UNIVERSITY OF CALIFORNIA SAN DIEGO

U.S. Exempted Fishing Permits: Role, Value, and Lessons Learned for Adaptive Fisheries Management

A Thesis submitted in partial satisfaction of the
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in

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by

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LIST OF ABBREVIATIONS

ACL	Annual Catch Limit
AM	Adaptive management
CFMC	Caribbean Fishery Management Council
CPS	Coastal pelagic species
EEZ	Exclusive economic zone
EFP	Exempted fishing permit
FMC	Fishery Management Council
FMP	Fishery Management Plan
GFMC	Gulf of Mexico Fishery Management Council
HMS	Highly migratory species
IFQ	Individual fishing quota
MAFMC	Mid-Atlantic Fishery Management Council
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSE	Management strategy evaluation
NEFMC	New England Fishery Management Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
nm	Nautical mile
NPFMC	North Pacific Fishery Management Council
PFMC	Pacific Fishery Management Council
SA	Stock assessment

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ABSTRACT OF THE THESIS

U.S. Exempted Fishing Permits: Role, Value, and Lessons Learned for Adaptive Fisheries Management

by

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Experimental fishing is a tool within adaptive management, but greater capacity exists to use experimentation to test alternative ideas to meet the national standards of the Magnuson-Stevens Act and promote sustainable fisheries. Few programs exist to allow for experimentation in federal waters, 3-200nm offshore, which is a crucial

component of adaptive fisheries management. The exempted fishing permit (EFP) program, administered by the National Oceanic and Atmospheric Administration (NOAA), promotes collaboration between scientists, managers, and industry to develop creative solutions to evolving fisheries challenges by leveraging resources across fisheries sectors. To date, no synthesis of EFP implementation and efficacy has been conducted, leaving those who manage these fisheries in the dark as to their success more generally. Although regional managers discuss EFP projects on an individual basis, an analysis of the entire program provides useful guidance to management more broadly and describes trends in success to effectively translate experimentation to management. Here we developed the first standardized database of EFPs in the U.S. to summarize regional trends in applicant types, fisheries, gear types, goals, and exempted regulations. EFP documentation from 2008-2018 was compiled across seven broadly defined fisheries in four coastal regions in the U.S. We also evaluated factors that were associated with the degree to which EFPs were informative for fisheries management; 'informative' being defined as either informing regulatory change within a fishery or providing supporting data to fisheries reports (e.g. stock assessments, fishery management plans). We found strong differences between regions of the U.S. with the groundfish fishery strongly represented in the western regions and a mixed assortment of fisheries for the eastern regions. Western region projects had a greater focus on new gear and methods testing to reduce bycatch, whereas eastern regions had a mixture of goals, including projects that supplemented biological or ecological knowledge or contributed to stock assessments. We found strong coastal differences in the types of primary applicants that proposed projects, with eastern projects deriving from "top-

down” approaches and western from “bottom-up”. Finally, we found that management region, applicant type, fishery, and size of project were positively associated with success in EFP projects, with Alaska and West Coast regions accounting for the highest proportion of successful projects.

Introduction

Encompassing 4.4 million square miles of ocean (11,395,947 km^2), the United States marine fisheries represent the second largest Exclusive Economic Zone (EEZ) in the world, posing a difficult challenge for those agencies with their sustainable management (National Marine Fisheries Service, 2020b). Currently, the U.S. manages 461 stocks or stock complexes in 46 fishery management plans across the contiguous states and territories (National Marine Fisheries Service, 2019a). With such a diverse array of species, gear types, and ecosystems to consider, creating fisheries regulations that ensure sustainable yields while considering biological thresholds, changing oceanographic conditions, and cultural and societal needs is an ongoing challenge. Creating policy that is flexible to adapt quickly to changing challenges, yet consistent enough to meet the challenges of today and the future is critical. A changing climate poses novel challenges for those who manage this resource. Warming waters and acidifying oceans are redefining species' ranges (Perry, Low, Ellis, & Reynolds, 2005), altering catch composition and species' abundance, and contributing to declining stocks (Maltby, Rutterford, Tinker, Genner, & Simpson, 2020).

In addition to environmental shifts, numerous and diverse user groups pose a unique challenge to national fisheries management in the United States. Balancing seemingly conflicting uses of the marine resource is a constant challenge, as varying definitions of sustainable use exist within different stakeholder groups. In addition, the mandate to monitor the nation's fisheries poises its own set of challenges. At-sea monitoring is an expensive undertaking with limitations to both fishery-dependent and -independent sampling techniques, particularly during the present global pandemic

which has made on-board monitoring a human health and safety issue. Approaches of co-management offer unique opportunities to leverage resources from managers, scientists, and industry to conduct monitoring and develop innovative solutions to meet policy standards.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), first passed in 1976 (U.S. Congress, 1976), is the primary law guiding management of U.S. federal fisheries. The MSA builds from legislation passed in the preceding decade, including the Endangered Species Act (1973), the Marine Mammal Protection Act (1972), and the National Environmental Policy Act (1969), each of which impacts marine fisheries in specific ways. At its foundation, the MSA aims to prevent overfishing, rebuild overfished stocks, and increase long-term economic and social benefits. When first enacted, the MSA established the 200nm exclusive economic zone (EEZ), expanding the original international boundary of 12nm from shore. The MSA also formed eight regional fishery management councils (FMC), which represent fishery stakeholders who develop fishery management plans (FMP), set annual catch limits (ACL), and coordinate public forums. The FMCs are also charged with management of federal fisheries alongside NOAA Fisheries, however, the ultimate decision-making power resides with NOAA. Within the first enactment, the MSA mandated NOAA Fisheries to develop guidelines for the ten National Standards, or principles that must be followed in all FMPs to ensure sustainable and responsible fishery management. The MSA has undergone two significant re-authorizations, the first in 1996 with the Sustainable Fisheries Act (U.S. Congress, 1996) and in 2006 with the MSA Reauthorization Act (U.S. Congress, 2006). With national standards established, the region (Figure 1)

carries out regionally relevant fishery management based on the three pillars of implementation: science, management, and enforcement.

As scientific understanding and technology advances, federal fisheries management has shifted from a traditional single-species approach towards a more holistic one, including ecosystem-based management which incorporates a suite of biological, physical, social and economic factors. Historically a top-down management system, the U.S. is shifting to an adaptive management (AM) framework, an approach where stakeholder engagement is central to successful resource management (Rist, Felton, Samuelsson, Sandström, & Rosvall, 2013). Adaptive management is not a new concept (Holling, 1978; Walters & Hilborn, 1975) and while conceptually simplistic, has been difficult to implement in natural resource settings (Rist et al., 2013). However, given the ecological uncertainty in commercial fisheries management, adaptive management can be an incredibly useful strategy to increase knowledge and reduce the uncertainty in decision-making (Keith, Martin, McDonald-Madden, & Walters, 2011). While AM is centered around stakeholder participation, it is a cyclical process that allows for reflection and flexibility to revise management actions based on new information. For complex systems like multi-species fisheries with high degrees of uncertainty around environmental conditions, response to global changes like warming oceans, or harvest method effects, coupling AM with tools to compensate for incomplete knowledge are available, including simulation modeling and empirical testing (Brugnach, Dewulf, Pahl-Wostl, & Taillieu, 2008). Simulation modeling, or management strategy evaluation (MSE), is a theoretical approach to compare the relative effectiveness of different data collection methods, analysis, and process to achieve management

objectives (Punt, Butterworth, de Moor, De Oliveira, & Haddon, 2016). Although MSE has been praised as a successful tool for certain harvest management applications (Bunnefeld, Hoshino, & Milner-Gulland, 2011; Fulton, Smith, Smith, & Johnson, 2014; Mangel, 2010; Smith et al., 2007), the accumulation of more empirical data is a critical component to strengthen these existing tools for effective management. Purposeful experimentation to gather necessary data shifts fisheries management from a more common “passive” approach to an “active” one (Grantham et al., 2010). Within U.S. fisheries, the federal Exempted Fishing Permits (EFP) allows for direct experimentation to conduct exploratory fishing, conservation engineering, health and safety surveys, environmental cleanup, hazard removal, and data collection that would otherwise be prohibited.

The Exempted Fishing Permit program was established during the 1996 Sustainable Fisheries Act, a reauthorization of the MSA (U.S. Congress, 1996) that aimed to prevent overfishing with stronger prevention methods, rebuild overfished stocks, set standards for FMPs, add three new national standards, and introduce fish habitat as a component of fisheries management. The language of the EFP authorization is flexible, allowing each NOAA region to adapt and execute the program to meet the needs of their constituent fisheries and participants. The EFP process begins with an application submitted to the regional NOAA Administrator, who reviews the application materials as prescribed by federal law. If deemed necessary, the application may be shared with the regional fishery management council (FMC) for a consultation. NOAA also reviews applications for fishing activity with potential interaction with a protected species, as regulated by the ESA, MMPA, and NEPA**.** Once

the aforementioned conditions are met, the proposed EFP is made available to the general public via the Federal Register, the official journal of the federal government of the United States that contains government agency rules, proposed rules, and public notices. Assuming a favorable public comment period, the Regional Administrator may authorize the exempted permit and outline the conditions of exempted, experimental fishing activities. All permits stipulate annual reporting if the permit covers multiple years, and a final report at the conclusion of the project. There are no guidelines pertaining to the details to be included in the reports, nor do guidelines exist for the implementation of the experimental fishing, preferred analyses, or general data management. The lack of detail in the EFP directives can be incredibly useful when developing an adaptable and nimble program to address modern fishing concerns, however, can also hinder the rigor in which projects are executed and reported.

To date, no national or regional analysis has been conducted of the exempted fishing permit program to assess trends and modes of success. Here we developed a national database of exempted fishing permits awarded by NOAA from 2008-2018 to quantify regional and national trends of this adaptive management mechanism, and to assess the relative contribution of these projects to regulatory change. We aim to answer the following questions:

- What is the temporal stability of EFP issuance, and to whom are they issued (fishing industry, academia, NGOs, government agencies, etc)?
- Which fisheries and gear types are commonly investigated nationally and regionally?
- What objectives are common to each region?

- Which regulations are most requested for exemption?
- What defines EFP “success”?
- How many EFP projects have been “successful” in informing or implementing policy?

Methods

Database Development

A total of 2,746 scanned and electronic EFP documents were provided by collaborating NOAA Fisheries regional representatives. These materials included documentation of applications, issued permits, federal register notices, rejection letters, withdrawal notices, interim and final reports, and other supplemental materials from 2008-2018 (Figure 2). Although the EFP mechanism was available for use by NOAA Administrators from 1996-2008, these permits were not included due to inconsistent and ad hoc permit processing and reporting during that time frame. The documents provided by NOAA were compiled into a standardized database to facilitate regional and national summaries. The database is organized by individual ‘permit case’ entries; a permit case refers to an individual permits and all the associated documents that contribute to the timeline of individual permit, including the application, federal register notice, permit, rejection letter, withdrawal letter, and reports. Each permit case was identified by an applicant, region, fishery, and date. Permit cases were categorized by permit type, since EFP program materials included four types of permitting documents: exempted fishing permits (EFP), letters of acknowledgement (LOA), shark display permits (SDP), and scientific research permits (SRP). Only EFP’s were evaluated in this study. Permit

cases were assigned multiple goals themes and regulatory exemptions based on the information described in the application and permit and summarized in Supplemental Tables 1-2. In most cases, permits are issued to individual vessels and multiple permits can fall under a single EFP project. Whenever possible, individual permits were assigned to a project so management outcome determinations could be made at a project level.

Thematic goals and regulatory exemptions were analyzed to determine frequency of occurrence and co-occurrence between keywords for individual permits using the packages dplyr and widyr in R (R Core Team, 2020; Robinson, 2020; Wickham, François, Henry, & Müller, 2020). Pairwise counts of thematic goal and regulatory exemption keywords were tallied and displayed using a network visualization of cooccurrence using the packages ggraph and ggplot2 in R (Pedersen, 2020; Wickham, 2020). The distance between nodes, representing the goal type or exempted regulation, was determined by the value of the pairwise count. The distance between the nodes is determined by the value of the pairwise count; the higher the value of the pairwise count, the shorter the distance between the two nodes. The color and thickness of the segments connecting the nodes represents the strength of the pairwise counts.

A Kruskal-Wallis test, a rank-based nonparametric test, was used to determine if there are statistically significant differences between the approval times of EFPs for each region.

Management Outcome Determination

EFP projects were tracked to determine if data collected under an exempted permit had informed regulation or prompted regulatory change using two approaches, a text analysis and regional NOAA Fisheries expert validation. A binary response of "success" or "no success" was recorded for each EFP project as determined by regional NOAA expert opinion and results of the text analysis. If no outcome was known, EFP projects were removed from subsequent analysis of success. A project was defined as a "success" if the project informed or prompted regulation and defined as "no success" if the project had no impact on management outcomes.

Using a text analysis approach, all relevant stock assessments (SA) or fishery management plans (FMP) from 1996-2019 were downloaded from fishery management council websites and analyzed to identify whether the keywords "exempt", "efp", or "experiment" appeared in document text. Sections where keywords appeared more than 10 times were extracted, read in their entirety, and were used to determine if EFP data has been used to inform regulatory action. A random subset of documents where keywords appeared 5-9 times were selected for review to ensure EFP data was not included in the text; none of these screened documents were found to include EFP data.

Regional EFP experts at each FMC and NOAA Regional office were contacted to review EFP projects that had occurred within their jurisdiction. Experts were selected based on their affiliation with either an FMC or NOAA Region, and have direct experience managing or working with EFPs. From discussions with EFP facilitators, projects were categorized as successful, unsuccessful, or unknown using the standards

defined for the text analysis. In most cases, NOAA or Council staff were able to provide references to specific regulatory amendments that reflected the use of EFP data.

To evaluate factors that have a significant association with “success”, a Pearson’s chi-square analysis was performed. The following factors were investigated as to whether there was a significant association with success: region, fishery, applicant type, scientific collaborator, number of permits per project, and length of project. The null hypothesis of the chi-square analysis assumes there is no relationship between the categorical variables, whereas the alternative hypothesis states there is a relationship between the variables. Mosaic plots were used to visualize conditional probabilities calculated from contingency tables for each categorical variable. The summarized relationships are represented by color and cell size in each mosaic plot.

Results

Descriptive Summaries

The 2,746 individual documents received from NOAA were distilled into 1,359 unique permit cases, inclusive of all permit types (EFP, LOA, SRP, SDP), and are the foundation for the national database of EFPs from 2008-2018. As noted above, a permit case includes all associated documents to an individual permit including the application, permit, amendments, reports, etc. Of the 1,359 permit cases, 953 were classified as EFPs and used for subsequent analyses. The remaining 406 permit cases were classified as a letter of acknowledgement, shark display permit, scientific research

permit, or not listed and excluded from further analyses. In total, the 953 EFP cases were assigned to a project, resulting in 195 EFP projects available for further analysis.

Geographically, the West Coast issued more permits than any other region (n=631), and only issued EFPs (Figures 3-4). The New England/Mid-Atlantic region processed half the volume of permits (n=315) as the West Coast region and issued all four permit types, with most being EFPs (n=223). Similarly, the Southeast region issued all permit types (n=271), but only a small fraction of EFPs compared to the West Coast region (n=95). Alaska region issued only 13 EFPs during the period evaluated. The types of primary applicants varied coast to coast as well, with fishers and fishing companies comprising the majority of EFP applicants along the western coast (Alaska 89.5% of applicants, West Coast 88.9%), and universities and government agencies comprising the majority of those in the east (New England/Mid-Atlantic 65.6%, Southeast 61.8%) (Figure 5).

Strong regional differences in fishery type were apparent within EFPs, with groundfish fisheries dominating in the west coast regions (West Coast and Alaska) and highly migratory species (HMS) most prevalent in the east (Figure 6, Table 1). The Southeast region issued EFPs across the greatest range of fisheries including HMS (63.2% of EFPs), snapper-grouper (20%), reef fish (11.6%), coral (3.2%), and invertebrate (2.1%). New England/Mid-Atlantic region had a similar array of fisheries represented within their EFPs with HMS accounting for 47.7%, groundfish 39.9%, invertebrate 11.2%, and other (herring, spiny dogfish, tilefish) 1.9%. The West Coast primarily issued permits to groundfish fishers (80.5%), followed by HMS (13.6%), and

coastal pelagic species (5.9%). Alaska's experimental fisheries are represented entirely by groundfish.

Trends within fisheries are mirrored in the types of fishing gear permitted under EFPs (Figure 7). Overall, bottom and pelagic trawl gear are the most common gear types (55.3% of permits) requested under an EFP, driven largely by the prominent use of trawl gear within the western regions, Alaska and the West Coast. Alaska EFP fleet is almost entirely comprised of trawl gear (92.3%), whereas the West Coast region has included more gear types, primarily trawl gear (72.1%), hook-and-line (16.2%) and buoy gear (13.8%). The eastern regions have a mixed assortment of gear types, reflecting the diversity of fisheries represented in the issued EFPs. The permits issued in the Southeast region are largely represented by hook-and-line based fisheries (63.2%), longline (29.5%), and other (25.3%) which included hand nets, drumline, SCUBA and spear. New England/Mid-Atlantic similarly has hook-and-line as the most common gear type (39.7%), followed by trap/pot (37.4%), longline (29.4%), and gillnet (18.2%).

Despite regional differences in fishery and gear types, the time to approve EFPs was not significantly different across regions, except for the West Coast (chi-squared = 11.646, df = 3, $p<0.05$). The approval time ranged from 5.0 ± 0.4 months (mean and standard error) in New England/Mid-Atlantic region to 8.6 ± 1.2 months in the West Coast region (Figure 8). However, the number of permit cases that were complete, having both an application and issued permit, varied greatly between regions. Application documentation was not received from NOAA for this analysis for a large portion of West Coast EFP permits, resulting in a low sample size (n=27) of matched applications to permits, despite the West Coast region having the highest number of

approved permits (n=631). The number of individual EFPs issued annually was relatively stable for all regions with the exception of the West Coast, which saw spikes in permit issuance in 2010 and again in 2015 (Figure 9).

In evaluating the permit goals for each EFP, differences were observed between western and eastern regions (Figure 10). Nearly all issued permits in the western regions had the goal of gear and method experimentation (West Coast 91.6%, Alaska 84.6%) and reducing bycatch (West Coast 27.7%, Alaska 69.2%). This pattern is further explored in the network visualization of cooccurrence (Figure 11), where the West Coast and Alaska region are strongly associated with gear and method testing and bycatch goals. The Southeast and New England/Mid-Atlantic regions have a wide array of goals within their EFPs, but are most strongly associated with biology/ecology (72.6% and 66.8%, respectively), and stock assessments (83.2% and 63.1%, respectively) (Supplemental Table 3). This split was driven largely by the greater proportion of highly migratory species work conducted in the Greater Atlantic region.

The types of regulations exempted through the permitting process were less regionally distinct compared to the goal are gear types. Across all regions, the top regulations requested for exemption included closed season/area, possession/landing limits, prohibited species, catch limits, size limits, and gear restrictions (Figure 12). The remainder of the regulations exempted were less common in any region, including observer requirement, permitting or reporting regulations, days-at-sea, sales restrictions, and vessel monitoring systems (VMS). However, the West Coast and Alaska regions both showed the strongest associations with prohibited species, and the Southeast and New England/Mid-Atlantic both exempted the minimum size and

possession restrictions/limit regulation most frequently (Figure 13, Supplemental Table 4).

Management Outcomes

We utilized a two-pronged approach to determine whether an EFP project informed or prompted regulatory change: a text analysis of fisheries documents (SA and FMP's) and expert consultations. For the text analysis, 894 fisheries documents retrieved from seven fishery management councils (NPFMC, PFMC, GMFMC, CFMC, SAFMC, MAFMC, and NEFMC), 200 documents met the qualifications for further review (Table 1). Each document was examined at every keyword instance to identify whether EFP data had been used to inform regulatory or management efforts. A "successful" outcome was attributed to 13 EFP projects based on the text analysis. The remaining 187 documents did not contain substantial information to determine a management outcome.

Regional expert consultations aided in the determination of management outcomes for 93% of the EFPs projects represented in the national database. Of those 195 projects (953 individual EFPs) in total, 31.8% of projects were determined to be successful, having contributed to regulatory reform or background research to these efforts in some manner. Conversely, 20% of EFP projects were deemed not successful, not having contributed to regulatory reform. The remaining 48.2% of projects were not classified by management outcome, as sufficient supporting information was not found. These 94 projects were removed from subsequent analysis of success.

The rate of success in EFP projects again showed strong coastal differences (Figure 14). The western regions, Alaska and West Coast, had high rates of success with Alaska seeing 100% success rate of their EFP project outcomes (n=13 success/13 total), and the West Coast following with a 91.2% success rate (n=31/34). The eastern regions did not achieve the same level of success, with the Southeast region only showing a 23.1% success rate among their projects (n=3/13), and New England/Mid-Atlantic region a 25.6% success rate (n=10/39).

Of the 101 EFP projects with assigned outcomes, six factors were evaluated to whether there was a significant association with “success” (Table 2). These factors included region, fishery, applicant type, presence of a scientific collaborator, number of permits per project, and length of project. Of the six factors evaluated, four were found to be significantly associated with success (p-value <0.05), including region, applicant type, fishery, and number of permits (Figure 15).

Discussion

In this study, we developed a standardized national database of exempted fishing permits to track the uses, roles and resulting management outcomes of exempted fishing permit activities at regional and national scales. Through this process we observed distinct trends between the west and east coasts that contribute to the relative success of experimental fishing activities. Relative to east coast regions, the west coast regions, Alaska and West Coast, have a lower number of fishery and gear types, longer permit approval times, and higher rates of success within their experimental fishing projects. The eastern regions, Southeast and New England/Mid-

Atlantic, had a broader range of fisheries and gear types, shorter permit approval times, and lower rates of success. While each permitted project is unique in its participants, goals, and timelines, there are many factors that can predict success of a particular EFP project. This work has provided a foundation to reflect on the progress made by one the primary mechanisms to innovate federal fisheries management in the United States.

Regional programmatic differences

Although each region follows the same federal statute, the Magnuson-Stevens Act, in regulating exempted fishing permits, the implementation of the program differs from region to region. The MSA was written to allow for flexibility when needed, as fisheries and management needs vary across the nation. Flexibility is a positive aspect of the MSA, but flexibility without sufficient oversight, accountability, standardization, and coordination can cause a national program to become disjointed and less efficient. No language exists in the MSA dictating the volume of permits to be processed annually, specifics of experimental fishing activities, nor the level of detail the applicant must outline in the design. These programmatic details are left to the discretion of the NOAA Regional Administrator to whom the application for a permit was submitted and the Council, if consulted. The level of involvement of the regional Fishery Management Council is the first notable difference between each NOAA region. As described by MSA, the Council's role in EFP issuance is to provide additional guidance where deemed necessary by NOAA Fisheries, but the power to issue permits remains solely with NOAA. The NOAA EFP facilitators in western regions choose to heavily involve their regional FMC, beyond what is outlined in the MSA. The most conservative

interpretation of Council input is utilized by the Alaska region, which requires the Regional Administrator to consult with the North Pacific Fishery Management Council prior to issuing an EFP (National Marine Fisheries Service, 2020a). Similarly, the West Coast region allows EFP applications to be submitted to either the Pacific Fishery Management Council (PFMC) or the NOAA regional office, elevating the role and power of the PFMC in the EFP approval process. The PFMC has developed their own protocols and research priorities for approving applications, a process that NOAA has not regulated to the same level of detail (Pacific Fisheries Management Council, 2011, 2012, 2017). The eastern regions have not employed the same procedures in the EFP approval process, only consulting with their regional FMC's on an "as-needed" basis (C. Kellogg, personal communication, July 24, 2020). The heavy inclusion of FMC input in the western region translates into longer approval times (Figure 8), as the applicant is subject to the timing of the Council's meeting schedule. Despite the extensive consultation process and application review period, the majority of the West Coast and Alaskan EFP projects have translated into informative datasets for stock assessments, rollback of fishery regulation, implementation of new regulation, or approval of a new gear type (Figure 14).

In addition to thorough Council consultation, western regions require or strongly recommend a sound scientific protocol to experimental fishing proposals. A large proportion of exempted permits (Figure 10) involve testing of new fishing gear or methods, which necessitates a robust experimental design in the early planning stages. As such, the Alaska region requires approval from the Alaska Fisheries Science Center before a permit may be issued. Although the West Coast region does not currently hold

the same requirements, there is a desire to include a scientific sponsor with EFP applications (L. Massey, personal communication, August 17, 2020). The eastern regions do not require scientific partners to submit an EFP application. The more scientific support available, the more rigorous and thorough the data products and results are likely to be, and consequently used to inform management decisions. However, requiring additional expertise can deter potential applicants by increasing cost if a scientific liaison needs to be hired to meet this requirement.

Factors leading to success in experimental fishing

Through systematic review of EFPs from 2008-2018 and expert consultation, we have identified key elements that determine whether EFP datasets will be useful in supplementing management decisions. The main factors we found to be strongly associated with “successful” projects include the type of primary applicant, presence of scientific collaborators, size of projects and region.

The type of primary applicant was a key component in resolving the usefulness of an EFP project. Regardless of region, most proposals were collaborative in nature and included multiple parties, but when comparing the applicant type singularly, we see distinct patterns. Notably, the Southeast and New England/Mid-Atlantic EFPs were led by universities and government agencies (61.8% and 65.6% respectively) and the western regions, Alaska and West Coast, were spearheaded by individual fishers, fishing for-profit companies, or fishing associations (89.5% and 88.9% respectively). We see evidence that success is more likely when applicant teams are led by members of the fishing industry (individuals, association, and companies) and less likely when

applicants are led by research organizations (universities, government agencies, research institute, and NGO) (Figure 15). Importantly, these observations are not proscribed, the eastern regions emphasize and encourage the inclusion of industry partners in their EFP projects, and western regions do heavily promote partnering with a scientific expert. However, there is a sense of a “bottom-up” versus “top-down” approach in how EFP projects are developed between the coasts. The nature of how EFP project idea and design is crafted can subtly influence how successful a project may be.

While grassroots experimental projects were more likely to inform management decisions, larger projects with more participants involved signaled higher rates of success as well. The two factors are inherently linked, as bottom-up projects are likely to have buy-in from fishing communities from the beginning, thus increasing the number of participants. Larger projects are an indication of multiple factors that can contribute to success; more involvement and support from the local community translates into larger sample sizes and better ability to detect a statistical signal. A study in climate sciences found that the total number of people involved in a grassroots sustainability movement was significantly correlated with a successful outcome (Feola & Nunes, 2014), a similar finding to this study. While bigger projects often signify more complexity in the form of increased managerial needs and cost, in order to solve large-scale fisheries problems like those addressed within the exempted fishing permit program, the more community and industry support the better.

The importance of having scientific partners was not a statistically significant factor in predicting success, however, it was identified as an important element in

discussions with EFP experts. As seen in the Alaska region, scientific consultation with both the Fisheries Science Center and FMC was mandatory, translating into a high success rate in implementing EFP data directly into regulation. Scientific backing ensures sound experimental design, provides guidance on implementation, and strengthens data analyses and reporting. Requiring scientific expertise can form a barrier to entry into the EFP program for some, as this may add an added cost and lengthen the time spent developing the application materials. There is a delicate balance in maintaining the openness and availability of this program to all but ensuring that there is return on investment for resource managers. There is no dedicated budget to support the administrative cost to NOAA to review, approve, and manage this program, so ensuring the highest quality applications are submitted is ideal.

The regional effect on project success is more difficult to disentangle, since there are multiple factors that can contribute to regional differences. Early consultation and regular communication with NOAA was consistently recommended by all regional managers. However, with stark differences between the east and west coasts within fisheries, gear types, and project goals of EFP projects, we cannot definitively state the underlying mechanism as to why the regions differ so greatly. Fishery type was strongly associated with success (Figure 15), but we see clear differences in EFP fisheries between the coasts (Figure 6) independently, thus convoluting the driver in the regional results. The programmatic differences between regions results in strong coastal differences in success, but no single mechanism can be determined at this time.

Case Studies

An example of EFP data resulting in regulatory change can be seen in a series of EFPs in the West Coast region collectively known as the “Trawl Gear EFP” executed from 2017-2020 (National Marine Fisheries Service, 2016, 2017, 2018, 2019b). The goal of this EFP is to test whether removing certain gear, along with time and area restrictions for vessels fishing under the Trawl Rationalization Program’s Shore-based IFQ program may impact the nature and extent of salmon bycatch when targeting pelagic rockfish. This groundfish EFP project exempts midwater and bottom trawl vessels from the requirement to have a 4.5 mesh size and the requirement to use a selective flatfish trawl north of 40°10’ North Latitude and shoreward of the Rockfish Conservation Area (RCA). Success of this EFP project can be attributed to the strong management of the experiment, organized tracking and documentation of activities, clear communication between partners, and a defined set of desired outcomes (L. Massey, personal communication, August 17, 2020). Data from this project have already been used to lift trawl regulations for vessels that fish in the shoreside IFQ fishery (National Marine Fisheries Service, 2018). A summary of key elements used by this project and others that have contributed to EFP data translated into regulatory changes can be found in Table 3.

Some might argue that despite the successes seen throughout the EFP program, by exempting regulations the door is opened for some to abuse the program. However, we did not see evidence of systemic misuse or abuse of the program through this review. There are many safeguards in place to disallow individuals from taking advantage of the regulatory loophole, namely by not allowing fishers to exceed quotas

or to not report landings. Although there have been some highly contested EFP proposals, these permits generally are not awarded and the voice of the public is heard and heeded (Angers, 2017; Holshouser, 2017). The exempted fishing process is an explicit way for the fishing industry, researchers, and community organizations to leverage resources to test innovative ideas to overcome management hurdles the domestic fishing fleets face today.

This thesis uses material currently being prepared for submission for publication as U.S. Exempted Fishing Permits: Role, Value, and Lessons Learned for Adaptive Fisheries Management. Bonito, Lindsay; Bellquist, Lyall; Jackson, Alexis; Kauer, Kate; Gleason, Mary; Wilson, Jono; Sandin, Stuart. The thesis author was the primary investigator and author of this paper.

Figures

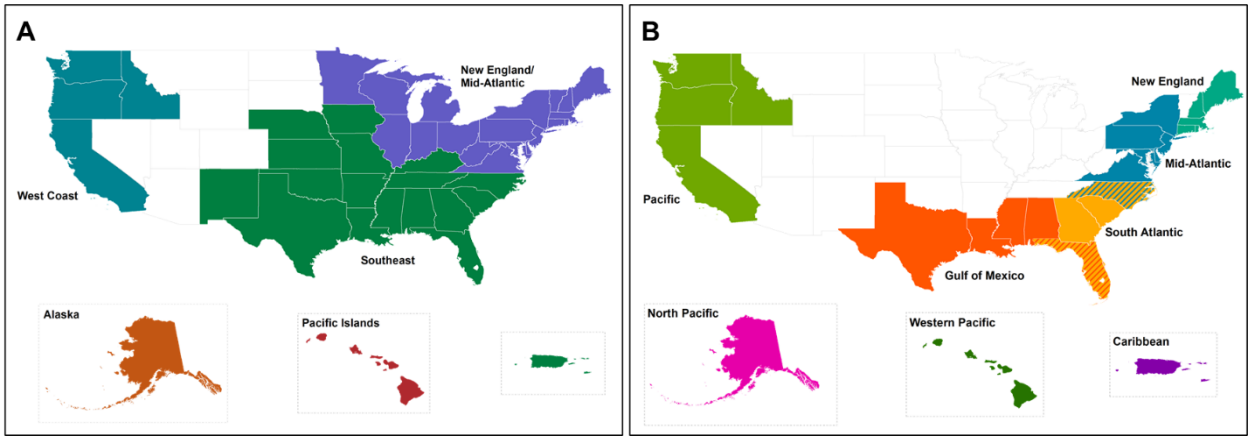

Figure 1. Regional designations for NOAA Fisheries regional fisheries management (A) and Fishery Management Councils (B).

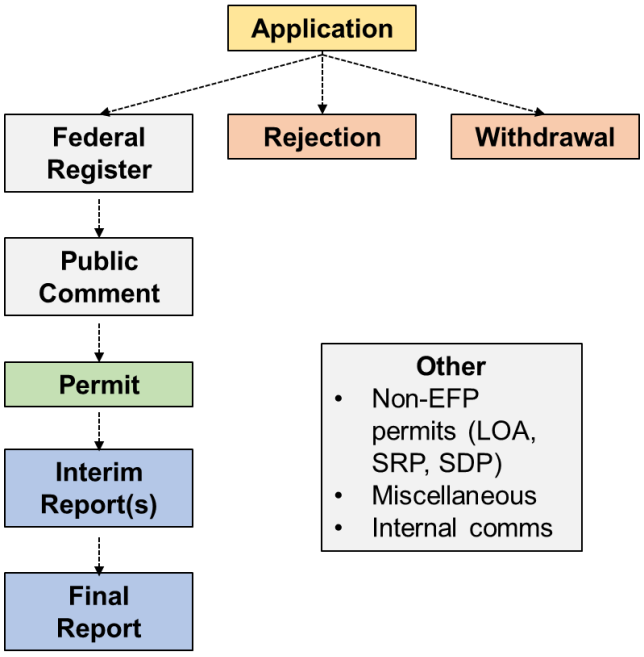

Figure 2. Conceptual figure of exempted fishing permit process and classification of documents provided by NOAA. “Other” includes non-EFP (LOA- letter of acknowledgement, SRP- scientific research permits, SDP- shark display permits), miscellaneous documents (boat registration, duplicate documents, etc), and internal communication documents.

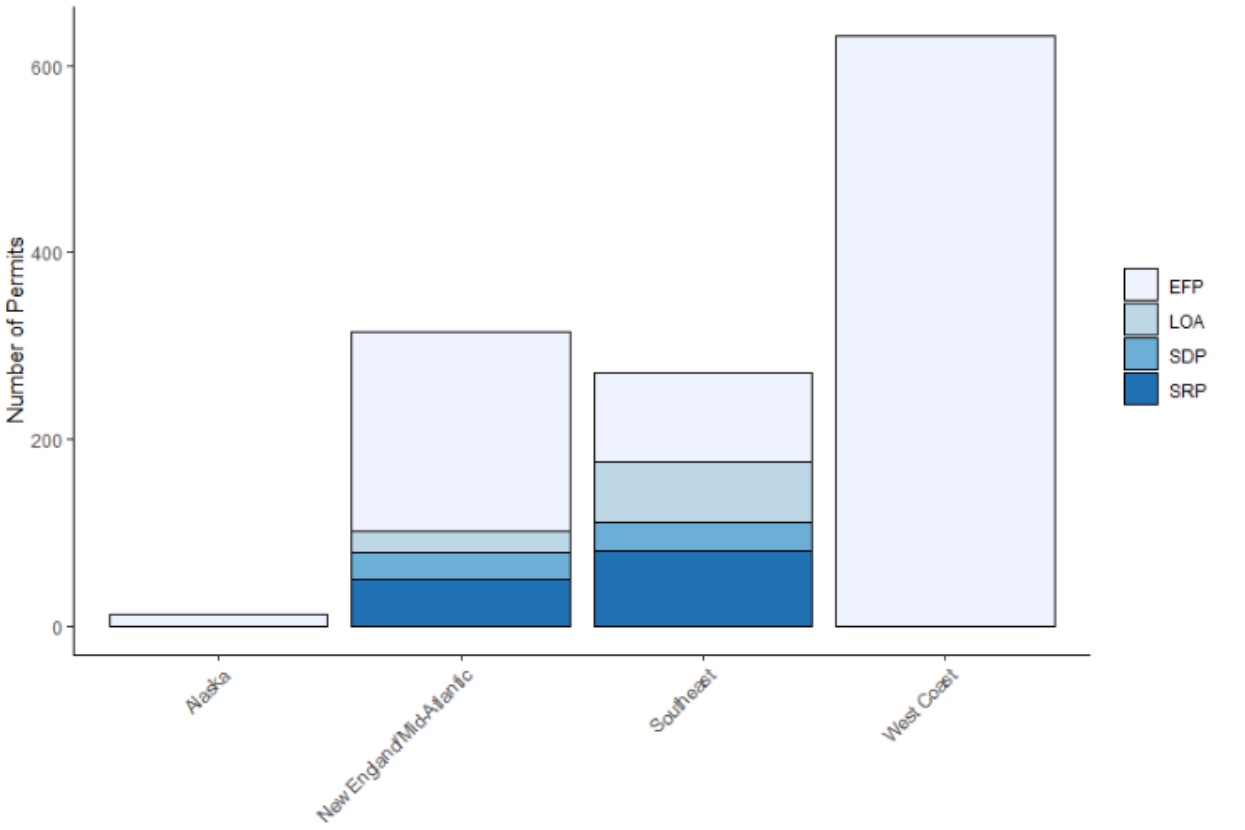

Figure 3. Distribution of permit types by NOAA region (EFP- exempted fishing permit; LOA- letter of acknowledgement; SDP- shark display permit; SRP- scientific research permit).

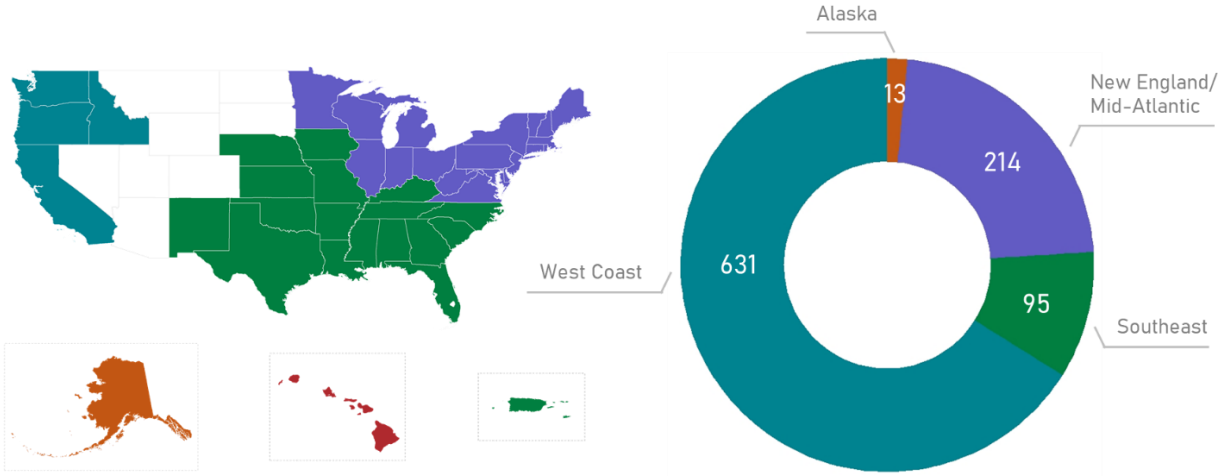

Figure 4. Regional distribution of exempted fishing permits.

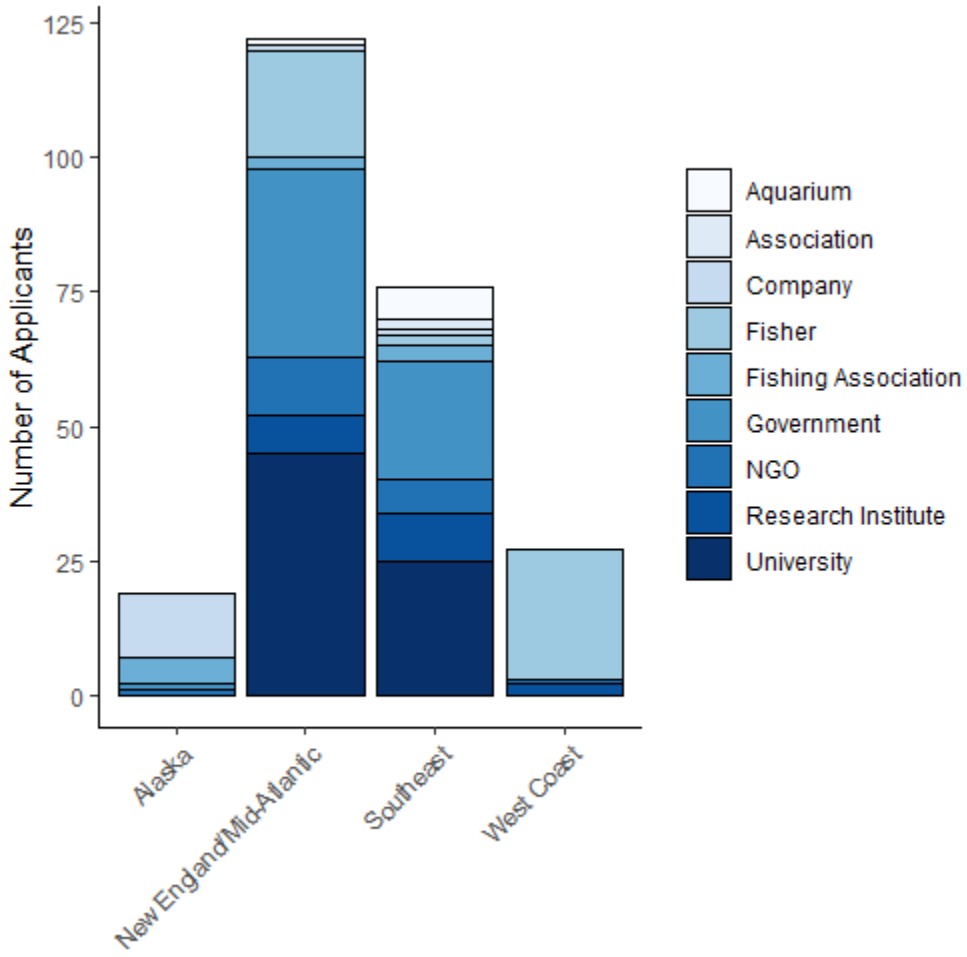

Figure 5. Primary applicant type by NOAA region, not including partners or collaborators.

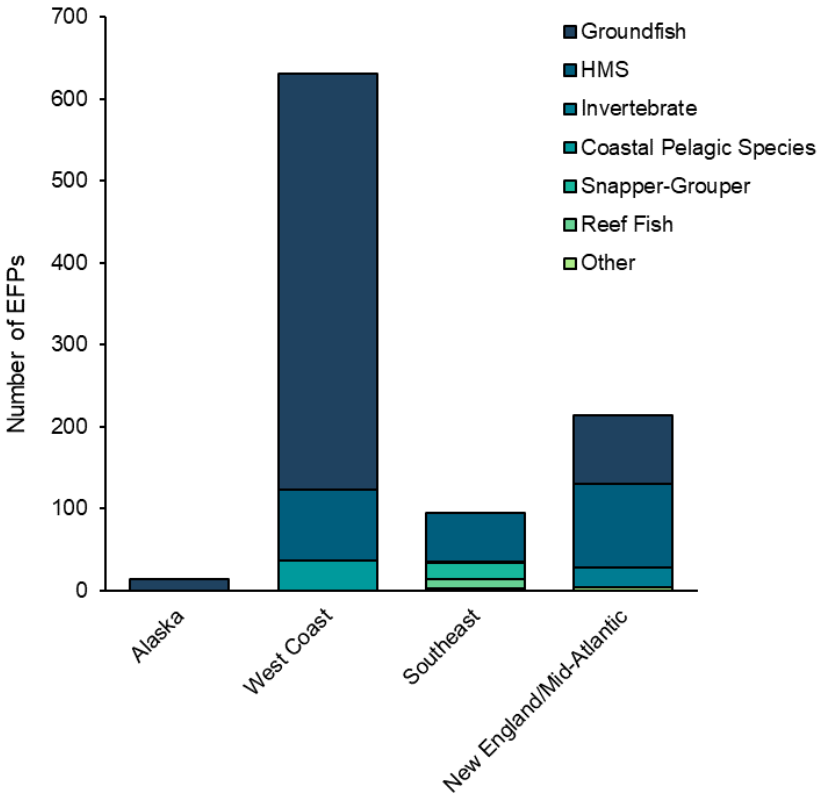

Figure 6. Distribution of fisheries represented in EFPs by NOAA region. Other includes herring, tilefish, spiny dogfish, and coral.

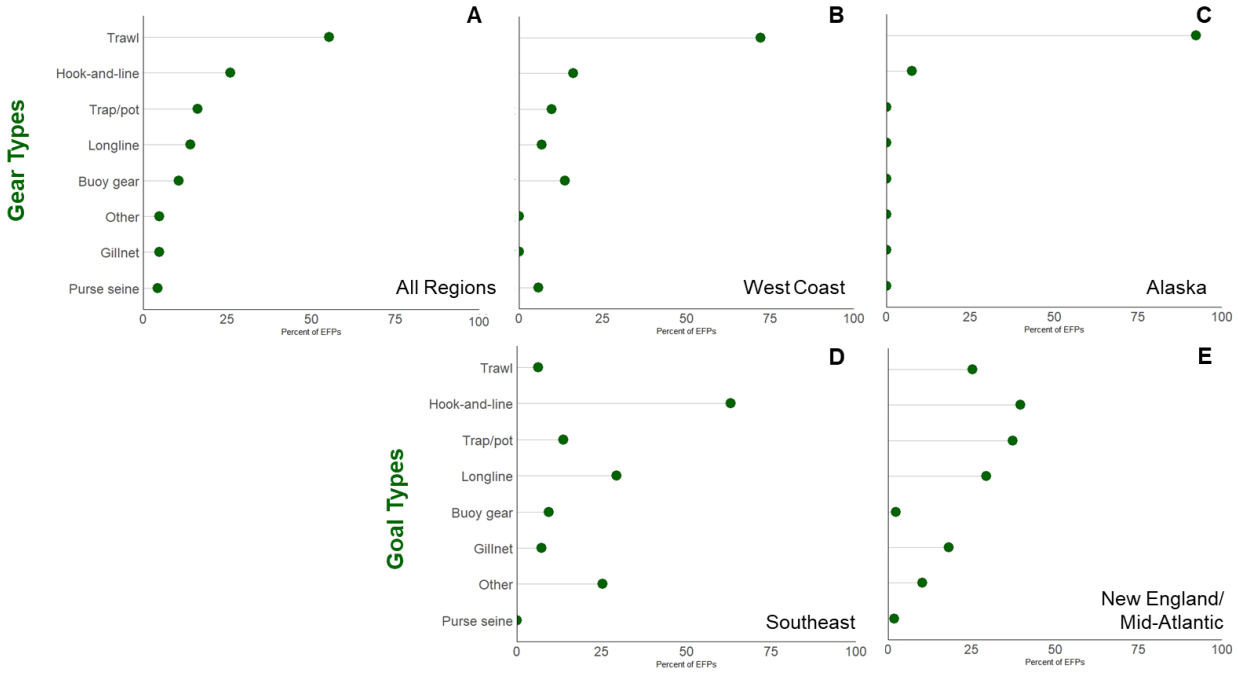

Figure 7. Frequency of gear types assigned to individual permit cases by region.

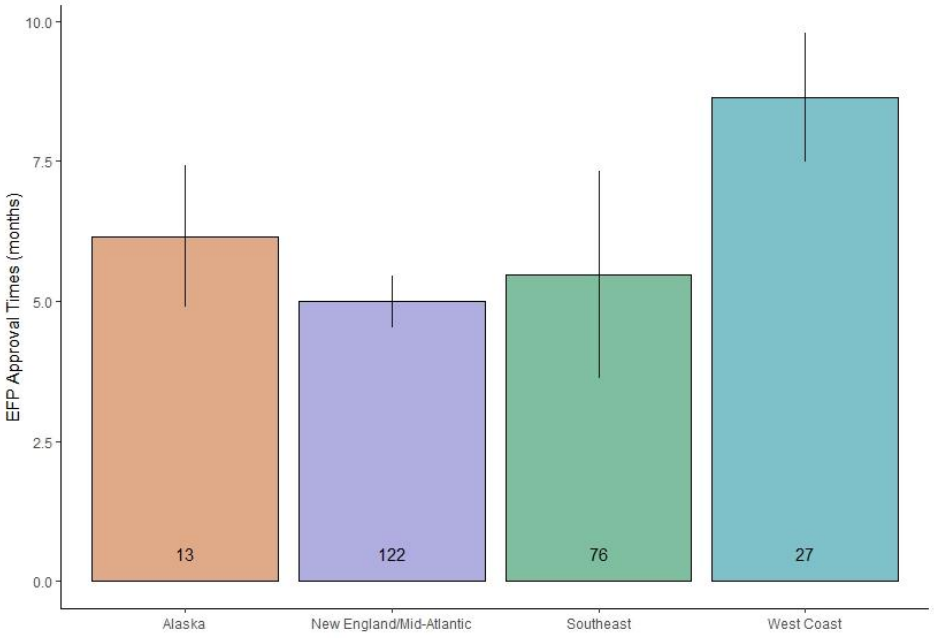

Figure 8. Mean, standard error, and sample size of permit approval times for each region.

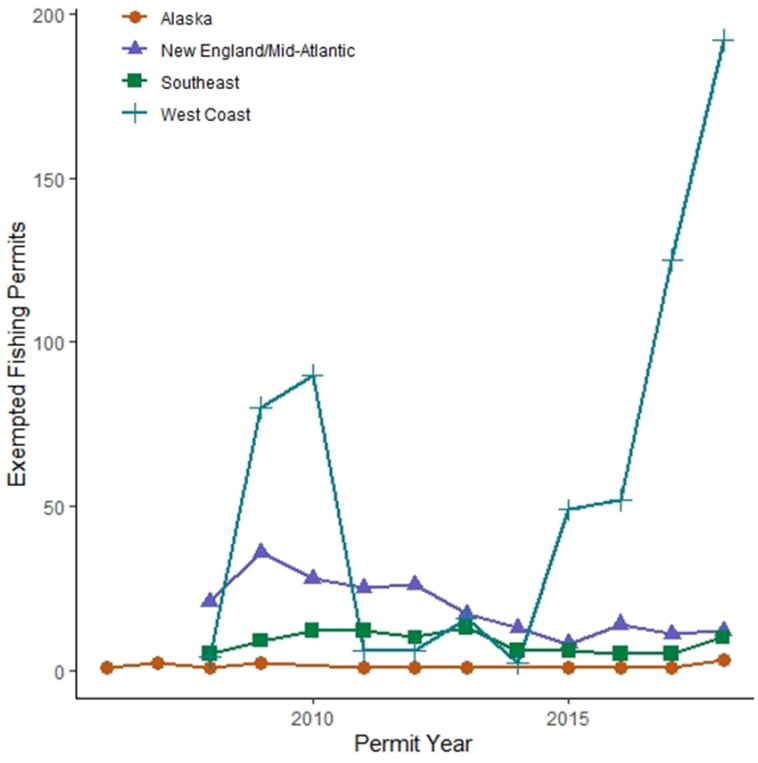

Figure 9. Time series of individual exempted fishing permits issued per year by NOAA region.

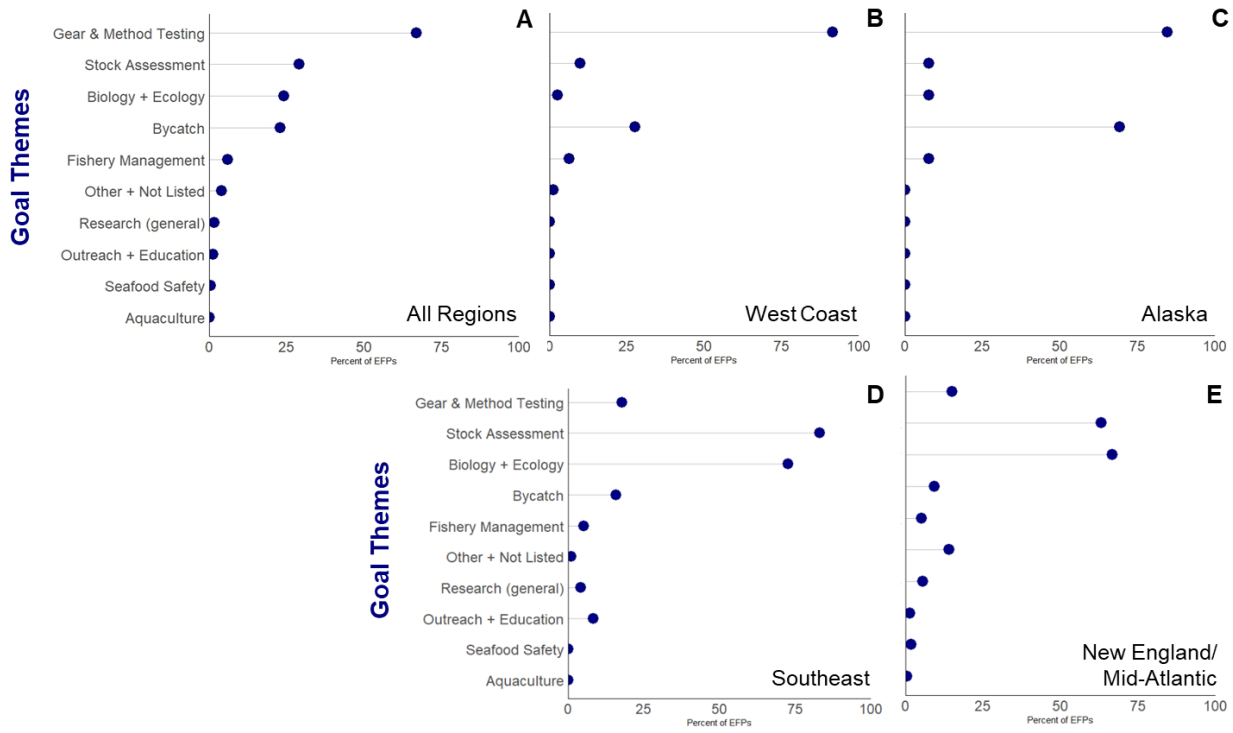

Figure 10. Frequency of goal themes assigned to individual permit cases by region.

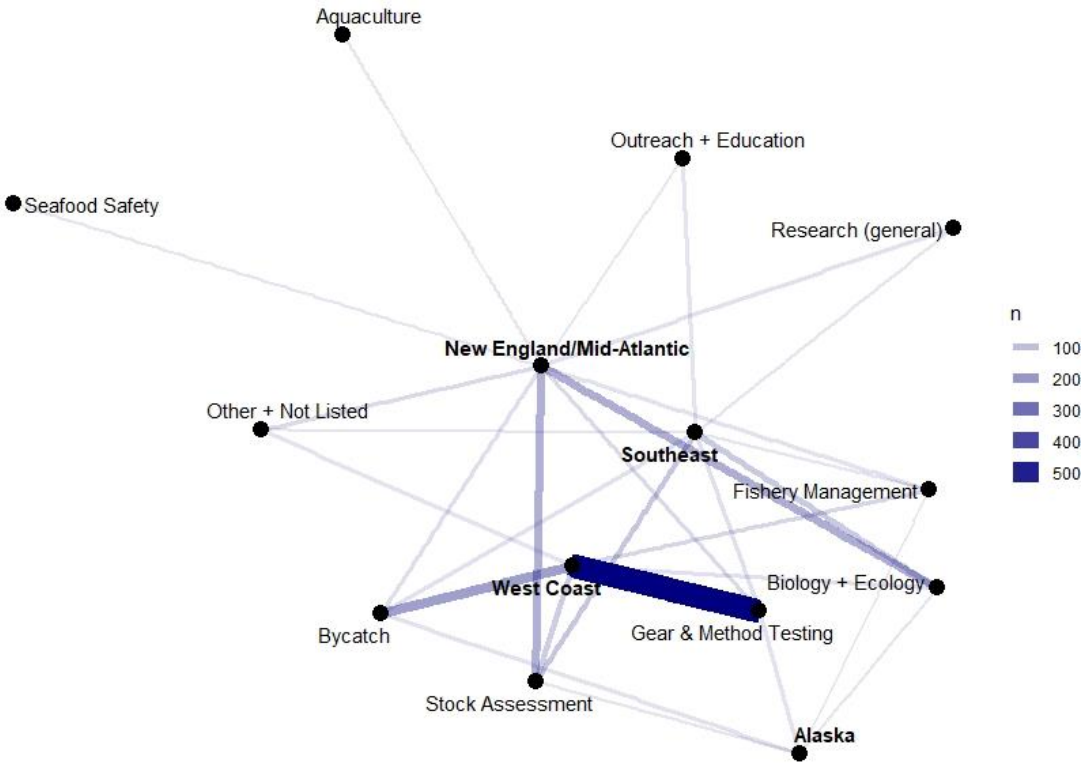

Figure 11. Network visualization of cooccurrence analysis of all thematic goals and regional association attributed to individual permit cases.

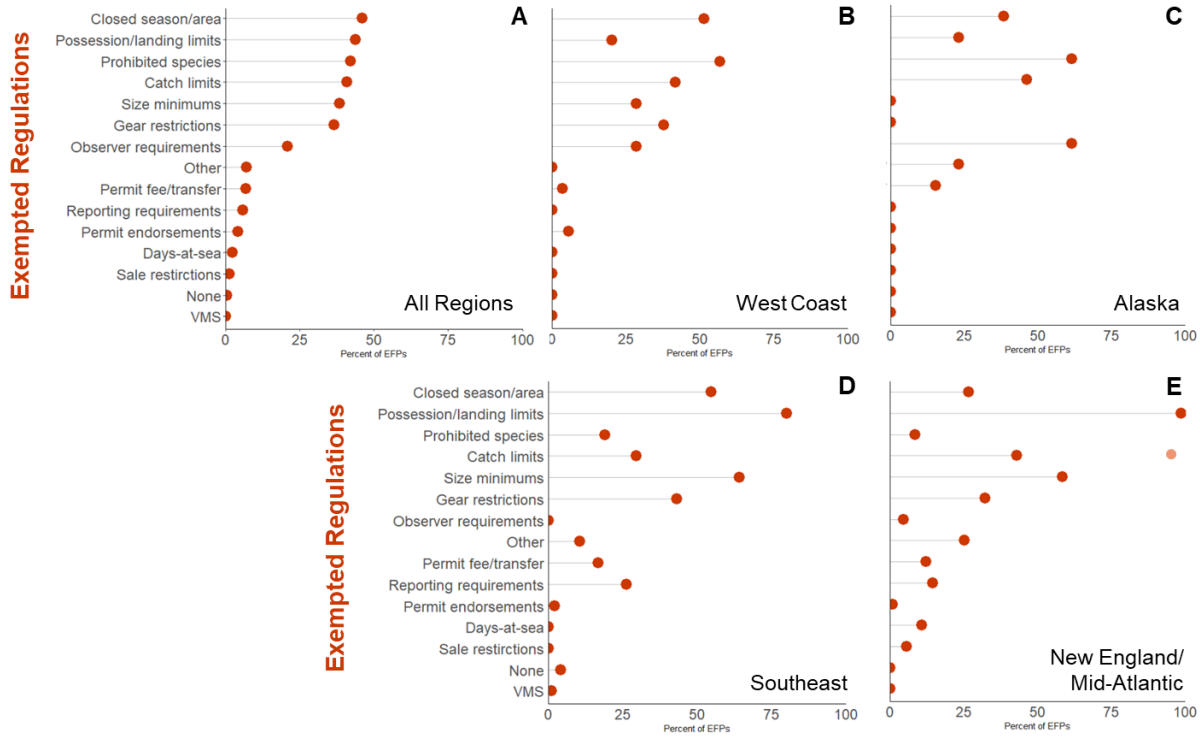

Figure 12. Frequency of exempted regulations assigned to individual permit cases by region.

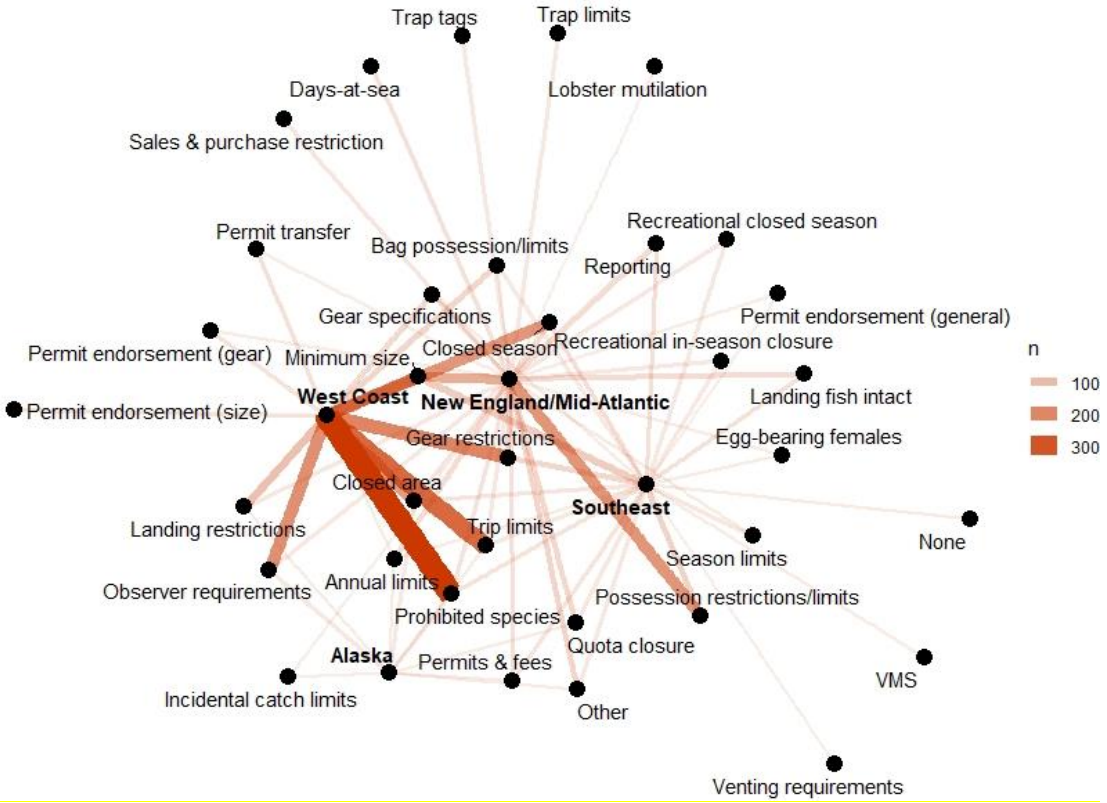

Figure 13. Network visualization of cooccurrence analysis of all exempted regulation groups and regional association attributed to individual permit cases.

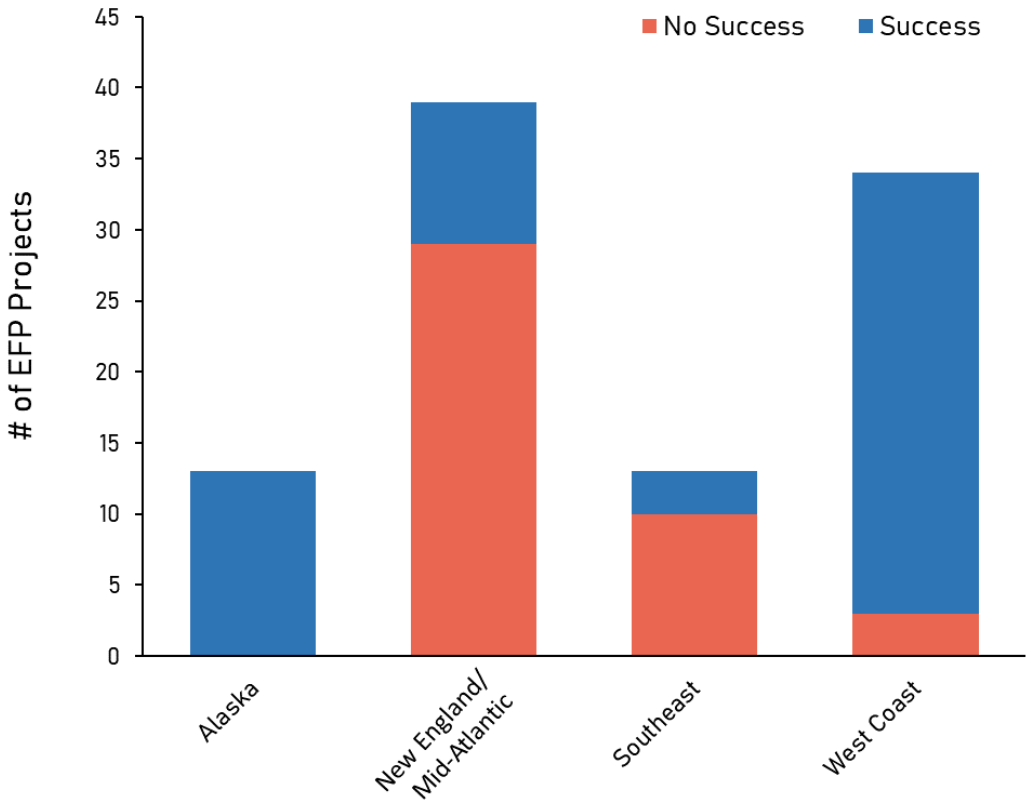

Figure 14. Management outcomes of EFP projects. Number of EFP projects classified as successful (blue) or unsuccessful (red) by region.

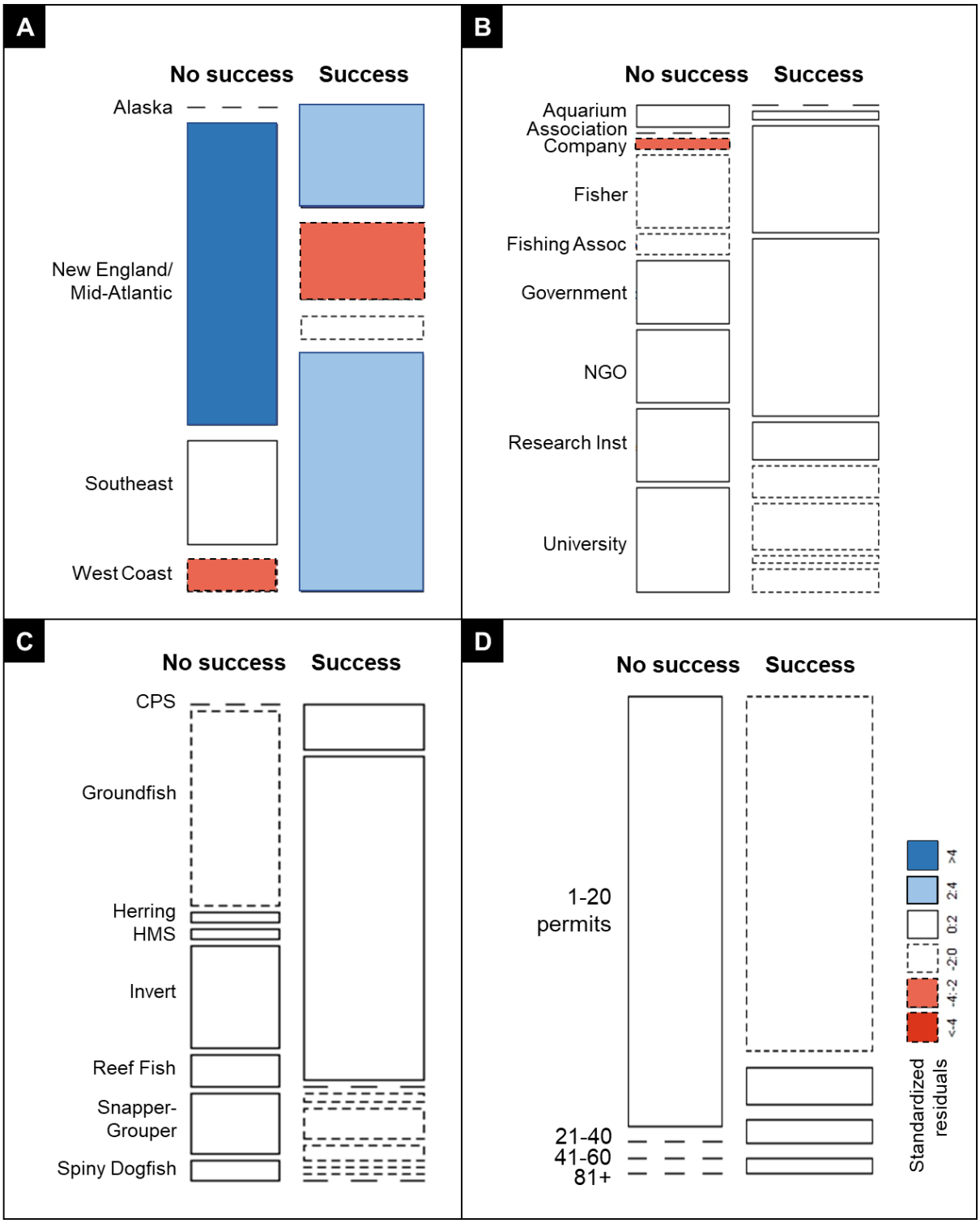

Figure 15. Mosaic plot visualization of contingency tables. Blue indicates that the observed value is higher than the expected value if the data were random. Red specifies that the observed value is lower than the expected value if the data were random. Size boxes reflect the relative magnitude of its value. A- region; B- applicant type; C- fishery; D- number of permits.

Tables

Table 1. Results from text analysis. Total number of documents analyzed, including significant documents with keyword appearance more than 10 times per document, and date range of documents.

Council	Fishery	Total	"exempt"	"efp"	"experiment"	Years
CFMC	Coral	1	1	0	0	2013
	Ecosystem-Based Management	1	0	0	0	2011
	Generic Amendment	1	0	0	0	2013
	Golden Crab	2	0	0	0	1995-2010
	Reef Fish	3	0	0	0	1996-2013
	Sargassum	1	0	0	0	2002
	Shrimp	8	1	0	2	1996-2012
	Snapper-Grouper	50	4	0	4	1997-2019
	Spiny Lobster	5	0	0	1	1998-2012
GMFMC	Aquaculture	1	1	1	1	2009
	Coastal Migratory Pelagics	42	0	0	0	1983-2020
	Coral	5	0	0	0	1984-2000
	Essential Fish Habitat	3	0	0	1	2005-2016
	Reef Fish	81	3	3	0	1995-2019
	Shrimp	14	0	0	0	1995-2019
	Spiny Lobster	7	0	0	1	2001-2018
	Stone Crab	3	0	0	0	1998-2001
MAFMC	Atlantic Mackerel-Squid-Butterfish	26	8	1	0	1996-2019
	Bluefish	8	2	1	2	2000-2018
	Flounder-Scup-Sea Bass	28	5	1	2	1996-2019
	Spiny Dogfish	8	3	1	2	2000-2017
	Surfclam-Quahog	13	4	1	4	1996-2018
	Tilefish	11	2	1	1	2001-2018
NEFMC	Atlantic Herring	13	6	2	3	2007-2020
	Atlantic Salmon	2	1	0	1	2008-2015
	Monkfish	17	10	0	5	1999-2020
	Northeast Multispecies	25	19	0	13	1996-2005
	Red Crab	9	3	2	1	2005-2020
	Sea Scallop	39	21	2	15	1996-2020
	Skate	11	5	0	2	2008-2020
	Small-Mesh Species	7	5	0	2	2000-2018
NPFMC	Crab	1	1	0	1	2011
	Groundfish	298	2	0	1	2014-2019
	Scallop	1	0	0	0	2014
PFMC	CPS	21	0	4	0	2006-2019
	Groundfish	90	1	1	0	2006-2019
	HMS	15	0	5	0	2004-2019
SAFMC	Coastal Migratory Pelagics	18	0	0	0	1996-2018
	Coral	3	0	0	0	1998-2014
	Wahoo	2	1	0	0	2015

Table 2. Results from Pearson's chi-square test

	X^2	df	p-value
Region	40.48	3	<0.05
Scientific Partner	0.33041	1	0.5654
Permit Length	3.3799	2	0.1845
Applicant Type	31.277	8	<0.05
Fishery	22.886	7	<0.05
Number of Permits	8.1963	3	<0.05

Table 3. Factors determined to be key elements in designing an EFP project

Key elements for a successful program	
Measure twice, cut once	Deliberate and thorough **planning well in advance** of application submission
Early and often	**Early consultation with a scientific advisor.** Support from resource managers and science centers is critical to determine validity and timeliness of proposals and priority needs of regulatory bodies
Draw the line	**Clear roles and responsibilities** for project participants, including tracking progress to meet deadlines, data management, and data analysis and reporting
Less is More	**Fewer, larger projects** rather than numerous small ones**.** Bolster sample sizes, inclusive of more industry participants, and administratively less costly to process
Follow up	**Stronger reporting requirements** upon project completion that requires thorough review by resource managers and/or NOAA

Supplemental

Table 1. Goal types assigned to each permit case. Specific goals types were further categorized into thematic goal groups.

Goal Type	Goal Thematic Group
Aquaculture	Aquaculture
Connectivity	Biology + Ecology
Habitat	
Life History	
Reproductive Biology	
Tagging Effects	
Bycatch	Bycatch
Fishery Management	Fishery Management
Fishing Effort	
Market Development	Market Development
New Gear Testing	Gear & Method Testing
New Methods Testing	
Not Listed	Other + Not Listed
Other	
Education	Outreach + Education
Outreach/Aquarium	
Research (general)	Research (general)
Seafood Safety	Seafood Safety
Aggregation Sites	Stock Assessment
Stock Assessment	
Telemetry & Movement	

Table 2. Regulation exemptions assigned to each permit case. Specific regulations were further categorized into regulation groups.

Regulation Exemption	Regulation Group
Annual limits	Catch limits
Incidental catch limits	
Quota closure	
Season limits	
Trap limits	
Trip limits	
Closed area	Closed season/area
Closed season	
Recreational closed season	
Recreational in-season closure	
Days-at-sea	Days-at-sea
Gear restrictions	Gear restrictions
Gear specifications	
None	None
Observer requirements	Observer requirements
Egg-bearing females	Other
Lobster mutilation	
Other	
Trap tags	
Venting requirements	
Permit endorsement (gear)	Permit endorsements
Permit endorsement (general)	
Permit endorsement (size)	
Permit transfer	Permit fee/transfer
Permits & fees	
Bag possession/limits	Possession/landing limits
Landing fish intact	
Landing restrictions	
Possession restrictions/limits	
Prohibited species	Prohibited species
Reporting	Reporting requirements
Sales & purchase restriction	Sale restrictions
Minimum size	Size minimums
VMS	VMS

Table 3. Frequency table of pairwise counts of goal thematic group and region.

NOAA Region	Goal Thematic Group	Pairwise Count
West Coast	Gear & Method Testing	578
West Coast	Bycatch	175
New England/Mid-Atlantic	Biology + Ecology	143
New England/Mid-Atlantic	Stock Assessment	135
Southeast	Stock Assessment	79
Southeast	Biology + Ecology	69
West Coast	Stock Assessment	62
West Coast	Fishery Management	40
New England/Mid-Atlantic	Gear & Method Testing	32
New England/Mid-Atlantic	Other + Not Listed	30
New England/Mid-Atlantic	Bycatch	20
Southeast	Gear & Method Testing	17
West Coast	Biology + Ecology	16
Southeast	Bycatch	15
New England/Mid-Atlantic	Research (general)	12
Alaska	Gear & Method Testing	11
New England/Mid-Atlantic	Fishery Management	11
Alaska	Bycatch	9
Southeast	Outreach + Education	8
West Coast	Other + Not Listed	8
Southeast	Fishery Management	5
New England/Mid-Atlantic	Seafood Safety	4
Southeast	Research (general)	4
New England/Mid-Atlantic	Outreach + Education	3
Alaska	Biology + Ecology	1
Alaska	Fishery Management	1
Alaska	Stock Assessment	1
New England/Mid-Atlantic	Aquaculture	1
Southeast	Other + Not Listed	1

Table 4. Frequency table of pairwise counts of exempted regulation group and region.

NOAA Region	Regulation Group	Pairwise Count
West Coast	Prohibited species	358
West Coast	Trip limits	259
West Coast	Gear restrictions	202
West Coast	Minimum size	180
West Coast	Observer requirements	180
New England/Mid-Atlantic	Possession restrictions/limits	171
West Coast	Closed season	167
West Coast	Closed area	157
New England/Mid-Atlantic	Minimum size	125
West Coast	Landing restrictions	86
Southeast	Minimum size	61
Southeast	Possession restrictions/limits	49
New England/Mid-Atlantic	Gear restrictions	44
New England/Mid-Atlantic	Other	44
West Coast	Bag possession/limits	42
New England/Mid-Atlantic	Quota closure	40
Southeast	Gear restrictions	40
West Coast	Gear specifications	37
New England/Mid-Atlantic	Annual limits	32
New England/Mid-Atlantic	Reporting	31
New England/Mid-Atlantic	Closed season	30
New England/Mid-Atlantic	Landing fish intact	30
Southeast	Closed season	28
New England/Mid-Atlantic	Gear specifications	25
Southeast	Reporting	25
New England/Mid-Atlantic	Permits & fees	24
New England/Mid-Atlantic	Days-at-sea	23
Southeast	Landing fish intact	22
West Coast	Permit transfer	22
West Coast	Permit endorsement (gear)	19
New England/Mid-Atlantic	Prohibited species	18
Southeast	Prohibited species	18
West Coast	Permit endorsement (size)	17
Southeast	Permits & fees	16
New England/Mid-Atlantic	Closed area	14
New England/Mid-Atlantic	Sales & purchase restriction	12
Southeast	Closed area	12
New England/Mid-Atlantic	Observer requirements	10
Southeast	Quota closure	10
Southeast	Season limits	10

Table 4. Frequency table of pairwise counts of exempted regulation group and region, Continued.

NOAA Region	Regulation Group	Pairwise Count
Alaska	Observer requirements	8
Alaska	Prohibited species	8
New England/Mid-Atlantic	Landing restrictions	8
New England/Mid-Atlantic	Trip limits	8
Southeast	Other	8
New England/Mid-Atlantic	Recreational closed season	7
New England/Mid-Atlantic	Trap tags	7
Southeast	Recreational closed season	7
Southeast	Trip limits	7
New England/Mid-Atlantic	Recreational in-season closure	6
New England/Mid-Atlantic	Trap limits	6
Alaska	Closed area	5
Southeast	Bag possession/limits	5
Southeast	Recreational in-season closure	5
New England/Mid-Atlantic	Season limits	4
Southeast	None	4
West Coast	Annual limits	4
Alaska	Annual limits	3
Alaska	Landing restrictions	3
Alaska	Other	3
Alaska	Permits & fees	2
New England/Mid-Atlantic	Bag possession/limits	2
New England/Mid-Atlantic	Egg-bearing females	2
New England/Mid-Atlantic	Incidental catch limits	2
New England/Mid-Atlantic	Permit transfer	2
Southeast	Permit endorsement (general)	2
Alaska	Incidental catch limits	1
Alaska	Quota closure	1
Alaska	Trip limits	1
New England/Mid-Atlantic	Lobster mutilation	1
New England/Mid-Atlantic	Permit endorsement (gear)	1
New England/Mid-Atlantic	Permit endorsement (general)	1
Southeast	Annual limits	1
Southeast	Egg-bearing females	1
Southeast	Gear specifications	1
Southeast	Venting requirements	1
Southeast	VMS	1

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