Step 1 – Define and Quantify the Available Resource

Tracking the Attributes of a Successful Catch Share

Key Attributes	Definition
Secure	Tenure length of shares is sufficiently long for participants to realize future benefits.
Capped	**Catch limits or geographic areas are set at scientifically-appropriate levels.**
Accountable	Share holders regularly comply with catch limits.
Limited	Shares include all sources of mortality (landed and discarded) and when combined do not exceed the catch limit or total geographic area.
Exclusive	Secure privileges are assigned to an entity (individual or group) and are recognized and defendable by law.
Scaled	Management units are set at the appropriate biological level, taking into consideration social and political systems.
Transferable	Privilege holders can buy, sell and/or lease catch shares.

Once you have defined the fishery's goals and identified which sectors to include, you are ready to start designing a catch share. Nearly all fisheries considering a move to catch shares will already have some existing management traditions in place. In the US, that means a Fishery Management Plan (FMP) has been developed by the regional Fisheries Management Council and approved by the Secretary of Commerce. These existing plans include answers to many basic questions and are a logical starting place. FMPs are generally implemented through issuing permits or licenses with terms and conditions by which participating fishermen must abide.

To determine and quantify the available resource, you must answer four key questions: which species will be included, which stocks will be included, what the spatial range will be and what the allowable take will be for each of these units.

By completing this step, your fishery will be addressing the key catch share attribute of **Capped**.

1.1 WHICH SPECIES WILL BE INCLUDED?

One hallmark of catch share programs is the practice of tracking and accounting for both caught and landed fish. Catch share programs can accommodate any number of species, including both targeted species and non-targeted species, or bycatch. There are a few key questions to ask when you are thinking about which species to include in a catch share program:

- Are the species commonly caught together?
- What is the amount of mortality from the catch and its impact on species sustainability?
- Do management objectives require accounting for the mortality of those species (such as overfished vulnerable species)?

Catch shares can either be single-species or multi-species. There are many successful programs of both types.

Single-Species
Single-species catch share programs have been commonly used in two instances: when there is relatively little bycatch or a low target to non-target catch ratio or when existing management has already created single-species management through limited-access licensing. In the case of a fishery with low bycatch, a single-species approach is likely to be highly effective, but if there are significant interactions with multiple species, then it is advisable to consider a multi-species catch share.

Examples of single-species catch shares include striped bass in Virginia, geoduck in British Columbia and rock lobster in New Zealand.

Multi-Species
Multi-species catch shares are typically adopted when species are related either biologically or commercially. Many fisheries worldwide encounter more than one species. When different species are often caught together, a multi-species approach may be preferable.

The British Columbia Groundfish Trawl Individual Vessel Quota (IVQ) program is an example of a catch share fishery that includes species that interact both biologically and commercially. This fishery targets groundfish, a group comprised of dozens of distinct species that are ecologically related. These fish are often sold through the same distribution channels, and sometimes even called by the same name in the marketplace. As a result of these interactions, managers decided to implement a multi-species catch share in which 55 species area groups have individual caps and individually allocated shares (Grafton et al., 2005a).

> ***Rule of Thumb – You should consider including in the catch share program the species that are commonly caught together in the fishery.***

Trade-offs
If your fishery is not clearly single-species, then determining which species to include in a program can be challenging and will likely require adaptive management over time. While a multi-species catch share is preferable for a multi-species fishery, it is also possible to start with just one key species and expand the program over time. This

approach may be preferable based on available information or to expedite design and implementation. It is always possible to incorporate more species as new information or fishing patterns emerge.

A multi-species catch share will help solve many complex management problems by allocating shares rather than developing an array of input controls to manage multiple species. If a fishery interacts with more species than are included in the catch share program, there is a risk that fishermen will target more effort on non-catch share species. If you continue to use additional controls such as gear restrictions or time and area closures to regulate interaction with those species, the whole fishery management program may become more onerous to navigate (NOAA, 2007). This will require careful management over time.

However, there are challenges to managing multi-species catch shares. When one or more of the stocks is of low abundance, there is often a fear that those stocks will constrain the ability to access higher abundance stocks. This is often a challenge in non-catch share fisheries as well. The benefit under catch shares is that fishermen have an incentive to find innovative ways to avoid low abundance stocks while continuing to access higher abundance stocks. For example, in the British Columbia Groundfish IVQ, many fishermen have successfully modified practices in order to minimize their take of species that are in lower abundance and for which the shares are more costly. In order to ensure the health of all stocks and species, real-time accounting of catch and landings will be important. Some common approaches have emerged to make multi-species catch shares easier to administer.

Special approaches for multi-species fisheries

Multi-species catch shares can provide substantial flexibility and improve management on an ecosystem level. From a biological perspective, it would be ideal to have a distinct catch limit for every stock and species with full transferability of shares. Participants could maintain shares that accurately reflect the composition of their catch.

Multi-species catch shares may be more complex to administer because you need information for all managed stocks in order to set catch limits and distribute shares. In addition, under multi-species approaches an appropriate trading platform to facilitate trades and information becomes even more important. Multi-species catch share systems have commonly used two tools to assist with implementation and administration:

Quota baskets

Quota baskets are groupings of species for which participants are allocated a percentage of the total limit for species in the grouping. Each fish species does not have its own individual quota, so fishermen are allowed to land any species within that quota basket up to the overall limit. If fishing gear is relatively indiscriminate and there are not distinct pressures that would cause certain fish to be more desirable than others, then quota

baskets can be a good option. There is an important risk though that more vulnerable species may suffer disproportionally under this system.

Weighted transfers

Some multi-species catch shares allow participants to substitute the shares from a one species to cover catch of a different species. For example, shares for species "a" may be allowed to cover catch and landings for species "b". Again, this provides more flexibility for participants. In many cases, more vulnerable or more valuable species will "cost" more in terms of shares from a different species. This way, participants must weigh the benefit of using that share allocation. Just as with quota baskets, there are risks to this approach, especially if the transfer weightings are set at levels that encourage more take of vulnerable species. The weighted transfers will need to be watched and adjusted as necessary (Sanchirico et al., 2006).

1.2 WHICH STOCKS WILL BE INCLUDED?

Many fisheries contain numerous and distinct fish stocks. These stocks may intermingle with each other at various points in time and may be targeted by a variety of different sectors. Furthermore, fishermen may catch fish from multiple stocks at once.

Many catch share fisheries distinguish between different stocks and establish individual trading units for each. For example, New Zealand hoki has two distinct stocks that each has a catch limit and separately allocated shares (Newell et al., 2002).

> ***Rule of Thumb – You should create a separate catch limit and shares for each stock (which is a biologically-based, geographically distinct unit of the fishery).***

Lumping multiple fish stocks into the same catch share pool can be biologically detrimental since it is possible to overfish one stock while not exceeding the total catch limit for the entire fishery. On the other hand, when fish from various stocks are commonly caught together, it may be impossible to determine which stock is represented. In this case, it may be necessary to come up with additional methods (e.g., identifying geographic zones that largely distinguish stocks, or creating different counting methods based on known abundance of different stocks). Fishery managers who have already been faced with these challenges under existing management systems may have developed approaches that can be easily adapted to a catch share.

1.3 WHAT WILL THE SPATIAL RANGE OF THE CATCH SHARE BE AND WILL THERE BE DIFFERENT ZONES?

The spatial range of a catch share can also be customized and is largely related to species and stock boundaries. Existing political or socio-cultural boundaries may also be important in defining managed areas.

Biological Considerations
Catch shares can be easily divided geographically. Spatial range and zone boundaries are usually driven by the species and stock biology. For example, a pelagic fish like anchovies will likely have a large, single zone, whereas more sedentary animals like lobster may need multiple zones in order to avoid localized depletion. See discussion of stocks in Step 1.2 above.

Social Considerations
Social considerations, such as the promotion of community access to localized resources, can also be accommodated through zones. New Zealand has created certain areas that are only for Maori use, while Mexico has created a series of area-based lobster cooperatives that match community boundaries along the Pacific coast of Baja California (Bess and Rallapudi, 2007; Defeo and Castilla, 2005). See Step 2 in Practice for more information.

Trade-offs
Creating different catch share areas may help accommodate various biological or social considerations, but creating more zones may increase complexity and make it more challenging to navigate. If zones are implemented, it is important to identify them based on existing biological, geographical or social boundaries.

When the area of jurisdiction is smaller than the stock or species boundary, it may be more difficult to implement effective management of any kind because activities outside jurisdictional control can negatively impact the fishery. This is the case for Australia's take of bluefin tuna, which is managed by an international treaty. While Australia has a catch share in place for its country's share of the Pacific bluefin tuna stock and they successfully manage their portion, other countries continue to overfish the stock (ABARE, 2007). For truly effective management on a stock-wide basis, all jurisdictions must cooperate to ensure compliance.

Table 1 – Fishery Management Units - Catch shares are flexible enough to accommodate a wide variety of fisheries. Above are select examples including single and multi-species fisheries, with single or multiple geographic zones and single or multiple sectors.

Fishery	Number of Species	Number of Geographic Zones	Sector(s) included
British Columbia Groundfish IVQ	27	8	Hook and Line, Trawl
Pacific Whiting Conservation Cooperative	1	1	At-sea catcher-processor sector
Australian Southern and Eastern Scalefish and Shark IFQ	34	4 (with some further divisions)	Hook and Trap, East Coast Deepwater and Gillnet, Commonwealth Trawl, Great Australian Bight Trawl
Alaskan Halibut and Sablefish IFQ Program	2	8	Targeted halibut fishery and targeted sablefish fishery
Australia Southern Bluefin Tuna ITQ	1	1	Australia's Bluefin Tuna fishery
New Zealand Quota Management System	129	10	All commercial and Maori fishing activity
Mexican Baja Lobster cooperatives	1	9-10	10 communities and 9 cooperatives

Sources: (Grafton et al., 2005a; Pacific Whiting Conservation Cooperative, 2005; AFMA, 2009a; NOAA, 2007; Meany, 2001; Lock and Leslie, 2007; and Scientific Certification Systems, 2004.)

1.4 WHAT WILL BE THE SCIENCE-BASED ALLOWABLE TAKE FOR EACH SPECIES, STOCK AND ZONE?

Setting the appropriate catch limit is a vital component of any fishery's management plan. To be effective, a catch limit must account for all sources of mortality, whether from different sectors of a directed fishery, other sectors that catch the species as indirect catch, or from fish that are discarded dead or dying. Depending on the biology of the species, limiting the take of certain size classes may also be important.

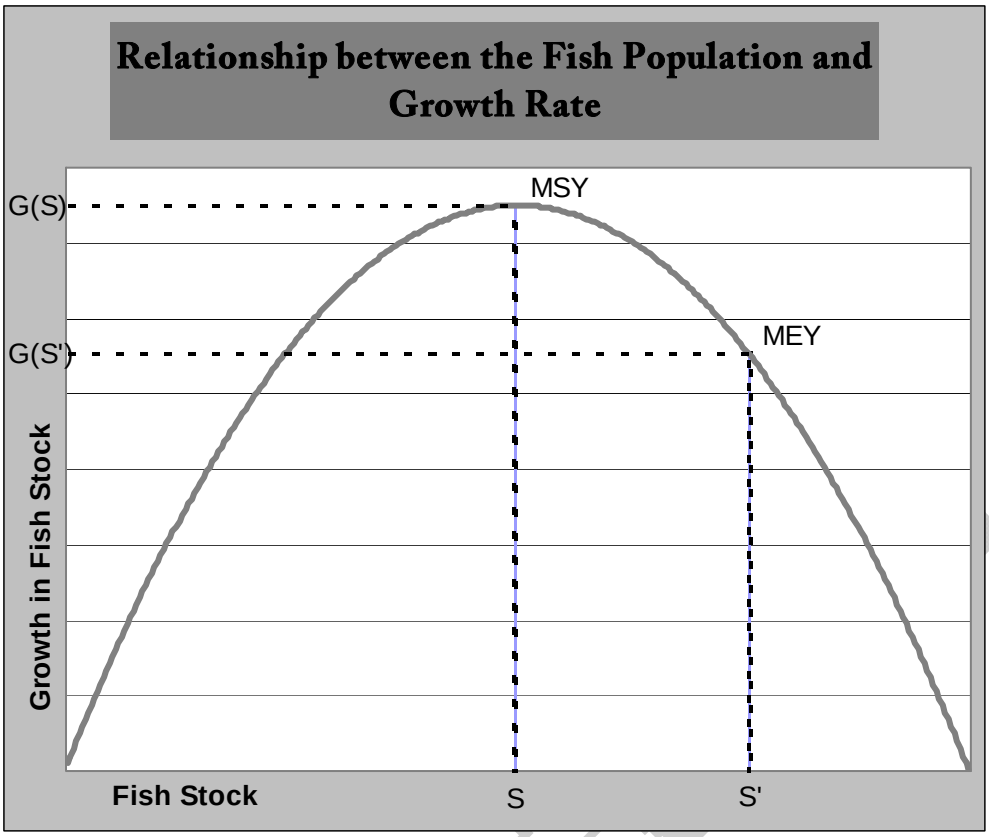

Figure 1 - This graph depicts the sustainable harvest rates (points at which annual harvest equals the annual growth rate of stock) at varying sizes of the fish population. Maximum Sustainable Yield (MSY) is the catch level at which the sustainable annual harvest rate is greatest, while Maximum Economic Yield (MEY) is the catch level that produces the largest annual benefits. In most fisheries, the Maximum Economic Yield will result in a larger stock size and lower catch levels than the Maximum Sustainable Yield (Tietenberg, 2006).

The catch limit is generally set at a level determined by national or state policy. For example, in Australia the policy is to set the cap at the Maximum Economic Yield (MEY), which is the level at which the fishery can maximize profits and achieve optimal economic value. In the United States, the cap is set at the Optimum Yield (OY), which is the harvest level for a species that achieves the greatest overall biological, economic and social benefits. From a biological perspective, MEY tends to be a more conservative level than the Maximum Sustainable Yield (MSY) (Tietenberg, 2006). However, as the name indicates, harvesting at the MEY produces higher economic return because it is where revenues are greatest relative to costs. Catch share fisheries often tend to fish under their catch limit, which is likely closer to MEY (NMFS Southeast Regional Office, 2009; NMFS Alaska Regional Office 2009a; NMFS Alaska Regional Office 2009b; NMFS Alaska Regional Office 2009c).

If a catch limit is set too high, any fishery, including a catch share fishery, is at risk of becoming overfished. This was seen in the early days of the New Zealand orange roughy fishery where available science was inadequate and catch limits were set too high for the

fishery. Because participants effectively caught the entire limit, they overfished the stocks. As better science came to light, catch limits were lowered and the stock is still recovering (Straker et al., 2002). Slow recovery is exacerbated because orange roughy is a long-lived species that is slow to reproduce.

> ***Rule of Thumb: Setting a catch limit is critical. The catch limit should account for all sources of fishing mortality and should prevent overfishing. If the stock is already overfished, the catch limit should be set at a level that will rebuild the stock.***

Trade-offs

Setting a catch limit is vital for nearly every fishery and a catch limit is an important component of catch share systems. Many fisheries have existing processes and protocols for setting a catch limit. It is necessary for a catch share fishery to work within those protocols or to alter the process over time as new information becomes available.

Your fishery may not have a catch limit or an established process for setting a catch limit. This often occurs when there is insufficient data to set a catch limit or when the fishery is based more on escapement or protection of a brood stock. For example, many crab, lobster and shrimp fisheries rely solely on size, sex and season limits, rather than on a total catch limit. In data-poor fisheries, there may not be enough information to accurately set a catch limit under traditional methods. However new techniques have been developed for setting catch limits in data poor fisheries that should be considered in these cases (Fujita, *in review*).

In rare cases when you can't set a meaningful catch limit, you might consider an area-based catch share without a catch share. This is a far less desirable alternative. The key is to identify an appropriate area size that accommodates the species life cycle, identify a group of users that can effectively manage the area, and explicitly exclude non-authorized participants. For more discussion on area-based approaches, see Step 2 – Define the Privilege.

Under select circumstances, a tradable effort-based system may merit consideration. This has had some success in lobster and prawn fisheries around the world, but requires strong compliance with season, sex and/or size limits (Vieira and Hohnen, 2007). An effort-based approach is technically not a catch share, but it may be a viable option for fisheries where a meaningful cap is too difficult to establish. For more discussion on effort-based approaches, see Step 2 – Define the Privilege.

Step 1 in Practice – Australian Southern and Eastern Scalefish and Shark Fishery

Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) is a good case study for Step 1 – Define and Quantify the Available Resource. The SESSF covers the entire southern coast of Australia, from Fraser Island in Queensland, to Cape Leeuwin in Western Australia. The fishery comprises nearly half of the waters within the Australian Fishing Zone and encompasses nearly all fishing activity. It is a commonwealth (federal) fishery managed by the Australian Fishery Management Authority (AFMA).

The SESSF is a multi-gear, multi-sector, multi-species fishery that was formed in September 2003 by combining multiple sectors that had been managed as separate fisheries, many under their own catch share programs (AFMA, 2007). The SESSF currently consists of six sectors under one management plan (AFMA, 2007):

- Scalefish Hook Sector
- Shark Hook Sector
- Gillnet Sector
- Great Australian Bight Trawl Sector (GABTS)
- Commonwealth Trawl Sector (CTS)
- East Coast Deepwater Trawl Sector (ECDWTS)

The gears used in the SESSF include scalefish hooks, shark hooks, gillnets, dropline, fish traps, long lines, demersal trawls, otter trawls, Danish seines and midwater trawls,. Individual Transferable Quotas were first introduced in 1992 to the trawl sector and were later implemented in the non-trawl sectors in 1998 (AFMA, 2007).

Since the introduction of shares, the system has rapidly grown from the 16 species to the current 34 species or species grouping. The species in the SESSF are managed as single stocks, except for orange roughy, gemfish and deepwater sharks. Annual catch limits are determined for each species or species groupings and the allocated shares can be traded across the different sectors (AFMA, 2007).

There are about 15 area closures created to protect fishing stocks, breeding groups, critical habitat and endangered species. The closures vary between sectors and gear type (e.g. some closures might be closed only for a specific gear types such as bottom trawls).

The SESSF, like many fisheries worldwide, has a complex array of species, gears, habitat and zones. The SESSF can shed light on how to design and implement catch shares and importantly, it shows that even a complicated and extensive fishery can be successfully managed under a catch share system.

Status: Based on available science, only 4 out of 34 species are overfished. Australia Fisheries Management Authority has developed stock rebuilding strategies to manage these stocks (AFMA, 2009a).

Step 1 in Practice – United States Mid-Atlantic Surfclam and Ocean Quahog Fishery

The United States Mid-Atlantic Surfclam and Ocean Quahog fishery offers a good case study of "Step 1 – Define and Quantify the Available Resource".

The Atlantic surfclam (*Spisula solidissima*) and the ocean quahog (*Arctica islandica*) are bivalve mollusks found primarily in the western North Atlantic region. The surfclam ranges from the southern Gulf of St. Lawrence to Cape Hatteras, North Carolina; the quahog can be found in the eastern Atlantic from around Iceland to as far south as Spain, and in the western Atlantic from Newfoundland to Cape Hatteras. Under the direction of the Mid-Atlantic Fishery Management Council, individual transferable quotas (ITQs) were implemented for the surfclam and ocean quahog fisheries in 1990 for their US range. The ITQ system allocates a fixed share of the Total Allowable Catch to fishermen or vessel owners, which can be sold or leased. This fishery is the first to be managed under ITQ in the United States (McCay, 2001).

Both the surfclam and ocean quahog are managed and assessed as single stocks in the United States, with particular regions of interest including, Georges Bank (GBK), Southern New England (SNE), Long Island (LI), New Jersey (NJ), Delmarva (DMV) and Southern Virginia/NC (SVA). The US surfclam commercial fishery is concentrated off the coast of New Jersey, the Delmarva Peninsula and on Georges Bank. The US ocean quahog fishery is concentrated off the coast of Maine and between Georges Bank and the Delmarva Peninsula (Jacobson and Wienberg, 2006).

Due to the biology of these species and the ecology of their key habitats there are relatively few regulatory discards or managed bycatch. Therefore, managers do not account for the catch of other species either through a multi-species catch share program or through gear restrictions to limit bycatch of non-target species. The principal type of gear used in this fishery is a hydraulic clam dredge (McCay, 2001).

The Surfclam Ocean Quahog Fishery Management Plan establishes an allowable range of harvest. Each year the Mid-Atlantic Fishery Management Council, in conjunction with an industry advisory panel, recommends specific catch limits.

Status: Currently the surfclam and ocean quahog stocks are not overfished and overfishing is not occurring (Jacobson and Weinberg, 2006).

Table 2 – Step 1 Design Options - The table below provides guidance on selecting design options based on your goals. The representative objectives – Ensuring Effective Stewardship, Maximizing Fleet-Wide Economic Benefit and Promoting and Improving Fishing-Related Jobs and Communities – are listed on the left side of the table along with goals within each objective, and all steps are represented across the top of the table. To use the table, review the guidance in the boxes below each step to understand which design options will help you meet your goals.

<table>
<tr><th colspan="3"></th><th>Species Included</th><th>Stocks Included</th><th>Spatial Range of Management Zone</th><th>Allowable Take for Each Species</th></tr>
<tr><td rowspan="4">Outcomes</td><td rowspan="3">Ensure Effective Stewardship</td><td>End overfishing</td><td rowspan="2">Include all species that are overfished, undergoing overfishing and/or need to rebuilt</td><td rowspan="2">Create separate shares for biologically-distinct stocks</td><td rowspan="2">To the extent possible, include entire biological range of species and stocks</td><td>Catch limits should account for all sources of mortality and should prevent overfishing</td></tr>
<tr><td>Rebuild stocks</td><td>Catch limits should account for all sources of mortality and should be set at a level to rebuild the stock</td></tr>
<tr><td>Reduce waste and bycatch</td><td>Include species that are commonly caught as bycatch</td><td colspan="2"></td><td>Regulatory and economic discards should be appropriately included as sources of mortality in the catch limit</td></tr>
<tr><td rowspan="2">Maximize Fleet-Wide Economic Benefit</td><td>Increased asset value due to long-term sustainability</td><td colspan="4">See "Ensure Effective Stewardship" outcome above</td></tr>
<tr><td>Address overcapitalization</td><td>Include species that are often caught on the same trip, by the same gear and/or are often sold together</td><td></td><td>Include all participants that encounter the species and stocks in question, regardless of their location</td><td>Consider setting the catch limit at the Maximum Economic Yield (MEY)</td></tr>
</table>

			Species Included	Stocks Included	Spatial Range of Management Zone	Allowable Take for Each Species
		Leverage the market place and encourage innovation				
	Promote and Improve Fishing-Related Jobs and Communities	Improve Jobs	See "Ensure Effective Stewardship" outcome above		Consider creating smaller sub-zones of management that align with sociopolitical boundaries, such as spatially-defined communities	See "Ensuring Effective Stewardship" outcome above
		Support and Promote Fishing Communities				
		Ensuring Fairness	Consider how different stakeholders interact with different species			

Design Worksheet
Step 1 – Define and Quantify the Available Resource

USE THIS SHEET TO RECORD YOUR NOTES AND DESIGN DECISIONS AS YOU WORK THROUGH THE DESIGN MANUAL

What are your goals?	

1. Which species will be included?

_____

2. Which stocks will be included?

_____

3. What will the spatial range of the catch share be and will there be different zones?

_____

4. What will be the allowable take for each species, stock and zone?

_____

At a Glance - Define and Quantify the Available Resource

The first step of designing a catch share is to define and quantify the available resources for the fishery. This means answering four key questions: which species will be included, which stocks will be included, what the spatial range will be, and what the allowable take will be for each of these units. By completing this step, your fishery will be addressing the key catch share attribute of **Capped**.

1. Which species will be included?

Catch share programs can accommodate any number of species, including both targeted species and non-targeted species, or bycatch. The species that are commonly caught together in the fishery should be considered for inclusion in the catch share program.

2. Which stocks will be included?

Many fisheries contain numerous and distinct fish stocks. These stocks may intermingle with each other at various points in time and may be targeted by a variety of different sectors. Furthermore, fishermen may catch fish from numerous stocks at once. Where biologically-based geographical distinctions have been identified, each stock should be managed with its own separate catch limit and shares.

3. What will the spatial range of the catch share be and should there be different zones?

The spatial range of a catch share can also be customized and is largely related to species and stock boundaries. If there are distinct biological stocks, then separate limits should be set for each stock to avoid stock depletion. Existing political and socio-cultural boundaries may also be important to establish zoning.

4. What will be the science-based allowable take for each species, stock and zone?

Setting the allowable take for each species and stock is a vital component for a catch share. The catch limit should account for all sources of fishing mortality and should prevent overfishing. If the stock is already overfished, the catch limit should be set at a level that will rebuild the stock.