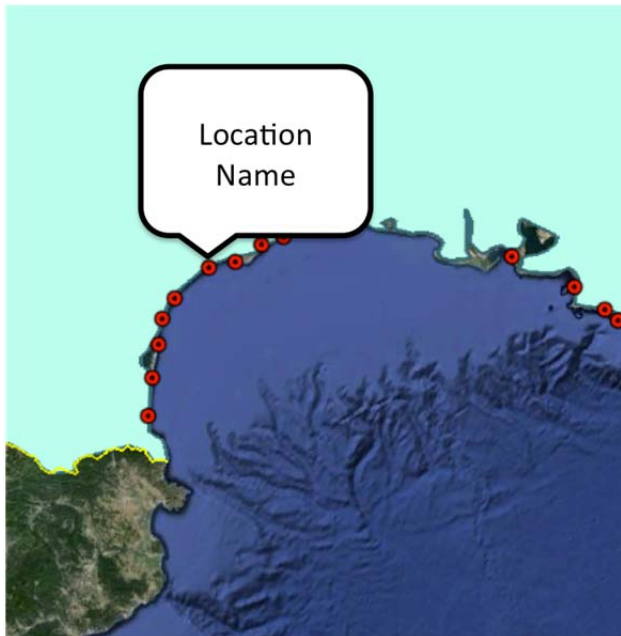
Figure 2. Potential option for how site specific data could be displayed. Site specific level information could be provided in either tabular or paragraph form. All specific TURFs have a least a point representing the approximate location of the TURF. In many cases (n= 51), a polygon representing the boundaries of the TURF is also available.

Figure 3. Potential option for how location only data could be displayed.

Encouraging User Participation

While a functioning web map with accessible data would be incentive enough for some people to contribute information, the map operator will likely need to actively encourage participation. This could be achieved through advertisements, personal communication, and/or monetary or other incentives. For instance, contributors' names could be added to periodic drawings for prizes. Alternatively, similar to Wikipedia, popup windows could be used to remind users of the value of their contribution. Highlighting a so-called 'TURF of the Month' could also be used to encourage people to enter information so their TURF may be featured as a future TURF of the Month.

Data Availability and Processing

All data collected in this analysis are currently stored as either Excel or CSV spreadsheets; spatial data is available as ArcGIS shapefiles and geodatabases. While all data are currently available, preparing these data in a way that is easily incorporated into an online map will require additional time and effort that is beyond the abilities of this project.

Country-level Data

Appendix 1 provides a brief overview and map of each of the 41 countries identified as having TURFs in this analysis. Since many countries have multiple, independently operating TURF systems[1], some countries have multiple entries to describe the system-level differences. These data are therefore currently ready for display in an interactive map.

Raw country-level data is available in varying formats. As described in the report, we identified 43 TURF systems in 33 countries and have a single compiled spreadsheet with key information about each system. While our case study survey was not designed to gather system or country-level data, we were able to use the survey spreadsheets to answer most of the survey questions at the system-level. Therefore, some but not all, of the systems identified have individual spreadsheets with specific, in-depth information. Additional information at the country/system-level is available as citations and notes.

Case Study Data

Appendix 2 lists all 103 case studies identified in this analysis. All case study data was collected using the questions from our survey. Each case study was given a unique identification number and a separate spreadsheet for each case study was generated[2]. Therefore, case study level data is available in two formats:

> 1) Compiled CSV files with all 103 case studies (both raw and transformed for analysis)
> 2) Individual folders for each case study containing a raw Excel spreadsheet, citations, and all relevant spatial data (paper maps, KML files, or shapefiles).

The case study data are currently not in a format that is conducive to display on an interactive map. These data will need to be processed, compiled, and written in a way that is easily read and understood by a general audience. The information that can be displayed will depend on the goals of the organization hosting the map, the level of desired standardization between case studies, and whether data will be presented in tabular and/or paragraph form. The map operator will need to determine which data will be most appropriate to facilitate additional data collection. Whichever datum is presented in the map would most likely serve as the framework for all additional data collection. For instance, the data initially presented in the map would then serve as the template to create a shorted survey capable of adding additional data to the map database. Figure 4 shows the data availability of each survey question asked in our analysis

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[1] For the purposes of this analysis, we define TURF systems as one or more TURFs that operate under a similar management structure or legal framework. Many countries have multiple systems that operate independently of one another.

[2] Unique files are not available for the 19 case studies taken from Afflerbach et al., (in progress) since a full spreadsheet of those entries is already available.
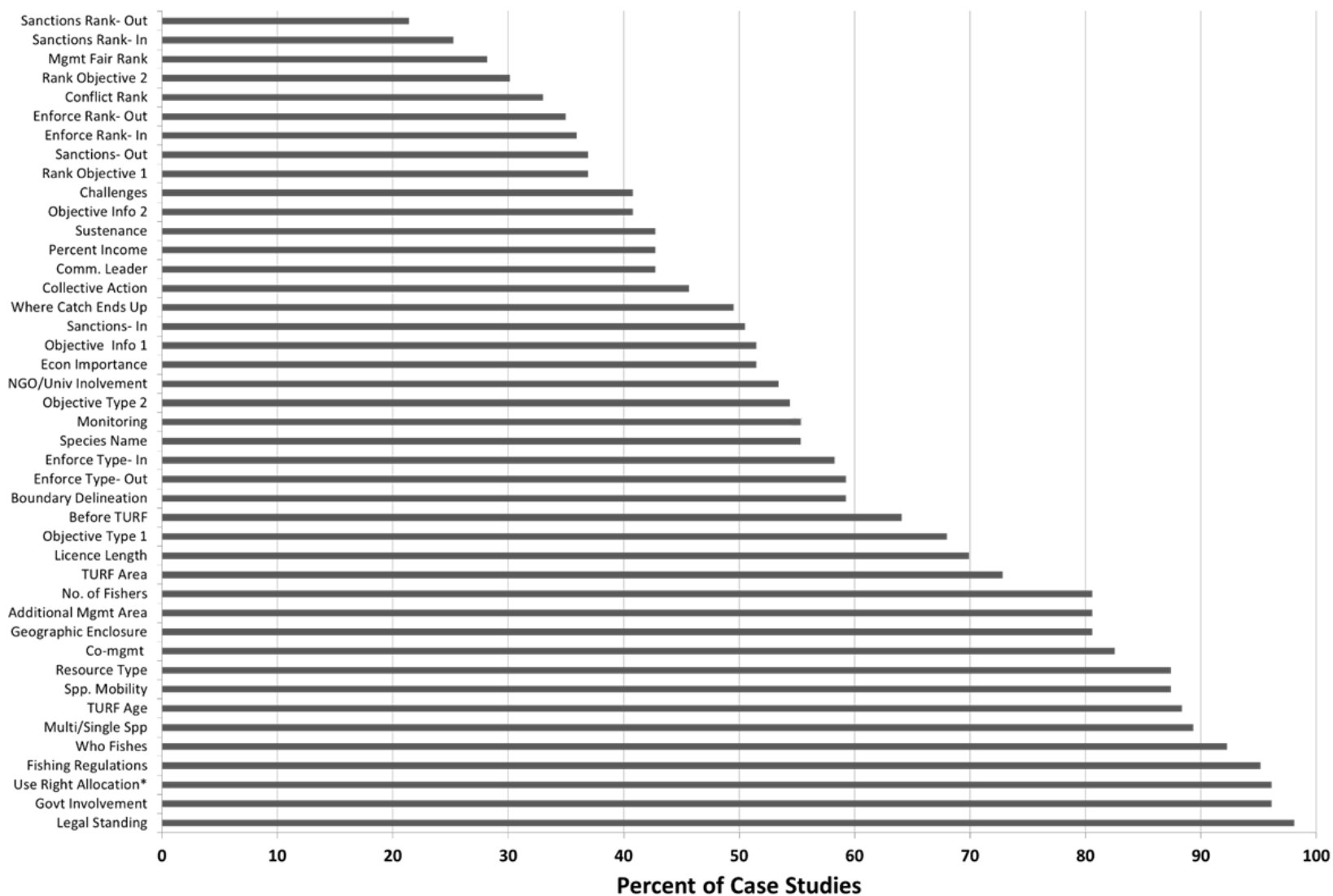
Figure 4. Percent of case studies with a response for the survey questions specified on the vertical axis. Data are based on 103 case studies. These summary data indicate if any response was given, but does not specify how in-depth or complete the data provided is. Asterisks are used for questions that may be difficult to use in a map because the survey questions proved ambiguous, Objective Types 1 and 2 represent the top two management objective categories chosen (i.e. social, fisheries, conservation, or economic objectives); ranking data is self-reported estimates of whether a task/objective was being met. The survey asked questions about enforcement and sanctions for both inside users (TURF members) and outsiders (people without permission to access the TURF).

Spatial Data

Spatial data are available in multiple formats and levels of resolution. We identified 1,133 points representing the approximate locations TURFs. In most, but not all cases, a TURF name is also associated with the point. These data are available on a global and per country basis as ArcGIS shapefiles, but can also be converted to KML files for display in Google Earth or Google Maps.

In some cases, we were able to obtain detailed polygon data for individual TURFs (see Methods of main report). In total, polygon data is available for 176 TURFs and 51 of our case studies. These data are available as ArcGIS shapefiles, but can also be converted to KML files for display in Google Earth or Google Maps.

Summary of types of available data

Data Format	Country/System Data	Case Study Data	Location Data
Compiled CSV	x	x	
Compiled Raw Excel	x	x	
Individual Raw Excel	x (some)	x	
Spatial			
point		x	x
polygon		x (some)	x (some)
Additional Processing required	low	high	medium

Mapping Platforms

There are many different mapping platforms that could be used to display TURFs. Typically, as the desired functionality and capacity of the map increases, so do the computer programming requirements and server space required. Here we provide a brief overview of the potential mapping platforms that could be used.

Google Earth

Google Earth is a free application that can be downloaded to a local computer for use offline. A map created in Google Earth will have a single KMZ file that can be uploaded to a website so users can download the file to their personal computers. The advantage of this format is that it is relatively easy to generate, requires no additional server space, and has built-in and intuitive navigation. However, this map would not be easily edited by users and would require users to frequently download updated version of the map. Therefore, we do not recommend this format. For an example of a downloadable KMZ file see the Chilean government TURF website (http://www.subpesca.cl/servicios/603/w3-article-79986.html).

Google Maps JavaScript API v3

Google Maps is a widely used Application Programming Interface (API) that can be easily embedded into any webpage[3]. Since Google Maps runs on Google's servers, no additional server space is required and the map can run free of charge (assuming usage limits are not reached). Google Maps has many advantages including relatively easy computer programming, extensive documentation and sample code, and a user interface that is intuitive and familiar to most users. We recommend using Google Maps. For examples (with varying levels of complexity) see Open EI webmap for wind farms in the United States (http://en.openei.org/wiki/Map_of_Wind_Farms) and the Protected Planet webmap for protected areas around the world (http://www.protectedplanet.net/).

ESRI APIs

ESRI's ArcGIS for Developers offers a wide array of options for creating webmaps[4]. ESRI offers more programming flexibly as compared to Google and is compatible with ArcGIS files. ESRI's APIs also allow for greater control over the appearance of a map. The disadvantages of ESRI are that it is a paid service and requires more advanced computer programming knowledge. For an example see MPAtlas (http://www.mpatlas.org/explore/).

Several Potential Map Platforms

	Google Earth	Google Maps	ESRI
Interactive	x	x	x
Live Updates		x	x
Embedded on Website		x	x
Download Data		x	x
Programming Expertise	low	medium	high
Server Space Required	none	low	high
Design Flexibility	low	medium	high
Price	free	free	$$

Moving Forward

Currently, DiscoverTURFs has conceptualized and advertised the idea for an interactive map on our website (discoverturfs.com) and through survey distribution. We currently own the domain name discoverturfs.com, so this website could be maintained if desired. Many people have expressed interest in the goals of DiscoverTURFs and the site has been advertised by multiple organizations (e.g. SeaWeb, Live with the Sea, Fisheries Law Center, Rare, the Environmental Defense Fund, Sustainable Fisheries Group, Small-scale and Artisanal Fisheries Research Network). Since the site was launched in June 2013, the website has received 1,163 visits, 527 unique visitors, and over 3,400 page views from users in 51 different countries (Figure 5).

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[3] Get more information for the Google Maps JavaScript API:
https://developers.google.com/maps/documentation/javascript/tutorial

[4] Get more information about ESRI ArcGIS for Developers: https://developers.arcgis.com/en/

There is clearly a great deal of interest in a TURF map and many users have a familiarity with the name DiscoverTURFs. While DiscoverTURFs could remain as a separate website, a parent organization would need to create and maintain the map, as long-term maintenance is beyond the scope of this Master's project. It is also possible that a TURF interactive map could potentially partner with or be incorporated into another map service. For instance, MPAtlas features some marine areas that function as both MPAs and TURFs. A webmapping platform such as MPAtlas could serve as a potential collaborative partner. Overall, we recommend a TURF map be integrated into either Fish Forever or EDF's Catch Shares Design Center. Both organizations would benefit from having an interactive map capable of displaying and gathering information about TURFs around the world.
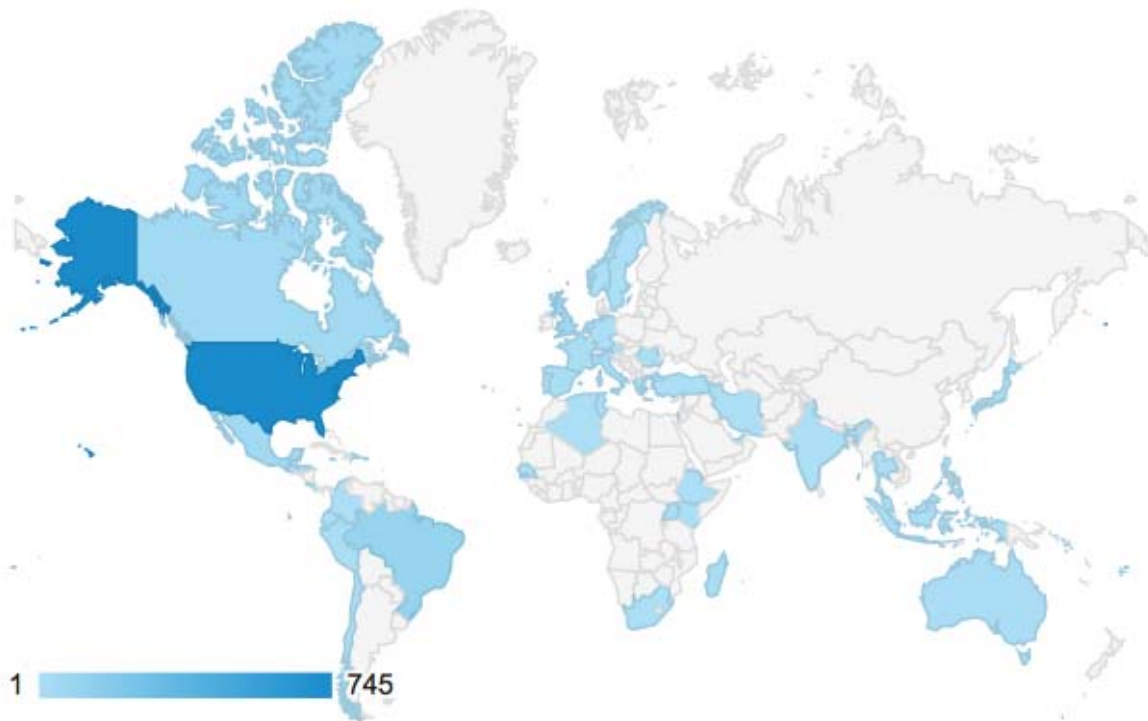

Figure 5. Map of all the countries where at least one person has visited the DiscoverTURFs website. In total, over 500 unique visitors from 51 different countries have viewed the website at some point between June 2013 and March 2014. Data was made available through Google Analytics.