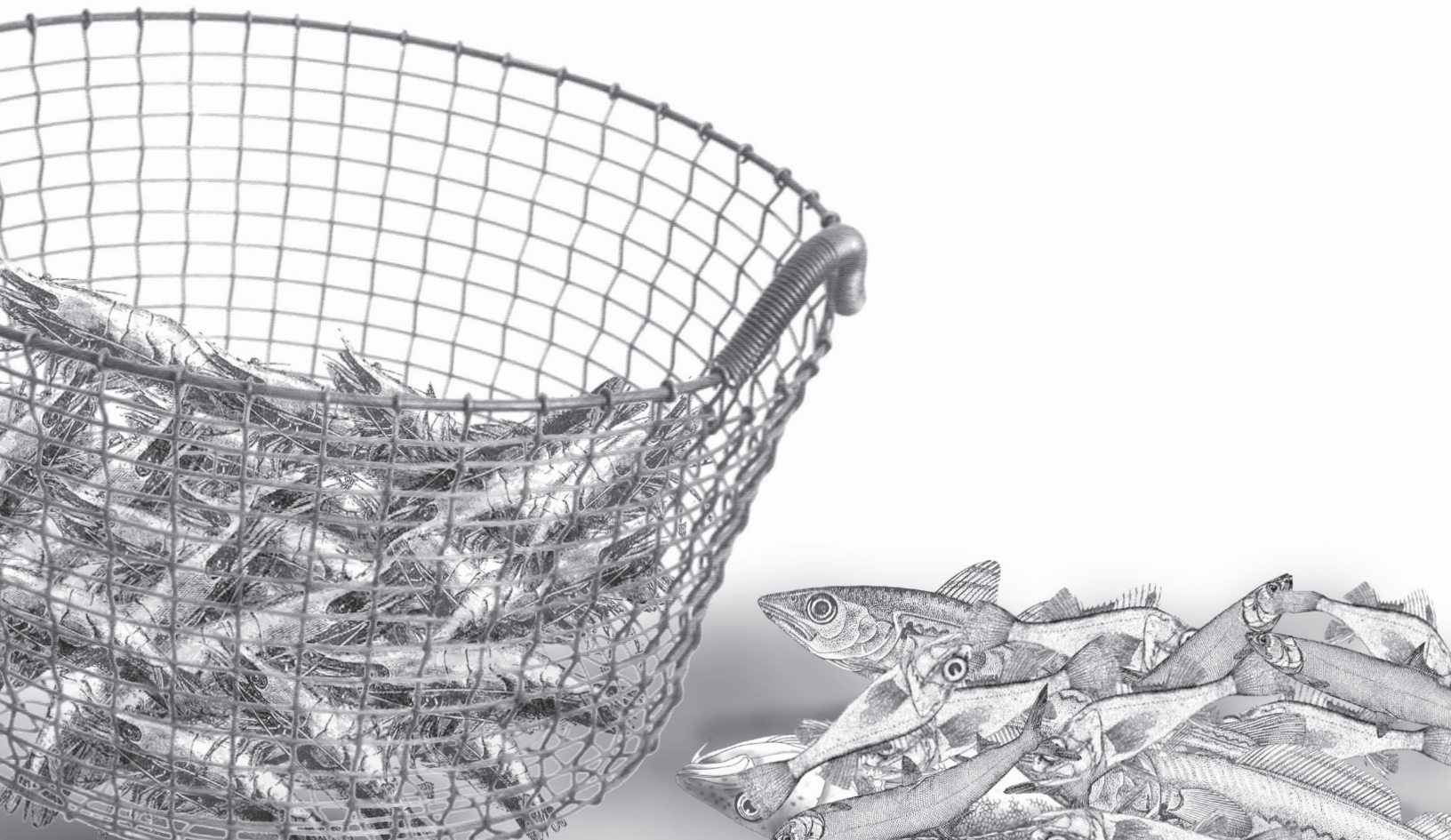
Eliminating Discards

A SUPPLEMENT TO THE

CATCH SHARE DESIGN MANUAL

Karly Kelso and Nicole Sarto



ACKNOWLEDGEMENTS

Environmental Defense Fund gratefully acknowledges the Gordon and Betty Moore Foundation and the Walton Family Foundation for their generous support of this project.

CONTRIBUTORS

Randall Bess, Merrick Burden, Larry Epstein, Shems Jud, Jake Kritzer, Rahel Marsie-Hazen, Sarah O'Brien

Any views expressed in the Design Manual are those of the authors and do not necessarily represent those of the contributors or their organizations. Any errors are those of the authors.

Kelso, K. and Sarto, N. (2018). *Eliminating Discards: A Supplement to the Catch Share Design Manual*. Environmental Defense Fund.

Table of Contents

List of Abbreviations

AC	Advisory Councils
CCTV	Closed Circuit Television
CFP	Common Fisheries Policy
EDF	Environmental Defense Fund
EM	Electronic Monitoring
EU	European Union
ICES	International Council for the Exploration of the Seas
IFQ	Individual Fishing Quota
ITQ	Individual Transferable Quota
MSY	Maximum Sustainable Yield
PO	Producer Organizations
TAC	Total Allowable Catch
TURF	Territorial Use Rights for Fishing
U.K.	United Kingdom
VMS	Vessel Monitoring System

Figures, Snapshots and Tables

Figures

Snapshots

Tables

Introduction

While estimates of bycatch[1] are variable due to the difficulty of accurately quantifying this practice, some sources have estimated that bycatch constitutes as much as 40% of global catch (Davies et al., 2009; Keledjian et al., 2014). Much of this catch is thrown overboard either dead or dying due to contact with fishing gear, handling upon the fishing vessel and the general shock from capture and removal from water. In addition to being an extremely wasteful practice, discarding poses an important problem for scientists who estimate fishing mortality, or the total number of fish removed from the ocean. This information is vital as it informs important decisions about how fisheries are managed, species' ability to recover, fishermen's ability to make a living and the availability of a critical protein source for billions of people. As such, discarding is a practice that is abhorred by fishermen, fishery managers, environmental groups and the public alike.

Environmental Defense Fund's (EDF) Eliminating Discards Guide discusses different design options to help fishery managers, fishermen and other stakeholders achieve a shared goal to reduce, and even eliminate, discarding practices in a fishery that is operating or moving towards secure fishing rights. Secure fishing rights, sometimes called catch shares in the United States, are a type of fishery management that allocate a secure area, or privilege to harvest a share of a fishery's total catch, to an individual (i.e., fisherman) or a group (i.e., fishing cooperative or fishing community). These programs establish appropriate controls on fishing mortality and hold participants accountable to these controls in exchange for secure, exclusive fishing privileges.

This guide helps fishery stakeholders align incentives to reduce, and potentially eliminate, discards through considerations in design of a secure fishing rights program. This guide does not provide a step-by-step process for designing a secure fishing rights program. A comprehensive roadmap for the design of a secure fishing rights program can be found in the following three volumes:

- *Catch Share Design Manual, Volume 1: A Guide for Managers and Fishermen (Second Edition)*
- *Catch Share Design Manual, Volume 2: Cooperative Catch Shares*
- *Catch Share Design Manual, Volume 3: Territorial Use Rights for Fishing*

1 There are many different definitions of bycatch. Please see the glossary for clarification.

TABLE 1 | TYPES OF SECURE FISHING RIGHTS

	ALLOCATED TO	QUOTA OR AREA-BASED
INDIVIDUAL QUOTA (IQ)	Individual	Quota-based
INDIVIDUAL TRANSFERABLE QUOTA (ITQ)	Individual	Quota-based
INDIVIDUAL VESSEL QUOTA (IVQ)	Vessel	Quota-based
COOPERATIVE[1]	Group	Quota-based or Area-based
COMMUNITY FISHING QUOTA (CFQ)	Community	Quota-based
TERRITORIAL USE RIGHTS FOR FISHING (TURF)	Individual, Group or Community	Area-based[2]

1 The term "cooperative" has many meanings and generally refers to any group that collectively works together. Throughout the Design Manual, "Cooperative" is capitalized when referring to a group that has been allocated a secure area or share of the catch limit, i.e., when it is a type of secure fishing right. When not capitalized, "cooperative" refers to an organized group that has not been allocated secure shares, but may coordinate other activities, such as marketing.

2 Some TURFs are also allocated a secure share of the total catch, in which case they are area-based and quota-based.

An important component of any secure fishing rights program is accountability of individuals to quota holdings. Accountability through appropriate monitoring and reporting systems will be needed to ensure fleet compliance with restrictions and to verify changes in discarding. With effective monitoring and reporting systems, not only will fishermen be accountable to their catch and fishery regulations, but all stakeholders will benefit from improved fishery science that can support improved stock assessments that help ensure sustainability of the fishery.

One of the most important aspects of any secure fishing rights program is its flexibility in design. With the diversity of fisheries, fleets and fishing industry structures around the world, a secure fishing rights program can be tailored to meet the characteristics of each fishery and directly address the issues driving discards. Each country and fishery should evaluate design options and determine ones to use based on their own legal structures and the fishery characteristics and goals. The key will be to incorporate stakeholders' knowledge and available technology to tailor solutions to specific fishery circumstances.

WHAT ARE DISCARDS?

Discarding is the return of a portion of the catch, dead or alive, to the ocean before offloading, often due to regulatory constraints or lack of economic value (FAO, n.d.). In fisheries, there are generally two classifications: regulatory discards and economic discards.

TABLE 2 | TYPES OF DISCARDS

	DEFINITION
REGULATORY DISCARDS	Fish and ocean wildlife that must be thrown back due to laws or fishery regulations that prohibit their retention, based on factors like the fishing season, trip limits and/or the size, species and sex of fish.
ECONOMIC DISCARDS	Fish and ocean wildlife that are thrown back due to the economics of fishing, such as a lack of a market or an expectation that higher-value fish can be found to fill a vessel's capacity. • Dumping or Discretionary Discards: Catch that is discarded because of undesirable species, size, sex or quality, or for other non-regulatory reasons (NMFS, 1998). • High Grading: Fish or ocean wildlife discarded due to size, though still marketable, to reserve room for more marketable fish (Kelleher, 2005).

As alluded to in their definitions, each of these discard types has different underlying causes. Regulatory discarding is a result of policies that do not allow fishermen to keep what they catch, so there is a mismatch between what the regulations allow and what the fishermen are catching. Management policies that fall into this category are sometimes called onerous controls (see Figure A on the next page). Economic discarding is a result of market forces which influence fishermen behavior.

In some cases, both regulatory and economic discarding may be present within a fishery. Understanding and diagnosing the type of discarding that occurs in the fishery are important steps in addressing the underlying incentives that allow, if not promote, discarding.

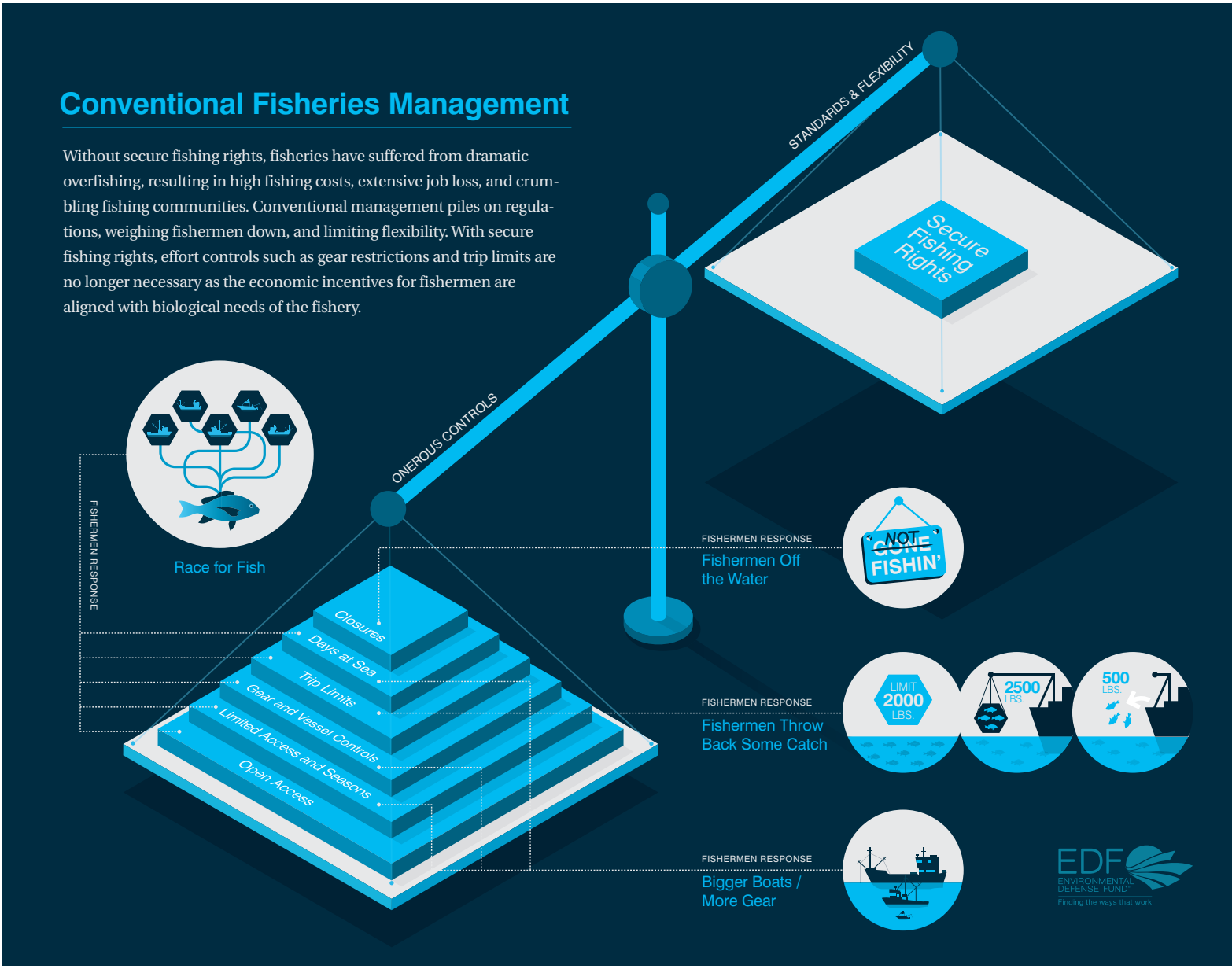


FIGURE A | *Weighing the differences between the standards and flexibility of secure fishing rights and the onerous controls of conventional management.*

SNAPSHOT A | Reasons for Discarding in the European Union (EU)

The new Common Fisheries Policy (CFP), ratified in 2013, introduced a requirement for EU fleets that would stop the practice of discarding with target species managed by a catch limit. This section under the CFP is called Article 15, the landing obligation, and requires all member states to provide full documentation, meaning that detailed and accurate documentation of all fishing trips exists to ensure catch is fully documented and accounted for.

The landing obligation and its requirements represent a significant challenge to fishermen, member state governments, regional advisory councils, the Directorate-General for Maritime Affairs and Fisheries and other stakeholders who have previously worked under a completely different incentive structure. Under the old CFP, fishermen were not actively encouraged to avoid discarding, and there was little or no regulation concerning mortality at sea. Instead, fishermen faced multiple constraints on fishing behavior—in effect telling them how to fish—in an effort to keep within annual quota and harvesting levels. Unfortunately, these regulations solely targeted what was landed and often ignored what happened to total mortality at sea. This resulted in a situation where fishermen often felt compelled to discard, when lacking the necessary quota, large amounts of undersized but marketable fish while retaining larger marketable fish.

HOW WELL HAVE SECURE FISHING RIGHTS PERFORMED TO REDUCE DISCARDS?

Several fisheries that have designed and implemented secure fishing rights programs, with the specific goal to reduce discards, have demonstrated success. In these fisheries, the incentives for discarding have been identified and appropriate design options and reporting and monitoring systems have been utilized to reach these results. Examples include:

- Discards of non-target species declined by 46% in the sablefish and halibut fisheries in British Columbia (Fujita et al., 1998; Branch, 2008), while in the same fisheries in Alaska, non-target species discards declined by 58% (Fujita et al., 1998; Branch, 2008).
- Overall, estimated discards during the Gulf of Mexico Red Snapper IFQ program years were considerably less than during the years leading up to program implementation. On average, across gear types and regions, 60% fewer fish were discarded annually during 2007–2011 compared to 2002-2006 (Agar et al., 2014).

- Discard rates in the United States Pacific Coast Groundfish Limited Entry Trawl IFQ program have dramatically decreased under a secure fishing rights program. Currently, discards are down to around 5% of overall catch (NOAA, 2012). Prior to the secure fishing rights program, discards were estimated to be 20-25% of the total catch depending on the species (NOAA, 2012).

One of the reasons for these discard reductions is the transition from a conventional management system to a more flexible fishery management system. In a fishery operating previously under race for fish conditions, transitioning to a secure fishing rights program provides the opportunity to re-evaluate the regulations that have allowed, if not promoted, discarding, as well as the expected fishing behaviors under competitive conditions. Fishermen may have more time to consider where and when to fish to reduce their bycatch and, therefore, their discards. When bycatch occurs, secure fishing rights programs provide mechanisms for acquiring the additional quota needed to account for that catch. Furthermore, well-designed secure fishing rights programs provide fishermen with a long term secure stake in their fishery, which ties their current behavior to future outcomes, thus creating a stewardship incentive and the incentive to comply with legal obligations (Young & McCay, 1995; Sanchirico & Wilen, 2007; Costello et al., 2008; Festa et al., 2008; Bonzon et al., 2010).

This was demonstrated in the Gulf of Mexico red snapper commercial fishery where the required size limits, seasonal closures and trip limits created race for fish conditions and discarding incentives (GMFMC, 2013). With the implementation of the secure fishing rights program, season closures and trip limits were eliminated while size limits were adjusted to allow for increased flexibility. Fishermen were now allowed to fish 365 days with no seasonal closure, remaining accountable to their quota holdings. This resulted in a 60% decrease in discards across gear types and regions in the four years after the program was implemented, compared to the four years leading up to the program (Agar et al., 2014).

Under conventional management in the sablefish and halibut fisheries in Alaska, the entire annual quota was landed in just three days and large amounts of discarding (finfish and seabirds) and ghost fishing occurred. Regulations prohibited sablefish fishermen from landing halibut and halibut fishermen from landing sablefish, creating the requirement to discard large amounts of marketable fish (Bonzon et. al., 2010). When the secure fishing rights system went into place, the fishing industry was no longer held to these regulations; rather, they became accountable to their quota allocations and had the flexibility to transfer quota to cover their catch. Longer seasons allowed for fishermen to switch to more selective gear, and in some cases develop innovative gear to reduce their impact on discards and seabird bycatch (Bonzon et al., 2010). With this transition, non-target species discards declined by 58% (Fujita et al., 1998; Branch, 2008).

SNAPSHOT B | How to Use this Supplemental Guide

This supplemental guide is intended to help you—whether you are a fishery manager, fisherman or another stakeholder—to design a successful fishery management program that allows a fleet or vessel to reduce, and in some cases eliminate, discards. There are design options that support the reduction, and in some cases the elimination, of discards. Before considering those options, it is important to distinguish clearly which circumstance best describes your fishery's current management approach and the challenges resulting in discarding. These can be grouped into the following three scenarios:

- SCENARIO 1: *The fishery management approach is based on a catch limit, but does not allocate rights for the quota. This scenario includes, but is not limited to, the following:*
  - A fishery is managed by a catch limit but participants are not individually accountable to the limit, often resulting in a race for fish. Requirements to stay under the annual catch limit for the fishery may encourage high-grading or dumping.
  - The overall fishery catch limit covers the total catch for a stock, but quota allocations to eligible participants (i.e., community, fishing cooperative or individual fishermen) do not match catch compositions.
  - The fishery is managed by reported landings, rather than catch, and therefore does not account for all sources of mortality.
  - Input regulations, such as gear used, size limits, trip limits, etc., lead to regulatory discards.

  If any of these circumstances describes your fishery, then the question becomes one largely focused on secure fishing rights program design and addressing issues of quota allocation and efficiency. For design solutions please turn to *Section 1 – Designing a Secure Fishing Rights Program to Reduce Discards.*

- SCENARIO 2: *The fishery management approach is not based on a catch limit.* This scenario includes, but is not limited to, the following:
  - Catch limits are not incorporated into the management; rather, mortality is managed through conventional fishery management approaches, including input regulations (e.g., season limits, days at sea, vessel horsepower, etc.).
  - The secure fishing rights program is area-based (i.e., Territorial Use Rights for Fishing, or TURF) and controls on fishing mortality do not include a catch limit.
  - Fishery management is through transferable effort shares (i.e., effort-based).

- SCENARIO 3: *There are operating inefficiencies that promote discarding.* This scenario includes, but is not limited to, the following:
  - Gear technologies, fishing strategies or other sources of economic inefficiencies have resulted in the fishery's level of fishing mortality becoming higher than the scientifically sustainable limit.
  - Fishermen are not permitted to choose the fishing method and technology best suited to their circumstances. In some cases, this might include use of gear types that are not selective and capture of non-target species that are discarded.
  - The fleet does not actively avoid fishing where there are juvenile and bycatch hotspots.

  If any of these circumstances describes your fishery, then the question becomes: "How can the fishery's fleet catch less of this stock?" For ways of dealing with this issue, please turn to *Section 2 – Catch Selectivity and Avoidance Solutions.*

For some fisheries, a combination of these scenarios may be applicable. For example, a quota-based fishery that does not allocate rights to the quota, but that wants to allocate rights to individuals and/or groups (Scenario 1) and reduce operating inefficiencies, such as making gear more selective (Scenario 3), can use design options and tools from Sections 3 and 4 together to effect change and allow the fishery to reduce, or even eliminate, discarding.

In either circumstance, the implementation of design options intended to reduce discarding should be incentivized and controlled through an appropriate monitoring system for compliance and full accountability of quota holdings (see Section 3). Note that in all likelihood, there will be a need for improved catch selectivity, which is the ability to target and capture fish by size and species during harvesting operations, allowing juvenile fish and non-target species to escape capture unharmed. In most fisheries, there will also be a need for better use of available quota. However, if your fishery is not managed through a catch limit and quota, *Section 2 – Catch Selectivity and Avoidance Solutions* will be most relevant.

FIGURE B | *Tools Discussed in this Manual*

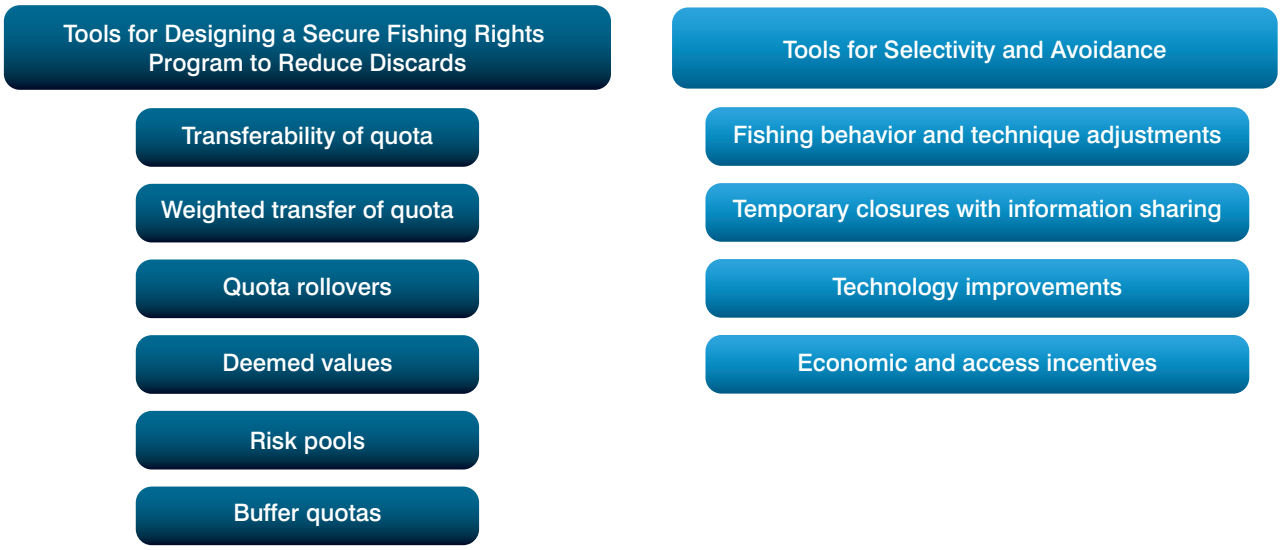
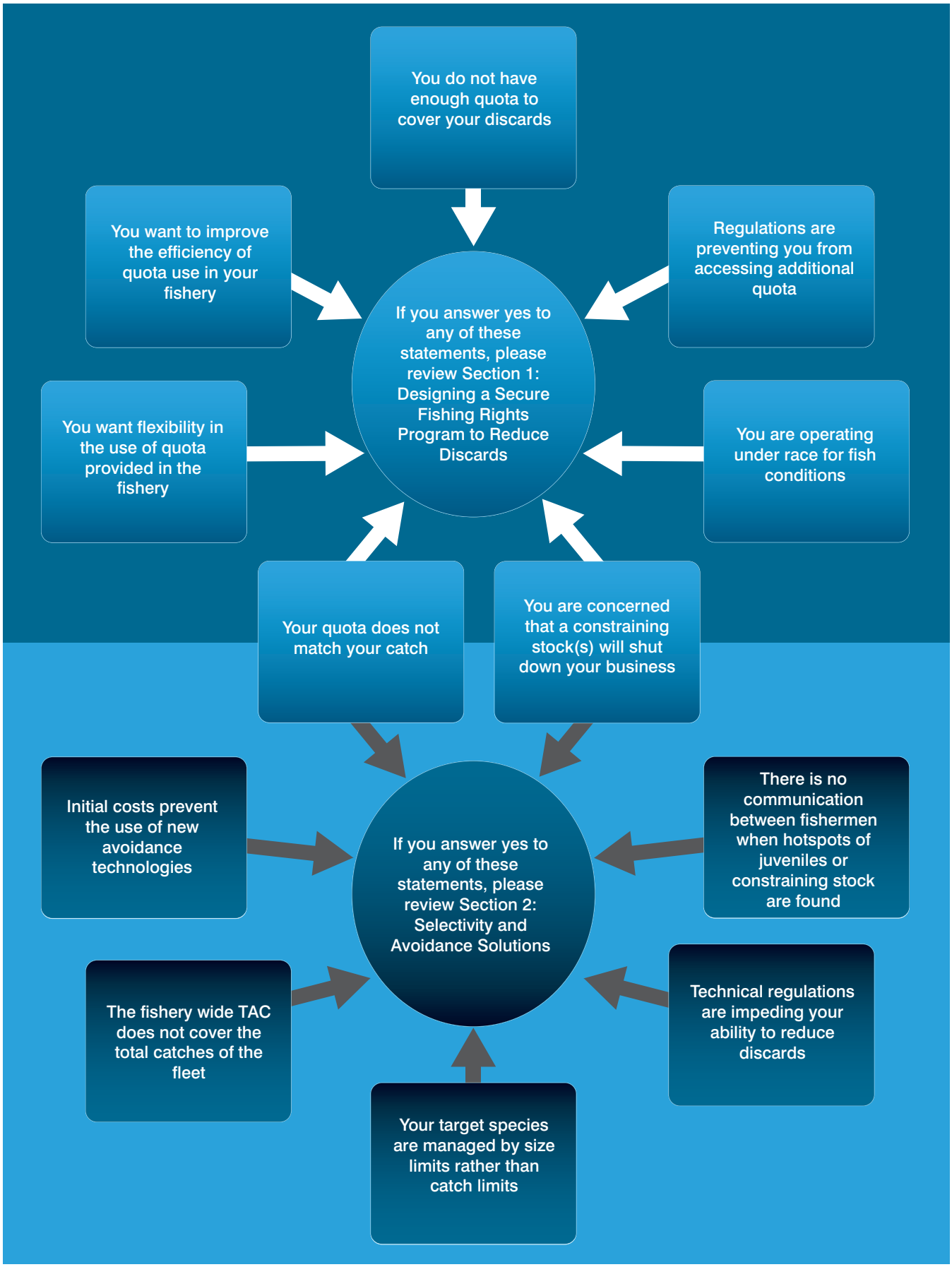


FIGURE C | *Questions to Guide the Use of this Manual*



1 Designing a Secure Fishing Rights Program to Reduce Discards

One proven approach to reducing discards is the combination of:

- A secure fishing rights program;
- Monitoring and reporting systems to ensure compliance and accountability to quota holdings.

A secure fishing rights program provides those with quota allocations with an important mix of the right to harvest a secure, exclusive share of a fishery's total catch; responsibility to be accountable to quota holdings; and long-term rewards whenever improvements are made to the fishery. These programs establish appropriate controls on fishing mortality and systems to ensure compliance and accountability. The design options found in this section focus specifically on using a secure fishing rights program that allocates a share of the total catch to an individual or group. For fisheries that are managed under an area-based TURF program, with appropriate controls on fishing mortality, see Section 2.

Fisheries operating under a secure fishing rights program have shown increased resiliency in the face of environmental fluctuations and market disruptions. Research has shown that secure fishing rights programs are able to reduce discards as well as meet other economic, environmental and societal goals, including:

- Preventing, and even reversing, the collapse of fish stocks (Costello et al., 2008);
- Reducing ecological waste, such as discards and bycatch (Branch, 2008; Essington, 2010);
- Ensuring that participants comply with catch limits (Branch, 2008);
- Ending the race for fish (Essington, 2010);
- Stabilizing fishery landings and catch limits (Essington, 2010);
- Providing stability to the fishing industry through better paid, safer, sustainable jobs (Crowley and Palsson, 1992; McCay, 1995; Knapp, 1999; GS Gislason and Associates, Ltd., 2008);
- Improving economic performance through an increase in the profits and value of fisheries (Grafton et al., 2000; Newell et al., 2005);
- Providing incentives for fishing industry-led innovations (Sylvia et al., 2008); and
- Supporting a shift away from micromanagement, with greater autonomy for fishermen to demonstrate their compliance with the rules, so long as overarching targets are adhered to (Bonzon et al., 2010; Makino, 2011).

When fishermen have a secure, exclusive share of the total catch and are held accountable for their quota holdings, fishery managers can reduce other regulations that had previously been in place to control effort, such as days at sea, vessel capacity requirements, tow times or other input constraints. Rather, fishery managers can tailor regulations for the characteristics of each fishery and its fleet. In addition, business plans that drive the decisions of each fisherman can focus on how best to optimize economic returns from quota holdings.

1.1 AVAILABLE DESIGN OPTIONS

When creating a secure fishing rights program, there are many design options that can be implemented to help the program reach its stated goals. This supplemental guide focuses on design options that will help minimize discards, manage constraining stocks and address unavoidable and unwanted bycatch. With a properly designed program, there is an opportunity not only to reduce, and in some cases eliminate, discards, but also improve economic performance for fleets and the biological status of fish stocks. Below are some of the key design options that have been used, in combination with monitoring and reporting systems, to support fisheries around the world that are working to reduce discards through secure fishing rights programs. Those discussed in this guide include:

- *Transferability of Quota (Permanent and Temporary):* Allows fishermen (or groups of fishermen, and communities) to sell or lease quota to align quota holdings with harvesting operations and the composition of the catch.
  The Alaska Halibut and Sablefish Fixed Gear Individual Quota (IFQ) Program allows both permanent and temporary transferability of quota between participants. Strict rules regarding the use of transferability have helped the program reach its stated goals, such as maintain historic fleet and participant structure (See Snapshot 1.1).
- *Weighted Values of Quota:* Substitutes quota for one species to cover catch of a different species based on a weighted formula, typically allowing the more valuable species quota to be traded for a larger proportion of quota for a less valuable species (i.e., not a 1:1 ratio quota exchange).
  Iceland uses weighted values called cod equivalents. Each year regulations determine the weight of the cod equivalent and the relative market value of different fish species. Transfers between vessels in Iceland are frequently measured in cod equivalents (Icelandic Ministry of Fisheries and Agriculture).
- *Quota Rollover:* Provides fishermen (or groups of fishermen, and even countries) the flexible option to roll over a set percentage of uncaught quota to harvest the following year or deduct a set percentage of quota from next year's allocation to land catch in the current year, provided that transfer of quota in either direction will not jeopardize the biological sustainability of the stock.
  British Columbia allows for quota of specific species to be rolled over between years, typically ranging from 10% to 30% of total quota for a species. However, fishery managers have the option to reduce the percentages of rolled over quota in the next year, or even eliminate rollovers for conservation purposes (Sanchirico et al., 2006).
- *Deemed Values:* Requires fishermen who land species for which they do not have quota to pay a pre-agreed fee to the government.
  New Zealand has a system of deemed values in which fishermen who land species for which they do not have quota pay a fee based on port prices to the government (Walker and Townsend, 2008). The goal is to make the fee high enough that fishermen are not incentivized to fish for that species, yet low enough that they do not dump fish overboard or otherwise fish illegally. The fee is refunded if they subsequently purchase or lease quota, referred to as annual catch entitlements (See Snapshot 1.4).
- *Risk Pools:* Fishermen cooperatively pool their species quotas, allowing fishermen to access quota without requiring the purchase of quota on the market in a risk pool. Risk pools essentially act as an insurance policy for vessels, and often require members to agree to practice additional catch selectivity measures to reduce the catch of species that are represented by quota in the pool.
  When extremely low catch limits were established for seven groundfish species in the United States Pacific Coast Groundfish Limited Entry Trawl Individual

Fishing Program, fishermen formed risk pools. The risk pools allowed fishermen to collectively manage quota and provide increased stability for their fleet by allowing members to access a larger pool of quota for these overfished species (See Snapshot 1.5).

- *Quota Banks:* Quota banks are a collection of quota in which certain rules and stipulations govern the use of the privileges and distribution of benefits in order to meet a set of stated fishery goals.
  Established in 2015, the Gulf of Mexico Reef Fish Quota Bank leases red snapper quota to Florida-based grouper fishermen to account for red snapper discards in their IFQ fishery. The quota bank allows for accountability and more accurate scientific basis for stock assessments for the grouper fishery, resulting in a reduced impact on the red snapper population (See Snapshot 1.6).
- *Buffer Quotas:* Portions of a fishery's, individual's or community's quota are set aside from the total quota to be released when deemed necessary, e.g., in the occurrence of constraining stock quota depletion. A constraining stock is a species in a mixed fishery that will prematurely close the fishery when its total catch level is exhausted. This is also called a choke species (See Snapshot 1.2).
  In the Danish Pelagic and Demersal ITQ Fishery, managers have implemented a system of buffer quotas to promote specific social goals, including access for new entrants and 17 meters or shorter vessels (Strauss, 2013).

1.1.1 Transferability of Quota

Transferability of quota means that an individual or group can buy, sell and/or lease quota to other individuals or

FIGURE 1.1 | *Levels of Transferability*

Transferability can be implemented at different levels to help align quota with the needs of each individual entity.

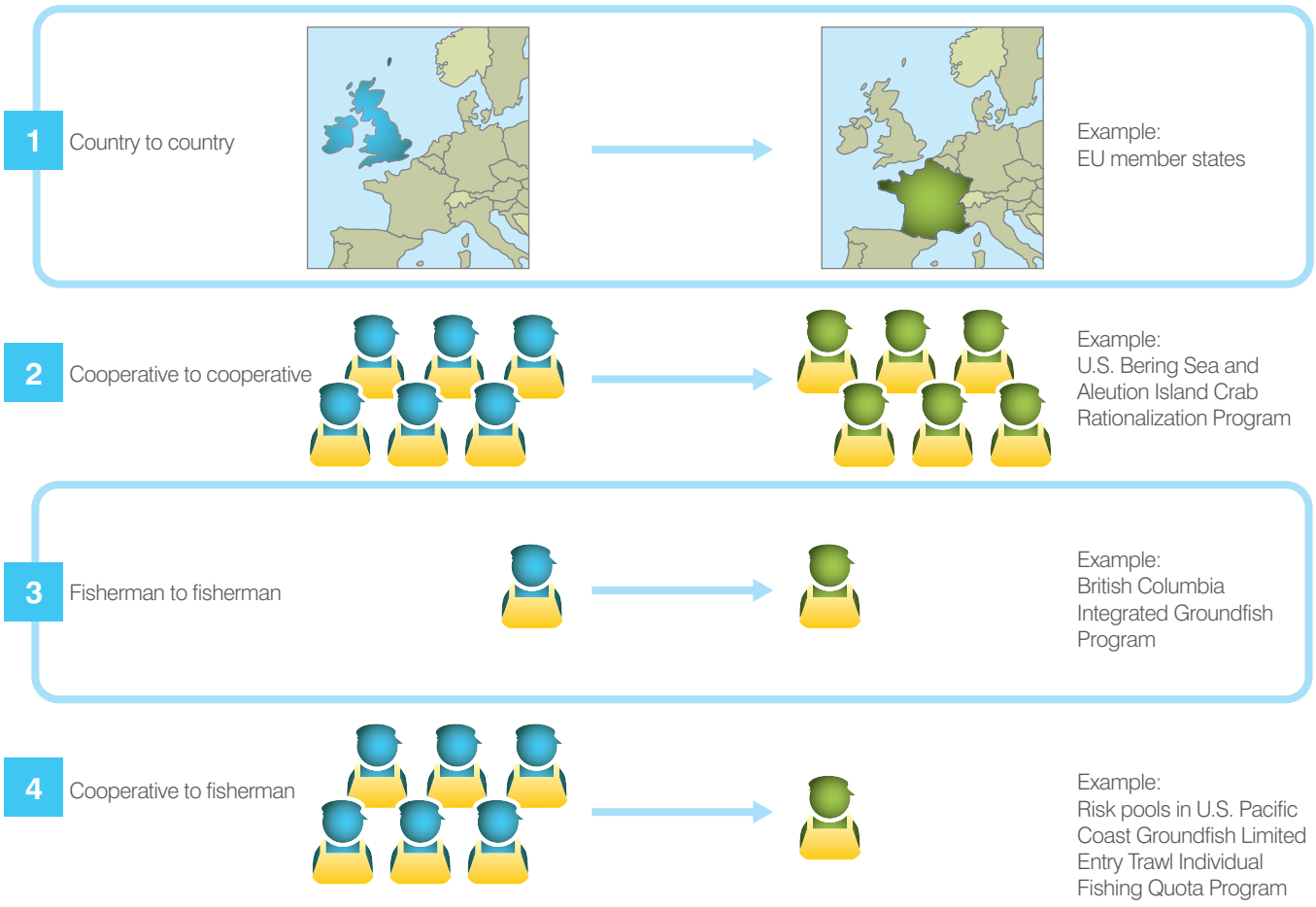


FIGURE 1.2 | *Permanent Transferability*

TWO SCENARIOS

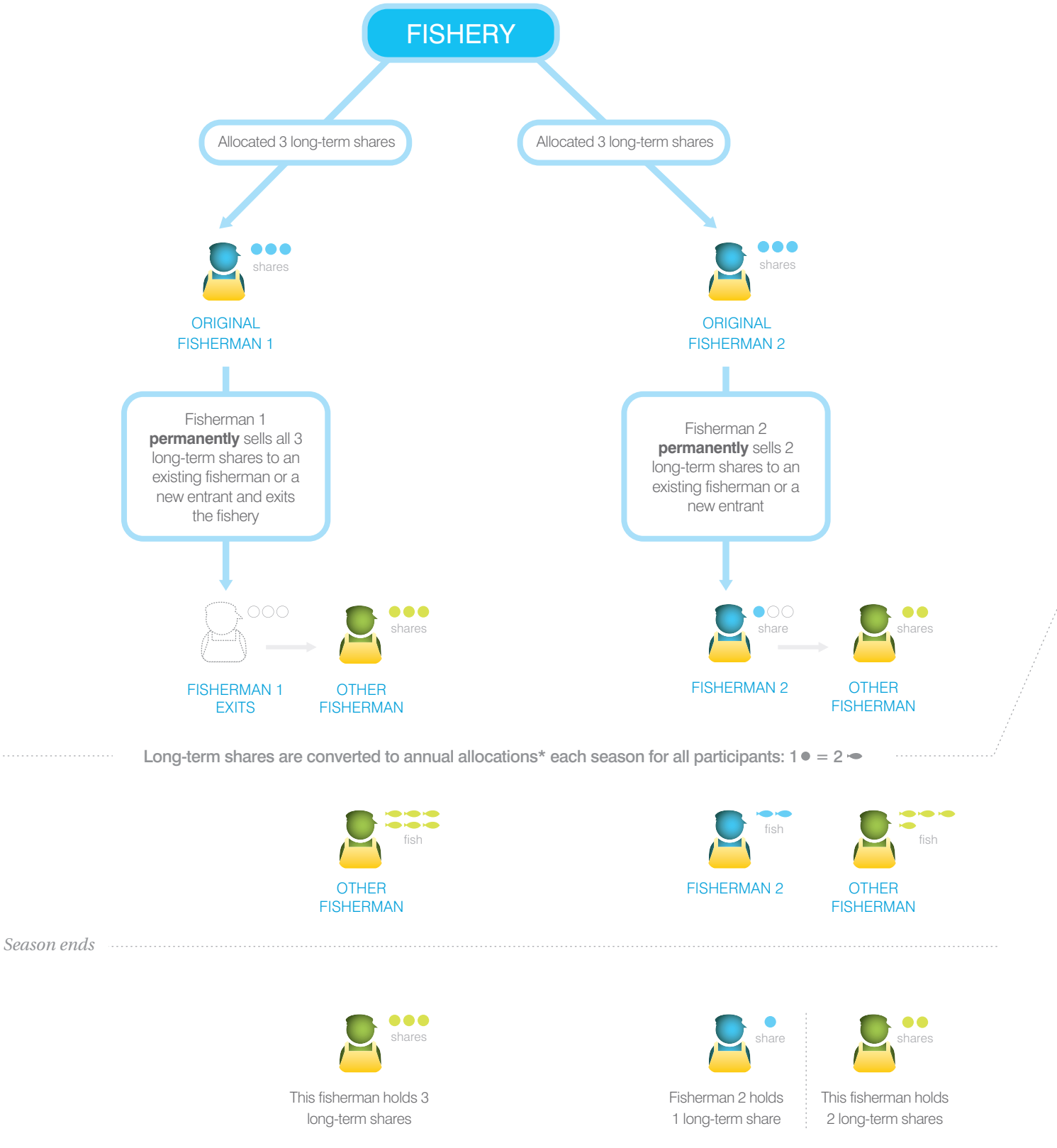
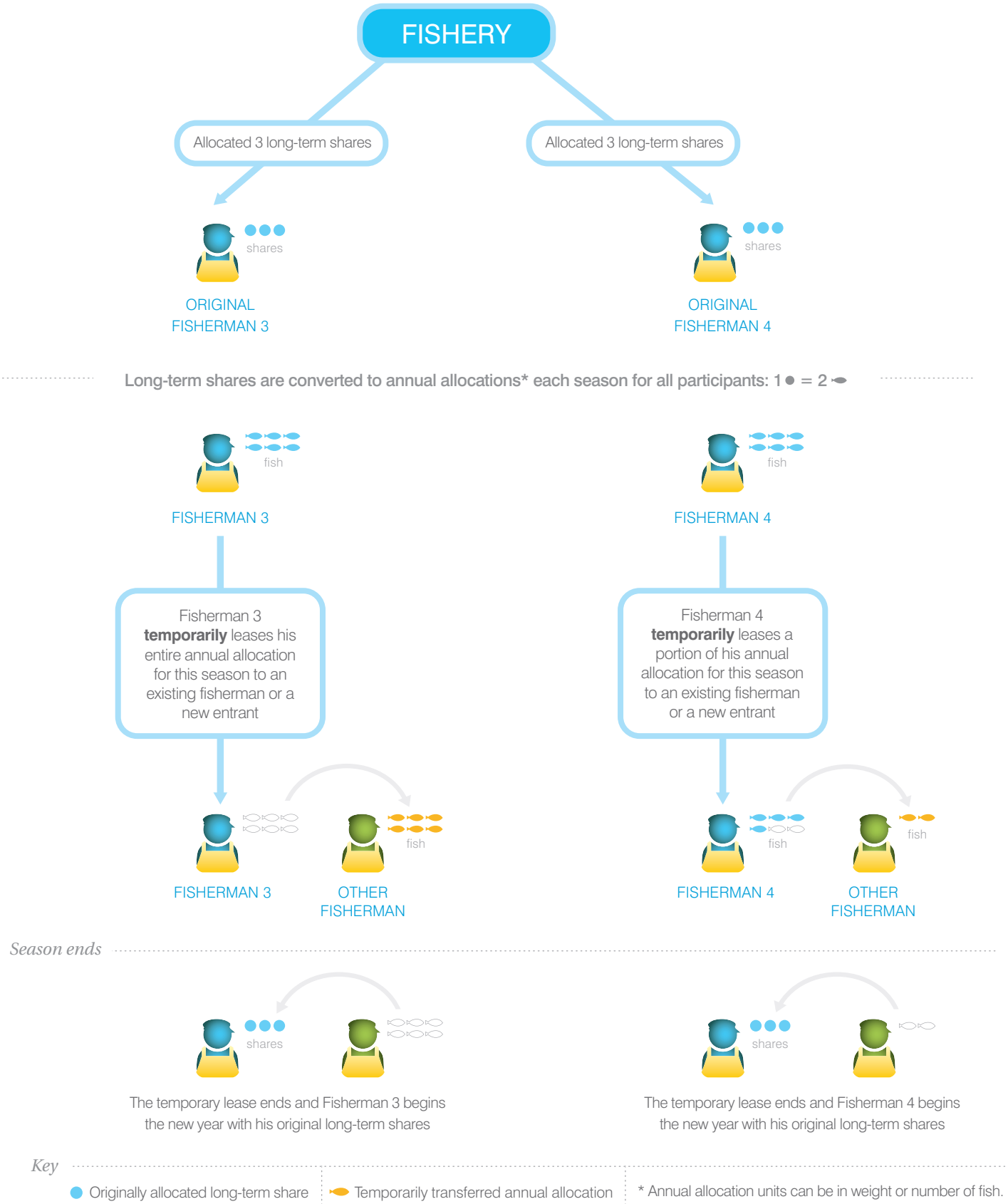


FIGURE 1.3 | *Temporary Transferability*

TWO SCENARIOS



groups within a specific fishery (Bonzon et al., 2010). Quota is often transferred to allow the quota holder to match catch composition. This can prevent overages or enable the fishermen to sell unused quota to others. These individuals or groups could include eligible fishermen, fishing cooperatives, fishing communities and/or fishing businesses, such as the producer organizations (PO) that hold quota in many European member states and the cooperatives in the United States Bering Sea Pollock Conservation Cooperative American Fisheries Act Program.

In the context of addressing discards, transferability can be implemented at different levels to align quota with catch and reduce incentives to discard. The levels include transferability between countries, cooperatives and individual fishermen/vessels. When more fishery participants are able to transfer quota, quota will be more effectively aligned with catch and the potential to reduce discarding will increase.

Quota can be *temporarily* transferred—also called leasing—between entities, or *permanently* transferred (i.e., sold). The primary difference is that at the end of the season leased quota is reverted back to the original quota holder for the next fishing season, whereas permanently transferred quota will remain with the new quota holder. Transferability is beneficial in that it increases flexibility for fishermen to trade their quota through an efficient and effective process while still being able to meet overarching goals and stay within maximum sustainable yield (MSY) limits (Bonzon et al., 2010).

Considerations for Limiting Transfers

When including transferability in a secure fishing rights program, the program goals should guide the decision-making process. There are many ways to design and implement transferability which can significantly impact the performance of a program. Transferability can allow new entrants into a fishery and improve the economic efficiency of a program. However, without consideration of a program's goals, transferability may lead to undesirable effects because market forces tend to drive the location and flow of quota toward places where it has the highest economic value, which may not be socially optimal for the fishery (Bonzon et al., 2010). Below are some considerations regarding the impact of transferability on social and fleet composition goals.

Social Goals

When implementing a secure fishing rights program with transferability, fishery managers may have the goal to maintain historical fleet structure by establishing strict eligibility requirements to participate in the fishery, as well as limiting the amount of quota allowed to be held by a single individual or group. There are multiple safeguards that can be designed into a secure fishing rights program to address or prevent such outcomes. These design options include the use of "concentration caps" (i.e., accumulation limits) on the percentage of quota that any individual, PO, cooperative or community group may hold temporally and/or permanently. The use of caps prevents what might be considered "excessive" quota consolidation in the fishery, though the level that would define "excessive" will be different for every fishery.

Fishery managers may also decide to have a quota owner onboard when fishing against quota, a design option called an "owner-on-board" requirement. In this scenario, catch harvested against quota is prohibited unless the "owner" is physically onboard the vessel. Some fisheries elect to set a percentage of quota to be landed with the owner onboard, which allows the owner to have some flexibility while preventing "absentee" owners from entering the fishery.

Fleet Transfers

Fishery managers should clearly identify the goals for fleet composition to help best inform the rules regarding transferability of quota. When transferability is unconstrained, it may impact the composition of the fleet both in terms of vessel numbers and fishery participants. Sometimes there is a concern that transferability may lead to quota being permanently moved from:

- one fleet sector to another (e.g., commercial to recreational);
- one country to another (e.g., U.S. to Canada);
- one gear sector to another (e.g., trawl to hook and line); or
- one management region to another (e.g., U.S. Halibut and Sablefish Fixed-gear IFQ Program, see Snapshot 1.1)

PHOTO: SCOTT DICKERSON

SNAPSHOT 1.1 | United States Alaska Halibut and Sablefish Fixed Gear Individual Fishing Quota (IFQ) Program

At the establishment of the U.S. Alaska Halibut and Sablefish Fixed Gear IFQ Program, fishery managers and fishermen identified the retention of historical fleet structure as a key goal. To meet this goal, concentration caps became a key design option, in addition to strict participant eligibility and restrictions on transferability of quota. Concentration caps are used in two different levels within the program, specifically:

1. Vessel IFQ Cap – A concentration cap to limit the amount of fish a vessel is allowed to land per year.
2. Quota Share Use – A concentration cap to limit the amount of long-term quota held by a single fishery participant. This cap ranges from 0.5%–1.5% depending on the management zone (there are multiple zones based upon biological stocks). Some fishermen were grandfathered into the program with larger amounts of quota holdings based on the value of their historical landings.

The concentration caps have played a significant role in the performance of the program. Since implementation, the fleet has successfully maintained its historical structure and prevented the consolidation of ownership of quota by corporations[2] (McIlwain, 2013). Additionally, the "owner-on-board" requirement has maintained a fleet of owner-operators (McIlwain, 2013).

2 In the design of the secure fishing rights program, the North Pacific Fishery Management Council determined that all eligible participants who would receive allocation be either individual U.S. citizens and U.S based-corporations with catch history, and the Alaska communities under the Community Development Quota Program. Only these U.S. corporations that received initial allocation are allowed to purchase or lease quota, whereas this regulation does not affect individual U.S. citizens.

BEST PRACTICES

Transferability

- Refer to program goals to help inform decisions regarding the use of transferability in the program.
- Establish a real-time, transparent trading platform to track and monitor transactions between participants.
- Consider concentration caps that limit the amount of transfers between participants to best meet social goals.
- Consider a transition period, during which only temporary transfers are allowed, to introduce the concept of transferability to participants.

SNAPSHOT 1.2 | Constraining Stocks in Mixed Fisheries

Constraining stocks, also called choke species, in a quota-managed mixed fishery are those that will prematurely close the fishery when their quota is exhausted (i.e., fully caught). Typically, these species are the stocks with the smallest amount of quota in a mixed fishery and are frequently considered bycatch when caught with other species. In other cases, constraining stocks can be targeted, and exhibit the highest rate of capture compared to other species. In this scenario, the constraining stock quota may be the first exhausted.

The presence of constraining stock increases the risk that a mixed fishery will be forced to close before other species quotas are fully caught, potentially creating significant economic losses. These conditions may severely limit the economic opportunities for the fleets targeting mixed fisheries or for those targeting a subset of the stocks in a mixed fishery. Constraining stocks can also result in hazardous fishing conditions by creating a "race for fish". In this scenario, fishermen are incentivized to fish early to ensure they land as much as possible of their target catch before the quota of the constraining stock becomes exhausted by other fishermen.

These behaviors occur in fisheries around the world when constraining stocks are not managed under a secure fishing rights program. A well-designed program provides flexibility in efforts to reduce, and in some circumstances, avoid closures due to constraining stock. Buffer quotas, deemed values, risk pools and weighted transfer of quotas are presented in this guide as design options that can help manage constraining stocks.

Constraining stocks have been problematic in European fisheries as many fishermen operate in multi-species fisheries with multiple catch limits. Under these circumstances, once fishermen fully catch the quota for a single species, they are required to cease fishing and return to port. This requirement can be financially crippling for fishermen, and so it is the single biggest concern in overcoming compliance with the new CFP landing obligation in EU waters.

If a fishery participant has a concern regarding quota transferability, there are two design options that can be considered to help mitigate the cause of concern.

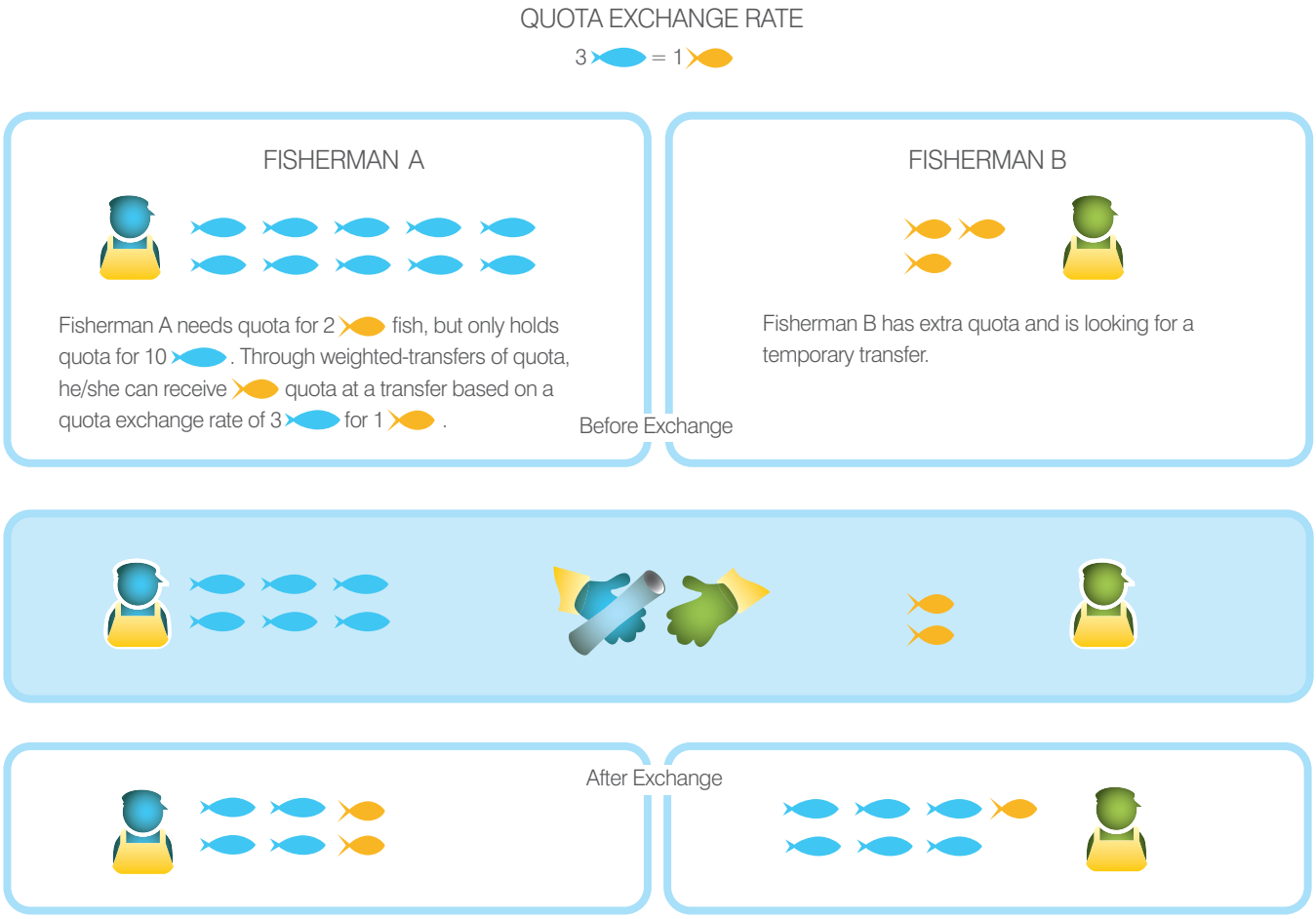
First, only temporary (leasing) transfers of quota between eligible participants could be allowed. At the end of the season leased quota is reverted back to the original quota-holding fishery participant for the next fishing season.

The second feature is to limit the amount of quota eligible for transfers between eligible fishery participants altogether. This type of transferability constraint would set a concentration cap that limits the amount of transferable quota to a level deemed acceptable. This may be a viable option if fishery participants wish to maintain the historic level of participation within their own sectors or designated borders.

One concern expressed by those who hold quota in these fisheries is that even with transferability of quota, the price of quota for constraining stock could become prohibitively high whenever it becomes scarce (e.g., if the catch limit is reached, the entire fishery is closed).

When transferability is included as a design option, an increase in the pool of people eligible to receive quota transfers can increase the demand and, therefore, the price. In these circumstances, transferability will further incentivize catch selectivity within fleets. Some fishing sectors will improve their catch selectivity so that they can sell their unused quota.

FIGURE 1.4 | *Using Weighted-Transfers of Quota*



Transfer from Accountable to Unaccountable Sectors

In international fisheries, the issue of "flagging" (i.e., when a vessel from one country fishes under the flag of another country) should also be addressed to prevent a loophole for quota landed by other participants who lack individual accountability measures. In this scenario, clear transferability, eligibility and enforcement will need to be established to ensure that quota is only transferred to and from eligible participants. Quota transfers from accountable to unaccountable sectors can undermine stated program goals, including reductions in discards.

For additional design options and safeguards regarding transferability, please see *Catch Share Design Manual, Volume 1: A Guide for Managers and Fishermen.*

1.1.2 Weighted Transfer of Quota

Some existing multi-species secure fishing rights programs allow participants to substitute the quota from one species to cover catch of a different species (i.e., quota for species A may be allowed to cover catch and landings for species B). In many cases, the cost of quota for more vulnerable or more valuable species will be higher than for another species (i.e., a portion of a more valuable species' quota can be traded for a larger portion of quota of a less valuable species).

The use of weighted transfers brings an additional layer of complexity to program design and system requirements. Weighted transfers would need science-based and market-based evaluations to determine appropriate transfer amounts, in order to ensure fish stocks are not adversely affected. A real-time trading platform to track and monitor the use of landings would be strongly advised. The increased complexity in trades associated with weighted transfers and the need for caution in setting catch limits for constraining stocks may make this feature less attractive.

The use of cod equivalents in the Iceland secure fishing rights program is a successful example of weighted transfers. In this program, all species can be traded according to set conversion rates of cod. These rates are established by the Icelandic Ministry of Fishery and are published annually.

1.1.3 Quota Rollovers

In some fisheries, participants are allowed quota rollovers, which provide the flexibility to roll over a set percentage of quota to the next fishing year. With secured rights in the fishery, participants are provided with increased flexibility to plan their harvests from year to year. In some cases, fishermen may over- or under-harvest their quota as a part of their business plan. In other cases, fishermen may unintentionally catch more or less of a species than they hold quota for within a given year. This design option allows fishermen to improve their business planning.

BEST PRACTICES

Weighted Transfer

- Determine appropriate transfer values according to science-based evaluations with frequent reviews to account for unforeseen changes in abundance, environmental impacts, etc.
- Establish a real-time trading platform to track and monitor transactions involving weighted transfers.
- Consider limits on the amount of weighted transfers for each species quota to ensure that transfers do not adversely affect fish stocks.

SNAPSHOT 1.3 | Providing Resiliency for Climate Change while Designing Systems to End Discards

Overfishing and discarding are only two of the multiple drivers affecting the health of global fisheries. Climate change, habitat degradation and pollution are all threatening the sustainability of fisheries worldwide (Sumaila et al., 2011). Research, observations and modeling exercises have demonstrated that one of the most significant concerns will be the impact of climate change on the distribution and range of fish species and stocks (Benfey, 2001; Cheung et al., 2010; Sumaila et al., 2011). There are examples of key regional fisheries already experiencing the impact of climate change, such as the recent dispute over the need to adjust country-level quota for the shifting mackerel population between the EU, Iceland and the Faroe Islands (Egea, 2014). Fishermen and fishery managers will undoubtedly have to address this dispute in the near future.

Secure fishing rights programs can provide opportunities to mitigate the impact of climate change. Changes to range and distribution of species and fish stocks will likely manifest in catch not aligning with quota, which can result in regulatory discarding. Design options such as transferability of quota between sectors and within regions will provide flexibility for the fishing industry and fishery managers to improve the alignment of quota and catch. Weighted quota transfers between different species provide flexibility in managing changes in fishery composition. While secure fishing rights programs may not address all the impacts of climate change, they can provide industry with options that will allow for resilient and adaptable management (Fujita, 2013).

Quota rollovers provide an additional option for managing constraining stocks. For example, in the event that a fisherman's catch of a constraining stock exceeds the annual quota, the quota rollover option might provide the fisherman with the option of covering this year's catch by borrowing quota from the next fishing year. When creating the rollover option, the primary consideration is to record and enforce the overages or underages of quota over the entire fishing year, or season, whichever is applicable. As such, reliable, real-time data collection systems are very important.

There is one main concern regarding the use of rollovers. That is, if too much quota rollover or "borrowing" occurs, then the fish stock can be at risk of depletion from overfishing. In this case, limits could be placed on an individual fisherman's rollovers and on the fleet as a whole to avoid jeopardizing the fishery's sustainability.

Rollovers can incorporate an "interest rate" equal to net population growth of the resource that could be added to or subtracted from a participant's quota holdings. For example, 1,000 pounds of cod quota left in the water for another year may be "worth" 1,050 pounds the next year if gains due to growth and recruitment exceed losses due to natural mortality and fishing mortality. Rollovers with an interest rate, although theoretically sound, have not yet been tested in a fishery, and may be more suitable for incorporation in a pilot project to test their effectiveness.

1.1.4 Deemed Values

Deemed value is a design option that requires fishermen who land species for which they do not have quota to pay a pre-agreed fee to the government. The fees are set high enough that fishermen are not incentivized to fish for that species, but low enough that they do not encourage illegal discarding.

This design option assumes that fines will prevent a fisherman from profiting off the landings in excess of quota holdings or fish that do not meet regulations (e.g., undersized or oversized fish, should a size measurement be in place), while allowing his/her fishing costs to be covered. As such, fishermen are further incentivized not to illegally discard at sea if faced with such a decision, as the fee would be far less than the fine for illegally discarding. Deemed values have been implemented with success in the New Zealand Quota Management System, though not without a trial and error period to encourage the desired behaviors (See *Catch Share Design Manual, Volume 1: A Guide for Managers and Fishermen;* Snapshot 1.4)

To effectively utilize deemed values, the government will need to carefully track landings to ensure that deemed values are set appropriately and that landings are not exceeding the catch limit. The government may consider setting aside or purchasing some quota to cover the fishery's total catch, or may refund deemed values if participants retroactively purchase quota to cover overages.

Deemed values can be an effective discard management alternative for a fishery that lacks at-sea monitoring systems, as it can provide a baseline incentive to reduce discards. However, deemed values may need to be combined with effective monitoring and reporting systems and fines for violations, to increase incentives to reduce discarding.

SNAPSHOT 1.4 | New Zealand's System for Balancing Catch Against Quota

After implementing the ITQ system in 1986, New Zealand trialed several systems for balancing catch against quota. In 2001, a system was put in place based on annual catch entitlements (ACE). ACE is the annual allocation of quota derived from long-term quota ownership. ACE allocation determines the weight of fish that can be caught during the fishing year. ACE is generated in accordance with the quota holdings as a proportion of the catch limit. ACE does not need to be purchased before fishing occurs. At the end of the fishing year, if the catch of a fish stock exceeds ACE for that stock, and there is no available quota to lease, then a higher annual deemed value must be paid for the excess.

However, when first implemented in 2001, the initial deemed values were set too low for some fish stocks. Some fishermen responded by not purchasing ACE, but instead landed catch for a profit by paying deemed values that were below the price of ACE. This led to the total catch of some fish stocks being well in excess of the catch limits. Afterwards, deemed values were set in ways that encouraged the desired behavior, by increasing the deemed values and applying differential rates to all landings over 110% of ACE. The rates increased as the level of catch increased above the ACE so that profit was removed from catching above the ACE. These changes had a significant effect on reducing the amount of catch that exceeded ACE. However, in certain fisheries, the effect on the amount of fish discarded is unknown due to low levels of observer coverage. As well, the use of deemed values provides an incentive to underreport port prices, which are the ever-changing basis for setting deemed values (Mace et al., 2014).

BEST PRACTICES

Deemed Value

- Consider establishing a real-time, transparent system to track landings to ensure prices are set appropriately and fishermen are not exceeding the catch limit.
- Consider applying differential rates to all landings over a certain percentage of individual quota holdings to better ensure fishermen demonstrate the desired behavior.
- Consider reimbursement of the deemed value should a participant retroactively purchase quota to cover the catch overage.

1.1.5 Risk Pools

A risk pool refers to fishermen cooperatively pooling their species quotas, which allows pool members to access quota without requiring the purchase of quota on the market. Risk pools are generally designed to accommodate quota for constraining stocks or to achieve other fishery goals. Often these pools operate by individual fishermen paying to be active members, agreeing to contribute quota and to meet the risk pool's bylaws. Payment for inclusion may be in the form of money, quota or a combination of both, and generally at the discretion of members. These arrangements are also known as quota pools.

Oftentimes, joining a risk pool requires members to adhere to additional discard avoidance measures (e.g., voluntary closures, gear switching, etc.) determined by the group. These options provide a "safety net" for fishermen while providing an incentive for them to be innovative in their efforts to avoid constraining stocks and other unwanted catch. Sometimes these measures are reactive, and only implemented should a constraining stock be encountered, such as in closed areas or during seasonal closures.

Risk pools (and sometimes quota banks) essentially act as an insurance policy for fishermen, allowing them access to constraining stock quota without requiring the purchase of quota when the demand and, therefore, the cost is high. This design option can be employed by a fishery cooperative or PO on behalf of all its members for whom it manages quota, or by groups of fishermen operating under systems that allocate a secure portion of the catch limit to fishery participants, such as in an ITQ or group-allocated catch share. The collaborative and cooperative nature of these management arrangements increases the sharing of information and technology about how to best avoid unwanted catch.

Risk pools are a voluntary component of the United States Pacific Coast Groundfish Limited Entry Trawl IFQ Program. When the program was established, fishermen were faced with early closures due to the low availability of quota for constraining stocks and gear restrictions that created fishing effort constraints (see Snapshot 1.5).

In the EU context, the Danish Pool system in the Danish Pelagic and Demersal ITQ Program covers all quota-managed pelagic and demersal species. The pool system allows fishermen to match catch against quota retrospectively. The program requires them to purchase quota for any overages for which quota is available before they discard (under the "old" CFP). Under the new CFP, the pool system will require amendment to account for the landing obligation.

SNAPSHOT 1.5 | United States Pacific Coast Groundfish Limited Entry Trawl Individual Fishing Quota Program – Use of Risk Pools to Manage Constraining Stocks

PHOTO: COREY ARNOLD

In 2011, the U.S. Pacific Coast Groundfish Trawl Fishery transitioned to an IFQ program to improve the biological and economic performance of the fishery. At the beginning of the program, seven species were determined to be significantly overfished, resulting in establishment of very low catch limits which restrict access to healthier target species. These species became known as "constraining stocks" (See Snapshot 1.2). Additionally, several other species, such as halibut and sablefish, were considered to be constraining fishermen's operations. Before the IFQ program, these overfished species were considered bycatch and were required to be discarded. As part of the IFQ program, scientifically-based quotas for overfished species were distributed to fishermen, allowing them to land the species, provided they have enough quota to cover the catch.

The multi-species groundfish fishery predominantly uses trawl gear. It is challenging for fishermen to avoid bycatch species as a single tow could cause a fisherman to overfish his individual quota for the constraining stock. This scenario posed a threat to many fishermen, as the average allocation for one constraining stock was just over three kilograms (i.e., seven pounds). As a result, the fishermen would have to find other fishermen willing to sell their limited annual quota for that species in order to continue fishing. The limited availability of quota could make it difficult to obtain additional quota, as it could potentially be very expensive (Holland and Jannot, 2012).

To address overage concerns and to minimize this risk of their season ending early, some fishermen formed a "risk pool" by pooling their individual quota for overfished species, allowing risk pool members access to a larger pool of bycatch quota. Members contribute their quota to the risk pool so that it can be accessed collectively in exchange for compliance with rules established by the risk pool members. The risk pool is premised on the idea of insurance, as it provides a "safety net" for fishermen where the collective helps support individuals against potential disasters. The compliance requirements create an incentive for the fishermen to be innovative in avoiding constraining stock.

Discard rates in the United States Pacific Coast Groundfish Limited Entry Trawl IFQ program dramatically decreased after the first year under the secure fishing rights program. These reductions ranged between 10% and 97% of the prior season's discard levels, depending on the species (NOAA, 2012). Since it is the economic interest of fishermen to reduce the catch of unwanted catch, they are also experimenting with gear modifications, switching from trawls to more selective gears and other behavioral changes.

1.1.6 Quota Banks

A quota bank is a collection of quota in which certain rules and stipulations govern the use of privileges and distribution of benefits in order to meet a set of stated fishery goals. In other words, quota banks own quota and lease it to eligible fishery participants that are aligned with the bank's objectives.

This design option can be used when fishery participants are operating under systems that allocate a secure portion of the catch limit, such as in an individually-allocated or group-allocated catch share. Quota banks in the U.S. have largely been established as a not for profit entity, 501(c)(3), by stakeholders such as a community group, a group of fishermen and in some cases an environmental non-profit (CCFT, 2015). However there are other business model options for setting up and operating quota banks that can be tailored to the specific context of the fishery and the stakeholders' goals.

Quota banks look to lease quota to vessels in a way that entices them to meet the quota bank's objectives. In the U.S. context, quota banks are frequently established to attain certain social objectives such as retaining historical fleet structure, anchoring quota to a community, making quota available for existing fishermen to balance catch against quota and supporting new entrants (MBCQB, 2011; CCFT, 2015). However, quota banks can also be used as a tool to manage for discard reduction. For example, if a quota bank's goal is to reduce discards, similar to a risk pool, the quota bank may require leasees to adhere to additional discard avoidance measures (e.g., voluntary closures, gear switching, etc.) determined by the bank in exchange for leasing quota. Sometimes these measures are reactive, and only implemented if constraining stocks are encountered.

1.1.7 Buffer Quotas

Buffer quotas are portions of a fishery's, individual's or community's quota that are set aside from the total quota to be released when deemed necessary. Access to this quota can be granted (either sold or leased) as an incentive for fishermen who demonstrate compliance with best practice fishing behaviors for reducing discards. These best practices could include participation in voluntary spatial/temporal closures, gear switching, implementation of electronic monitoring with closed-circuit cameras, etc.

Buffer quotas are similar to risk pools and quota banks. The main difference is that buffer quotas are implemented

SNAPSHOT 1.6 | The Gulf of Mexico Reef Fish Quota Bank

The Gulf of Mexico Reef Fish Quota Bank was launched in February 2015 by the Gulf of Mexico Reef Fish Shareholders' Alliance. Designed by fishermen, this quota bank pools red snapper quota from fishermen in the IFQ program to be leased to Florida-based grouper fishermen, allowing for the grouper fishery to have a reduced impact on the red snapper population. The Quota Bank provides grouper fishermen the ability to access red snapper quota so that the catch is landed instead of discarded at sea, which frequently happens when fishermen do not have red snapper quota to cover their catch. In exchange, the grouper fishermen have agreed to operate under a higher standard of accountability, including reporting catch and effort information electronically within 24 hours, operating within outlined best business practices and practicing avoidance measures. In the inaugural year, the Quota Bank looks to pool and distribute 30,000 pounds of red snapper to six to 10 eligible Floridian grouper fishermen (Cochrane, 2015). The Gulf of Mexico Reef Fish Quota Bank is an innovative fishermen-led concept that looks to begin addressing the issue of red snapper discards in other Gulf of Mexico fisheries.

at the government level rather than as a voluntary, market-driven collective action. To further incentivize best practices, fishery managers could grant buffer quota to eligible fishermen after the fishing season has closed. This incentive would allow only those fishermen who have implemented best practices to continue fishing, while others would be unable to do so.

Buffer quotas can be established with or without a secure fishing rights program in place. However, should they be implemented without secure allocation to individual fishermen, vessels or cooperatives, there will need to be clear mechanisms in place to prevent a "race for fish", which can in turn diminish the economic benefits through shortened fishing seasons or surplus supply that reduces market prices for catch.

1.2 INFRASTRUCTURE FOR QUOTA TOOLS

Quota Registry

A significant barrier to efficient operation of quota tools is the need for transparency of quota holdings and usage. Fisheries that lack mechanisms to register quota holders, or the amount of quota that is distributed to holders, will struggle with effective and efficient operation of the overall secure fishing rights program. This can impact the ability for transferability to occur in the fishery.

To address this challenge, there needs to be a transparent mechanism for documenting quota holders and quota holdings. Often this role has been fulfilled by the government and can be in the form of a public quota registry. For example, a quota registry has been used in Scotland for the Fixed Quota Allocation (FQA) program and includes information regarding fishing vessel license and entitlement holders who hold FQA units (DEFRA, 2014). These data are now available in real-time, allowing for readily accessible, up-to-date information for fishery participants (DEFRA, 2014).

Quota-trading Platform

A transparent quota-trading platform is highly recommended. Trading platforms can provide fishermen and fishery managers with a range of information, including real-time data regarding quota landed, quota available for purchase or lease and analysis of market prices and trends. The platform can also help fishermen and fishery managers manage quota holdings and can mediate trades between fishermen and groups, such as communities and fishing cooperatives.

Typically a web-based program, quota-trading platforms allow operators to efficiently transfer quota to buyers and lessees to cover catches before or after vessels leave port—depending on the regulations. Quota-trading platforms provide the fishing industry flexibility in developing business plans and tailoring their fishing operations accordingly. With better information and quota trading markets, there are more opportunities for the fishery to operate with economic optimization.

Quota-trading platforms can be established and managed by a range of stakeholders, including the government, POs, fishery cooperatives or a third party provider. There are successful examples of quota-trading platforms that have been implemented in a variety of ways, ranging in sophistication from informal websites that connect individual fishermen, to highly functional and innovative platforms.

One example of an innovative quota-trading platform managed by a third party provider is Integrated Quota Management Inc. (IQMI), which services the fishermen in Canada's British Columbia Integrated Groundfish Program. IQMI provides real-time listings of quota available for trades—both permanent and leasing—and includes support for quota management.

TABLE 3 | EXAMPLES OF STAKEHOLDER GROUPS THAT HAVE IMPLEMENTED AND MANAGED A SECURE FISHING RIGHTS QUOTA-TRADING PLATFORM

STAKEHOLDER	EXAMPLE
FISHERY MANAGERS	Trading between harvesting cooperatives (inter-cooperative trading) in the United States Crab Rationalization Program is overseen by fishery managers. More specifically, the Restricted Assess Management (RAM) division of the National Marine Fisheries Service (NMFS) is responsible for approving, managing and tracking trades conducted between the cooperatives.
FISHERY COOPERATIVES / PRODUCER ORGANIZATIONS	The United States Crab Rationalization Program uses internal cooperative management systems to track and manage trading between members of a single harvest cooperative (intra-cooperative trades).
A GROUP OF FISHERMEN	Informal, independent websites established by individual fishermen in the United States Gulf of Mexico Commercial Grouper and Tilefish Individual Fishing Quota Program and the United States Gulf of Mexico Commercial Red Snapper Individual Fishing Quota Program.
THIRD PARTY PROVIDER	The complexity of trading requirements in the Integrated Groundfish Program in British Columbia resulted in the development of privately-operated third party providers. These providers help facilitate trades by connecting willing sellers and buyers in the market.

2 Catch Selectivity and Avoidance Tools

Catch selectivity and avoidance tools provide fishermen with the ability to target and capture fish by size and species during harvesting operations, allowing bycatch of juvenile fish and non-target species to escape unharmed.

These tools can also be employed in fisheries managed by an area-based (TURF) secure fishing rights program, in addition to quota-based systems. The tools focus on a change in the day-to-day, on-the-water operations of the fishing industry to improve utilization of target stocks. They are also the main tools available to address issues related to undersized catch.

It is important to note that these tools are not exclusive to secure fishing rights programs, as they can also be implemented under conventional fishery management approaches. Some fisheries have shown that the best way to incentivize implementation of catch selectivity and avoidance tools is to implement a secure fishing rights program and allow fishermen to decide which tools best match their individual operations and the fishery's goals. This section discusses the use of these tools in a variety of contexts.

Catch selectivity and avoidance tools have been implemented in fisheries around the world with significant successes (Haflinger and Gruver, 2009; WWF Scotland, 2009; WWF, 2014). The success of the tools often depends upon the level of collaboration between fishermen, their willingness to share information and the ability of fishery managers to align incentives that lead to the desired behaviors and techniques.

TABLE 4 | CATCH SELECTIVITY AND AVOIDANCE TOOLS DISCUSSED IN THIS GUIDE

TOOL	DEFINITION
ADJUSTING FISHING BEHAVIORS AND TECHNIQUES	Fishing behaviors and techniques that can reduce the occurrence of discards, including fishing at different depths, gear switching, temporal changes and test tows.
REAL-TIME SPATIAL AND TEMPORAL CLOSURES WITH INFORMATION SHARING	Ad-hoc tools for avoiding areas with high juvenile catch rates or "hot spots" of a specific species aggregation by temporarily implementing a voluntary or mandatory closure.
EMERGING TECHNOLOGIES TO IMPROVE CATCH SELECTIVITY	Technological advancements in fishing gear that help improve catch selectivity.

SNAPSHOT 2.1 | Addressing Technical Measures Under the New CFP

In most circumstances, the use of input controls alone does not provide the flexibility needed for fleets to effectively reduce discarding. Technical measures, such as a minimum landing size, have impeded or even prohibited fleets from reducing discards. These types of measures have promoted regulatory discarding of certain sizes of fish and caused economic inefficiencies for fleets. Technical measures have also created incentives for fishermen to undermine or evade regulations, rather than incentivize fishermen-led innovations for discard avoidance.

Under the CFP, all fishery stakeholders need to develop new ways of ensuring compliance with the landing obligation. One option is to specify high-level output goals and allow the fishing industry to develop innovative technical avoidance tools (e.g., fishing gear) and fishing practices to meet those goals. Minimum standards should be developed at the appropriate level (e.g., regional or gear type), taking into account the characteristics of the fisheries and the relevant fleets. Accountability at the individual fisherman/vessel level to demonstrate adherence to the standards and practices should be a critical prerequisite, in return for flexibility in finding innovative, technical tools to meet the landing obligation.

Scaling back technical measures and allowing stakeholders to identify and implement appropriate tools and standards will assist in the development of resilient and flexible systems. The technical measures should be drafted in ways that create positive incentives and rewards for achieving the landing obligation and other CFP goals. Current technical measures that may need revaluation under the new CFP include:

- ***Days at sea*** – The days at sea measure constrains the amount of time a vessel is allowed to harvest. This time constraint often limits the amount and diversity of fishing grounds a vessel can access. In some cases, the only option is to harvest in nearby areas with undesirable conditions, such as high catch rates of juveniles and/or constraining stocks. When this constraint is removed, vessels have more options for choosing fishing grounds, providing time to fish in low-risk areas under more optimal conditions.
- ***Gear flexibility and mesh size restrictions*** – Some gear types are inherently more selective than others in the type and size of fish caught, which can affect the rates of bycatch and discards. However, in some fisheries, the types of gear used are regulated. Under the new CFP, there is more flexibility in the gear types used, which allows fishermen to fish more selectively. The new CFP also promotes the use of innovative gear designs for finding new ways to catch target species and avoid unwanted catch. For example, the United States Pacific Coast Groundfish Limited Entry Trawl Individual Fishing Quota Program allows fishermen to switch from trawl to longline or pot gear types in order to fish their individual quota and reduce bycatch (NOAA, 2012).

Through the flexibility provided under the new CFP, there are opportunities for EU fisheries to recover and transform the fishing industry so that it has greater flexibility and more control over fishing practices.

2.1 ADJUSTING FISHING BEHAVIOR AND TECHNIQUES

Fishermen around the world have demonstrated that simple adjustments to fishing behaviors can lead to significant reductions in discards. The adjustments outlined below may have minimal upfront costs and time requirements compared to adjusting to certain regulatory requirements. Further, when combined with a secure fishing rights program, fishermen have an opportunity to innovate to improve catch selectivity by ending the "race for fish" and cooperating to increase the economic returns from their fisheries.

- *Fishing at different depths* – Adjusting the depth at which gear is set may have a significant impact on catch composition. This was found to be especially applicable for pelagic longline fleets in Hawaii, which have reduced discards of endangered turtles, sharks, and non-commercial finfish species, by setting longline hooks deeper than 100 meters (Beverly and Robinson, 2004; SPC, 2005). This depth was sufficient to capture the target species (tuna, swordfish, and marlin), while avoiding unwanted catch found at shallower depths (SPC, 2005).
- *Switching gear types* – Some fishermen decide to switch to more selective gear types when faced with bycatch or discard constraints. This switch is also often made as a fishery transitions to a secure fishing rights program. The gear type used might be inferior once the "race for fish" is over and fishermen have more options regarding fishing areas and preferred times to fish. The ability to switch gear type may require an amendment to technical regulations.
- *Temporal changes* – Similar to gear type switching, some fishermen may decide to adjust the time of day and/or season for fishing to avoid or reduce discards. This is largely due to species' biological characteristics (e.g., there is a seasonal trend when undersized juveniles are more prevalent) and behavior characteristics (e.g., species practice vertical migration, making them less prevalent in certain depths during specific times of day or season).
- *Test tows* – Test tows are short, brief tows to determine the relative species composition of the area. If the brief tows establish that there is low presence of constraining stocks, or other species to avoid, then fishermen might decide to make a standard, longer tow. If the test tow results in a catch composition high in bycatch species, fishermen might move to a new area to resume tows. Test tows allow fishermen to determine if the area is appropriate for harvesting before committing to a full tow and the subsequent quota usage and prospect of bycatch. It is important that any catch made during a test tow is accounted for.

2.2 REAL-TIME SPATIAL AND TEMPORAL CLOSURES WITH INFORMATION SHARING

Fishermen sometimes do not favor fishing closures, which limit their freedom to fish when and where they choose, and, in some cases, prohibit fishing altogether. However, there are a number of fisheries where fishermen have embraced and sometimes instituted their own closures due to the associated benefits (Makino, 2011; PWCC, 2013).

For discard avoidance, voluntary, short-term closures, identified through information sharing within the fleet, can be essential to avoiding areas with high juvenile catch rates or "hotspots" for constraining stocks. These voluntary closures do not require a secure fishing rights program to be implemented. The sharing of sensitive information between fishing participants requires a certain level of trust and/or a third party data collector for successful implementation. Due to the secure allocation of quota in a secure fishing rights program, fishermen are often willing to share information to avoid quota overages and the catch of constraining stocks (Sylvia et al., 2008; NOAA, 2012; PWCC, 2013).

An example of voluntary "hotspot" closures is the United States Bering Sea Pollock Conservation Cooperative American Fisheries Act Program. In this program, the fishermen report real-time catch information to a third party data collector for analysis. Based upon this shared information, should a bycatch rate reach a designated level, a voluntary closure will be declared for all vessels in the specified area for a limited amount of time. This innovative feature has been credited with bycatch reductions across the fleet.

SNAPSHOT 2.2 | United States Pacific Whiting Conservation Cooperative Program – Designing with the Goal to Reduce Bycatch

The United States Pacific Whiting Conservation Cooperative (PWCC) Program is an industry-led secure fishing rights program in the catcher/processor sector of the whiting (*Merluccius productus*) fishery. Established in 1997 by three seafood companies owning 10 vessels, the Cooperative was formed with the goal to end the race for fish while reducing discards and improving the economic efficiency of the fleet (PWCC, 2013). To reach these goals, the Cooperative negotiated secure allocations of the total catcher/processor sector's quota to each of the individual company members. As all of the vessels in the sector joined the Cooperative, this was a completely self-established secure fishing rights program led by the industry. Through these allocations, the Cooperative effectively ended the race for fish, as each company and its vessels became fully accountable to their allocated portion of the total catch level.

Information sharing and collaboration became essential to ensure full accountability and reduction of bycatch. Operating under a secure fishing rights program provided the opportunity for the fleet to be selective in its fishing grounds and to only target areas and whiting schools with lower concentrations of bycatch (PWCC, 2013). In the past, such flexibility would not have been allowed when vessels were operating under competitive conditions with a constant threat of early closure due to quota exhaustion.

Today, real-time catch data is shared with a third party data collector, Sea State Inc., to determine if areas have high amounts of bycatch species (Sylvia et al., 2008; PWCC, 2013). If Sea State Inc. reports that an area has significant concentrations of unwanted catch, the area is temporarily closed to fishing. A series of temporary closures is referred to as "rolling hotspots" (Sylvia et al., 2008).

Finally, all catches are monitored through 100% observer coverage. Changes in fishing methods and behaviors, combined with a strong reporting system, allowed the Cooperative to successfully reduce catches of unwanted catch. The Cooperative reports that in most years, bycatch and discards are less than one percent of the total Cooperative's whiting catch (PWCC, 2013). For some individual species, such as the yellowtail rockfish *(Sebastes flavidus)*, percentage reductions have been even greater.

Bycatch and discard reduction are not the only improvements made by the PWCC. The Cooperative annually funds efforts for the improvement of the fishery's science and bycatch avoidance programs (PWCC, 2013). The PWCC is an example of a fishery whose industry self-led reform resulted in the removal of fishing behavior constraints that had inadvertently promoted discarding.

2.3 EMERGING TECHNOLOGIES TO IMPROVE SELECTIVITY

Emerging technologies have the prospect of dramatically reducing and, in some circumstances, eliminating discards by improving the selectivity of fishing gear, which might also lead to altering fishing behaviors. These technologies range from physical tools, such as excluder devices, to data collection systems that calculate locations to avoid unwanted catch, while also improving the efficiency and effectiveness in catching target species.

The Smart Gear Competition is an annual international competition that utilizes fishermen's extensive knowledge to create innovative gear modifications for the reduction of unwanted catch. Launched by a collaboration of scientists, fishermen, industry leaders and the World Wildlife Fund (WWF), this initiative has seen much success. Some of the past winners have already implemented their winning technologies in EU fisheries subject to the landing obligation. Some of the gear technologies are in the process of becoming mandatory for implementation in select EU fisheries. For example, a gear technology called the Eliminator reduces the capture of sharks, cod and skates in haddock trawl fisheries and has been suggested as mandatory for EU trawl vessels fishing in Norwegian waters (WWF, 2014). Another innovation is the Flexigrid, which improves selectivity of trawl nets and is now required in European whiting fisheries (WWF, 2014).

Web-based portals play an increased role in improving catch selectivity by predicting areas with high concentrations of undersized and unwanted catch. These technologies collect fishery-dependent data from fishermen, and historic observations of high concentrations

SNAPSHOT 2.3 | Scotland Conservation Credit Scheme

Established in 2008, the Scotland Conservation Credit Scheme is an effort-based program which was implemented with the goal of reducing cod discards in the North Sea. A steering committee comprised of fishery managers, fishing industry, non-governmental organizations and scientists advised the government in management of the program. The program is voluntary and incentivizes fishermen to adopt conservation-minded behaviors in exchange for additional days at sea under the effort-based program (WWF Scotland, 2009). The program focused on two main strategies for discard reductions: (1) changing fishing behaviors to minimize, unwanted catch, and (2) reducing the amount of fishing effort (WWF Scotland, 2009).

Design options employed in the Scheme were real-time rolling closures, and seasonal and permanent closure, of specified areas to avoid cod-spawning aggregations and areas of high cod density. Gear modifications, including cod excluder devices for the nephrops—a small lobster species, also called a Norwegian Lobster—and limitations on a single net per vessel were also enforced. Finally, a high-grade ban was placed on the fleet, which prevented vessels from discarding small but marketable fish to make room for larger and more valuable fish (WWF Scotland, 2009). To ensure fishermen complied with these changes at sea, the fleet was monitored through at-sea observers and closed circuit television (CCTV) monitoring systems. Based on these collective efforts, and the level of reduction in cod discards, the Scheme has been viewed as a success (WWF Scotland, 2009).

SNAPSHOT 2.4 | Challenges for Swedish Innovation

In Sweden, gear developers have been experimenting with a range of gear modifications, such as using different panels, mesh shapes and sizes to help reduce discards. While these are the types of innovations needed to meet the requirements of the new CFP and landing obligation, Swedish prawn fishermen have been hampered by an inability to scale up their efforts due to the current framework for technical measures around minimum and maximum trawl mesh sizes, as well as shapes and lengths. Additionally, the time-consuming efforts to secure necessary exemptions to test new gears have stifled innovations, and the opportunity to scale up successful projects is threatened.

Under the new CFP, however, there are opportunities for both the Swedish fishermen and other innovators in similar scenarios around EU fisheries. Pilot projects provide a new opportunity for testing these fishermen-led innovations, and the European Maritime and Fisheries Fund should be accessed to aid fishermen in their transition towards sustainable fisheries and reduced discarding. Through these advancements, Swedish fishermen will have the opportunity to employ these new design efforts to meet the landing obligation.

of undersized and unwanted catch, and combine with fishery-independent data to predict the hotspot locations (NOAA, 2013). This technology is currently used by participants in the Pacific Whiting Conservation Cooperative program through a third party data collector, Sea State Inc. (PWCC, 2013). Current pilot projects in the Redfish Trawl Fishery in the Gulf of Maine, called the REDNET network, are working to improve discard rates with this information sharing technology (NOAA, 2013).

Existing technologies have also been repurposed to help predict a species' presence in an identified area. For example, a temperature/depth probe, a common

SNAPSHOT 2.5 | New Zealand's Precision Seafood Harvesting Technology

The New Zealand government and three of the largest fishing companies have jointly invested in development of a innovative trawl gear design. The joint venture, titled Precision Seafood Harvesting, is in the commercialization phase of a trawl net made of a flexible PVC liner that allows vessels to target specific species and fish size and greatly increase protection of small fish that can swim free through 'escape portals'.

The goal in developing this design is to have every fish landed alive, while allowing small fish and bycatch species to be released alive underwater before the net is lifted onboard (PSH, 2014). Once onboard, the fish are still swimming inside the PVC liner, which means they are fresher for consumers and higher-value products for the fishing companies. The level of catch selectivity in the design is intended to ensure unwanted catch is discharged as fast as possible at depth, but if brought onboard they could be returned to the sea unharmed, thus eliminating wasteful discarding.

tool in oceanography, is now used on fishing vessels to measure the bottom temperature of the ocean. Using this information, fishermen have improved their ability to predict the type of species that will be present and possibly caught during a trawling tow (NOAA, 2013).

These are just a few emerging technology examples that help to reduce or potentially eliminate discarding. There are many other technologies in development and being tested through pilot projects in a variety of fisheries (WWF Scotland, 2009; NOAA, 2013).

2.4 INCENTIVES FOR IMPLEMENTING EFFICIENCY AND AVOIDANCE TECHNIQUES

The use of avoidance technologies is often hampered by the need for initial capital to cover upfront costs. The existence of avoidance technologies does not necessarily lead to adoption by fleets, as many fleets may face barriers to implementation. Barriers vary between fisheries and vessel categories, but often include hesitation to purchase these technologies due to upfront costs, or concerns regarding information sharing between vessels, particularly when it is an unfamiliar practice.

A key to fleet adoption of new technologies is creating incentives for fleet participation and giving rewards to participants who adopt more sustainable fishing practices. A well-designed secure fishing rights program can provide a strong incentive to avoid bycatch and adopt new technologies, as demonstrated by the Pacific Whiting Conservation Cooperative and United States Bering Sea and Aleutian Islands Non-Pollock (Amendment 80) Cooperative Program. More specific incentives can come in the form of quota set-asides or allocation preferences, which are becoming common in secure fishing rights programs.

However, there are other forms of incentives, such as tax incentives and monetary incentives. For example, the European Maritime and Fisheries Fund (EMFF), the funding entity for the CFP, has allowed for subsidies to the fleet to meet the new CFP requirements, including the landing obligation. Specifically, the EMFF provides resources to support the transition to sustainable fishing, including projects that create jobs and mechanisms that will improve access for financing (Priddle, 2013).

3 Administrative Systems

The introduction of effective monitoring, reporting and enforcement systems is essential for incentivizing fishermen compliance and accountability to fishery regulations. Often this requires fleets to provide detailed and accurate documentation of all fishing trips to ensure all catch is recorded and landed according to regulatory requirements. Reporting and monitoring systems should have the design flexibility to best meet fleet needs and fishery characteristics, while meeting all regulatory requirements.

Implementing reporting and monitoring systems includes addressing sensitive issues, such as personal privacy and private data concerns, which typically benefit from stakeholder engagement in the design of the system. While challenging, often the benefits of full documentation of catch far outweigh the challenges. Some of these benefits include:

- Increased operational flexibility, including when, where, what and how to fish;
- Improvement in fishermen's reputations, as it will be possible to demonstrate they are reducing discards and complying with other marine environmental regulations;
- Increased amounts and types of data collected, which leads to improvements in accuracy of stock assessments and trust in the data from fishermen; and
- More opportunities for collaboration among fishermen, fishery managers, scientists and other relevant stakeholders, such as environmental groups.

Monitoring and full accountability of quota holdings can provide opportunities for flexibility, innovation and improved economic performance while at the same time enabling the fishing industry to meet important environmental targets.

This section examines the options for designing reporting and monitoring systems, including general information regarding the monitoring tools and methods available to fisheries and the pros and cons of each. The section focuses on reporting and monitoring systems used to document aspects of at-sea fishing including discarding, compliance with area-based regulations, application and effectiveness of bycatch mitigation techniques and catch composition. The Fisheries Monitoring Roadmap provides a deeper evaluation of these tools, and guidance to match tools with management goals (see Section 6.2).

3.1 REPORTING AND MONITORING TOOLS

Reporting and monitoring tools discussed in this section include: (1) electronic logbooks and fish tickets, (2) at-sea observers, (3) electronic monitoring systems and (4) reference fleets. While there are other options for reporting and monitoring systems that can be used in fisheries, when discards are a concern, tools that provide accountability at the individual vessel level are preferable in order to promote accountability. Information about other reporting and monitoring tools that do not directly account for at-sea discarding (e.g., hail program, dockside monitoring, dealer

reports) but that may strengthen the overall reporting and monitoring system when combined with the tools listed here can be found in Appendix A of the *Catch Share Design Manual.*

Pilot projects can be introduced to encourage sub-sectors of a fishery (such as vessels sharing a gear type or a landing site) to experiment with monitoring systems and performance measures when the entire fishery may not be prepared to do so. In this way, fishery innovators can lay the groundwork for widespread application of the systems.

3.1.1 Electronic Logbooks, At-sea Weights and Fish Tickets

Electronic logbooks—also called self-reporting—and fish tickets are software systems that record information related to the vessel's catch, to be later uploaded to an online platform (Lowman et al., 2013). Traditionally, this information has been in paper format and submitted when the vessel docks at port; however, fisheries are increasingly evolving from paper reporting and transitioning to electronic monitoring (Lowman et al., 2013).

Electronic logbooks record information regarding location of catch, species composition, weight, gear type and other pertinent trip information (Lowman et al., 2013). Fish tickets provide information regarding the landing and purchase of fish by a buyer (Lowman et al., 2013). These systems can be accompanied by at-sea weight technologies to improve accuracy of reporting. Often these forms of self-reporting are the method preferred by fishermen (Mangi et al., 2013).

- *Pros* – These systems offer the ability for product traceability and detailed recordkeeping for both fishery managers and the fishing industry. Self-reporting is also believed to contribute to building trust between fishermen and the scientific community (Mangi et al., 2013). Additionally, electronic logbooks allow for real-time data collection.
- *Cons* – When used on their own, these systems are heavily dependent upon the willingness and ability of fishermen to accurately record catch composition during fishing operations. Consequently, these systems have significant limitations with respect to verifying the accuracy of submitted information. There have been significant issues with self-reporting in a handful of fisheries, including misidentification of species, underreporting of catch and underreporting of bycatch and discards.

3.1.2 At-sea Observers

At-sea observers are government or third party representatives who accompany a vessel during fishing trips. The observers are responsible for watching the practices of the vessel and its crew, collecting catch data and reporting any observed infractions during the trip.

- *Pros* – At-sea observers are able to determine first-hand whether or not discarding occurs. In addition, at-sea observers have the ability to collect fishery data that are both reliable and independent for scientific data collection. Often observers are credited with collecting the most detailed biological information for fisheries compared to other monitoring methods (Mangi et al., 2013).
- *Cons* – Smaller vessels often do not have room to accommodate an additional person during a fishing trip. There are also financial considerations, as the cost of at-sea observers is often borne by the vessel operator. Costs can be considerably higher if the vessel must be retrofitted to accommodate observers. Other considerations include crews altering their behavior in the presence of an observer. Unless at-sea observers are present for 100% of fishing trips, this may bias the information generated by the system. Finally, arranging observers will be much more logistically challenging if vessels are departing from ports across the coastline or from isolated or remote ports, compared to a fishery where vessels are concentrated in a small number of proximal ports (Mangi et al., 2013).

PHOTO: ERIK LINDEBO

SNAPSHOT 3.1 | The Danish Fisheries Traceability System

The Danish Fisheries Traceability System (Sporbarhed i fiskerindustrien, or SIF) was established to address the issue of traceability of fish products. The SIF system allows for the tracking of fish from the harvesting vessel to docks, fish buyers, processors and retailers, and finally to consumers (Helledie and Tørring, 2013). The SIF system is based on the use of a program similar to an electronic logbook, in which fishermen upload catch data and a record is then created and updated at every point of transaction until purchased by the consumer (Helledie and Tørring, 2013) The technological advancements employed in the SIF system are not only an example of successful traceability, but also provide options for monitoring systems to track landings and real-time data collection that can inform quota transfers between fishing participants.

While the SIF system is an option for reporting, it does not address monitoring of fishing behaviors, which might allow for omission of data regarding discards at sea. The SIF system is currently being used to explore the addition of CCTV cameras that could address underreporting of discards by creating a robust monitoring system that can provide for both ease of quota transferability and full documentation (Helledie and Tørring, 2013).

3.1.3 Electronic Monitoring (EM) Systems

Electronic monitoring (EM) systems, also called remote electronic monitoring (REM), are comprised of one or more CCTV cameras (i.e., sensors that monitor use of fishing gear); Global Positioning Systems (GPS)—also called Vessel Monitoring Systems (VMS)—to locate the vessel's direction and speed through the water; and a data center to collect, manage and store data (Lowman et al., 2013). Reported catch and video are reviewed at a shore-based data center to ensure compliance. To lower costs, a random subset of EM data can be used to audit self-reported data, with 100% of the footage audited if discrepancies are detected. (Bonzon et al., 2010). This technique has been implemented in the British Columbia Integrated Groundfish Program, in which the EM video footage is reviewed for 10% of the tows/sets for each vessel (Bonzon et al., 2010).

- *Pros* – Depending on how the EM system is designed, it may provide a cost-effective substitute for at-sea observers while generating comparable quality of data. Key cost drivers include EM data storage, speed of data turnaround time, and type of data collected and analyzed. This system provides data sharing capabilities and data can be available in real-time. Depending on the level of coverage, EM systems have the ability to reconcile fishing industry data with scientific assessments by validating catches at sea. EM systems also provide robust accountability and documentation to ensure compliance with fishery regulations.
- *Cons* – One of the largest barriers to EM system implementation is the expressed unease of crew members at having their actions monitored by onboard cameras (Mangi et al., 2013). Other barriers may be the lack of infrastructure for collecting electronic data, harmonizing EM data with existing datasets, institutional resistance to changing the structure of monitoring systems, and changes to how catch must be handled or what can be discarded. There are rather significant financial implications for the use of EM systems, including the purchase and installation of the equipment combined with annual operational fees. EM systems typically have high one-time costs and relatively low ongoing costs, although there are the additional costs of onshore data storage and analyses. In general, EM systems are lower in cost than at-sea observer monitoring systems (Mangi et al., 2013). EM systems are functionally limited in their ability to collect detailed biological data, such as size, age or sex. When direct measures of catch weight aren't available, it is sometimes necessary to extrapolate catch weight based on volumetric measurements, and some species are not possible to identify from an image alone. However, EM technology is improving rapidly.

3.1.4 Reference Fleets

Reference fleets, also known as study fleets, are identified vessels in a fleet whose fishing behaviors and catch compositions are monitored, typically by an EM system or an at-sea observer, to establish a discard rate. Based upon the reference fleet's catch composition, discard rates are extrapolated across all vessels in the fleets and applied to the discard species quota. This information can also be a basis for the formation of fishery regulations.

- *Pros* – Coupled with one of the above monitoring systems (e.g., at-sea observers and electronic monitoring), reference fleets have the ability to collect fishery data that is both dependable and independent for scientific data collection (i.e., biological sampling) to help bolster scientific assessments.
- *Cons* – Reference fleets do not provide accountability at an individual vessel level. This can be an issue for multiple reasons. First, it can allow an opportunity for non-compliant behaviors, as vessels are not held to a comprehensive, complete and reliable documentation of all catches, including discards. Second, it can be seen as disadvantageous to vessels that fish more efficiently than the reference fleets, and therefore have lower discard rates than those estimated. This can not only disadvantage fishing vessels, but it can also create a disincentive for the reference fleet to improve selectivity through innovation and smart fishing practices. Furthermore, it will require a large number of vessels to establish reference fleets that are adequate, given the variety of vessels, gears and fishing patterns typical of many fisheries.

SNAPSHOT 3.2 | United Kingdom – North Sea and English Channel Discard Pilot Projects

Discard reduction pilot projects have been established for UK fleets in the North Sea and English Channel targeting cod (*Gadus morhua*) and sole (*Solea solea*), respectively. Under these pilot projects the two core goals of full accountability and documentation were incorporated in the project designs in order to support the overarching goal of full catch retention. Fleets were required to deduct all catch from their vessel's allocated quota, regardless of size or marketability (Condie et al., 2013). All participating vessels were also required to use EM systems, specifically CCTV cameras and sensors, to provide documentation that full retention of the catch was followed. As full accountability and documentation became required, other restraints on fishing—such as gear restrictions—were lifted from the fleets, providing freedom to innovate fishing methods and behaviors (Condie et al., 2013).

Twenty-five vessels participated in the Scottish fleet pilot project targeting cod in the North Sea. Participation in the project provided the fleet with an increase of 30% in cod quota, an amount smaller than the estimated annual amount of discards from the fleet, in exchange for the required full accountability and documentation (MSFD, 2011). As a result of the project, significant changes were observed. The fleet made gear modifications and alterations to their typical harvesting behaviors, including harvesting at alternative fishing grounds to avoid large populations of juvenile cod (MSFD, 2011; Condie et al., 2013).

Similar changes in fishing behaviors and methods were seen for the six participating vessels in the English North Sea cod pilot project. The vessels experienced a reduction in discard rates to 6% or less of the catch, as well as reductions in the amount of undersized cod caught (Course et al., 2011). The fleet elected to change to a more selective gear type, in addition to a reduction in fishing effort. This combination allowed the fleet to efficiently manage quota to ensure it did not run out before the end of the year, while substantially decreasing the level of discards (Course et al., 2011).

In addition, the pilot projects demonstrated the effectiveness of EM systems as a substitute for at-sea observers. As the cost of at-sea-observers is generally more than that of EM systems,[3] it was an important advancement to show that documentation is possible with the use of EM systems alone. The pilot projects also identified constraining stocks as a concern, with further consideration and appropriate system design options needed to move forward (MSFD, 2011).

3 Monitoring costs may vary based on location, fishery characteristics and the technology provider. In general, onboard observers are more expensive than EM systems (Mangi et al., 2013). For example, the average cost of an EM system is $146 USD per day, compared to $527 USD for onboard observers in the British Columbia Integrated Groundfish Program (Bonzon et al., 2010).

3.1.5 Considerations for a Reporting and Monitoring System

Similar to the design of a secure fishing rights program, the development of a monitoring system can vary across fisheries (i.e., different sectors use different monitoring techniques). However, there are common considerations in designing a system to monitor, collect and manage data, including:

- *Fishery characteristics* – It will be important to match fishery characteristics with an appropriate monitoring system. Fishery characteristics, such as single versus mixed species catch or small-

scale versus industrial fleets, will have significant implications for the compatibility of different monitoring systems. For example, observers will not be compatible for small boats where space is not available for an extra person onboard. A single monitoring system will not be appropriate for implementation across all fishery contexts.

- *Stakeholder input* – Surveys of fishermen's opinions have shown reluctance in implementing onboard monitoring systems (Mangi et al., 2013). Often fishermen prefer self-reporting, despite their acknowledgment that this system lacks reliability (Mangi et al., 2013). To build credibility and support for systems, it is important to include fishermen and other stakeholders in the design and implementation of a fishery monitoring system.
- *Ownership of data* – Ownership of data will need to be established prior to the implementation of a monitoring system and will vary depending on the monitoring tool employed. Ownership can be held by the government, vessels owners, producer organizations, fishermen and/or fishing communities. This decision may require a legal assessment to fully understand the legal context in which the fishery is operating before a determination of ownership can be made.
- *Sharing of data* – Similar to ownership of data, guidelines for the sharing of data should be established prior to the implementation of a monitoring system. There are many benefits to sharing data, such as more effective avoidance of discards and bycatch (e.g., establishing areas of high juvenile catch and prohibited species catch that should be avoided). Determining these guidelines will be important and can potentially prevent future conflicts between data users.
- *Real-time data availability* – Various fishing industries have expressed concern about the use of dated scientific information that does not reflect the current biological status of the fisheries. In the context of the landing obligation, the use of these data for decision making may lead to unnecessarily low catch limits that create constraining stocks or limits that are too high, causing fleets to unknowingly overfish a stock. Real-time data on important attributes, such as size frequencies and volume of catch, help stock assessments and catch limits to be up to date. For this reason, regardless of which monitoring system is employed, it is strongly suggested that data are made available in real-time, wherever possible.

  Furthermore, if up-to-date spatial data on catch per unit effort (CPUE) and catch composition are made available in real-time, that can allow the industry to make more informed decisions on the water, such as choices regarding fishing grounds and harvesting methods. In some cases this may help businesses improve economic efficiency and understand immediately if they need to transfer or purchase quota to cover their catch if they are accountable to a catch allocation.
- *Incentives* – Aligning incentives will be key for fishermen buy-in when designing and implementing monitoring systems. Similar to incentives for implementation of secure fishing rights programs, incentives for implementing a monitoring system might include access to additional quota (through set-asides), preference in allocation formulas, and lower uncertainty buffers in catch limits.

3.2 ADDITIONAL BENEFITS OF DOCUMENTATION

There is an inherent amount of uncertainty in fisheries management, as human activities and nature can impact habitat and productivity in ways that are not fully understood. Furthermore, market demand and prices can have strong effects on fishing operations for target species. Fishery managers must regularly make decisions based on uncertain information and without a comprehensive understanding of the consequences of those decisions.

Documentation through monitoring and reporting systems ensures fisherman compliance with regulatory requirements, while informing science and allowing for improved decision making. Data collection can lead to improved fisheries science, helping to reduce uncertainty and enabling managers to limit the degree of precaution necessary when setting catch limits. Improved data to inform science and assessments can result in increased allocations over time.

Other direct benefits of improved monitoring have been shown to include increased operational flexibility, decreased costs (NMFS, 2012), and increased traceability, possibly resulting in certification or increased market access (Parkes et al., 2015).

4 Pilot Projects

Pilot projects provide the fishing industry an opportunity to test tools for reducing discards before permanently adopting them. These projects may be used to demonstrate the operation of a secure fishing rights program, new technologies, new systems for data management, changes in fishing regulations, or a combination of these.

Additionally, pilot projects can help build the evidence needed to give fishery managers the confidence to shift away from gear-specific, spatial-based and other input controls that limit the ability to innovate in achieving the overall requirements of fisheries policies.

SNAPSHOT 4.1 | United Kingdom – Project 50%

Beginning in 2009, a pilot project was developed between the Devon Beam Trawler Fleet and UK scientists with the goal of reducing discards of juvenile fish by 50% in the English Channel. Prior to the project, the Devon Beam Trawler Fleet had one of the largest discard rates in the UK fisheries (Armstrong and Revill, 2010).

The collaboration allowed fishermen to identify barriers to reducing discards and begin to address these barriers with support from the government (Armstrong and Revill, 2010). The top-down restrictions on gear type were identified as the most significant barrier to discard reduction. The pilot project provided for the removal of gear specific restrictions and allowed fishermen to individually experiment with gear modifications to improve catch selectivity. This enabled them to innovate based on their knowledge and experience in the fishery (Armstrong and Revill, 2010; Condie et al., 2013). At the end of the project, there were 11 different modifications made to mesh sizes and trawl structure. Through the development of these gear modifications, the pilot project reached a discard reduction of 52%, exceeding the original goal of 50% (Armstrong and Revill, 2010). The project results also showed that fish arrived for market in improved condition. The results also showed increased information sharing between fishermen and the government (Armstrong and Revill, 2010). This pilot was a large success by demonstrating overall improvements not attainable under the previous regulatory controls.

Despite the successful changes made in the trawl fishery, additional changes will be needed under the new CFP to meet the landing obligation. The fishery continues to operate under a conventional fisheries management approach that created other limitations on the fleet's ability to innovate and adopt design options that can assist in meeting the landing obligation.

5 Incentives for Compliance

While this guide focuses on the challenges of discarding, and options for addressing these challenges, the transition to secure fishing rights programs and catch selectivity tools can be designed to provide incentives for compliance. The section below details some additional opportunities and incentives to avoid unwanted catch.

5.1 NEW OPPORTUNITIES FOR UNAVOIDABLE AND UNWANTED CATCH

What might be considered unwanted catch may be redefined under secure fishing rights programs. As discussed, unavoidable and unwanted catch might be more common under regulations for discarding (e.g., not meeting minimum landing size, trip limits or other requirements). Additionally, fishermen might have incentives to discard less marketable fish of legal size for more marketable fish, even under a secure fishing rights program.

However, secure fishing rights programs provide for changes in what constitutes unavoidable and unwanted catch.

First, by obtaining a quota or right to land fish that previously had to be discarded, the fish has some landed value, due to fishermen being legally required to land and sell them. Under a secure fishing rights program, fishermen have the ability to align their quota holdings with their catch by either purchasing quota from others and/or selling surplus quota.

Second, secure fishing rights programs generally increase incentives and collective opportunities to avoid unwanted catch, such as undersized species or species prohibited from harvesting. These opportunities might have arisen when limited days-at-sea, short fishing seasons, or fleet-wide quotas previously encouraged hurried and less careful practices (i.e., the race to fish). In some cases, these constraints have caused vessels to harvest in areas under undesirable conditions, such as where there are known high catch rates of juveniles or constraining stocks.

However, compliance with a landing obligation will not necessarily lead to significant increases in the value of all landed catch, and some fishermen may still have their views on the potential market value of certain species. While a portion of catch might not gain in value due to the lack of available markets, the design options and tools outlined below provide opportunities to alleviate the financial consequences and improve operations when landing what had previously been considered unwanted catch.

5.2 COST COMPENSATION MECHANISMS FOR ILLEGAL SPECIES

To reduce and, in some circumstances, eliminate discards under a secure fishing rights program, all sources of fishing mortality should be documented and counted against each fisherman's quota. In some cases, full retention policies are employed to ensure all catch is brought to shore for accounting, as is the case under the new CFP (See Snapshot A). Under the landing obligation, fleets are required to land all species managed under a catch limit

with minimum conservation reference sizes, and with some concessions regarding end uses (i.e., human and non-human consumption). These concessions are in place to accommodate fish landed with little, if any, economic value, or fish that are illegal to sell for commercial purposes (also called illegal species).[4] These concessions may create financial consequences for fishermen, as unwanted catch will take up hold space on vessels that would otherwise be used to contain marketable catch. The loss of onboard space and additional handling of this catch in turn creates an anticipated incentive for illegal discarding.

To avoid these types of scenarios, cost compensation mechanisms should be considered. Similar to deemed values, cost compensation mechanisms allow fleets to sell and keep a portion of the market value of catch to recoup operating costs. The level of cost compensation should be set such that retaining the catch results in no profit, which would incentivize the fleet to continue harvesting and avoid illegal discarding. This approach can improve compliance with any full retention policies without incurring significant financial consequences. The sale revenue from the catch is split between fishermen and the government (i.e., remaining funds after the fishermen's costs are deducted), whose share can be used to fund management measures, such as data collection, research, monitoring and enforcement.

Norway has implemented a cost compensation mechanism that incentivizes fishermen to land illegal fish to reduce incentives for discarding. This mechanism allows for the illegal fish to be sold with the rest of the catch, compensating fishermen 20% of the catch value from the catch that would have previously been discarded. The remaining 80% of the catch value is passed through one of the six Norwegian fishery sales organizations (Gullestad, 2013).[5] Similar mechanisms could be implemented in EU fisheries and, where relevant, fishery cooperatives or POs could help manage the implementation of the mechanism.

Cost compensation is similar to deemed values, but there are a few key differences. Cost compensation is applicable in any management system, whereas deemed values are only applicable to quota systems. Cost compensation allows the fishermen to sell their catch, but fishermen can only keep enough of the revenue to break even. In contrast, deemed values sets a fee that is challenging to align exactly with the costs of fishing, creating the potential for fishermen to make a profit from selling illegal fish (See Snapshot 1.4).

5.3 VALUE ADDED PROCESSES AND ECO-CERTIFICATIONS

There are several examples of how fishermen have utilized the flexibility that can come with secure fishing rights programs to achieve more efficiency in fishing and increasing market opportunities for fish products, including (Bonzon et al., 2010):

- *Value-added processes* – Economic discards are typically addressed through increased monitoring and reporting, and in some fisheries marketing tools and value-added processes may help reduce discarding and improve the economic viability of the fishery. For example, in the goose barnacle fishery in Spain, economic discards were a significant problem, as fishermen would only retain large goose barnacles while discarding the smaller barnacles. To address this wasteful practice, a group of goose barnacle fishermen established a company, Mar de Silleiro, to diversify available fishery products by creating canned barnacle products and a high-end barnacle pâté made with seaweed that uses the smaller, less valuable goose barnacles (EC, 2011). This solution seeks to reduce high grading and the amount of wasteful discards; participants are already benefiting from increased incomes from the new products (EC, 2011).

4 For this purpose, illegal species (also called prohibited species) refer to species with prohibitions on profiting from their harvest. Illegal species status may be imposed due to sustainability concerns or other fisheries' regulations, or to limit a fleet's participation in adjacent fisheries.

5 Fishery sales organizations are similar to industry unions and fishermen associations. They can be involved in a range of activities, including market purchasing of fish, work condition reform, etc. (Hannesson, 1988).

- *Higher quality of catch* – When the "race for fish" ends, the fishing industry is often in a position to significantly increase the time to fish. Increased fishing time may provide incentives to explore new types of products brought to market (Bonzon et al., 2010). For example, prior to the Alaska Halibut and Sablefish Fixed Gear Individual Quota (IFQ) Program, fishermen had to contend with ongoing reductions in the time available to fish (see Snapshot 1.5). The time constraints meant that they were forced to primarily provide frozen product to the market, as a large supply of fish became available during short openings (e.g., 24 hours). This resulted in a limited amount of time available to process the product, in addition to the overall poor quality of fish landed and processed in large volumes (Bonzon et al., 2010). However, once the secure fishing rights programs were implemented, the fishing season length drastically increased. Fishermen could provide more than just frozen product. Processors began to produce higher quality fresh products, including fillets, to customers, resulting in increased revenue for both fishermen and processors (Bonzon et al., 2010).
- *Better pricing through elimination of gluts in market* – As secure privileges are provided under a secure fishing rights program, the fishing industry is generally provided more opportunities to decide when and where to fish. By eliminating the "race for fish" and regulations that constrain innovation, fishermen have the ability and incentive to time the delivery of catch to markets to maximize their incomes. Fleets are no longer required to bring catch to market during short periods of time, but rather at their discretion. Before secure privileges, the conventional fishery management approach resulted in a glut in the market, or an oversupply of product, that drove down the price. Where gluts can be eliminated, fishermen can capture better prices in the marketplace. Secure fishing rights programs in the U.S. Alaskan halibut and sablefish fishery and Gulf of Mexico commercial red snapper fishery have resulted in price increases for their products, in part due to elimination of the market glut (Bonzon et al., 2010; NMFS, 2011).
- *Eco-certification* – Fisheries operating under well-designed, robust management systems have better opportunities to meet the requirements for eco-certifications, such as the Marine Stewardship Council (MSC). Fisheries products with eco-certification can increase the value and profits for fishermen. Examples of MSC certified fisheries include:
  - Danish Demersal Transferable Fishing Concession, for Haddock, Shrimp, Monkfish
  - Mexican Red Rock Lobster Fishery managed by Baja California Regional Federation of Fishing Cooperative Societies (FEDECOOP)
  - Argentina's Patagonian Grenadier Fishery (Cunningham, 2013; Young, 2013) and Scallop Fishery
  - United States West Coast Groundfish Trawl Fishery
  - British Columbia Groundfish Hook and Line Sablefish Fishery
  - United Kingdom Herring Pelagic Trawl Fishery
- *Direct niche marketing* – Because a secure fishing rights program can provide fishermen with increased time to improve the quality of catch and delivery timeframes, fishermen are able to diversify their fishing products and possibly focus on providing for niche markets. Fishermen in the Gulf of Mexico commercial red snapper fishery have created their own niche branding called *Gulf Wild*. The *Gulf Wild* brand is focused on expanding markets while providing detailed information to their consumers. Innovative technology allows consumers to track their fish purchases from vessel to plate, including the vessel name, captain's biography and the exact time and location the fish was caught (Gulf Wild, 2013). Additionally, community supported fisheries (CSFs) create opportunities for fishermen to sell a wider ranges of species, including some that might otherwise be discarded, through direct relationships and agreements with consumers. This model can promote value-adding, and deliver higher quality of catch by simplifying the supply chain.

6 Resource Center

While this supplemental guide is focused on the incorporation of tools and design options to eliminate discards in fisheries, there are other important resources available that can improve a fishery's overall performance. The resources below provide design advice and examples from fisheries around the world that can help further the understanding of issues regarding discards, as well as provide advice for other types of fisheries management reforms.

6.1 EDF'S FISHERY SOLUTIONS CENTER TOOLKIT

The Fishery Solutions Center has developed the world's most comprehensive collection of research-driven materials on improving fisheries management. Available on the website (http://fisherysolutionscenter.edf.org) is a toolkit of research and planning materials to improve fisheries management, including step-by-step manuals, reports on various fisheries, infographics and interactive learning tools. Some of the key materials include:

6.1.1 Catch Share Design Manuals

Whether you are a fisheries manager, fisherman, practitioner or any other fishery stakeholder, the Catch Share Design Manuals and supplemental guides will help chart a customized path to a more sustainable and profitable fishery. The publications highlight how better fisheries management can address existing challenges and maximize potential benefits. Most importantly, these tools are not prescriptive. Rather, they offer a series of questions whose answers help guide and inform the design of secure fishing rights programs.

- *Catch Share Design Manual, Volume 1: A Guide for Managers and Fishermen (Second Edition)* – The Catch Share Design Manual is the most comprehensive overview of catch share design, drawing on hundreds of fisheries in more than 30 countries and the expertise of more than 60 fisheries experts from around the world. Through a series of questions, it provides a step-by-step roadmap for designing a customized catch share program to meet your fishery's goals.
- *Catch Share Design Manual, Volume 2: Cooperative Catch Shares* – Nobel Laureate Elinor Ostrom popularized the understanding that resource users can and, under the right conditions, will engage in co-management of their resources. The Cooperative Catch Shares volume discusses this notion for fisheries and provides important design guidance for fishery managers and fishermen.
- *Catch Share Design Manual, Volume 3: Territorial Use Rights for Fishing* – TURFs date back thousands of years; numerous studies highlight their effectiveness for managing nearshore fisheries. Recent innovations in TURF design, including approaches for scaling management across a broad area, are expanding their appeal and applicability. The TURF volume builds upon this growing experience, offering clear guidance for customized design.

- *Science-Based Management of Data-Limited Fisheries: A Supplement to the Catch Share Design Manual* – The majority of fisheries worldwide lack sufficient data to conduct industry-standard stock assessments, and a *Science* paper shows these fisheries are at serious risk of being depleted (Costello et al., 2012). Due to this lack of data, more than 10,000 fisheries worldwide have been left out of recent advances in effective management. This guide outlines an approach for science-based management of fisheries, even in the absence of good data.
- *Transferable Effort Shares: A Supplement to the Catch Share Design Manual* – Transferable effort share programs are a type of secure fishing right. While these programs do not provide all the benefits of catch or area-based rights, they are often used when fisheries lack key data and may be a useful stepping stone. Before ruling out a catch or area-based program due to data constraints, see our guide on data-limited fisheries.

6.1.2 Catch Shares in Action Reports

In addition to the available manuals, there are 15 available *Catch Shares in Action Reports* on diverse fisheries from around the world that have tailored fisheries management programs to meet their unique needs. Each report highlights the key decisions made for each of the seven steps in designing the catch share program, as well as the fishery's history and performance.

6.2 FISHERIES MONITORING ROADMAP

The Fisheries Monitoring Roadmap is a tool to help fishery managers and other stakeholders better understand the different capabilities and drawbacks of available monitoring tools; match monitoring tools with clearly identified management and monitoring goals; and ultimately allow for the optimization of fishery reporting and monitoring systems. The Roadmap is especially helpful for fisheries that are considering incorporating electronic monitoring or electronic reporting tools into their reporting and monitoring systems.

References

References

Armstrong, S. and Revill, A. (2010). *Project 50% final report: Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS).*

Agar, J. J., Stephen, J. A., Strelcheck, A. and Diagne, A. (2014). The Gulf of Mexico Red Snapper IFQ Program: The First Five Years. *Marine Resource Economics, 29*(2), 177–198.

Benfey, T. J. (2001). Use of sterile triploid Atlantic salmon (Salmo salar L.) for aquaculture in New Brunswick, Canada. *ICES Journal of Marine Science: Journal du Conseil, 58*(2), 525–529. doi: 10.1006/jmsc.2000.1019

Beverly, S. and Robinson, E. (2004). New deep setting longline techniques for bycatch mitigation. Noumea, New Caledonia: Secretariat of the Pacific Community.

Bonzon, K., McIlwain, K., Strauss, C. K. and Van Leuvan, T. (2010). *Catch Share Design Manual, Volume 1: A Guide for Managers and Fishermen*. Environmental Defense Fund.

Branch, T. (2008). How do individual transferable quotas affect marine ecosystems? *Fish and Fisheries, 10*(1), 39–57.

Cape Cod Fisheries Trust (CCFT) (2015). Banking on your fishing future: How to guide, fund and sustain America's small-boat fishing traditions through the permit bank system. Retrieved from: http://capecodfishermen.org/images/documents/Campaign_Materials/CCFT_Brochure_Web.pdf

Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D. and Pauly, D. (2010). Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. *Global Change Biology, 16*(1).

Cochrane, B. (2015). Letter to Kevin Anson and Dr. Roy Crabtree. 27 Mar. 2015. Retrieved from: http://shareholdersalliance.org/documents/QuotaBankAnnouncement.pdf

Condie, H. M., Grant, A. and Catchpole, T. L. (2013). Incentivizing selective fishing under a policy to ban discards; lessons from European and global fisheries. *Marine Policy*.

Costello, C., Gaines, S. and Lynham, J. (2008). Can catch shares prevent fisheries collapse? *Science,* 321, 1678-1681. Retrieved from http://science.sciencemag.org/content/321/5896/1678.short

Costello, C., Ovando, D., Hilborn, R., Gaines, S. D., Deschenes, O. and Lester, S. E. (2012). Status and Solutions for the World's Unassessed Fisheries. *Science, 26*(338), 517–520.

Course, G., Pasco, G., Revill, A. and Catchpole, T. (2011). The English North Sea catch-quota pilot scheme - Using REM as a verification tool. The Center for Fisheries, Environmental and Aquacultural Sciences (CEFAS).

Crowley, R. W. and Palsson, H. (1992). Rights based fisheries management in Canada. *Marine Resource Economics, 7*(1–21).

Cunningham, E. (2013). Catch Shares in Action: Mexican Baja California FEDECOOP benthic species territorial use rights for fishing system. Environmental Defense Fund.

Davies, R. W. D., Cripps, S. J., Nickson, A. and Porter, G. (2009). Defining and estimating global marine fisheries bycatch. *Marine Policy, 33*(4), 661–672. Retrieved from http://www.sciencedirect.com/science/article/pii/S0308597X09000050

Department for Environment, Food and Rural Affairs (DEFRA) (2014). FQA register. Retrieved from https://www.fqaregister.service.gov.uk

Egea, R. M. F. (2014). Cambio climático y la sostenibilidad de los recursos pesqueros del mar del norte: La controversia comercial entre la Unión Europea y las Islas Feroe. *Revista del Instituto Español de Estudios Estratégicos,* (4).

Essington, T. (2010). Ecological indicators display reduced variation in North American catch share fisheries. *Proceedings of the National Academy of Sciences of the United States, 107*(2), 754–759.

European Commission (EC) (2011). Commercialisation of new goose barnacle products - FLAG Ria de Vigo-A Guarda - ES. Retrieved from https://webgate.ec.europa.eu/fpfis/cms/farnet/commercialisation-new-goose-barnacle-products-flag-ria-de-vigo-guarda-es

Festa, D., Regas, D. and Boomhower, J. (2008). Sharing the catch, conserving the fish. Issues. Retrieved from http://issues.org/24–2/festa/

Food and Agriculture Organization of the United Nations (FAO). (n.d.) Fisheries Glossary. Retrieved from http://www.fao.org/fi/glossary/

Fujita, R. M., Foran, T. and Zevos, I. (1998). Innovative approaches for fostering conservation in marine fisheries. *Ecological Applications,* 8, 139–150.

Fujita, R. M. (2013). Climate Change is Changing Fisheries. Retrieved from http://blogs.edf.org/edfish/2013/05/29/climate-change-is-changing-fisheries/#more-4858

Gullestad, P. (2013) *The "Discard Ban Package" – Norwegian Experiences in Efforts to Improve Fisheries Exploitation Patterns.* Norwegian Directorate of Fisheries. Print.

Gislason, GS and Associates Ltd. (2008). Employment impacts of ITQ fisheries in Pacific Canada. *Prepared for Fisheries and Oceans Canada, Ottawa.*

Grafton, R. Q., Squires, D. and Fox, K. (2000). Private property and economic efficiency: A study of a common-pool resource. *Journal of Law and Economics, 43*(2), 679–713.

Gulf of Mexico Fishery Management Council (GMFMC) (2013). Red Snapper Individual Fishing Quota Program 5-year Review. Retrieved from http://gulfcouncil.org/docs/amendments/Red%20Snapper%205-year%20Review%20FINAL.pdf

Gulf Wild (2013). My gulf wild. Retrieved from http://mygulfwild.com

Haflinger, K. and Gruver, J. (2009). *Rolling hot spot closure areas in the Bering Sea walleye pollock fishery: estimated reduction of salmon bycatch during the 2006 season.* Paper presented at the American Fisheries Society Symposium. http://www.fisheriessociety.org/proofs/ayk/haflinger.pdf

Hannesson, R. (1988). Studies on the role of fishermen's 1988 organizations in fisheries management. Fishermen's organizations and their role in fisheries management: theoretical considerations and experiences from industrialized countries. *FAO Fisheries Technical Paper 300:1-27*. Rome. Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/003/T0049E/T0049E01.htm

Helledie, O. and Tørring, P. (2013). SIF – The Danish fisheries traceability system. Retrieved from http://fiskerforum.dk/pdf/sif.pdf

Holland, D. S. and Jannot, J. E. (2012). Bycatch risk pools for the U.S. west coast groundfish fishery. *Ecological Economics,* 132.

Icelandic Ministry of Fisheries and Agriculture (n.d.). Icelandic Fisheries – Cod Equivalents. Retrieved from http://www.fisheries.is/management/total-allowable-catch/cod-equivalents/

Keledjian, A. Brogan, G., Lowell, B., Warrenchuk, J., Enticknap, B., Shester, G., Hirshfield, M. and Cano-Stocco, D. (2014). *Wasted catch: unsolved problems in U.S. fisheries.* Oceana. Retrieved from http://oceana.org/sites/default/files/reports/Bycatch_Report_FINAL.pdf

Kelleher, K. (2005). Discards in the world's marine fisheries. *FAO Fisheries Technical Paper. No. 470.* Rome. Food And Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/008/y5936e/y5936e00.HTM

Knapp, G. (1999). Effects of IFQ management on fishing safety: survey responses of Alaska halibut fishermen. Anchorage, AK: ISER University of Alaska Anchorage.

Lowman, D., Fisher, R., Holliday, M., McTee, S. and Stebbins, S. (2013). Fishery monitoring roadmap.

Mace, P. M. (1996). Developing and sustaining world fisheries resources: the state of the science and management. In: Hancock D.A., Smith, D.C., Grant, A., Beumer, J.P., editors. *Proceedings of the second World Fisheries Congress, Developing and Sustaining World Fisheries Resources.* Australia, Brisbane.

Mace, P., Sullivan, K. J., and M. Cryer (2014). The evolution of New Zealand's fisheries science and management system under ITQs. *ICES Journal of Marine Science, 71*(2), 204–215.

Makino, M. (2011). *Fisheries management in Japan: its institutional features and case studies.* Fish and Fisheries Series. Vol 34.

Mangi, S. C., Dolder, P. J., Catchpole, T. L., Rodnell, D. and de Rozarieux, N. (2013). Approaches to fully documented fisheries: practical issues and stakeholder perspectives. *Fish and Fisheries.*

Marine Scotland Fisheries Division (MSFD) (2011). Report on catch quota management using remote electronic monitoring (REM).

McCay, B. J. (1995). Social and ecological Implications of ITQs: An overview. *Ocean and Coastal Management, 28*(1–3), 3–22.

McIlwain, K. (2013). Catch shares in action: Alaska halibut and sablefish fixed gear individual fishing quota program. Environmental Defense Fund.

Morro Bay Community Quota Bank (MBCQB) (2011). Proposal: Morro Bay Community Quota Bank an Institution to Achieve a Stable and Sustainable Local Fishery. Retrieved from: http://www.morro-bay.ca.us/DocumentCenter/Home/View/1280

Newell, R. G., Sanchirico, J. N. and Kerr, S. (2005). Fishing quota markets. *Journal of Environmental Economics and Management, 49*(437–462).

National Marine Fisheries Service Southeast Regional Office (NMFS) (1998). Economics of bycatch: the case of shrimp and red snapper fisheries in the U.S. Gulf of Mexico. In *Managing the nation's bycatch: priorities, programs and actions for the National Marine Fisheries Service*. Retrieved from http://www.nmfs.noaa.gov/by_catch/docs/bycatchplanonline.pdf

National Marine Fisheries Service Southeast Regional Office (NMFS) (2011). *Gulf of Mexico 2010 red snapper individual fishing quota annual report*. Retrieved from http://sero.nmfs.noaa.gov/sustainable_fisheries/lapp_dm/documents/pdfs/2014/red_snapper_ifq_2012_annual_report.pdf

National Oceanic and Atmospheric Administration (NOAA) (2012). *The west coast groundfish fishery: results from the first year of catch shares 2011*. Retrieved from http://www.nmfs.noaa.gov/stories/2012/07/docs/catch_sharesyear1_report.pdf

National Oceanic and Atmospheric Administration (NOAA). Networks of researchers and fishermen working together to reduce bycatch, maximize fishing opportunities and advance real-time technology. Retrieved from http://www.nero.noaa.gov/stories/2013/networkscoopresearch.html

Pacific Whiting Conservation Cooperative (PWCC) (2013). Retrieved from http://www.pacificwhiting.org

Parkes, G., Swasey, J. H., Underwood, F. M., Fitzgerald, T. P., Strauss, C. K. and Agnew, D. J. (2015). The effects of catch share management on MSC certification scores. Fish. Res. Retrieved from http://dx.doi.org/10.1016/j.fishres.2015.10.003

Precision Seafood Harvesting (PSH) (2014). Precision Seafood Harvesting: A catalyst for change. Retrieved from http://www.precisionseafoodharvesting.co.nz/

Priddle, E. (2013). Sustainable European fisheries depend upon sustainable investment mechanisms. Environmental Defense Fund.

Sanchirico, J. N., Holland, D., Quigley, K. and Fina, M. (2006). Catch-quota balancing in multispecies individual fishing quotas. *Marine Policy*, 30(6), 767–785. Retrieved from http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-05-54.pdf

Sanchirico, J. N. and Wilen, J. E. (2007). Global marine fisheries resources: status and prospects. *International Journal of Global Environmental Issues, 7*(2-3), 106-118. Retrieved from http://www.inderscienceonline.com/doi/abs/10.1504/IJGENVI.2007.013569

Secretariat of the Pacific Community (SPC) (2005). Set your longline deep: catch more target fish and avoid bycatch by using a new gear design. Retrieved from http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Set_your_LL_deep.pdf

Strauss, K. (2013). Catch Shares in Action: Danish Pelagic and Demersal Individual Transferable Quota Programs. Environmental Defense Fund. Retrieved from http://fisherysolutionscenter.edf.org/sites/catchshares.edf.org/files/Danish_Pelagic_and_Demersal_ITQ.pdf

Sumaila, U. R., Cheung, W. W. L., Lam, V. W. Y., Pauly, D. and Herrick, S. (2011). Climate change impacts on the biophysics and economics of world fisheries. *Nature Climate Change, 1*(9), 449–456.

Sylvia, G., Mann, H. M. and Pugmire, C. (2008). Achievements of the Pacific whiting conservation cooperative: rational collaboration in a sea of irrational competition. In R. Townsend, R. Shotton, and H. Uchida (Eds.), *Case Studies in Fisheries Self-governance*. FAO Fisheries Technical Paper 504. Food and Agriculture Organization of the United Nations.

Walker, S. and Townsend, R. (2008). Economic analysis of New Zealand's deemed value system. Retrieved from http://ir.library.oregonstate.edu/xmlui/handle/1957/37722

World Wildlife Fund (WWF) Scotland (2009). The Scottish conservation credit scheme: moving fishery management towards conservation. Retrieved from http://assets.wwf.org.uk/downloads/scottish_conservation_credits_scheme.pdf

World Wildlife Fund (WWF) (2014). International smart gear competition. Retrieved from https://worldwildlife.org/initiatives/international-smart-gear-competition

Young, J. (2013). Catch Shares in Action: Argentine individual transferable quota program. Environmental Defense Fund.

Young, M. D., & McCay, B. J. (1995). Building equity, stewardship, and resilience into market-based property rights systems. *Property Rights in Social and Ecological Context: Concepts and Case Studies*, Washington/DC: World Bank, 87–102.

Glossary

Glossary

Allocation – Distribution of a secure share of catch to individuals or groups.

Accountable (*syn*: Accountability, Full accountability) – In reference to the attributes of a catch share program, participants are required to stay within their allocated share of the overall catch and/or comply with controls on fishing mortality. See **SEASALT**.

All sources – In reference to the attributes of a catch share program, shares include all sources of fishing mortality (landed and discarded), and when combined do not exceed the catch limit(s) or other controls on fishing mortality. See **SEASALT**.

Area-based catch share (*syn.*: Territorial Use Rights for Fishing) – A catch share program in which participants are allocated access privileges based on specific areas and held accountable to catch limits or other appropriate controls on fishing mortality for harvested species.

At-sea monitoring – The collection of information on fishing activities taking place at sea, including harvesting, catch handling, biological sampling, fishing methods and interactions with protected species. At-sea monitoring is conducted with onboard observers or an electronic monitoring system.

Buffer quota (*syn*: Set aside quota) – Portion of quota that is set aside from the initial allocation to be released when deemed necessary.

Bycatch (*syns.*: Incidental catch, Non-target catch/species) – Fish other than the primary target species that are caught incidental to the harvest of those species. Bycatch may be retained or discarded. Discards may occur for regulatory or economic reasons (NRC, 1999).

Catch (*syn.*: Harvest) – The total number (or weight) of fish caught by fishing operations. Catch includes all fish killed by the act of fishing, not just those landed (FAO, n.d.).

Catchability (*syn.*: Vulnerability) – 1. The extent to which a stock is susceptible to fishing. Catchability changes depending upon fish behavior and abundance and the type and deployment of fishing gear (Blackhart et al., 2006). 2. The fraction of a fish stock that is caught by a defined unit of the fishing effort (FAO, n.d.).

Catch accounting – The tracking of fishermen's catch, including landings and discards, against their share holdings.

Catch limit (*syn.*: Total allowable catch) – The scientifically determined, acceptable level of fishing mortality.

Catch Selectivity – Ability to target and capture fish by size and species during harvesting operations, allowing bycatch of juvenile fish and non-target species to escape unharmed.

Catch share (*syn.*: Catch share program) – A fishery management system that allocates a secure area, or privilege to harvest a share of a fishery's total catch, to an individual or group. Programs establish appropriate controls on fishing mortality and hold participants accountable.

Constraining stock – A species in a quota-managed mixed fishery that will prematurely close the fishery when its quota is exhausted (fully caught).

Co-management – A process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision making (FAO, n.d.).

Command and control regulations (syn.: Conventional fishery management approaches) – The direct regulation of an industry or activity by legislation that states what is permitted and what is illegal. When applied to fisheries, this type of management holds fishermen accountable to regulations that are not directly tied to the catch or specific area, do not necessarily limit the catch and do not instill incentives for long-term stewardship. See Input controls.

Community – The populations that live and interact physically and temporally in the same area (Blackhart et al., 2006).

Community Fishing Quota (CFQ) (syn.: Community quota) – Catch share program in which shares are allocated to a specific community with certain rules and stipulations

that tie the share, or the proceeds of the share, to that community.

Concentration – A measurement of the percent of privileges held by one fishery participant.

Concentration cap (*syn.*: Accumulation limit) – The limit on the percentage of shares that any one fishery participant can hold and/or fish.

Consolidation – The accumulation of shares by a relatively small number of shareholders.

Controls on fishing mortality – Management measures such as catch limits, gear restrictions and seasonal and spatial closures that limit the total amount harvested each year. When set at appropriate levels, they ensure long-term sustainability of stocks.

Cooperative – 1. A group of fishery participants that is allocated a secure share of the catch limit or a secure area, and collectively manages its allocation. 2. A group of people who come together to coordinate activities in some way.

Cooperative catch share – A type of catch share in which one or more groups of fishery participants are allocated a secure share of the catch limit or a secure area, and accept certain fishery management responsibilities, including ensuring compliance with controls on fishing mortality.

Deemed value – A design option in a catch share program that requires fishermen to pay a pre-agreed fee to the government for landed species for which they do not have quota. It may be refunded should a fisherman retroactively purchase quota to cover his or her catch.

Derby-style fishing (*syns.*: Olympic-style fishing, Race for fish) – Fishing conditions characterized by short seasons and severe competition for fish, often resulting in low profits and harvests that exceed sustainable levels.

Disaster haul – A single haul during a fishing trip that exhausts a fisherman's constraining stock quota holdings for the year, unless additional quota is purchased and/or leased.

Discard (*syns.*: Regulatory discard, Economic discard) – To release or return a portion of the catch, dead or alive, before offloading, often due to regulatory constraints or a lack of economic value (FAO, n.d.).

Dockside monitoring – The monitoring of activities taking place upon a vessel's landing, including weighing or counting offloaded catch, biological sampling and identifying species composition.

Economic discard (*syn.*: Commercial discard) – Fish that are not retained because they are of an undesirable size, sex or quality, or for other economic reasons (16 U.S.C. 1802).

Effort (syn.: Fishing effort) – The amount of time and fishing power used to harvest fish; effort units include gear size, boat size and horsepower (Blackhart et al., 2006).

Effort-based – Fishing privileges based on a percentage or absolute number of the total effort unit available, often allocated as days, pots or trawl tows. Effort-based programs do not qualify as a catch share.

Electronic monitoring – A technique employed to monitor at-sea fishing activities, often consisting of cameras, sensors and Global Positioning System (GPS) units that record vessel and fishing location, fishing activity, catch (both retained and discarded) and compliance with fishing rules.

Eligibility – Standards or guidelines that qualify individuals or entities for allocation of catch shares.

Enforcement – Measures to ensure compliance with fishery regulations, including catch limits, gear use and fishing behavior.

Exclusive – 1. In reference to the attributes of a catch share program, secure privileges are assigned to an entity (individual or group) and are clearly recognized and defendable by law. See **SEASALT**. 2. A program or privilege that permits only assigned users to participate, thereby ensuring that benefits and costs of the privilege will accrue to the holder.

Fish – Used as a collective term that includes finfish, mollusks, crustaceans and any aquatic plant or animal that is harvested.

Fish stock – The living resources in the community or population from which catches are taken in a fishery. Use of the term usually implies that the particular population is more or less isolated from other stocks of the same species and hence self-sustaining. In a particular fishery, the fish stock may be one or several species of fish, but here is also intended to include commercial invertebrates and plants (FAO, n.d.).

Fish ticket – A record of purchase and documentation of harvest of a public resource. The fish ticket often records the species landed; the weight of each species; the gear used to catch the fish; catch dates; the fishery; the processor; the price paid for the fish; and the area fished (Alaska Department of Fish and Game, n.d.).

Fishery – The combination of fish and fishermen in a region, the latter fishing for similar or the same species with similar or the same gear types (Blackhart et al., 2006).

Fishery-dependent data – Data derived from the fishery, usually describing the catch (e.g., weight, species, length-frequency) from commercial and recreational sources. There are a variety of methods for obtaining fishery-dependent data. The most common approach is to use

recorded landings. Landings are a record of the amount of fish sold, typically reported in total weight. Another common mode for acquiring fishery-dependent data is through portside sampling of both recreational and commercial catch to obtain age and length information on the stock. Other less common methods for obtaining data include the use of onboard observers, self-reporting, telephone surveys and vessel-monitoring surveys.

Fishery-independent data – Data collected in ways that are independent of the fishery, such as random scientific fishing surveys or visual census surveys. This method of collection is intended to avoid the biases inherent to fishery-related data (modified from FAO, 1988).

Fishery information – The information needed in a fishery for science and compliance, which can be collected through various forms of monitoring and self-reporting.

Fishing community – A community that is substantially dependent on or engaged in the harvest or processing of fishery resources to meet social and economic needs. Includes fishing vessel owners, operators, crew and processors that are based in such a community (16 U.S.C. 1802).

Fishing inputs – The resources used to catch a species or group of species, often including fishing vessels, vessel type and power, gears used, fuel and more.

Fishing mortality (*syn.:* Mortality) – A measurement of the rate of fish removal from a population by fishing. Fishing mortality can be reported as either annual or instantaneous. Annual mortality is the percentage of fish dying in one year; instantaneous mortality is the percentage of fish dying at any given point in time (Blackhart et al., 2006).

Group-allocated – A catch share program in which privileges are allocated to a clearly defined group of people, often a community or fishing association.

Ghost Fishing – Derelict fishing gear, sometimes referred to as "ghost gear," is any discarded, lost, or abandoned, fishing gear in the marine environment. Ghost fishing is a term that describes when this gear continues to fish and trap animals, entangle and potentially kill marine life, smother habitat, and act as a hazard to navigation (NOAA).

Harvest – The total number or poundage of fish caught and kept from an area over a period of time (Blackhart et al., 2006).

High-grading (syn.: Economic discards) – Selectively sorting fish so that higher value, more marketable fish are retained, and fish that could be legally retained, but are less marketable, are discarded (NRC, 1999).

Individual Fishing Quota (IFQ) – A type of catch share program in which shares are allocated to individuals or individual entities. Recipients are generally fishermen and shares may or may not be transferable.

Individual Quota (IQ) – A type of catch share program in which shares are allocated to individuals or individual entities. Recipients are generally fishermen and shares are not transferable.

Individual Transferable Effort Quota (ITEQ) (*syns.*: Effort-based, Transferable effort share) – A percentage of the total allowable effort allocated to individuals, often in the form of days at sea or a set amount of gear. ITEQ is tradable between eligible participants.

Individual Transferable Quota (ITQ) – A type of catch share program in which shares are allocated to individuals or individual entities. Recipients are generally fishermen and shares are transferable.

Individual Vessel Quota (IVQ) – A type of catch share in which shares are allocated to an individual vessel. Shares are attached to the vessel, rather than the vessel owner, and shares may or may not be transferable. This has been used most commonly in Canada.

Individually-allocated – A catch share in which privileges are allocated to individuals or individual entities.

Input controls (*syns.*: Input regulations, Input-based regulations, Input-based controls, Input measures) – Management instruments used to control the time and place, as well as type and/or amount, of fishing in order to limit yields and fishing mortality; for example, restrictions on type and quantity of gear, effort, and capacity; and closed seasons (FAO, n.d.).

Landings – The number or weight of fish offloaded at a dock by fishermen. Landings are reported at the locations where fish are brought to shore (Blackhart et al., 2006).

Limited – In reference to the attributes of a catch share program, controls on fishing mortality are set at scientifically appropriate levels. See **SEASALT**.

Limited access (*syns.*: Controlled access, License limitation, Limited entry) – A fishery management approach that limits the number of fishermen participating in a fishery, usually by issuing a limited number of licenses.

Logbook (*syn.*: Logsheet) – A detailed, usually official, record of a vessel's fishing activity registered systematically onboard the fishing vessel. It usually includes information on catch and species composition, the corresponding fishing effort and location (FAO, n.d.).

Maximum Economic Yield (MEY) – The catch level that corresponds to the highest amount of profit that could be earned from a fishery (Blackhart et al., 2006).

Maximum Sustainable Yield (MSY) – The largest average catch that can be taken continuously (sustained) from a stock under average environmental conditions. This is often used as a management goal (Blackhart et al., 2006).

Monitoring (*syn.*: Catch control) – The collection of fishery information for the purposes of science (e.g., setting catch limits and assessing stocks) and ensuring accountability (e.g., catch accounting and enforcing fishery regulations).

Mortality – A measurement of the rate of death of fish resulting from several factors, but mainly predation and fishing.

Multi-species fishery (*syn.: Mixed fishery)* – A fishery in which more than one species is caught at the same time. Because of the imperfect selectivity of most fishing gear, most fisheries are "multi-species." The term is often used to refer to fisheries where more than one species is intentionally sought and retained (NRC, 1999).

Non-target species (*syns.*: Bycatch, Incidental catch) – Species not specifically targeted as a component of the catch but which may be incidentally captured (Blackhart et al., 2006).

Onboard observers (*syn.*: Observers) – A certified person onboard fishing vessels who collects scientific and technical information on the fishing operations and the catch. Observer programs can be used for monitoring fishing operations (e.g., areas fished, fishing effort deployed, gear characteristics, catches and species caught, discards, collecting tag returns, etc.) (FAO, n.d.).

Open access – Condition in which access to a fishery is not restricted (i.e., no license limitation, quotas or other measures that would limit the amount of fish that an individual fisherman can harvest) (NRC, 1999).

Overcapacity – A level of fishing pressure that threatens to reduce a stock or group of stocks below the abundance necessary to support Maximum Sustainable Yield and allow an economically sustainable fishing industry (Blackhart et al., 2006).

Overcapitalization (*syn.*: Excess capacity) – In the short term, fishing capacity that exceeds the level required to capture and handle the allowable catch. In the long term, fishing capacity that exceeds the level required to ensure the sustainability of the stock and the fishery at the desired level (FAO, n.d.).

Overfished – A state in which a fish stock is below a scientifically determined target biomass (e.g., one half of the biomass that produces Maximum Sustainable Yield).

Overfishing – A rate of fishing mortality that, if unchanged, will result in an overfished state.

Quota – The maximum number of fish that can be legally landed in a time period. Quota can apply to the total fishery or an individual fisherman's share under a catch share program (Blackhart et al., 2006).

Quota bank (*syns.*: Permit bank, Community license bank) – Collection of harvesting privileges in which certain rules and stipulations govern the use of privileges and distribution of benefits.

Quota-based catch share – A catch share program in which secure shares of the catch limit are allocated to individuals or groups and participants are held accountable to their share. Shares are based on the number or weight of fish.

Race for fish (*syns.*: Derby-style fishing, Olympic fishing) – A pattern of fishing characterized by an increasing number of highly efficient vessels fishing at an increasing pace, with season length becoming shorter and shorter (FAO, n.d.).

Regulatory discards – Fish that fishermen are required by regulation to discard whenever caught, or that are required by regulation to retain but not sell (16 U.S.C. 1802).

Risk pool – A collectively managed quota pool in which members have access to available quota.

Full retention (*syn:* Full catch retention) - All catch is landed. This is a requirement of the EU landing obligation.

Scaled – In reference to the attributes of a catch share program, management units are set at the appropriate biological level, taking into consideration social and political systems. See **SEASALT**.

SEASALT – A mnemonic that describes commonly occurring attributes of catch shares (Secure, Exclusive, All sources, Scaled, Accountable, Limited, Transferable).

Sector – 1. A specific division of a fishery with unique characteristics including management regulations, gear types, fishing locations, purpose of activity or vessel size. 2. A type of group-allocated catch share program most commonly used in New England.

Secure – In reference to the attributes of a catch share program, the tenure length of shares is sufficiently long for participants to realize future benefits. See **SEASALT**.

Shareholder (*syns.*: Privilege holder, Quota holder) – An individual or entity holding a secure share in a catch share fishery.

Single-species fishery – A type of fishery in which fishermen target only one species of fish, although it is usually impossible not to catch others incidentally (Blackhart et al., 2006).

Stewardship – Responsible management of resources for future generations, such as maintaining populations

of target and non-target species, protecting wildlife, conserving key habitats and strengthening ecosystem resilience.

Stock – A part of a fish population, usually with a particular migration pattern and specific spawning grounds, subject to a distinct fishery. A fish stock may be treated as a total or a spawning stock. Total stock refers to both juveniles and adults, either in numbers or by weight, while spawning stock refers to the numbers or weight of individuals that are old enough to reproduce (Blackhart et al., 2006).

Sustainable fishing – Fishing activities that do not cause or lead to undesirable changes in the biological and economic productivity, biological diversity or ecosystem structure and functioning from one human generation to the next (FAO, n.d.).

Sustainable harvest (*syns.*: Sustainable catch, Sustainable yield) – The biomass or number of fish that can be harvested without reducing the stock biomass from year to year, assuming that environmental conditions remain the same (Blackhart et al., 2006).

Target species (*syn.*: Directed fishery) – Those species primarily sought by fishermen in a particular fishery. There may be primary as well as secondary target species (FAO, n.d.).

Tenure length of shares – The duration for which an individual's or group's share is allocated.

Territorial Use Rights for Fishing (TURF) (*syn.*: Area-based catch share) – An area-based management program that assigns a specific area to an individual, group or community. To meet the definition laid out in the Design Manual, one or more species in the area must have a scientifically-based catch limit or other appropriate controls on fishing mortality.

Total Allowable Catch (TAC) (*syn.*: Catch limit) – The annual recommended or specified regulated catch for a species or species group (Blackhart et al., 2006).

Total catch – The landed catch plus discard mortality (Blackhart et al., 2006).

Transferable (*syns.*: Transferability, Tradable) – In reference to the attributes of a catch share program, shareholders can buy, sell and/or lease shares. See **SEASALT**.

Vessel Monitoring System (VMS) – A satellite communications system used to monitor fishing activities; for example, to ensure that vessels stay out of prohibited areas. The system is based on electronic devices which are installed onboard vessels and automatically send data to a shore-based satellite monitoring system (Blackhart et al., 2006).

Vulnerability (*syn.*: Catchability) – Equivalent to catchability, but usually applied to a specific part of the fish stock, such as individuals of a specific size or length (Blackhart et al., 2006).