1 Introduction

The combination of economic inefficiencies, competition for resources, and ecological declines in many of the world's fisheries has led to growing pressure to reform fisheries management. Two possible reform tools are the incorporation of market-oriented incentives and ecosystem-based approaches into management plans. In response, catch share programs are being increasingly implemented in commercial fisheries. Catch share programs are market-based fishery management programs that provide an individual fisherman, cooperative, or community the exclusive privilege to harvest a specified quantity (quota) of fish at any time within the fishing season or exclusive privileges to harvest within a specified area. Catch shares is an umbrella term that includes dedicated access privilege (DAP) programs, limited access privilege programs (LAPP), and individual transferable quota (ITQs) among others. Catch share programs are tailored to the specific economic, political, and biological conditions of a given fishery, and in some programs, such as ITQs, access privileges can be traded among vessels in the commercial fishery and between commercial and recreational sectors. Catch share management programs in the United States were first implemented in 1990 and have led to increased profits, decreased costs of gear and labor, and a safer and more stable industry (Dunnigan, 2005).

Despite these successes, catch shares have been limited to just a few commercial fisheries, and are virtually nonexistent in the recreational sector. While the operations and value-creating mechanisms of the recreational fishing sector are completely different than those of the commercial sector, in reality the two compete for the same resources. In fisheries where there is both a substantial commercial and recreational sector, this competition poses 4 problems: 1) the benefits accrued by catch share management in the commercial sector may be dissipated by the lack of parallel management in the recreational sector, 2) insufficient management of the recreational sector may have adverse environmental impacts, 3) society is not gaining from potential economic and social benefits of catch share management, and 4) regulating institutions that focus on one sector lack the capacity to manage competing sectoral interests. In any fishery in which multiple sectors compete for the same fish, management institutions will be unsuccessful unless they fully integrate all resource users into the management plan.

2 Objectives

The objectives of this group project were two-fold:

1. Create an analytical model to evaluate and compare the performance of different management scenarios that use catch shares. This model would analyze scenarios across economic, environmental, social and political criteria. Further, this model would be replicable such that any entity interested in catch share-based fisheries reform could easily duplicate this analysis in a similar fishery and compare the impacts of management scenarios in their specific fishery.
2. Use this analytical model to evaluate the management scenarios we created for the Nearshore Fishery in the Santa Barbara Channel and make a recommendation for management reform.

Different catch share management options were examined that integrate both the recreational and commercial sectors of a fishery into an integrated fisheries management plan. The area of focus was the Nearshore Fishery in the Santa Barbara Channel region, and the impacts of different management scenarios were compared across economic, environmental, social, and political criteria.

Because recreational fishing includes a number of entities with diverse professional and personal interest in the fishery, we divided the recreational fishery into two separate sectors.

- The recreational industry is the business sector that derives revenue from individuals who pay to go fishing on boats. The recreational industry includes Commercial Passenger Fishing Vessels (CPFVs) that accommodate up to 50 anglers per trip and "six pack" charter boats that take out a maximum of six anglers per trip. CPFVs are also commonly referred to as party boats, charter boats or head boats. CPFV, charter boat, and charter fishing vessels are used interchangeably throughout this report and all refer to the recreational industry sector.

- Recreational anglers are individual anglers who fish from shore or from their personal boats. These individuals may currently pay for fishing licenses, but they generally do not pay a third party each time they go fishing. Recreational anglers include shore-casters and anglers who fish from small boats that they operate. Recreational anglers who fish from man-made structures do not require fishing licenses. Both licensed and non-licensed recreational anglers purchase fishing equipment including rods, bait, and tackle. Recreational anglers may also participate in the recreational industry as paying customers of the recreational industry boats.

The Nearshore Fishery in California was an applicable choice for this study because it has been targeted for management reform (CDFG 2003), currently manages the recreational and commercial sectors separately (CDFG 2003), and the recreational sectors are responsible for the majority of the total catch (CDFG 2008). As a result, management reforms targeting the commercial sector may not be sufficient. The Nearshore Fishery is considered ecologically and economically unsustainable by many scientists and environmentalists (Environmental Defense 2007). In considering management reform for the Nearshore Fishery, there is interest in incorporating catch share-based programs into the management plan. It is not clear how the recreational sector will be incorporated into the management plan and what the costs and benefits would be if a catch share program was also implemented in the recreational sector.

Generally speaking, this project compared the impacts of three management scenarios that incorporate catch shares against a baseline scenario. Each scenario featured a different combination of management tools in which the commercial sector was rationalized to catch shares in all scenarios, and the recreational sector was progressively rationalized to catch shares in subsequent scenarios (Table 2.1).

Table 2.1. Generalized management scenarios

Scenario	Commercial	Recreational Industry	Recreational Anglers
Baseline	Catch shares Trading w/in sector	Managed using current regulations	
1	Catch shares Trading w/in sector	Catch shares Trading w/in sector	Current regulations
2	Catch shares Trading across sectors	Catch shares Trading across sectors	Current regulations
3	Catch shares Trading across sectors	Catch shares Trading across sectors	Catch shares Trading across sectors

We analyzed the three scenarios across four criteria that can be categorized as economic, environmental, social, and political. Within each category, we will design a standardized system of analysis used to evaluate each scenario. In evaluating the four management scenarios, we considered the impacts to the following stakeholders:

- Commercial fishermen
- Fishermen in the recreational industry sector
- Fishermen in the recreational angler sector
- Regulatory body
- Communities
- NGOs

The nearshore commercial sector was included as a stakeholder because changes in management scenarios would have a significant impact on numerous aspects of the industry, including expected catch, jobs, and revenue. While the commercial sector is only responsible for 15% of the current harvest, impacts on the environment and the surrounding communities can be quite profound (California Recreational Fisheries Survey (CRFS), 2008). This sector is dominated by hook and line and trap fishermen looking to sell their catch to live-fish vendors who distribute the fish to restaurants and fish markets in the Los Angeles area. In this analysis, the commercial sector was included in all models due to its affect on the criteria, or the criteria's affect on the sector.

Similarly, the nearshore recreational industry and recreational angler sectors were included as stakeholders due to their impact on the chosen criteria and the reciprocal impact of the criteria upon these particular stakeholders. The recreational industry sector, which includes Commercial Passenger Fishing Vessels (CPFVs) and charter vessels, is currently responsible for approximately 59% of the total harvest, making it the largest player in the Nearshore Fishery. Recreational anglers (anglers who fish from privately owned boats and from the shore) are responsible for the remaining 26% of the harvest (CRFS, 2008). Like the commercial industry, these two stakeholders will be affected by changes in management, and were included in all of the models in this analysis.

The regulatory body in this analysis was the California Department of Fish and Game (CDFG). CDFG is responsible for enforcing regulations and laws designed to protect and conserve California's diverse array of flora, fauna and habitat (CDFG, 2008). Because the analysis is focusing solely on the Nearshore Fishery, which falls almost entirely within state-regulated waters, CDFG is the only regulatory body considered as a stakeholder. While it was not included in the economic, environmental, or social models, CDFG is a significant stakeholder in the political model, as implementation of any of the proposed management scenarios will be dependent on CDFG's acceptance of those changes and its readiness to implement them effectively.

Communities were included in the social model because changes in management will greatly affect those who are dependent, or at least partially so, on the Nearshore Fishery for business or enjoyment. For the purpose of this analysis, communities included:

- Fishing related industries directly affected by fisheries management reform
    - Ports
    - Harbor
    - Boatyards

  - Fuel docks
  - Tackle shops
  - Fish processors
- Fish consumers directly affected by fisheries management reform
  - Fish markets
  - Restaurants
  - Asian live fish markets
- Tourism related industries indirectly affected by fisheries management reform
  - Hotels
  - Restaurants
- Ocean non-consumptive recreational industries indirectly affected by fisheries management reform
  - Kayaking and diving trip companies

Implementation of any of the proposed scenarios could greatly affect these stakeholders, as many of them rely on business brought in by the fishermen themselves, the opportunity to fish, tourism, recreation, and the prospect of locally caught seafood.

Non-governmental organizations (NGOs) were selected as a stakeholder because they often play a large role in the political process of approving natural resource management plans through lobbying efforts. Since they are usually the only political voices that represent the non-human species and the environment as a whole, their concerns tend to mirror those of the environment. These concerns need to be taken into consideration when analyzing any management reforms that will directly affect an environmental resource. One example of such an NGO is Environmental Defense, who is committed to solving environmental problems through collaborative efforts and is also our client for this project (Environmental Defense 2008).

Once we analyzed the impacts of each management scenario across criteria and for all stakeholders, we compared them and recommended the management scenario whose cumulative score was highest. Depending on how decision-makers weight the four criteria, their choice may be different. Finally, we propose how our analysis and methodology could be replicated to analyze management alternatives in other fisheries.

3 Significance of Project

The question of how best to manage commercial and recreational sectors of a fishery under a catch share program is relevant at local, regional, and national scales, and will have important economic, environmental, social, and political implications. Locally, the commercial sector of southern California's Nearshore Fishery is expected to implement an integrated management institution in the near future. This will hold particular importance for areas such as Santa Barbara and Ventura Counties, where a relatively large recreational sector presents an opportunity for direct interaction between the two sectors. However, there are few analyses of existing management institutions that integrate commercial and recreational sectors. Also, with the 1999 implementation of the Marine Life Management Act (MLMA) in California and its cross-sectoral implications, a framework for integration of the two sectors is needed. On a regional scale, catch share programs are becoming increasingly common along the West Coast, but again, policy makers have limited analyses to guide the design. Our client organization, Environmental Defense, recently completed a comprehensive analysis of catch shares in the commercial sector and concluded that catch shares generally lead to increased profitability, safety, stability, and decreased costs. Consequently, Environmental Defense has begun to engage with select fisheries where catch share management reforms may improve the performance of the fishery. However, neither their analysis nor existing published studies offer any guidance on the impacts of incorporating recreational sectors into these management reforms. Given the recreational sector's significant impact on regional fisheries, any management plan that does not integrate the recreational sector may fail to achieve the goals of the management plan. As a result, this study will contribute to both the catch share and recreational fishing literature. Further, it will present a tool that interested entities can use to examine the impacts of integrating the recreational and commercial sectors of any fishery into a catch share management scenario.

In addition, the Magnuson-Stevens Fishery and Conservation and Management Reauthorization Act of 2006 set forth the goal using market-based incentives, namely limited-access privilege programs, to protect and replenish America's fish stocks (Press Secretary 2007). This legislation makes the project particularly relevant to current trends and goals in fishery management reform at the national level.

4 Background

4.1 The Santa Barbara Channel and Nearshore Fishery

This project analyzes different management scenarios in the Santa Barbara Channel Nearshore Fishery which extends from Point Conception to Point Mugu, thus incorporating Santa Barbara, Ventura, Channel Islands and Port Hueneme harbors. The majority of our study region is within state jurisdiction, but some areas near Ventura also include waters beyond 3 nautical miles that are under federal jurisdiction (see Figure 4.1). The Santa Barbara Channel study area lies entirely within the California Department of Fish and Game's (CDFG) Southern Management Region, which extends from Point Conception in the north to the US/Mexico border in the south (CDFG 2003). This fishery includes significant recreational and commercial sectors. Competition between these two sectors has increased with the recent development of the commercial live-fish market.

Figure 4.1. Geographic scope of the project. The analysis focuses on the nearshore fishery between Point Conception and Point Mugu encompassing Santa Barbara, Ventura, Channel Islands, and Port Hueneme Harbors. Note that this project analyzes only the area off the California mainland and does not analyze the area surrounding the Channel Islands National Park.

4.1.1 Nearshore Fishery

The California nearshore is defined as ocean waters and substrate (the sea floor) from the mean high tide line to a depth of 20 fathoms (120 feet). High relief rocky reef, lush kelp beds, vast sand flats, and extensive surf grass fields make up the diverse habitats of this region. The complex ecosystem that thrives there is one of the most productive regions in the world and home to many species of marine organisms such as lobster, abalone, crabs, sea urchins, sea stars, mussels, marine mammals, several shore birds, and a diverse array of fish species. Nineteen of these finfish species are managed under California's Nearshore Fishery Management Plan (NFMP). Currently these species are jointly managed by the state under the NFMP and federally under the Groundfish Fishery Management Plan (GFMP) because a small percentage of waters less than 20 fathoms deep are beyond 3 nautical miles from the shore. These species are listed in Table 4.1, below.

Table 4.1 Species in the Nearshore Fishery	
1. California sheephead, *Semicossyphus pulcher*	11. Calico rockfish, *Sebastes dallii*
2. Cabezon, *Scorpaenichthys marmoratus*	12. China rockfish, *Sebastes nebulosus*
3. Kelp greenling, *Hexagrammos decagrammus*	13. Copper rockfish, *Sebastes caurinus*
4. Rock greenling, *Hexagrammos lagocephalus*	14. Gopher rockfish, *Sebastes carnatus*
5. California scorpionfish, *Scorpaena guttata*	15. Grass rockfish, *Sebastes rastrelliger*
6. Monkyface prickelback, *Cebidichthys violaceus*	16. Kelp rockfish, *Sebastes atrovirens*
7. Black rockfish, *Sebastes melanops*	17. Olive rockfish, *Sebastes serranoides*
8. Black-and-yellow rockfish, *Sebastes chrysomela*	18. Quillback rockfish, *Sebastes maliger*
9. Blue rockfish, *Sebastes mystinus*	19. Treefish rockfish, *Sebastes serriceps*
10. Brown rockfish, *Sebastes auriculatus*	(EPIC, 2007)

With its relative close vicinity to the coast and uniquely high productivity and diversity, the nearshore region is heavily utilized by the public for both recreational and commercial purposes. Additionally, life history characteristics of many of the nearshore species facilitate relative ease in catchability and exploitation, as well as sensitivity to habitat degradation from fishing practices. Rockfish, for example, often only occur in narrow depth ranges and within limited habitats. Furthermore, larval settlement is highly unpredictable and dependent on ocean currents with the long-lived, residential adult populations tending to move only short distances throughout their lives. Little is known about the current status of these populations and their ability to recover from heavy fishing impacts (CDFG 2003). As the human population of California continues to increase, the impacts on these resources have reached a critical level. The long-term sustainability of these nearshore species relies on a comprehensive and effective management institution that addresses all user groups.

The passage of the MLMA in 1999 mandated resource sustainability, science-based management, and the promotion of fishery sustainability in order to minimize socioeconomic impacts. It further mandated the use of marine protected areas (MPAs) and the development of regional fishery management plans to help reach these goals. The California Nearshore Fishery was a prime candidate for management reform. In adherence to the MLMA, in 2002 CDFG designed and implemented the NFMP with its own set of very similar goals. These include ensuring long-term resource conservation and sustainability, employing science-based decision-making, increasing constituent involvement in management, balancing and enhancing socio-economic benefits, and identifying implementation costs and sources of funding. In order to successfully facilitate the reaching of these goals, the NFMP employed five general measures:

1. Fishery Control Rules: This involves setting precautionary catch levels dependent on the amount of scientific knowledge for each species and then adjusting these catch levels as knowledge improves. To manage these rules, the CDFG uses size limits, time/area closures, and gear restrictions.
2. Regional Management: To address geographic differences in the nearshore fishery, the CDFG proposes tailoring management specific to each region. These regions are the four traditional regions used by CDFG: Northern, Bay Delta, Central, and Southern.
3. Marine Protected Areas (MPAs): MPAs will be used to ensure that ecosystem and habitat protection goals are met. The NFMP includes recommended approaches to help site MPAs for protection of nearshore species. MPAs will also be used for reference sites to assess natural species population abundance.
4. Restricted Access: The NFMP's restricted access approach is based on the Fish and Game Commission's (FGC) restricted access policy. These policies solely focus on commercial fisheries and include setting total allowable catches (TACs) and in some cases setting individual quotas. To make sure TACs are not exceeded there will be continued monitoring and seasonal closures if necessary.
5. Allocation: This is also reliant on FGC policy and mandates that TACs be allocated between commercial and recreational sectors based on historical catches on a regional level (CDFG 2003).

Since the implementation of the NFMP in 2002 there has been substantial progress. The CDFG has completed stock assessments for six nearshore species and collected essential fishery information (EFI), such as growth rates and age composition, for many of the other nineteen nearshore species. The CDFG has also made extensive efforts to consistently engage constituents in management discussions. Additionally, they have implemented improved recreational and commercial fishery data collection programs and achieved an active in-season management plan for cabezon, California sheephead, and greenlings. This includes TACs allocated in the recreational and commercial sectors, trip limits, and in-season monitoring of landings (CDFG 2006).
The 2008 allocation for these species are:

-California sheephead: 37% commercial, 63% recreational
-Cabezon: 39% commercial, 61% recreational
-Greenlings: 9% commercial, 91% recreational (CDFG 2008(c))

There are still no TACs set for any of the rockfish species and the current allocation based on historical catch is complicated because of the rapid development and persistence of the commercial live-fish fishery (CDFG 2007).

4.1.2 The Live-Fish Fishery

The live-fish fishery in southern California makes up nearly 100% of the Santa Barbara Channel region nearshore commercial fishing industries' catch.[1,2] Between 1989 and 1992, the number of commercial vessels targeting California sheephead for the fast growing live-fish fishery increased from 2 to 27 (CDFG 2004). Strong demand in Asian markets and restaurants in the Los Angeles area are largely responsible for this increase in the live-fish fishery. Many consumers are willing to pay high premiums for the freshest product, which they can hand select from live tanks (Lucas

[1] Hoeflinger, C. 2007. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[2] Lebeck, M. 2008. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.

2006). This new consumer base caused the live-fish fishery to quickly develop into a multi-million dollar industry within the entire state of California. Species other than California sheephead, such as cabezon and numerous rockfish species, are also targeted by the live-fish fishery. In the Santa Barbara Channel region the highest wholesale prices for live-fish are paid for Grass Rockfish ($12/pound) and Cabezon ($8/pound).[3,4] These prices are for plate-sized fish (under 16-inches in total length). Larger fish fetch about half the prices listed above because they are harder to sell in restaurants.[3,4]

4.1.3 Historical Recreational and Commercial Catch in the Nearshore Fishery

In response to a rapid increase in participation within the nearshore fishery, CDFG began to restrict access to the commercial sector by limiting the number of permits to fish. Before implementation of the NFMP in 1999, there were 1,128 participants in the commercial nearshore fishery in all of California, 712 of which had live-fish landings. CDFG responded by implementing nearshore fishing permits that limited the number of participants. By 2003, with a full restricted access program in place (the NFMP), the number of participants dropped to 216. In 2005, that number decreased even further to 202 participants and as of 2006 there were 191 participants with 68 in the Southern Management Region. CDFG's goal is to reach a participant level of 61 (CDFG 2006, Lucas 2006). Limiting permits to fish and thus limiting access to the fishery has drastically reduced the total landings in the commercial sector of the nearshore fishery. However, these regulations have not significantly reduced the fishing efforts and landings of the recreational sector shown in Table 4.2, which often exceed the commercial catch. In recent years (2004-06) the recreational sector has accounted for 85% of the total catch of rockfish species in the Santa Barbara Channel region, while the commercial sector has accounted for only 15% of the catch (RECFIN 2008). Within the four harbors considered in this project there were an estimated 14 CPFVs that operate year-round (Choy et al. 2007). The significant impact of the recreational sector on the nearshore fishery suggests that the recreational sector should be included in a management plan in order to achieve long-term sustainable management of the fishery and the other goals stated in the NFMP.

[3] Hoeflinger, C. 2007. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[4] Lebeck, M. 2008. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.

Table 4.2. Average annual weight in pounds of landings for the NFMP species before and after implementation of the NFMP restricted access program (CDFG, 2006)

	1998				2004			
	Annual Landings (Pounds)				Annual Landings (Pounds)			
Species	Recreational	Commercial	Total	Rank	Recreational	Commercial	Total	Rank
Blue rockfish	580,134	106,839	**686,973**	1	348,737	26,975	**375,712**	1
Cabezon	161,511	389,308	**550,819**	2	77,477	108,716	**186,193**	3
Black rockfish	257,175	189,813	**446,988**	3	233,628	125,015	**358,643**	2
California sheephead	160,649	262,441	**423,090**	4	47,139	87,243	**134,382**	4
California scorpionfish	182,668	112,758	**295,426**	5	94,716	11,051	**105,767**	8
Brown rockfish	95,718	121,851	**217,569**	6	62,372	54,245	**116,617**	6
Copper rockfish	94,621	121,731	**216,352**	7	57,358	11,130	**68,488**	9
Gopher rockfish	88,988	85,820	**174,808**	8	72,717	34,871	**107,588**	7
Olive rockfish	124,832	12,234	**137,066**	9	119,184	2,287	**121,471**	5
Grass rockfish	19,163	92,540	**111,703**	10	14,251	30,205	**44,456**	10
Black-and-yellow rockfish	13,024	58,108	**71,132**	11	5,532	23,180	**28,712**	12
China rockfish	16,394	29,350	**45,744**	12	16,882	5,142	**22,024**	13
Greenlings (all species combined)	25,751	17,549	**43,300**	13	25,347	4,524	**29,871**	11
Quillback rockfish	5,906	26,165	**32,071**	14	6,826	3,953	**10,779**	15
Treefish	21,803	560	**22,363**	15	9,577	1,554	**11,131**	14
Kelp rockfish	10,887	6,780	**17,667**	16	8,578	2,101	**10,679**	16
Monkeyface prickleback	4,171	78	**4,249**	17	7,542	82	**7,624**	17
Calico rockfish	623	0	**623**	18	392	0	**392**	18
Total All Species			**3,497,945**				**1,740,530**	

Notes: Recreational data is from Marine Recreational Fisheries Statistics Survey (MRFSS) in 1998 and California Recreational Fisheries Survey (CRFS) in 2004. Commercial data is from California Commercial data (CALCOM) for both periods.

4.2 The Tag System

One type of catch share program that has been used in limited recreational fisheries is harvest tag programs. Tag programs were adopted from big-game hunting and essentially allocate the owner of the tag the opportunity to harvest or take one individual of the target species. Johnston, et al. (2006) defines harvest tags as "paper documents or physical tags, typically issued by state natural resource agencies, authorizing the hunting or take of specified number of animals from a designated species, often at a specific time and place."

In most terrestrial harvest tag management programs, a hunter would have to acquire one tag for each individual animal that he or she plans to take. Once the animal has been taken, a harvest tag is attached to that animal as proof to the regulatory agency that the hunter has followed the regulations prescribed by the tag, and that the hunter has used one of his or her tags. In this manner, tags are associated with specific takes and there is less room for miscounting or accidental overages since the tag is matched to the animal at the time of take, and not counted after the harvest is finished.

The primary goals of terrestrial tag programs include controlling harvest, equal distribution of the opportunity to hunt, improving monitoring and enforcement, and providing biological data to the regulatory body. Successful harvest tag systems are used for big-game and water fowl management in many states in the US.

Compared with big-game and water fowl harvest tags, fish harvest tags are relatively new to fishery management, and were primarily designed to improve monitoring of stocks. Stock assessment becomes more accurate with harvest tags as the managing agency knows exactly how many tags have been distributed, and thus how many fish will be harvested. Harvest tags, when used in conjunction with catch share programs, work to eliminate derby fishing, control access to the fishery, and extend the length of the fishing season. Additional potential benefits of harvest tags in fisheries are the generation of revenue for the regulating body, and the integration of recreational and commercial fishing sectors. Currently, harvest tags are utilized in fisheries management in Florida, North Carolina, Maryland, Washington, and Oregon (Johnston et al. 2006).

According to many fishery managers, harvest tag systems have generally been successful in limiting total harvest or maintaining total harvest at desired levels. Results have been mixed regarding increasing the accuracy of catch and effort data, although this was dependent on whether or not reporting was mandatory. If tag holders are not required to report their catch, the amount of tags distributed may not accurately represent to total amount harvested. Some potential hurdles to implementing a harvest tag system included stakeholder education and support. In addition, some regulatory agencies have met resistance due to the perceived complexity and cost of harvest tags (Johnston et al. 2006).

4.3 Current Regulations in the Santa Barbara Channel Nearshore Fishery

The entire Santa Barbara Channel region is within the Southern Management Region of the California Department of Fish and Game and Pacific Fishery Management Council. The nearshore fishery is jointly managed by the two agencies (CDFG within 3 nautical miles and PFMC outside 3 nautical miles of the coast). There are different regulations for the commercial and recreational fishing sectors as described below.

4.3.1 The Commercial Sector

The commercial sector is regulated by gear type, season limits, and trip limits. In the nearshore fishery, all commercial fishing gear types used by fishermen are categorized as open-entry gear. These include hook and line and traps. Hook and line refers to "fishing sticks," which are small weighted pipes with multiple hooks attached to a buoy. Traps are modified lobster traps deployed and recovered within a few hours. The trip limits are bi-monthly catch limits that dictate how many pounds of fish one fisherman can remove in a two-month period. Commercial fishing is closed for all fish species in March and April. The trip limits for cabezon, greenlings, and California sheephead are set by CDFG. The trip limits for California scorpionfish and all remaining rockfish species (Minor Shallow Nearshore Rockfish) are set by the PFMC. Table 4.3 shows the trip limit values for all fish in the Santa Barbara Channel Nearshore Fishery.

Table 4.3 Commercial Regulations in the Santa Barbara Channel Nearshore Fishery (CDFG 2008(b)).

Commercial Regulations (Trip Limits)						
Species	**Jan/Feb**	**Mar/Apr**	**May/Jun**	**Jul/Aug**	**Sep/Oct**	**Nov/Dec**
Minor Shallow Nearshore Rockfish	600 lb / 2 months	CLOSED	800 lb / 2 months	900 lb / 2 months	800 lb / 2 months	600 lb / 2 months
Cabezon	300 lb / 2 months	CLOSED	250 lb / 2 months	150 lb / 2 months	900 lb / 2 months	100 lb / 2 months
Kelp or Rock Greenling	25lb / 2 months	CLOSED	25lb / 2 months	25lb / 2 months	25lb / 2 months	25lb / 2 months
CA Sheephead	2000 lb / 2 months	CLOSED	2400 lb / 2 months	2400 lb / 2 months	2400 lb / 2 months	2400 lb / 2 months
CA Scorpionfish	600 lb / 2 months	CLOSED	600 lb / 2 months	800 lb / 2 months	800 lb / 2 months	600 lb / 2 months

4.3.2 The Recreational Sector

The recreational sector is regulated by season limits, daily bag limits, minimum size limits and in-season closures. Boat-based recreational fishing is closed for all species during January and February with the exception of California scorpionfish, which is open all year. All species are open year-round to shore-based anglers. Daily bag limits are the total amount of fish per species or species complex that one angler is allowed to catch and keep in one day. Minimum size limits define the smallest total length that a fish must be in order to be kept. Minimum size limits are per species or species complex. Total length is the length from tip of head to tip of tail. All season limits, daily bag limits, and minimum size limits per species are found in Table 4.4. In-season closures are when CDFG prohibits catch of a certain species or species complex at any time of the year because the annual total allowable catch (TAC) limit has been reached. These only apply to cabezon, greenlings, and California sheephead, which have TACs set as explained in section 4.1.

Table 4.4 Recreational Regulations in the Santa Barbara Channel Nearshore Fishery (CDFG 2008(d)).

Recreational Regulations			
	Time Period	**Daily Bag Limit**	**Min. Size Limit**
RCG Complex (including all species of Rockfish, Cabezon, and Greenlings	Boat-based Anglers **Open:** Mar-Dec **Closed:** Jan, Feb Shore-based Anglers Open year-round	10 fish in combination per person; see sublimits for cabezon and greenlings	Rockfish NO size limit; see individual species and groups below
Cabezon	Boat-based Anglers **Open:** Mar-Dec **Closed:** Jan, Feb Shore-based Anglers Open year-round	1 fish per person; also included in the 10-fish aggregate RCG Complex bag limit	15" total length
Kelp or Rock Greenling	Boat-based Anglers **Open:** Mar-Dec **Closed:** Jan, Feb Shore-based Anglers Open year-round	2 fish per person; also included in the 10-fish aggregate RCG Complex bag limit	12" total length
CA Sheephead	Boat-based Anglers **Open:** Mar-Dec **Closed:** Jan, Feb Shore-based Anglers Open year-round	5 fish per person	12" total length
CA Scorpionfish	OPEN all year	5 fish per person	10" total length

5 Conceptual Model of Analysis

A conceptual model was constructed to illustrate the various components of our analysis and to show their interaction. This conceptual model is intended to illustrate our analysis process at a broad level. This conceptual model is shown in Figure 5.1.

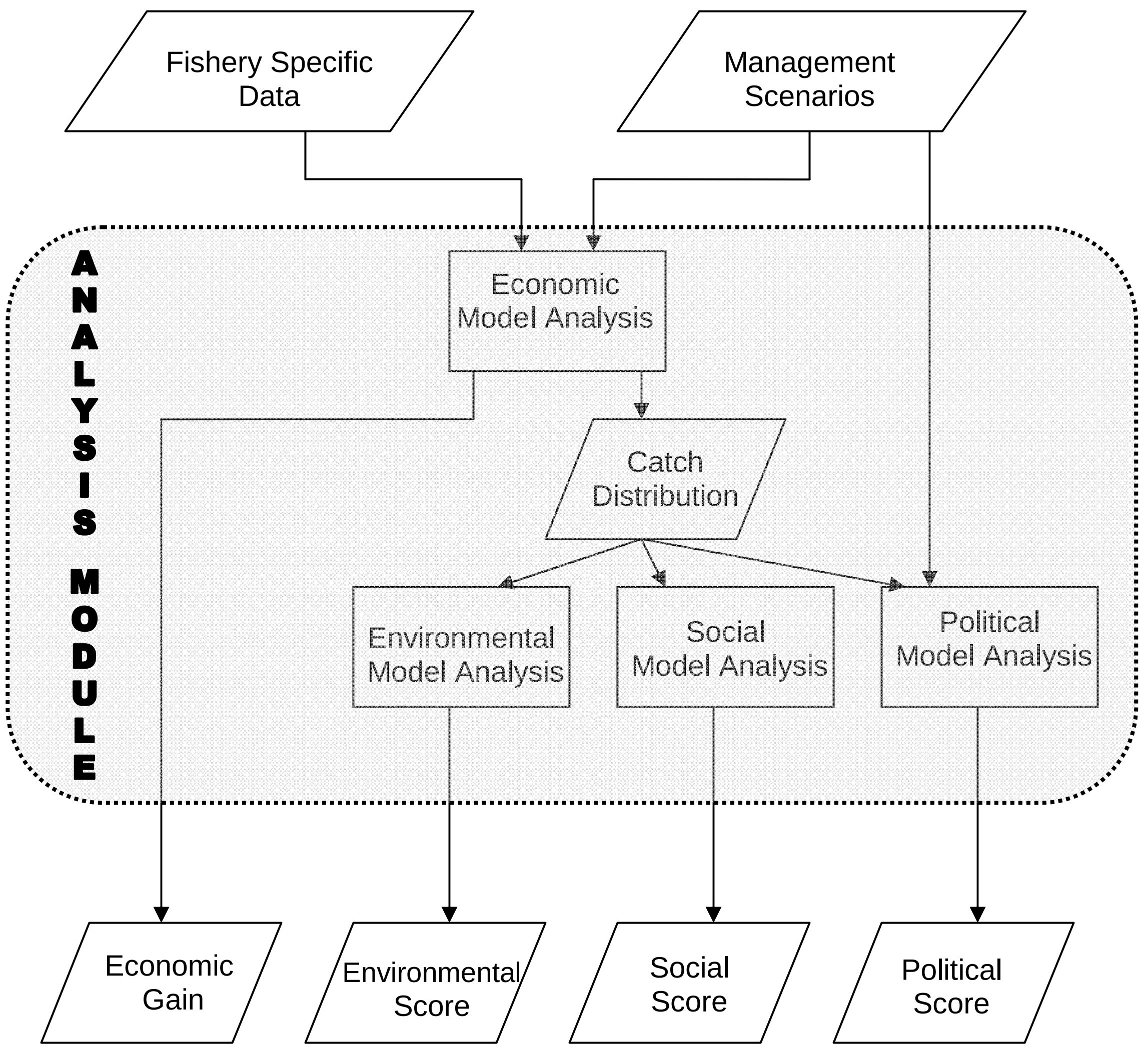


Figure 5.1. Conceptual model of the analysis process.

The shaded area in the conceptual model is the analysis module and can be viewed as a black box that takes inputs, performs the designed analysis, and generates the results of the analysis as the output.

There are two inputs to the analysis module. One input is fishery specific data, which includes information on historical catch, value of the landings, and distribution of catch between the various commercial and recreational sectors. Other fishery specific data may of a more qualitative character. Such data include the social value of a waterfront and recreational fishermen's view of a fish tag program.

The second type of input to the analytical module is the management scenarios to be analyzed. We used four catch share-based management scenarios that are outlined in section 6. The first scenario is the baseline scenario and all analyses are compared to this baseline scenario. Similarly, the results are reported as compared to the baseline scenario.

The output of the analysis module is a set of four numbers for each scenario. The first is the economic gain followed by the scores for the environmental, social and political parts of the analysis, respectively. The suite of outputs for each scenario can then be compared and, based on the management goals for that fishery, can be used to inform a recommendation for a management scenario. For example, if economic gain is of the highest priority, then a scenario with the highest economic gains would be a good candidate for recommendation. However, if the environmental outcome is a more important goal for the fishery, then a scenario with the higher environmental score would be favorable.

Further, we created a software program that performs the functions of the analysis module for the four scenarios that we analyzed in this study. This software program enables a user to replicate this analysis for other fisheries. A user can input the fishery-specific data from their target fishery, and the software will perform the analysis across the economic, environmental, social and political models. The software will generate performance scores for each management scenario as applied to the target fishery. This program is written in Excel VBA, and no specific software beyond Microsoft Excel is needed to run this program.

6 Management Scenarios

In order to analyze the effects of implementing catch shares in the commercial and recreational sectors of a fishery we had to first design specific management scenarios that defined in detail how the catch shares would operate. A tag system was used because it is the most well-understood and field tested means of integrating the recreational sector (Kim et al. 2006, Johnston et al. 2007). These management scenarios are referred to as the Nearshore Fishery Tag System (NFTS).

The NFTS is based on the recreational tagging systems used elsewhere in the country for terrestrial big game hunting such as bear hunting in Alaska (Alaska 2007) and deer and elk hunting in Idaho (Idaho 2007). In these tag systems, all resource users must acquire tags for the target species before they go hunting. Upon successful take of the target species, the hunter attaches a tag onto each individual animal taken. In the NFTS, one tag would be attached to the dorsal fin of each fish caught and kept from the nearshore fishery species listed in Table 4.1. These tags would be needed in addition to current fishing licenses required by CDFG.

In the commercial sector, attaching a tag to every fish that was caught and kept would significantly increase time and effort. Further, the commercial sector currently measures catch in pounds as opposed to individual fish. To accommodate these conditions in the commercial sector, a conversion factor could be used to convert pounds into tags for individual fish. For rockfish species in the Santa Barbara Channel region the conversion factor was set at 1.5lbs equal to one fish/tag.[5]

This analysis looked only at certain features of the NFTS across the hypothetical management scenarios. The four management scenarios can be seen as a spectrum ranging from least degree of tradability in the baseline scenario to most degree of tradability in scenario 3. When tags are not implemented in the recreational sector, the current management tools are present, such as daily bag limits and in-season closures. The features analyzed for each scenario, including the baseline

[5] Woods, C. 2008. "Average weight of rockfish in the nearshore fishery." Personal Communication. S. Choy. Santa Barbara.

scenario, are listed in Table 6.1. The scenarios will start with limited trading and progress toward full trading as other management tools are removed.

Table 6.1. Features of Designed Management Scenarios. This table shows the specific features of each management scenario. **X** demarks the presence of a specific feature in that scenario. **O** demarks trading between all sectors with an **O** mark for that scenario.

Feature	Management Scenario											
	Baseline			Scenario 1			Scenario 2			Scenario 3		
	Com. Ind.	Rec. Ind.	Rec. Ang.	Com. Ind.	Rec. Ind.	Rec. Ang.	Com. Ind.	Rec. Ind.	Rec. Ang.	Com. Ind.	Rec. Ind.	Rec. Ang.
Individual Quota / Tags	X			X	X		X	X		X	X	X
Tradability	X			X	X		O	O		O	O	O
"Rolling" or In-Season Closures		X	X			X			X			
Daily Bag Limits / Trip Limits		X	X			X			X			
Total Allowable Catch (TAC) Annual Limits	X			X	X		X	X		X	X	X

Notes:

Individual Quota/Tags meas this sector will have their own allotment of the total catch limit (TAC).

Tradability means the quota can be traded (bought or sold) to other individuals.

Rolling or in-season closures means take of specific species or complexes of species is prohibited by the CDFG for a specified amount of time during the regular fishing season.

Daily bag limits/trip limits means the total number of fish that can be caught in one day per person.

Total allowable catch (TAC) annual limits means the total number of fish that can be taken each year/season per sector.

A visual display of the trading schemes by scenario, where trading is allowed either within or across sectors, can be seen in Figure 6.1. Once again the resource users were divided into three categories: the commercial sector, the recreational industry sector (CPFVs), and the recreational angler sector (individual anglers that fish from private boats or shore).

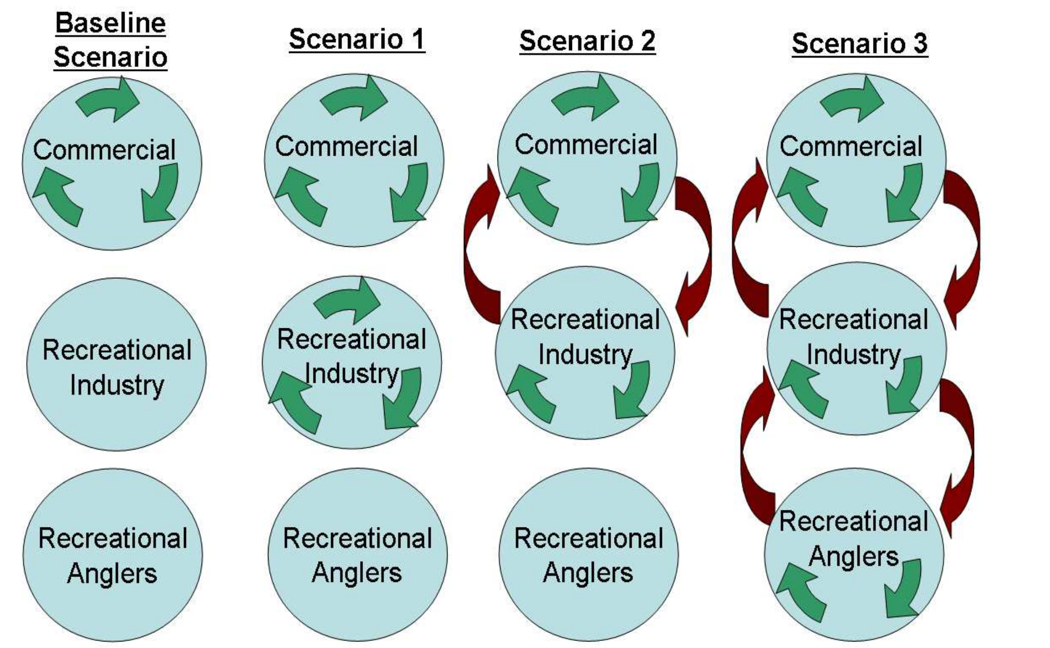


Figure 6.1. Trading Schemes Across All Proposed Management Scenarios and the Baseline Scenario. For each scenario the sectors are represented by separate blue circles. The green arrows in each circle represent tags that can be traded within that sector only. Red arrows indicate that tags can be traded across sectors.

6.1 Management Scenarios Defined

In order to analyze the management scenarios, some of the specific attributes of the management scenario must be defined. In designing management scenarios that could realistically be implemented in the nearshore fishery, we drew upon existing literature that examined management of the recreational sector, expert interviews with commercial and recreational fishermen, and management elements used in recreational tag systems implemented in other fisheries and with other game species (Alaska 2007, Idaho 2007, Johnston 2007, and Kim 2006).[6][7] For every scenario specifics are given for the three sectors.

6.1.1 Baseline Scenario

The baseline scenario assumes that the commercial sector has already been "rationalized" through the implementation of a catch share system. Incorporating tags in the commercial sector for the baseline scenario allows this analysis to focus solely on the impacts of integrating the recreational sector into fisheries management. All three of our hypothetical management scenarios are compared to this baseline scenario.

[6] Hoeflinger, C. 2007. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[7] McCrea, M. 2007. "CPFV Experiences." Personal Communication. J. Patterson. Santa Barbara.

Commercial Sector

All participants in the commercial sector are allocated a percentage of the commercial total allowable catch (TAC) for each species within the nearshore fishery in the form of tags. Tags can then be traded, bought, or sold among other tag holders within the same geographic management region designated in the NFMP (Southern Region). Trip limits are removed and fishermen are allowed to catch as many fish as they have tags for during any single trip. In-season or "rolling" closures will no longer be used because individual fishermen know how many fish they are allowed to catch at the beginning of the season based on their tag allocations. It is possible for individual fisherman to run out of tags and thus be done fishing for the remainder of the season unless they buy or trade for more tags from another fisherman. All annual seasonal closures set by the Fish and Game Commission and the Pacific Fishery Management Council remain intact. For this analysis the TAC for the entire commercial sector is set at the average historic catch level from 2004-2006.

Recreational Industry Sector

In the baseline scenario the recreational industry sector will be managed exactly as it is today with fishing licenses, daily bag limits, minimum size limits, and seasonal closures.

Recreational Angler Sector

In the baseline scenario the recreational angler sector will be managed exactly as they are today with fishing licenses, daily bag limits, minimum size limits, and seasonal closures.

6.1.2 Scenario 1

Scenario 1 sets a TAC and introduces tags into the recreational industry sector. This is the first time that any portion of the recreational sector is given an allocation of the TAC.

Commercial Industry

In scenario 1, the commercial sector is managed the same as it is in the baseline scenario.

Recreational Industry

A recreational industry TAC is set based on the average historic catch by this sector from 2004-2006 for all species or complex of species regulated under the NFMP. This TAC will be allocated among CPFVs and "6-pack" charter fishing vessels in the management region in the form of tags. Passengers on the CPFVs then use the vessel's tags for every fish they catch. Each CPFV operator will have to determine how to distribute his or her tags throughout the season. The tags are only tradable within the recreational industry sector and within the region where they are allocated. Daily bag limits will be removed while minimum size limits and annual seasonal closures remain in place. In-season or "rolling" closures will no longer be necessary because each CPFV will know how many fish they are allowed to catch at the beginning of the season based on their tag allocation. Under this system it is possible for a CPFV to run out of tags and be forced to stop fishing for the remainder of the season unless they wish to buy more tags, and tags are available from another CPFV in the region.

Recreational Anglers

In scenario 1 the recreational anglers will be managed exactly as they are today with fishing licenses, daily bag limits, minimum size limits, and seasonal closures.

6.1.3 Scenario 2

Scenario 2 introduces trade between the commercial sector and the recreational industry sector. This is the first time that there is cross-sectoral trading and a change in distribution of catch may occur.

Commercial Industry

In scenario 2, the commercial sector is allocated tags in the same way as it is in the baseline scenario. Under scenario 2, tags allocated to the commercial sector can be traded with the recreational industry sector in the same management region, in addition to being tradable within their own sector.

Recreational Industry

In scenario 2, tags are allocated to the recreational industry as they are in scenario 1; however, tags can now be traded with the commercial sector in addition to within their own sector.

Recreational Anglers

In scenario 2 the recreational anglers will be managed exactly as they are today with fishing licenses, daily bag limits, minimum size limits, and seasonal closures.

6.1.4 Scenario 3

Scenario 3 introduces tags in the recreational angler sector and trade across all sectors. This is the first time that the individual recreational anglers will be given an allocation of the TAC.

Commercial Industry

In scenario 3, the commercial sector is allocated tags in the same way as it is in the baseline scenario. Under scenario 3, tags can be traded with both the recreational industry sector and the recreational angler sector in the same management region, in addition to being tradable within their own sector.

Recreational Industry

In scenario 3, tags are allocated to the recreational industry as they are in scenario 1; however, tags can now be traded with the commercial sector and the recreational angler sector in addition to within their own sector.

Recreational Anglers

Scenario 3 allocates tags to the recreational angler sector based on the average historic catch of this sector from 2004-2006 for all species or complex of species regulated under the NFMP. Tags will be allocated to some form of recreational angling organization. Potential organizations that could be responsible for tag distribution are discussed in section 7.5: The Political Model and section 10: Discussion. Tags are tradable across all sectors within the same management region. Daily bag limits will be removed while minimum size limits and annual seasonal closures remain in place. In-season or "rolling" closures will no longer be necessary because there will be only enough tags allocated as the TAC allows. Individual anglers will be able to catch as many fish as they want as long as they have enough tags.

7 Methods and Results

7.1 Economic Model

The equimarginal principle in economics states that net benefits are maximized when the marginal benefits from an allocation of goods are equal for all users (Tietenberg 2003). Further, if the allocation of goods is such that the marginal benefits are not equal across all users, users will trade until the efficient point is met when the equimarginal principle is satisfied and net benefits are equal across all users.

Take the example of SO_2emissions from a coal-burning power plant, illustrated in Figure 7.1. In the absence of regulations, both firms emit 100 units SO_2 for a total of 200 units in the atmosphere. In this example, a policy is passed that mandates a 50-percent reduction in SO_2 emissions. One means of achieving this target would be to require each firm to reduce emissions by 50-percent. However, as Figure 7.1.a illustrates, the two firms face different costs to abate emissions. Firm B would undertake much higher costs to achieve their 50-percent reduction in emissions than Firm A, which is illustrated by their higher marginal abatement curve in Figure 7.1.a.

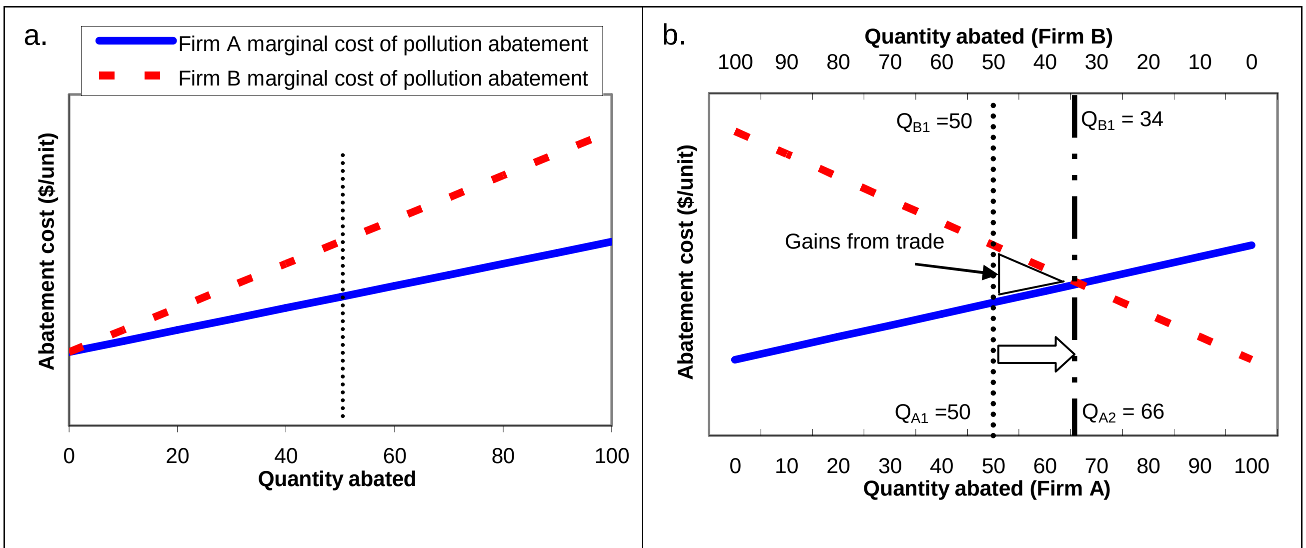


Figure 7.1 Equimarginal Principle

a. If a policy requires a uniform reduction in emissions across all firms, firms that have higher marginal abatement cost curves (Firm B) will undertake higher costs to achieve the same level of emissions reductions.

b. If emissions permits are issued to all firms, the same total emissions reductions can be achieved, but at a lower total cost because firms will buy and sell permits until all firms face the same marginal abatement costs.

An alternative means to achieve the emissions target of 100 units would be to allocate 50 emissions permits to each firm, and allow the firms to trade permits, illustrated in Figure 7.1.b. When each firm is issued permits for 50 units of SO_2 emissions, they face different marginal costs of abatement. However, in this scenario, Firm B can increase their emissions allowance by buying permits from

Firm A. The equimarginal principle suggests that Firm B will buy permits until both firms have the same marginal cost of abatement. In our example, Firm A will abate 66 units of SO_2, and Firm B will abate 34 units of SO_2. Firm B will buy 16 permits from Firm A. Both firms will benefit from the trade because Firm A will sell their permits at a price greater that their abatement cost, and Firm B will buy permits for less than their abatement costs. This will be the least-cost method to achieve the emissions target of 100 permits

In the context of this project, the equimarginal principle suggests that if the sectors of the nearshore fishery have a different marginal value for tags, they will trade until all sectors have the same marginal value for tags. As a result, the distribution of catch may shift such that the sector with the higher marginal value for tags after the initial allocation will purchase tags from sectors with lower marginal value for tags, resulting in that sector catching a larger portion of the total harvest.

In order to employ the equimarginal principle, and determine whether there would be a change in the distribution of catch, we had to determine the demand for tags in the different sectors.

7.1.1 Commercial Fishing Demand

To determine the commercial sector's demand for fish, data on the value and costs of the fish caught and the quantity of fish caught are needed. California Department of Fish and Game has extensive data for the Santa Barbara Nearshore Commercial Fishery. Landings in pounds and value of the landings by species are reported by ports. This data was obtained from years 2000 to 2006. The five ports in the Santa Barbara Channel regions used for this study were Port Hueneme, Santa Barbara Harbor, Ventura Harbor, Oxnard Harbor and Gaviota Harbor. The majority of the landings were reported from the Santa Barbara, Oxnard and Ventura harbors. Data for a subset of the nineteen nearshore species were selected. These twelve subset species were selected in order to be consistent with the species identified in the contingent valuation survey for the recreational demand and include all rockfish species except Black rockfish (*Sebastes melanops*), which are rarely caught in the Southern Management Region where our study took place. A list of these species is in Table 7.1.

Table 7.1. List of species used in determining demand for fish in the commercial sector.
Black-and-yellow rockfish, *Sebastes chrysomelas*
Blue rockfish, *Sebastes mystinus*
Brown rockfish, *Sebastes auriculatus*
Calico rockfish, *Sebastes dallii*
China rockfish, *Sebastes nebulosus*
Copper rockfish, *Sebastes caurinus*
Gopher rockfish, *Sebastes carnatus*
Grass rockfish, *Sebastes rastrelliger*
Kelp rockfish, *Sebastes atrovirens*
Olive rockfish, *Sebastes serranoides*
Quillback rockfish, *Sebastes maliger*
Treefish rockfish, *Sebastes serriceps*

An average value per pound of fish was calculated for the 12 species from the five ports in the Santa Barbara Channel region for each year between 2000 and 2006. The values were adjusted for inflation and reported in $2007. This average value is reported per unit pound. The economic analysis is performed on a per fish basis and a conversion factor of 1.5 pounds per fish was used to convert the average value in units of fish. The 1.5 pounds per fish conversion factor was determined from expert interviews. This average price data represents benefit to the commercial fishing sector per fish. Table 7.2 summarizes the results for the benefits calculations.

Table 7.2. Average landings and price per fish from years 2000 to 2006 in the Santa Barbara Channel region. (CDFG,2000)

Year	Average landings (fish)	Average price per fish ($2007)
2000	93176.00	10.22
2001	96919.33	11.52
2002	68590.00	11.47
2003	47737.33	13.44
2004	39860.00	11.52
2005	22642.00	11.90
2006	28350.67	14.38

The cost information for these species landed during the 2000 to 2006 period was not available. Cost information from this fishery from other time periods were also lacking. We were able to obtain cost data from the southern California white seabass fishery in 2000 from California Department of Fish and Game. The operating cost was associated with the "Set Long Line" mode of fishing for white seabass. The operating costs included crew salaries, fuel, maintenance, repair, insurance, license, permits, gear, and equipment. This data was used as a proxy for the cost of the Santa Barbara Nearshore fishing sector. Adjusted for inflation, we calculated the cost to be $4.79 per fish. Interviews with two local commercial fishermen from the nearshore fishery provided very rough estimates on the cost per trips and confirmed that the white seabass cost are within the range of cost values reported by the two local commercial fishermen.[8][9] The seabass cost data provided one data point for the cost function. From interviews with local fisherman, we determine that the cost was somewhat constant, and not highly dependant on the quantity of fish landed. Thus the marginal cost per fish was assumed to be constant.

Marginal benefits for the commercial sector are defined by the difference between the benefits and the cost estimates. These values were regressed with landing data (measured in fish) to derive a marginal benefits curve as a function of quantity of fish. A linear regression model was used and the resulting slope coefficient is -7.27×10^{-5} with a Y-intercept of $11.40. This marginal benefits function represents the demand, or willingness-to-pay, for tags in the commercial fishing sector.

The nearshore fishery primarily sells to the live fish market, and currently there is no market for frozen fish for these species. But if the live fish market becomes saturated, commercial fisherman may sell to the frozen fish market. The market price for frozen fish is much lower than live fish

[8] Hoeflinger, C. 2007. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[9] Lebeck, M. 2008. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.

prices. Using literature review from other markets (Howard, 2007), we estimate the net benefit to be about $.50 ($2007) per fish when the frozen fish market dominates the market. Figure 7.1 illustrates the marginal benefits for fish for the commercial fishing sector in the Santa Barbara Channel region taking the frozen fish market into account.

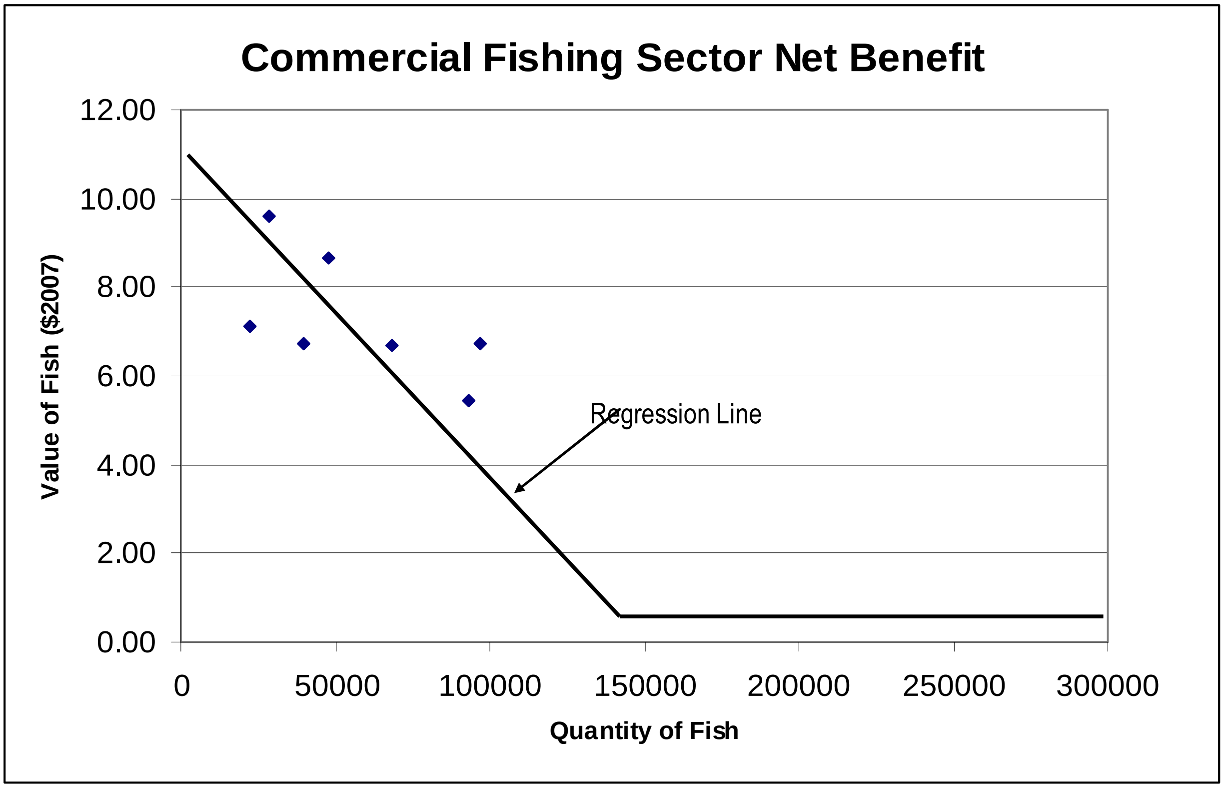


Figure 7.1: Net benefit function for fish for the Santa Barbara Channel Region Nearshore Commercial fishery.

7.1.2 Recreational Sector Demand for Tags

It is relatively straightforward, at least conceptually, to calculate the value of fish in the commercial sector, and thus to derive a marginal benefit curve for fish in the commercial sector. However, it is much more difficult to determine the value of fish in the recreational sectors.

The construction of demand curves for the recreational sectors requires data on anglers' marginal willingness to pay (WTP) for fish. After a thorough examination of the literature, we found sparse information on the value of fish to recreational anglers (CITE – find Linwood piece). There have been a number of studies that examine marginal willingness to pay (WTP) for fishing trips. However, these studies vary greatly in the fisheries they examine, the types of recreational fishing, the geographic scope, and the methodology. Further, most studies calculate the WTP for a *fishing trip*, and then use the average number of fish caught per trip to estimate the average WTP per fish.

Estimating the WTP per fish using the WTP per trip and the average catch per trip can result in an overestimation of the WTP per fish because this technique does not consider the other goods that anglers receive on a fishing trip. In fact, people go fishing for a number of reasons that include catching fish for a food source, catching fish for sport, experience on a boat, time with friends, opportunity to see marine mammals, and so forth. Because a fishing trip bundles all of these non-market goods, one cannot distill the value of a fish from these other goods by using the average catch. As a result, calculations of the average WTP for fish are too high because they don't extract the non-market goods that are bundled with the fish.

Further, constructing a demand curve for tags requires information on *marginal* WTP per fish. Studies that use the average catch rate and marginal WTP per trip are calculating the average WTP per fish, not the marginal WTP per fish.

Due to the limitations in the existing literature, we conducted a contingent valuation survey to ground truth the estimates from the literature and test our hypothesis that these studies overestimated with the WTP for fish.

<u>Studies of Recreational Fishing Values in the Literature</u>

Johnson, Ranson et al. (2006) conducted a meta-analysis of studies that calculated the WTP per fish among recreational fishermen. They examined 391 observations in 48 studies. They found that 87% of the studies reported a linear relationship between WTP and quantity. This study concluded that WTP per fish "is systematically sensitive to variation in resource, context, and angler attributes" (27).

Johnson, Ranson et al. (2006) report that the studies that used a revealed preference approach to determine WTP per fish used the average catch per trip and thus calculated the average WTP per fish, not the marginal WTP per fish. Further, these studies did not consider the other non-market goods that an angler receives on a fishing trip such as experience on the water, time with friends, marine mammal sightings, and so forth.

Because WTP per fish is sensitive to "variation in resource, context, and angler attributes" (Johnson, Ranson et al. 2006, p.27), a benefits transfer approach must be limited to studies that include similar types of fisheries, including the specific circumstances and regulatory environment. As a result, we identified two studies that might be appropriate for benefits transfer.

In a 1986 National Marine Fisheries Service study, Wegge, Hanemann, and Strand (1986) examined the economic importance of marine recreational fishing in southern California from Point Conception to the Mexican border. In this study, the authors estimated the per trip use value by four different modes of fishing: charter boat, private boat, shore, and rental boat. The Wegge, Hanemann et al. (1986) study presented two models to estimate WTP for fishing trips.

Demand equation based on the theory of collapsible versus separable time:
WTP = fcn (income, available time, actual costs, travel time, fish caught)

Conventional demand equation:
WTP = fcn (actual cost, fish caught)

Using the "conventional demand" equation, Wegge, Hanemann, et al. calculated a WTP per trip of $121.88 ($56.47 in 1983 dollars and corrected for inflation to 2007 dollars). Using the average catch rate per trip, they estimated a WTP per fish of $14.51 (2007$). Note that this is an average WTP per fish and does not account for other non-market values of a fishing trip.

In a 1985 National Marine Fisheries Service study, Rowe, Morey, et al. (1985) examined the value of marine recreational fishing along the Pacific coast in which they estimated the value of a typical fishing day for different locations and target catch. Similar to the Wegge, Hanemann, et al. study, the Rowe, Morey et al. study focused their analysis on WTP per trip. In their analysis of rockfish and bottom fish, Rowe, Morey at al. found that increasing expected catch by one fish would increase trip value by $5.85 (2007$) in Ventura County and $3.47 (2007$) in Santa Barbara County. Rowe, Morey et al. explicitly note that "these are not per fish values, but marginal increases in the value per trip for increased in expected catch by one fish" (1985, p.5-19).

Estimating WTP for tags

Neither the estimates from the Wegge, Hanemann, et al. (1986) study nor the Rowe, Morey, et al. (1985) study were appropriate for benefits transfer approach because both studies focused primarily on WTP per trip. Further, theses studies did not account for the non-market goods in addition to fish that a recreational fisherman benefits from when on a fishing trip. Finally, these studies provided only point estimates of WTP at a single quantity of trips, and there was not enough information to derive an entire demand curve.

Because of our hypothesis that the WTP estimates from the literature overestimated the value of fish to recreational anglers, a contingent valuation survey was conducted to ground truth these estimates. Recreational fishermen were intercepted at the Sea Landing in Santa Barbara, California on their way to go fishing on the commercial passenger fishing vessel *Stardust* for the day. A written survey was administered which solicited demographic information, expected catch, fishing behavior and frequency, and knowledge, values and perceptions towards fishing, fishing management and a working waterfront. The survey then described the tag system, presented the respondents with a hypothetical tag price randomly assigned between $0.50 and $8.00 and asked individuals how many tags they would purchase for the current day's trip. In the survey, we simplified the explanation of the tag system to include only rockfish (twelve of the nineteen species in the nearshore fishery are rockfish) since this is the most frequently caught fish in the nearshore fishery and the most widely recognized by anglers. The survey can be found in Appendix I.

Ninety-seven surveys were administered to CPFV passengers, 78 were sufficiently complete to include in analysis. Using ordinary least squares (OLS) regression analysis, we created a model that predicted demand for tags as a function of tag price, expected catch, age, and number of trips on a charter boat per year. Using the mean age, mean expected catch, and mean number of trips taken on a charter boat per year, a WTP for tags curve was constructed for an individual as a function of price per tag. Generally speaking, the mean expected catch and annual number of charter trips was similar to the means reported by Wegge, Hanemann, et al. (1986). Wegge, Hanemann, et al. (1986) did not report the mean age.

It should be noted that 12 surveys were administered to private boaters launching from Santa Barbara Harbor that differed from the surveys targeting anglers on CPFVs in the demographic and boat ownership questions asked. There were not sufficient responses to these surveys to include them in the analysis, but trends observed in the private boater surveys were consistent with the trends found in the CPFV.

Table 7.3. Model of tag demand in recreational industry as a function of expected catch, age, annual number of trips on a charter fishing boat, and tag price

Adjusted R square	0.36			**Mean value from survey**	**Stand. Dev.**
Variable	**Coefficient**	**t-stat**	**p-value**		
Intercept	8.489	4.528	2.27E-05		
Expected Catch (C)	0.428	2.412	0.018	7.8	2.9
Age (A)	-0.089	-2.480	0.007	37.6	16.9
Annual no. charter trips (R)	-0.143	-2.765	0.015	8.3	9.0
Price (P)	-0.646	-3.168	0.002		

$$Q_{T_{I_i}} = \alpha_I + \beta_I(C_i) + \delta_I(A_i) + \lambda_I(R_i) + \sigma_I(P_i) + \varepsilon_i$$

Variable explanation

Expected Catch (C) means the number of rockfish that an individual angler expects to catch and keep on the fishing trip to be undertaken that day under the current fishing regulations. The positive coefficient of 0.428 means that as the expected number of fish caught increases, the quantity of tags demanded will increase. More specifically, this model predicts that for an increase in expected catch of 1, the angler would buy 0.428 tags. There is not a one-to-one relationship between the expected catch and the number of tags demanded because fishermen may alter their behavior, and for example may choose to catch and release or to catch less fish.

In the survey, it was found that the mean expected catch on charter fishing trips was 7.8 fish. Wegge, Hanemann, et al. (1986) found a mean catch of 9.2 fish on charter trips.

Age (A) means the age of the individual angler. The negative coefficient of -0.089 means that older anglers are predicted to buy fewer tags. More specifically this means that for every additional year in age, an angler is predicted to buy .089 less tags. As a result, the model predicts that for two anglers who are 11 years different in age, but expect to catch the same number of fish and go on the same number of charter fishing trips per year, the younger angler will buy 1 more tag if faced with the same tag price. One explanation may be that the enthusiasm to catch lots of fish tempers with age.

The survey found that the mean age for anglers on charter fishing trips was 37.6 years. Wegge, Hanemann, et al. (1986) did not report this data.

Annual no. charter trips (R) means the number of trips on a charter fishing vessel that an angler takes in a year. The negative coefficient of 0.143 means that the more times an angler goes fishing on a charter fishing vessel per year, the less tags they would buy for a single charter fishing trip. This means that if angler A goes on 7 more charter fishing trips in a year than angler B, and the two anglers have the same age and expected catch, angler A will buy 1 less tag than angler B for a single charter fishing trip. One explanation for this negative coefficient may be that an angler who goes on more charter fishing trips is content to spread their annual catch over a number of trips, while an angler who goes on charter fishing trips less frequently wants to maximize their catch on their fewer trips.

In our survey, we found that the mean number of charter fishing trips taken per year was 8.3. Wegge, Hanemann, et al. (1986) found a mean of annual number of charter trips of 8.3.

Price (P) means the price per tag. Respondents were randomly assigned a tag price between \$0.50 and \$8.00 per tag and asked how many tags they would buy for the day's fishing trip. The negative coefficient of 0.646 means that for every three-dollar increase in the cost of a tag, an angler will buy 2 less tags. This suggests that tags are a normal good and that anglers respond to increases tag costs by decreasing demand, and thus catching less fish. Note that the price variable has the coefficient largest in magnitude, which means that the quantity of tags demanded responds more strongly to price than any of the other variables.

Quantity of tags demanded by the recreational industry (Q_{T^I}) means the number of tags that an angler on a charter fishing trip is predicted to buy given their age, expected catch, annual number of charter trips, and tag price.

This model predicts the number of tags that would be demanded by a single angler on a charter fishing vessel at different tag prices. In order to get the demand curve for the entire sector, we used information on the total number of angler trips made in 2005 on charter fishing vessels in the Santa Barbara Channel region as reported by the *California Recreational Fisheries Survey 2005 Annual Review: Report to the California Fish and Game Commission* (2006) (CRFS 2006). CRFS 2006 defines the Santa Barbara Channel region as Santa Barbara and Ventura Counties encompassing the same four harbors as covered in this project. CRFS 2006 reported that 33,118 angler trips were made on charter fishing vessels in the Santa Barbara Channel region in 2005.

Demand for tags on single angler trip in recreational industry sector:

$$Q_{T_{I\,i}} = \alpha_I + \beta_I(C_i) + \delta_I(A_i) + \lambda_I(R_i) + \sigma_I(P_i) + \varepsilon_i$$

$$Q_{T_{I\,\bar{i}}} = 8.489 + 0.428(C_{\bar{i}}) - 0.089(A_{\bar{i}}) - 0.143(R_{\bar{i}}) - 0.646(P_i)$$

$$Q_{T_{I\,\bar{i}}} = 7.288 - 0.646(P_i)$$

Demand for tags by recreational industry sector in one year:

$$Q_{T_I} = 33{,}118 * Q_{T_{I\bar{i}}} = 33{,}118 * (7.288 - 0.646(P_i))$$

In the description of the tag system in the survey, we told respondents that they would receive 10 free tags per year with the purchase of an annual license. We asked respondents how many tags they would buy at a given cost per tag, assuming that they had already used all of their free tags. As a result, the above demand curve must be adjusted to account for the free allocation of tags.

In order to estimate how many tags would be allocated for free, we needed information on the number of annual licensed issued in Ventura and Santa Barbara Counties. However, we could not find information about how many annual licenses were bought in the two counties. Instead, we used information on the number of ocean enhancements purchased in Ventura and Santa Barbara Country. Many anglers augment their annual license with an ocean enhancement stamp. An ocean enhancement costs $4.45 and is required to fish in ocean waters in Santa Barbara and Ventura Counties. An ocean enhancement is not required when fishing under one- or two-day licenses (http://www.dfg.ca.gov/licensing/fishing/fishdescrip.html). We found that in 2006, 9,617 ocean enhancement stickers were purchased in Ventura and Santa Barbara Counties (CDFG and US Census). We used this number as a proxy for the number of annual licenses purchased in Ventura and Santa Barbara Counties.

By assuming that 9,617 annual licenses were purchased in Ventura and Santa Barbara counties, we calculated that 96,170 free tags would be allocated. These free tags would be distributed between the recreational industry sector and the recreational angler sector. Because 70-percent of the total recreational harvest is caught by the recreational industry sector (RecFIN 2008), we calculated that 70-percent of the free tags (67,319 tags) would be allocated to the recreational industry sector. As a result, we shifted the demand curve for tags in the recreational industry out by 67,319.

Demand for tags by recreational industry sector in one year accounting for free tags:

$$Q_{T_I} = 67{,}319 + (33{,}118 * Q_{T_{I\bar{i}}}) = 67{,}319 + (33{,}118 * (7.288 - 0.646(P_i)))$$

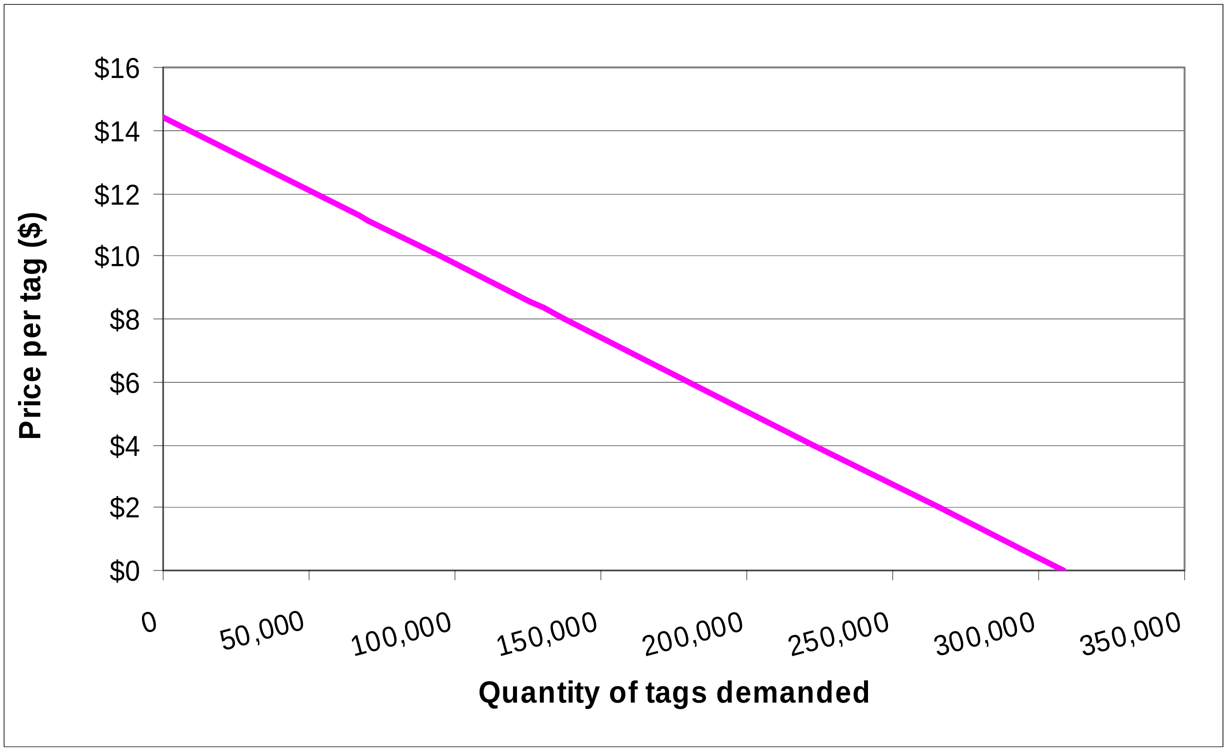


Figure 7.3 Demand for Tags by Recreational Industry Sector, holding age, expected catch and annual number of charter fishing trips constant.

Recreational Angler Demand for Tags

Our survey targeted the recreational industry. However, survey results revealed that many individual anglers who fish on charter fishing vessels also fish from private boats and from shore. This indicates that a number of individual anglers participate in both the recreational industry sector and the recreational angler sector. Due to the limited scope of our survey and the substitutability of trips in the recreational industry sector and the recreational angler sector, we assumed that anglers in the recreational angler sector have similar demand responses to age, expected catch, and tag price to those in the recreational industry sector. Using the data from the recreational industry survey, we created a regression model to determine the WTP for tags by an individual recreational angler. The recreational angler model predicted demand for tags as a function of tag price, expected catch and age. Number of trips on a charter boat per year was dropped from this model, and we did not have information on anglers' number of fishing trips to shore or on private boats per year.

For this study, it was assumed that all recreational anglers had the same demand response to age, expected catch, and tag price. Applying this assumption to anglers on private boats seems appropriate because the characteristics and bundle of goods of a fishing trip on a charter boat are very similar to the characteristics and bundle of goods of a fishing trip on a private boat. It might be considered a greater challenge to apply these assumptions to shore anglers; however, we feel that this did not significantly weaken the analysis given the small percentage of the total nearshore fishery harvest that is caught by shore anglers. If this study were to be replicated, we suggest allocating sufficient resources to perform a full contingent valuation survey where anglers in all fishing modes are surveyed.

Table 7.4. Model of tag demand in recreational angler sector as a function of expected catch, age, and tag price				
Adjusted R square	0.31			**Mean value**
Variable	**Coefficient**	**t-stat**	**p-value**	
Intercept	8.479	4.373	3.95E-05	
Expected Catch (C)	0.329	1.841	0.070	7.8[a] ; 1.0[b]
Age (A)	-0.099	-2.986	0.004	37.6[c]
Price (P)	-0.659	-3.124	0.002	

a: We assumed anglers on private boats expect to catch 7.8 fish per trip. This is the mean expected catch from the recreational industry survey. Wegge, Hanemann et al. (1986) report a mean catch rate of 9.3 on private boat trips targeting bottomfish.
b: We assumed anglers from shore expect to catch 1 fish per trip.
c: Mean angler age from survey. This is the same value used in the model to predict demand for tags in the recreational industry sector.

$$Q_{T_{A_i}} = \alpha_A + \beta_A(C_i) + \delta_A(A_i) + \sigma_A(P_i) + \varepsilon_i$$

Because of the different catch rates for shore anglers and private boat anglers, we divided the recreational angler sector into two sub-sectors and calculated their demand curves separately. Shore anglers fish from beaches and banks. Shore anglers have lower catch rates for fish in the nearshore fishery. Private boaters fish from private boats owned either by themselves, family or friends. For our analysis, we assumed that fishermen on private boats had the same fishing behavior and demographic characteristics as fishermen on charter boats.

The following equation predicts the quantity of tags demanded by an average angler in the private boat sub-sector:

$$Q_{T_{A(B)\,i}} = \alpha_A + \beta_A(7.8) + \delta_A(37.6) + \sigma_A(P)$$

The following equation predicts the quantity of tags demanded by an average angler in the shore sub-sector:

$$Q_{T_{A(S)\,i}} = \alpha_A + \beta_A(1) + \delta_A(37.6) + \sigma_A(P)$$

Variable explanation

Expected Catch (C) means the number of rockfish that an individual angler expects to catch and keep on the fishing trip to be undertaken that day under the current fishing regulations. The positive coefficient of 0.329 means that as the expected number of fish caught increases, the quantity of tags demanded will increase. More specifically, this model predicts that for an increase in expected catch of 1, the angler would buy 0.329 tags. There is not a one-to-one relationship between the expected catch and the number of tags demanded because fishermen may alter their behavior, and for example may choose to catch and release or to catch less fish.

For private boaters, the mean expected catch from the survey of 7.8 fish was used. Wegge, Hanemann, et al. (1986) found a mean catch of 9.3 fish on private boat trips targeting bottomfish. Note that the Wegge, Hanemann, et al. (1986) found that the mean catch on charter boats and private boats differed only by 0.1 fish. While the catch rate may have changed since 1986 due to changes in the fish stock and the like, it is reasonable to assume that the catch rate for anglers on charter boats and private boats would still have a similar relationship to each other as they did in 1986.

For shore anglers, an expected catch of 1 fish per trip was used. Wegge, Hanemann, et al. (1986) found that the mean catch for shore trips was 4.7 fish. However, most shore anglers caught surfperch, and only 6-percent of catch was rockfish. As a result, the majority of shore anglers are not targeting and do not expect to catch fish in the nearshore fishery. Our model is applicable only to anglers in the nearshore fishery. As a result, we assumed that shore anglers targeting the nearshore fishery would have a catch rate of 1 fish per trip. In order to scale up to the entire sector, we had to determine the percentage of total shore angler trips that target the nearshore fishery. Using Wegge, Hanemann, et al.'s finding that 6-percent of the catch from shore was rockfish, we assumed that 6-percent of shore trips targeted the nearshore fishery, and on those shore trips targeting the nearshore fishery, there was an expected catch of 1.

Age (A) means the age of the individual angler. The negative coefficient of 0.099 means that older anglers are predicted to buy fewer tags than younger anglers. One explanation may be that the enthusiasm to catch lots of fish tempers with age.

The mean angler age from the survey was used.

Price (P) means the price per tag. The negative coefficient of 0.659 means that for every three-dollar increase in the cost of a tag, an angler will buy two less tags. This suggests that tags are a normal good and that anglers respond to increases tag costs by buying less tags, and thus catching less fish. Note that the price coefficient is the largest in magnitude in the model, which means that the quantity of tags demanded responds more strongly to price than any of the other variables.

Quantity of tags demanded by the recreational angler from a private boat ($Q_{TA(B)\,i}$) means the number of tags that an angler on a private boat is predicted to buy given their age, expected catch, and tag price.

Quantity of tags demanded by the recreational angler from shore ($Q_{TA(S)\,i}$) means the number of tags that a shore angler is predicted to buy given their age, expected catch, and tag price.

Shore sub-sector

These models predict the number of tags that would be demanded by a single angler at different tag prices. In order to determine the demand curve for shore anglers as a sub-sector, we used information on the total number of angler trips made from shore in 2005 in the Channel Region as reported by the CRFS Annual Review in combination with knowledge about the number of shore trips targeting the nearshore fishery. CRFS reported 69,037 angler trips from shore in the Channel Region in 2005. Recall from the above discussion of the expected catch variable that our model can only predict demand for tags for anglers specifically targeting the nearshore fishery. Even though there were 69,037 angler trips from shore, we assumed that the majority of those trips did *not* target the nearshore fishery. In order to determine how many of those shore trips targeted the nearshore fishery, we used Wegge, Hanemann, et al. (1986)'s finding that 6-percent of catch from shore was rockfish. Thus, we assumed that 6-percent of these trips targeted the nearshore fishery and had an expected catch of 1 fish per trip. As a result, we calculated that 4,142 angler trips from shore target the nearshore fishery. Thus, we used 4,142 trips to scale up from an individual shore angler to the shore angler sub-sector.

Demand for tags on single angler trip from shore in recreational angler sector:

$$Q_{T_{A(B,S)\,i}} = \alpha_A + \beta_A(C_{(B,S)i}) + \delta_A(A_i) + \sigma_A(P_i)$$

$$Q_{T_{A(B,S)\,i}} = 8.479 + 0.329\,(C_{(B,S)i}) - 0.099\,(A_i) - 0.659\,(P_i)$$

$$Q_{T_{A(S)\,\bar{i}}} = 8.479 + 0.329\,(C_{(S)\bar{i}}) - 0.099\,(A_{\bar{i}}) - 0.659\,(P_i)$$

$$C_{(S)\bar{i}} = 1$$

$$Q_{T_{A(S)\,\bar{i}}} = 5.089 - 0.659\,(P_i)$$

Number of shore trips targeting the nearshore fishery:

$$ShoreTrips_{nearshore} = 69{,}037 * 6\% = 4{,}142 trips$$ [10]

Demand for tags by shore sub-sector in one year:

$$Q_{TA(S)} = 4{,}142 * Q_{T_{A(S)\,\bar{i}}} = 4{,}142 * (5.089 - 0.659(P_i))$$

In order to account for the free tags that would be allocated to the shore subsector, we used information on the distribution of catch among recreational sectors and sub-sectors. 70-percent of the total recreational harvest is caught by the recreational industry, and the remaining 30 percent is split between the shore sub-sector and the private boater sub-sector. In YEAR the recreational sectors accounted for 237,375 fish. Of this total, 71,212 fish were caught by the recreational angler sector. We previously calculated that 4,142 shore trips targeted the nearshore fishery and had an expected catch of 1 fish. As a result, we estimated that 4,142 of the 71,212 total recreational angler sector catch were caught by the shore sub-sector. The 4,142 catch comes out to 5.8-percent of the recreational angler sector harvest and 1.7-percent of the total recreational harvest.

Above, we calculated that 96,170 free tags would be allocated among all recreational sectors. We assumed that free tags would be distributed among sectors based on their proportion of the harvest. As a result, the shore sub-sector would receive 1.7-percent of the free tags, or 1,678 tags. As a result, we shifted the demand curve for tags in the shore sub-sector out by 1,678.

Demand for tags by shore sub-sector in one year accounting for free tags:

$$FreeTags_{shore} = 96{,}170 * 1.7\% = 1{,}678$$

$$Q_{TA(S)} = 1{,}678 + (4{,}142 * Q_{T_{A(S)\,\bar{i}}}) = 1{,}678 + (4{,}142 * (5.089 - 0.659(P_i)))$$

Private boater sub-sector

In order to scale up from an individual private boat angler to the private boat sub-sector, we used reported information on the distribution of recreational catch among recreational sectors. Between 2004 and 2006, an average of 70-percent of the recreational catch was caught by the recreational industry and 30-percent was caught by recreational anglers (RecFIN 2008). Of the 71,212 fish caught by the recreational angler sector, 5.8-percent (4,142 fish) were caught by the shore sub-sector, leaving 67,082 fish, or 94.2-percent of recreational angler sub-sector harvest, caught by anglers on private boats. Presented another way, 70-percent of the recreational harvest is caught by the recreational industry, 28.3-percent is caught by the private boater sub-sector, and 1.7-percent is

[10] 69,037 is the total number of fishing trips from shore in Ventura and Santa Barbara Counties in 2005 (CRFS 2006). 6% is the number of these shore trips that target the nearshore fishery (Wegge, Hanemann et al. 1986).

caught by the shore sub-sector. Assuming that anglers from private boats catch 7.8 fish per trip, we calculated 8,592 angler trips on private boats targeted the nearshore fishery.

Demand for tags on single angler trip from private boat in recreational angler sector:

$$Q_{T_{A(B,S)}\,i} = \alpha_A + \beta_A (C_{(B,S)i}) + \delta_A (A_i) + \sigma_A (P_i)$$

$$Q_{T_{A(B,S)}\,i} = 8.479 + 0.329 (C_{(B,S)i}) - 0.099 (A_i) - 0.659 (P_i)$$

$$Q_{T_{A(B)}\,\bar{i}} = 8.479 + 0.329 (C_{(B)\bar{i}}) - 0.099 (A_{\bar{i}}) - 0.659 (P_i)$$

$$C_{(B)\bar{i}} = 7.8$$

$$Q_{T_{A(S)}\,\bar{i}} = 7.329 - 0.659 (P_i)$$

Number of private boat trips:

$$CatchFrom\Pr ivateBoats = 94.2\% * (Harvest_{\text{Re}\,creationalAngler}) = 67{,}082$$

$$C_{(B)\bar{i}} = 7.8$$

$$\Pr ivateBoatTrips = 67{,}082 \div 7.8 = 8{,}592 trips$$

Demand for tags by private boater sub-sector in one year:

$$Q_{TA(B)} = 8{,}592 * Q_{T_{A(B)}\,\bar{i}} = 8{,}592 * (7.329 - 0.659 (P_i))$$

Above, we calculated that 96,170 free tags would be allocated among all recreational sectors. We assumed that free tags would be distributed among sectors based on their proportion of the harvest. Because anglers on private boats account for 28.3-percent of the total recreational harvest, the private boater sub-sector would receive 28.3-percent of the free tags, or 27,173 tags. As a result, we shifted the demand curve for tags in the private boater sub-sector out by 27,173.

Demand for tags by private boater sub-sector in one year accounting for free tags:

$$FreeTags_{\Pr ivateBoat} = 96{,}170 * 28.3\% = 27{,}173$$

$$Q_{TA(B)} = 27{,}173 + (8{,}592 * Q_{T_{A(B)}\,\bar{i}}) = 27{,}173 + (8{,}592 * (7.329 - 0.659(P_i)))$$

In order to get the aggregate demand in the recreational angler sector, we horizontally summed the two curves.

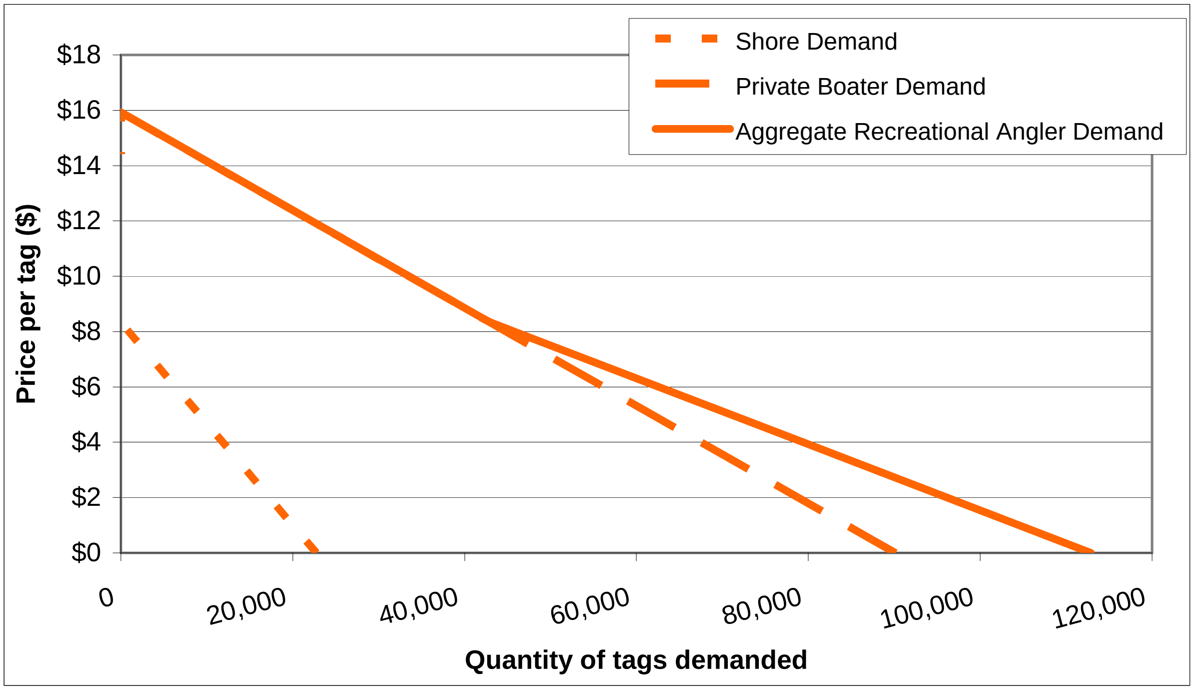


Figure 7.4. Demand for Tags by Recreational Angler Sector and Sub-Sector, holding age and expected catch constant for each sub-sector.

Anglers who fish from public piers were not included in the analysis because these individuals do not currently require a license to fish, and thus would not require tags under our management scenarios.

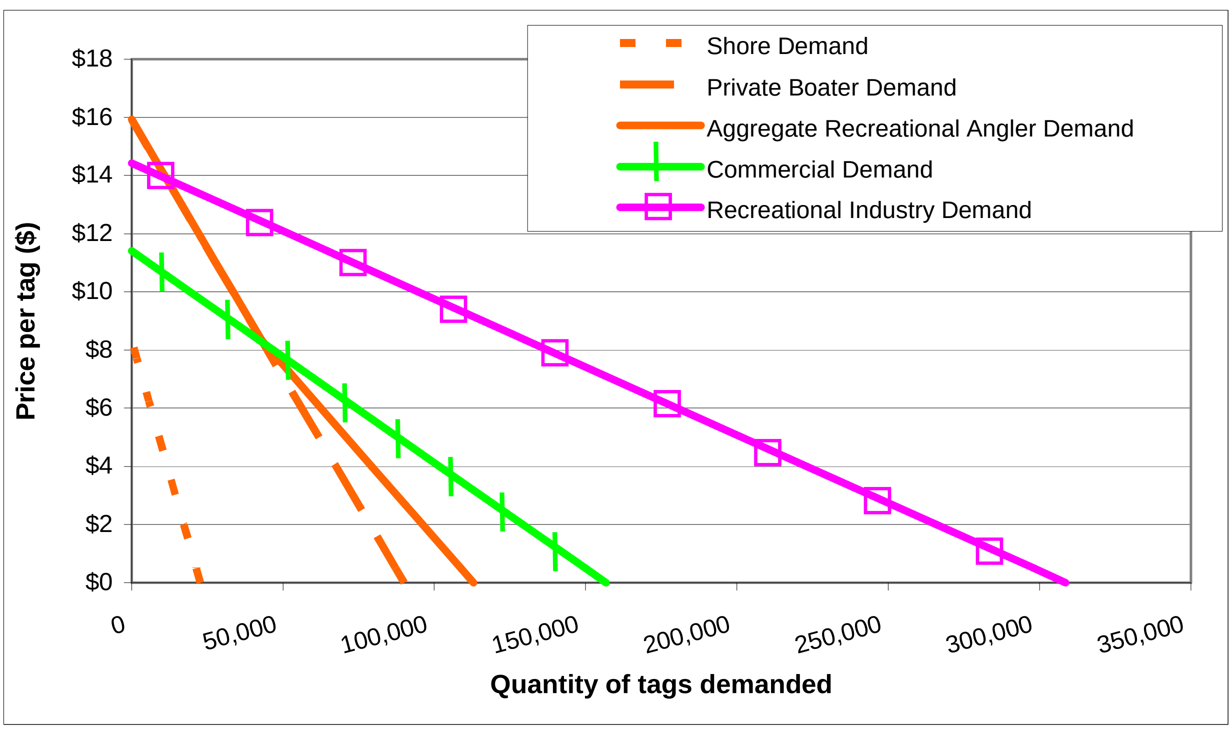


Figure 7.5. WTP for tags curves for all sectors of the Santa Barbara Channel Nearshore Fishery

Impact of management scenarios on distribution of catch

The demand curves for tags in the different sectors can be used to predict how many tags each sector would buy at any given total cap in the number of tags allocated. The initial allocation of tags among sectors will not affect the final outcome in terms of the distribution of tags. However, the initial allocation will affect the gains from trade within each of the sectors.

In the management scenarios used in this analysis, the total cap on the number of tags was set at the total harvest level that the fishery is currently managed for. See Table 7.5. Initial allocation of tags to each sector was based on the recent historic catch levels. After initial allocation the market for tags would determine the new distribution. These Annual allocation issues are not analyzed in this report, but a more in-depth discussion can be found in section 10. In short, the allocation of tags in the different sectors was based on the current harvest levels. However, under the current management, the commercial sector and recreational sectors are managed separately. Introducing tradable tags allows all sectors of the fishery to trade tags amongst each other such that the final distribution of tags is endogenous to the system, not an exogenous management variable.

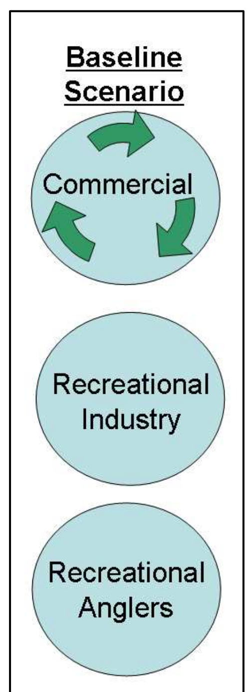
Table 7.5. Current harvest level per sector.
The allocation of tags per sector is based on these current harvest levels.

Sector:	Commercial	Recreational Industry	Recreational Angler		Total Harvest (TAC)
			Private Boater	Shore	
Harvest/ Tag allocation:	41,890 (15%)	166,162 (59%)	67,070	4,142	279,265
			71,212 (26%)		

Although this analysis did not vary the TAC from the current target harvest level, this same analysis could be used to examine how the distribution of catch would change under different TACs. Understanding how the fishery would react to the tightening or loosening of the TAC could help managers anticipate and plan for the political, social, and economic impacts that would be predicted under different TACs. This information would be especially useful to managers who may have to adjust the TAC due to changes in fish stocks or the advent of more complete fishery information.

Baseline Scenario

In the baseline scenario, management of the commercial and recreational sectors is not yet integrated. Management is separate with different harvest targets and different rules and restrictions in the different sectors. The commercial sector is managed for its sectoral target harvest of 41,890 fish, while the two recreational sectors are managed as they are today with no firm annual total catch limits, but with restrictions on daily catch, size, and so forth.



In the baseline scenario, tradable tags are issued to the commercial sector and there is no change in management of the recreational sector. As a result, there will be no change in the distribution of catch among sectors. However, within the commercial sector, individual operators would trade tags until all commercial fishermen have the same marginal value for tags. Assuming that in the absence of tradable tags, some commercial fishermen are operating inefficiently, the introduction of tags would improve the efficiency of the entire commercial sector.

Calculating the gains from trade within the commercial sector requires information on individual operators' revenues and costs. However, data was not available at this fine resolution for commercial fishermen in the nearshore fishery. As a result, we had to assume that the commercial sector was already operating efficiently, and the introduction of tradable tags would not affect the marginal benefits curve and thus not affect the demand curve for tags. In reality, the introduction of tags would likely improve the efficiency of the commercial sector, causing the demand curve for tags to shift up.

If tags are allocated based on the historic level of catch, 41,890 fish, our model predicts that tags would trade at a price of $8.36. The net benefits in the commercial sector would be $414,001, which is the area bounded by ABCD, and is the value of the commercial industry.

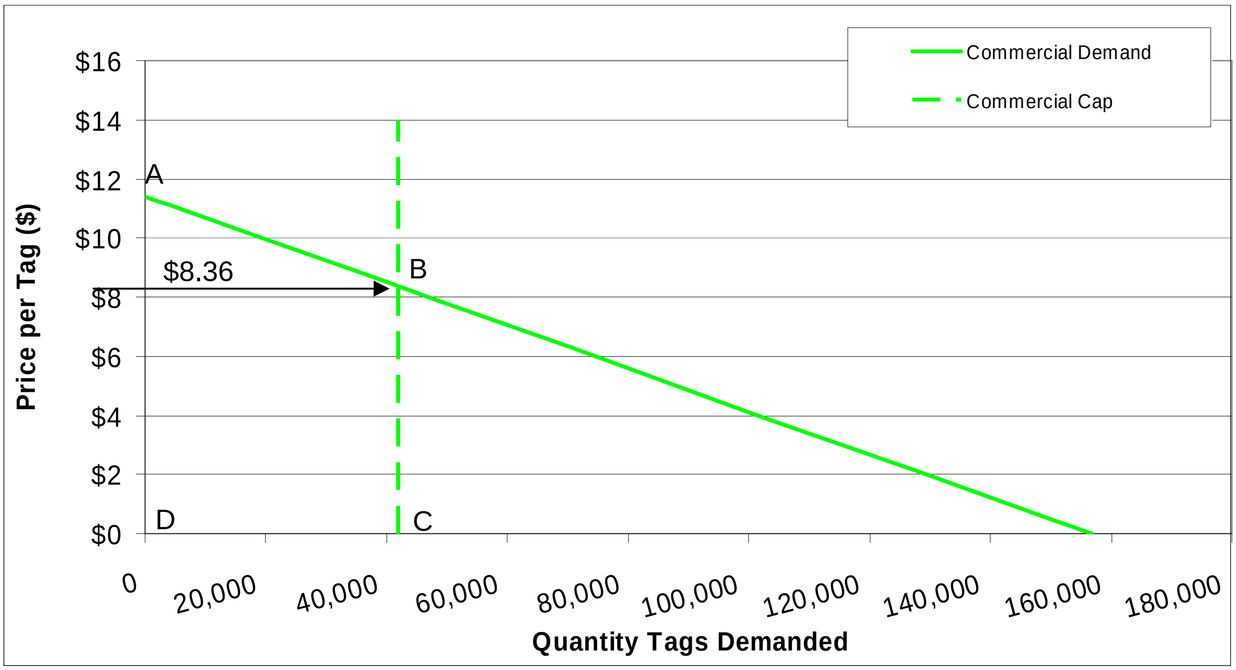


Figure 7.6. Baseline scenario with tags tradable in the commercial sector.

Welfare in the recreational sectors results from the value that anglers derive from the fish they catch. Assuming that recreational anglers are currently operating efficiently and the demand curves shown in Figure 7.5 represent the marginal benefits to the recreational industry and recreational angler sectors, one can calculate the total welfare of fish caught in each sector. Figure 7.7 shows the total welfare of fish caught to the recreational industry and the recreational anglers sectors. The total welfare experienced by the recreational angler sector is $728,823, represented by the area bounded by EFGD, and the total welfare experienced by the recreational industry sector is $1,751,717, represented by the area bounded by ABCD.

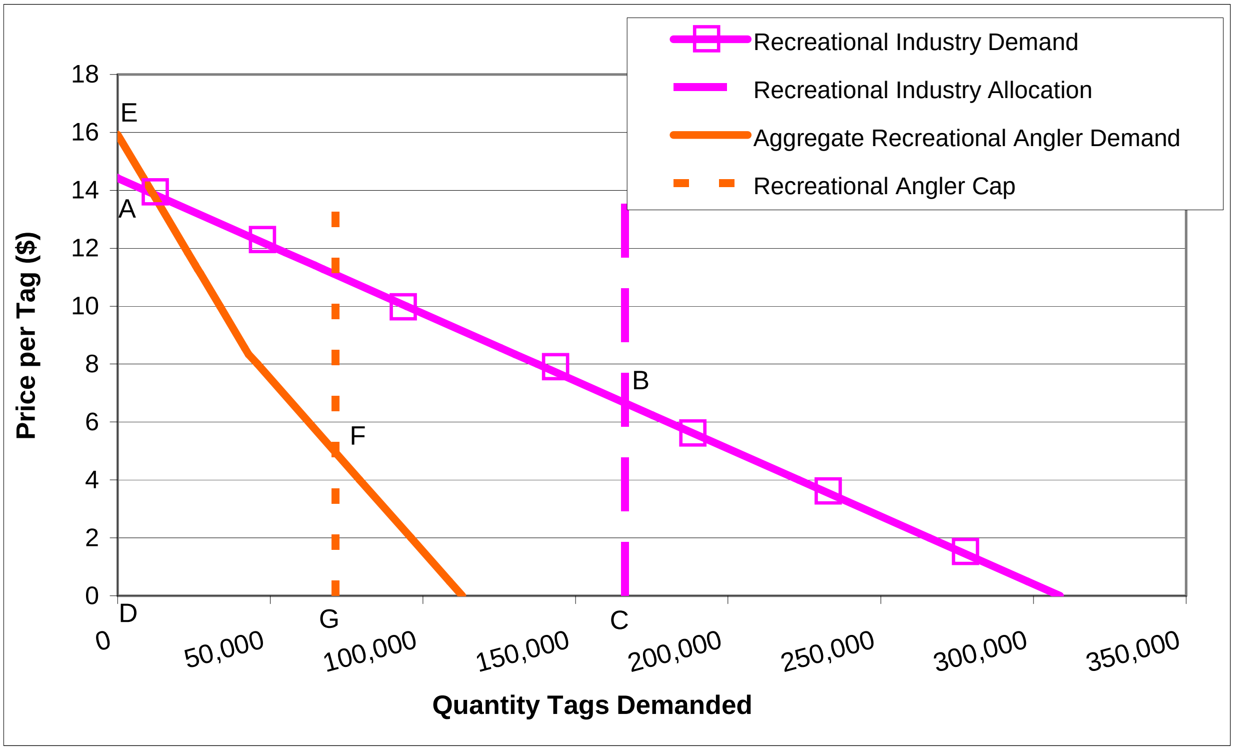
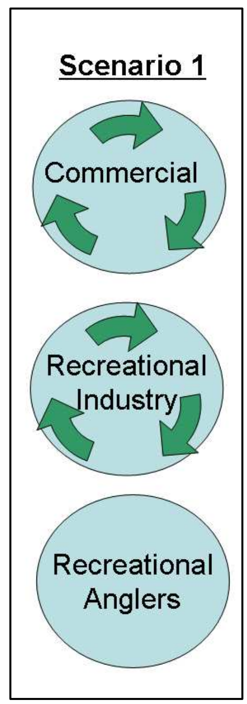


Figure 7.7. Welfare from fish caught in the recreational industry sector and recreational angler sector.

Scenario 1

In scenario 1, management of the commercial and recreational sectors is still not integrated. Even though tradable tags are introduced in the commercial and recreational industry sectors, each sector is managed separately for sectoral harvest targets, and tags cannot be traded across sectors. There is no change to the management of the recreational angler sector; thus all three sectors are managed separately. The commercial sector is managed for its sectoral target harvest of 41,890 fish. The recreational industry sector is managed for a harvest level of 166,162 fish, and the recreational angler sector is managed as they are today with no firm limits on total allowable catch.



In scenario 1, tradable tags are issued to the commercial sector and the recreational industry sector. Because tags cannot be traded across sectors, there will be no change in the distribution of catch among sectors. However, within the commercial sector and within the recreational industry sector, individual operators would trade tags until each operator within the sector had the same marginal value for tags. As explained in the baseline scenario, we did not have information of a fine enough resolution to calculate the gains from within-sector trade in the commercial sector. Similarly, we do not have information on a fine enough scale for the recreational industry sector to calculate the gains from with-in sector trade. Assuming that in the absence of tradable tags, some recreational industry sector anglers are operating inefficiently, the introduction of tags would improve the efficiency of the entire recreational industry sector and result in welfare gains.

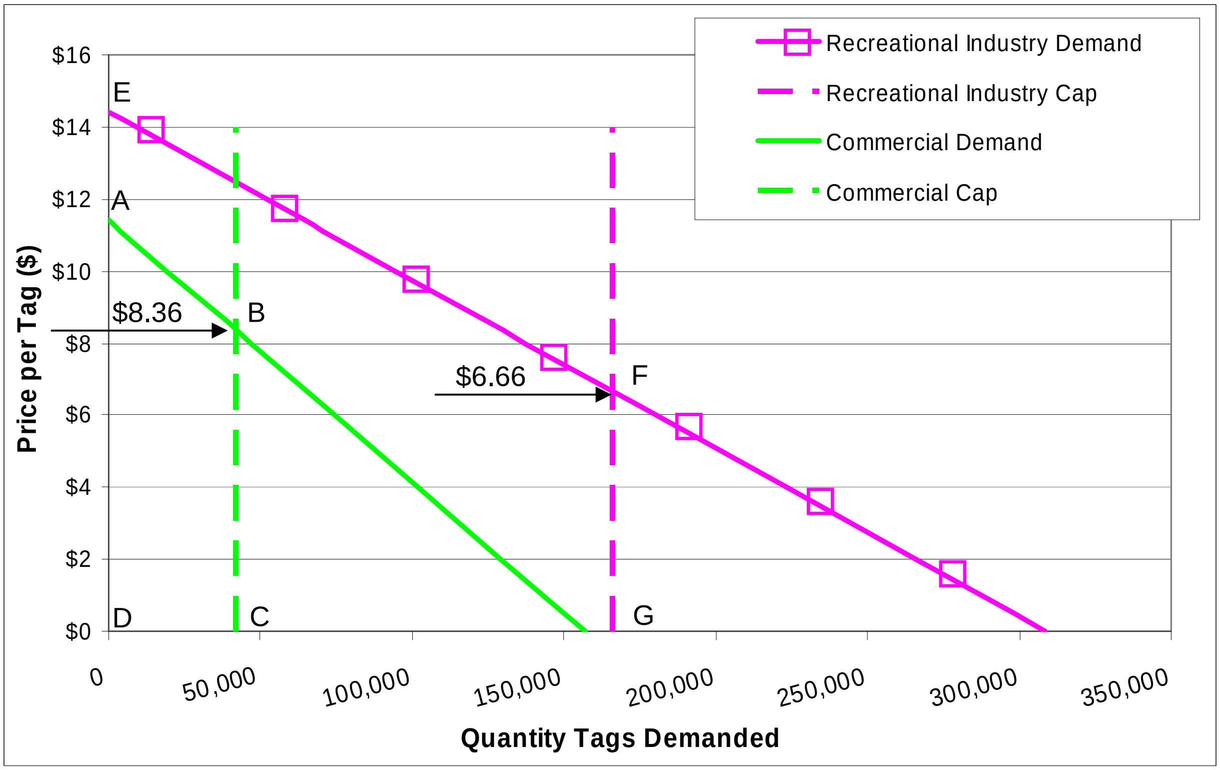


Figure 7.8. Predicted tag prices in scenario 1.

Our model predicts that if tags are allocated to sectors based on their recent historic catch levels, tags in the commercial sector would trade at a price of $8.36. Tags in the recreational industry sector would trade at a price of $6.66. This difference in the marginal value of tags between sectors suggests that there are gains from trade to be had.

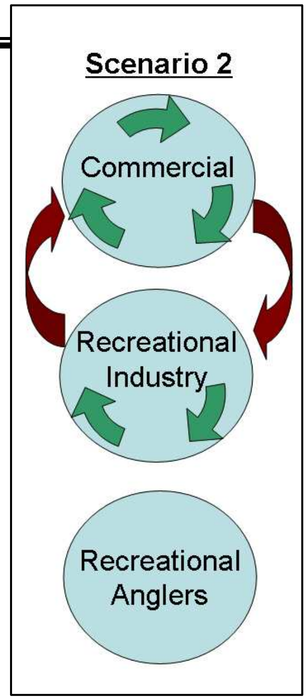
The net benefits to each of the sectors would be the same as they were in the previous scenario, assuming that the commercial and recreational industry sectors are already operating efficiently. Recall those benefits are: $414,001 in the commercial sector; $1,751,717 in the recreational industry sector; and $728,823 in the recreational angler sector. Welfare experienced by the recreational industry sector is represented by the area bounded by EFGD in Figure 7.8, and the welfare benefits experienced by the commercial sector is represented by ABCD in Figure 7.8. It is important to note that the benefits in the commercial sector are in the form of net profit from selling fish on the live-fish market. Benefits in the recreational industry sector are in the form of non-market value for the fish that they catch and keep.

Scenario 2

Scenario 2 integrates the management of the commercial and recreational sector by introducing tags that are tradable across sectors. Under scenario 2, tags are initially allocated in the commercial and recreational industry sectors, as they were in scenario 1. Additionally, these tags can be traded across sectors. There is no change to the management of the recreational angler sector; thus the recreational industry and commercial sectors would be managed under one cap, while the recreational anglers would still be managed separately. The commercial sector is initially allocated 41,890 tags, and the recreational industry sector is initially allocated 166,162 tags for a combined cap of 208,052.

Because tags can be traded across sectors, there may be a change in the distribution of catch among the commercial and recreational industry sectors for the first time. As explained in the baseline scenario and scenario 1, we did not have information of a fine enough resolution to calculate the gains from within-sector trade in the commercial and recreational industry sectors. As a result, we calculated only the gains from across-sector trade. There would likely be significant gains from within-sector trade as well.

In order to determine if and how tags would trade between sectors, we calculated the aggregate demand for tags in the two sectors by horizontally summing the two demand curves. The point at which the total cap (208,052) intersects the aggregate demand curve is the price at which tags trade, $7.32. According to our model 14,213 tags would be bought by the commercial sector from the recreational industry.



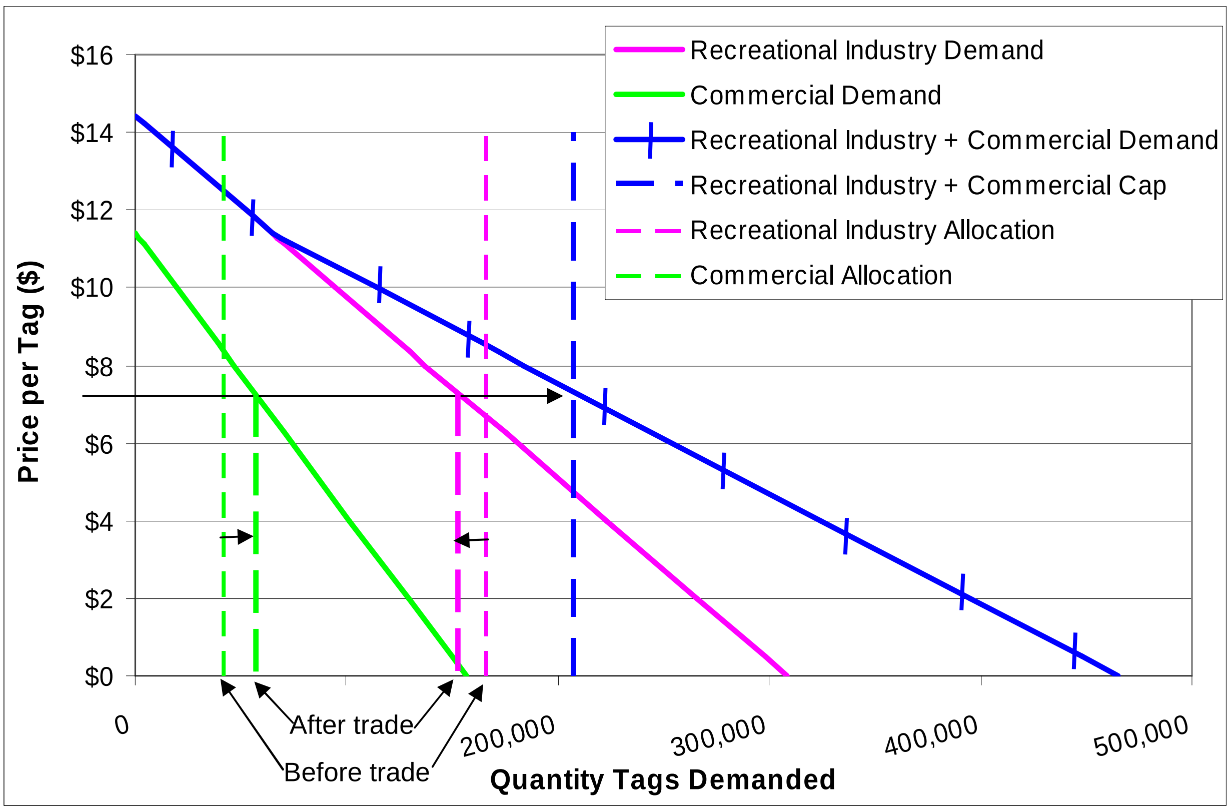


Figure 7.9. Scenario 2 with trade across the commercial and recreational industry sectors.

It is important to note that trade is voluntary and while some individuals in the recreational industry sector will choose not to sell any of their tags, other individuals will be happy to catch one (or more) less fish and sell their tag at the market price. Likewise, some commercial operators will be happy to buy tags at the market price because they will be able to use those tags to catch fish that they can sell at a higher profit than the cost of the tag. As a result, both sectors benefit from trade. The commercial sector benefits by $7,352 from trade, and the recreational industry benefits $4,720 from trade.

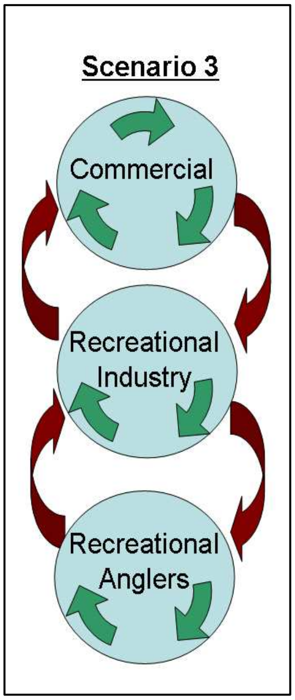
Commercial benefits = (profits from selling fish) – (cost of tags)

Recreational industry benefits = (non-market value from fish) + (revenue from selling tags)

Benefits from cross-sectoral trading = (Difference in commercial benefits between scenarios)
+ (Difference in recreational industry benefits between scenarios)

See benefits and gains from trade in Table 7.6.

Scenario 3



Management scenario 3 fully integrates the management of the commercial and recreational sectors by implementing tags that are tradable across all sectors. Under scenario 3, tags are initially allocated in the commercial, recreational industry, and recreational angler sectors based on their recent historic harvest levels. Tags can be traded across all sectors and there is a single TAC or cap that the fishery is managed for. As in the previous scenarios, the commercial sector is initially allocated 41,890 tags, and the recreational industry sector is initially allocated 166,162 tags. The recreational angler sector is initially allocated 71,212 tags, for a total fishery cap 279,265.

Because tags can be traded across all sectors, there may be a change in the distribution of catch among sectors. As explained in the previous scenarios, we did not have information of a fine enough resolution to calculate the gains from within-sector trade in any of the sectors. As a result, we calculated only the gains from across-sector trade. There would likely be significant gains from within-sector trade as well.

In order to determine if and how tags would trade between sectors, we calculated the total demand for tags in the fishery by horizontally summing the demand curves for all three sectors. The point at which the total cap (279,265) intersects the total demand curve is the price at which tags trade, $6.87. According to our model, 20,447 tags would be bought by the commercial sector, 4,502 from the recreational industry sector and 15,945 from the recreational angler sector. All sectors would benefit from trade.

Commercial benefits = (profits from selling fish) – (cost of tags)

Recreational industry benefits = (non-market value from fish) + (revenue from selling tags)

Recreational angler benefits = (non-market value from fish) + (revenue from selling tags)

Benefits from cross-sectoral trading = (Difference in commercial benefits between scenarios)
+ (Difference in recreational industry benefits btwn scenarios)
+ (Difference in recreational angler benefits btwn scenarios)

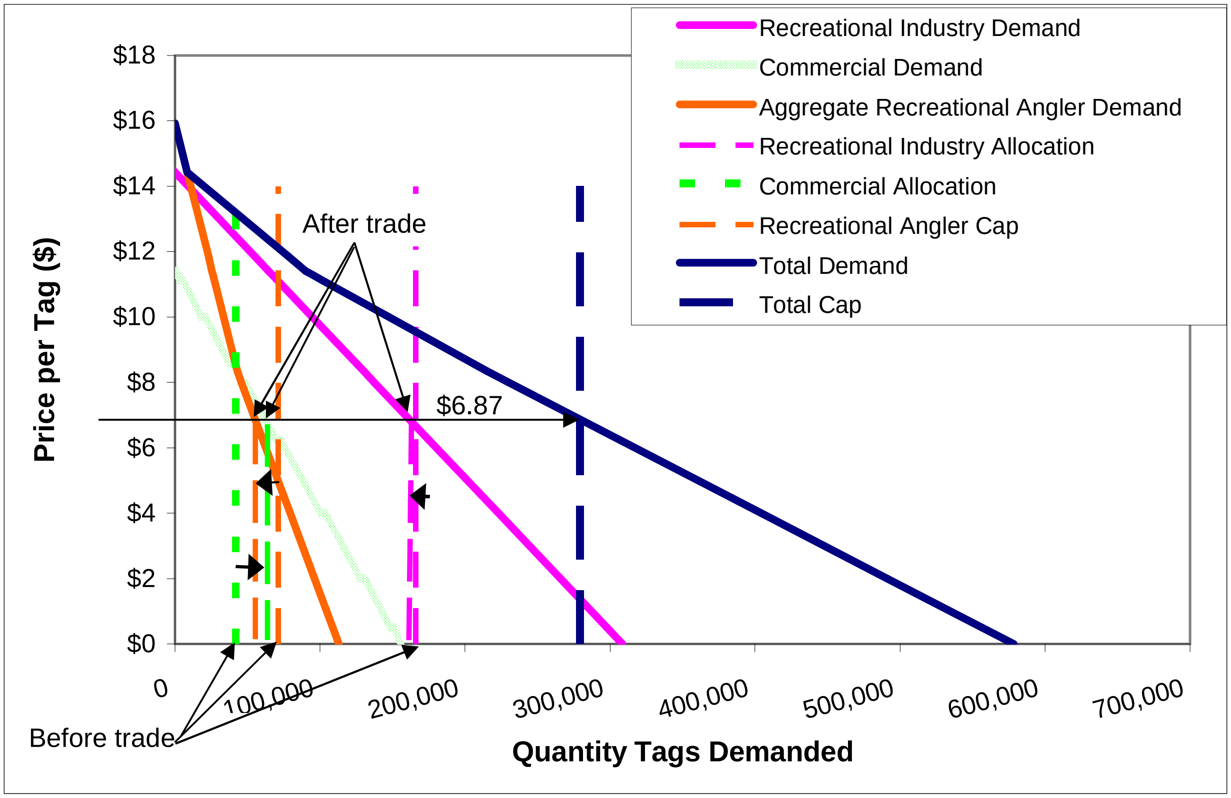


Figure 7.10.Scenario 3 with trade across all sectors

Summary

Table.7.6.

	Commercial		Recreational Industry		Recreational Angler		Fishery Total
Scenario	Welfare	Tags	Welfare	Tags	Welfare	Tags	Welfare[a]
Baseline	$414,001	41,890	$1,751,717	166,162	$702,163	71,212	$2,867,881
1	$414,001	41,890	$1,751,717	166,162	$702,163	71,212	$2,867,881
2	$421,353	56,103	$1,756,438	151,949	$702,163	71,212	$2,879,954
3	$429,218	62,337	$1,752,191	161,660	$724,258	55,268	$2,905,667

a: Total catch is always the same 279,265 fish

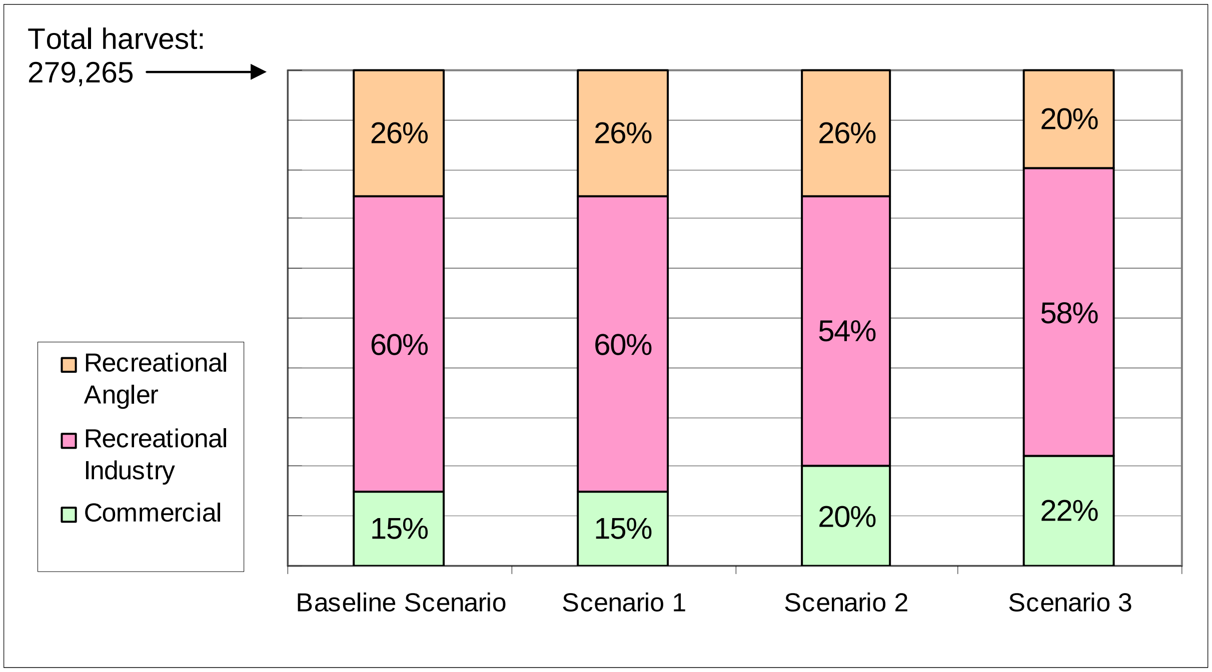


Figure 7.11. Distribution of catch in scenarios.
Note that when trade across sectors is allowed, the commercial sector increases its total catch to 20% and 21% of the total catch in scenarios 2 and 3, respectively.

Table.7.7. Results from cross-sector trade

	Commercial		Recreational Industry		Recreational Angler		Fishery Total
Scenario	Change in tags	Gains from trade	Change in tags	Gains from trade	Change in tags	Gains from trade	Gains from trade
Baseline	0	$0	0	$0	0	$0	$0
1	0	$0	0	$0	0	$0	$0
2	14,213	$7,352	-14,213	$4,720	0	$0	$12,072
3	20,447	$15,217	-4,502	$474	-15,945	$22,096	$37,786

7.2 The Multi Criteria Analysis Process

A Multi Criteria Analysis (MCA) was used to quantify comparisons of management scenarios and stakeholders in the environmental, social and political models. A Weighted Sum Method was used to aggregate weighted scores as this gave us the most differentiated results. The weighted product method was not used due to the score of 0, or no change in the models, as this resulted in very similar results in the final comparisons.

In each model, a list of relevant stakeholders was compiled. Each stakeholder was assigned a weight to represent their proportional impact or vested interest in the criterion. Weights for all stakeholders within a criterion summed to 1. These weights were determined through interviews and surveys with stakeholders.

Following the compilation of stakeholders, elements of comparison were compiled. These elements were viewed as performance barometers, in order to objectively compare management scenarios.

Each element also received a weight which cumulatively summed to 1 within the stakeholder grouping.

Scores for performance were assigned based on how each element performed in each management scenario as compared to the baseline scenario. Scores were -1 for a negative performance compared to the baseline, 0 for no change in performance, or 1 for a positive performance compared to the baseline. Generally the scores were determined through scientific literature and observation of similar management practices implemented elsewhere. Details of how scores were determined for each model can be found in their respective methods sections of this report (sections 7.3, 7.4, and 7.5).

The unit of comparison and output of this process is the weighted score. The weighted score is the combined product of the performance score, the element weight, and the stakeholder weight. The weighted score represents the performance of the scenario compared to the baseline for each stakeholder, and the scores from each model can be summed to represent the overall scenario performance, to decide between management scenarios. This flexibility and transparency is useful in allowing the models to show both the overall performance compared to the baseline, but also the points of contention and possible stakeholder resistance.

7.3 Environmental Analytical Model

For the environmental performance portion of this study, literature provided the majority of the information for the justification and analysis of the commercial sector. Because catch shares are relatively new to the recreational sector, theory, reasoning, and parallels between the two sectors were relied upon to estimate potential effects of trading on recreational fisheries. It is worth noting that with the implementation of the baseline scenario, previous analyses of catch shares in commercial fishing sectors show clear environmental benefits across all of the chosen environmental elements (Redstone Strategy Group 2007). The impact of the baseline scenario compared to the status quo was not analyzed in this study, and all predicted benefits or detriments are considered relative to the baseline scenario.

In order to rank the proposed scenarios based on environmental performance, we first chose the elements that impact the environmental performance of the fishery. Existing analyses of alternative management options in fisheries have focused on biomass, size distribution, habitat impact, bycatch, and discards to evaluate environmental performance. These same elements were used in this analysis to provide comparison and replicability. The weighting for the elements were based on their relevance to the marine ecosystem of southern California's Nearshore Fishery.

7.3.1 Elements

Biomass

A commonly used indicator of environmental performance is biomass. Here, biomass was defined as the total mass of a target species of fish that can be harvested. Biomass was selected and given the highest weight of all environmental elements at 0.3 due to its importance ecologically and economically. Ecologically, the more fish there are, the better the prospects for recruitment and reproduction, and thus sustainability. Economically, commercial and recreational industry fishermen rely on large amounts of biomass to increase the incidence and reduce the effort of making a catch. This element was evaluated using data from studies conducted on existing catch share programs in commercial fisheries around the world. Since this report is one of the first such reports that include the recreational fishery, it is necessary to apply reasoning and logic in addition to literature review to score biomass as an element.

Evaluations of commercial fisheries with catch shares have shown benefits to the overall biomass of the fishery. In Chile, the FAGA (Fish and Aquaculture General Act) authorizes the implementation of ITQs (Individual Transferable Quotas) when a "fishery has undergone overexploitation and is under a stock re-building program" (Bernal et al. 1999). In Chilean fisheries where ITQs have been implemented, such as the Squat Lobster fishery, catch shares have resulted in an increase in exploitable biomass by nearly 65,000 metric tons, and increased range of the target species. Overall in Chile, catch shares have helped to re-build stocks of high-value resources (Bernal et al. 1999).

In New Zealand, rock lobster fisherman chose to sacrifice short-term profits for the improvement of biomass. To accomplish this, they harvested at 85% of the TAC. As a result, the biomass of the fishery doubled in 10 years (Bray 2006, Donohue 2000, Sullivan 2004). Another study conducted in New Zealand reported that when ITQs were implemented, 56% of surveyed fishermen believed that the system would help to conserve stocks. By 1995, that percentage had jumped to 68%. For the Alaskan halibut fishery, 80% of all surveyed fishermen believed that IVQs (Individual Vessel Quotas) led to better conservation of halibut stocks (Dewees 1998).

Another positive outcome of catch shares is better data for stock assessment. Those who are skeptical about tight regulation of fisheries assert that monitoring is not sufficient to say whether or not the stock is in a state of decline. This is true of open access fisheries, such as the recreational fishery in California, where landing data is often times imprecise and inconsistent. In a catch share program, however, each individual or boat is responsible for his or her part of the TAC. If tags are issued in a similar manner to big-game and water-fowl management, accountability becomes even more precise since the managing agency knows exactly how many tags were sold, and theoretically how many fish were landed. With better stock and catch data, it would be possible to assess biomass, and implement an appropriate TAC with more confidence.

Size Distribution

Size distribution refers to the variety of lengths and weights of fish in a population. Generally, it is advantageous to have older, larger fish in the population because the amount of offspring that a fish produces is generally proportional to its size (Duarte et al. 1989). Size distribution is particularly critical to the health of nearshore fish species, and for that reason it was selected as an element for the environmental performance analysis.[11] Size distribution was given a weight of 0.2, because it is an important aspect of a fish population but not as crucial as overall biomass.

A study conducted on several demersal fisheries found that the average length of fish has decreased over the time period of the investigation due to fishing activity (Bianchi et al. 2000). This problem often occurs due to derby fishing and selective fishing practices. In certain fisheries, ITQs have been shown to positively benefit size distribution, such as the Squat Lobster Fishery in Chile where there has been a marked improvement in average size of the resource as a result of ITQs (Bernal et al. 1999). At the same time, however, catch share programs have been accused of promoting high-grading of size and quality. While it is a definite benefit if derby fishing is eliminated, the extra time allows fishermen to search for specific individuals within their target species. In other words, commercial fishermen can now take the time to find the resource that meets consumer demand (National Research Council (NRC) 1999).

[11] Fujita, R. 2008. "Weighting Elements in Environmental Model." Personal communication. S. Choy. Santa Barbara.

Habitat Impact

Fishing activity can be detrimental to a marine ecosystem through a number of mechanisms. Trawling can cause damage to benthic habitats through the interaction between the seafloor and large weights and nets, and as a result is outlawed in many areas. "Ghost fishing" occurs when nets float adrift in the open ocean, whether on purpose or by accident, and may entangle marine life as well as features on the seafloor. Even boat activity in crowded nearshore habitats can negatively affect marine environments through noise, wake, debris, and gear adrift (Cooke et al. 2006). Habitat impact was chosen as an element since fisheries not only deplete fish populations, but as a result of certain fishing practices and activities may also destroy critical habitat necessary for replenishment and survival. Like size distribution, habitat impact was given a weight of 0.2 since it is important, but not as influential to the study as biomass.

Habitat impact often occurs on a large scale and is hard to quantify. Many studies have shown that catch share programs often decrease the environmental impact on fisheries and the associated habitat, as entry into the fishery is decreased and derby fishing is eliminated. This means that less gear overall is deployed, and the gear that is deployed is more spatially and temporally dispersed. Also, the ownership that goes along with catch shares promotes better marine stewardship and more responsible fishing practices (Redstone Strategy Group 2007). In the Alaskan Halibut fishery, which operates under ITQs, the International Pacific Halibut Commission (IPHC) estimated that halibut mortality due to lost or abandoned gear decreased from 554.1 metric tons to 125.9 metric tons between 1994 and 1995 (NRC 1999). Much like the size distribution element, the effects that catch shares have on a fishery will be highly dependent on the characteristic of the specific fishery in question.

Bycatch

Bycatch occurs when non-target species are unintentionally caught along with the target species. Usually, members of the non-target species are thrown back into the water, possibly dead or dying, thus contributing to the depletion of other species. While almost exclusively a commercial phenomenon, bycatch is a pressing issue in many fisheries, such as the Pink Shrimp trawl fishery in Northern California (Frimodig 2007). This waste can have a detrimental impact on many fish populations, leading to the selection of bycatch as an element. However, because the survivability of bycatch is inversely related to depth at which caught, individuals caught in shallower water have a better chance at survival than those caught in deeper water (Ross et al. 1997) (Fujita 2008). As a result, bycatch was given a weight of 0.15. Since the commercial industry is the only stakeholder in the analysis that experiences bycatch, the recreational industry and angler sectors were not evaluated for the bycatch element. In order to keep the weights of the elements summing to 1 and in the same relative proportion, the weight for bycatch (0.15) was divided by 4, and added onto each of the other elements in the recreational industry and angler sectors' models (Table 7.8).

Catch share programs have been found to reduce bycatch in commercial fisheries throughout the world through reductions in gear deployment, and extension of fishing seasons. According to the Redstone Strategy Group, LAPPs (Limited Access Privilege Programs) resulted in reductions in bycatch and even improvements in enforcing, monitoring, and compliance with bycatch TACs as in British Columbia fisheries (Redstone Strategy Group 2007). In the Alaskan Sablefish fishery, halibut bycatch was reduced from 860 metric tons to 150 metric tons from 1994 to 1995, although the associated mortality has not been calculated (NRC 1999). Regardless of mortality, this is still a marked improvement in bycatch numbers. In British Columbia, TAC compliance increased such that violations were virtually non-existent, and bycatch was reduced by 46% (Fujita et al. 1998).

Discards

Discards are related to bycatch in that discards involve the wasting of unwanted fish. Discards occur when there are TAC overages, there is bycatch, or the value of caught fish is not enough to cover the cost of processing and transportation (Turner et al. 1997). Discards was chosen as an element due its impact on both target and non-target fish populations, and like bycatch, was given a weight of 0.15 due to relatively high expected survivability of discarded fish in the nearshore environment.

Recent studies of commercial fisheries have shown that catch share programs drastically reduce the amount of discards due to the ability to trade portions of the TAC to cover overages. In addition, since catch shares have been shown to reduce bycatch, discards as a result of bycatch have also been reduced. In the Chilean Squat Lobster fishery, discards were reduced from greater than 100 metric tons to negligible amounts (Bernal et al. 1999). In the 10 major commercial fisheries studied by the Redstone Strategy Group, discards were reduced by an average of 51% (Redstone Strategy Group 2007). However, when shares are scarce as in the end of the season, catch shares may actually contribute to discards, again highlighting the importance of appropriate TACs (NRC 1999) (Turner et al. 1997). With catch shares, commercial fishermen have time to search out resources that fit consumer demand. Thus, in order to maximize profit, fish that are either too large or too small may be discarded.

7.3.2 Environmental Model Stakeholders

The commercial industry, recreational industry, and recreational angler sectors were chosen as stakeholders because they are directly affecting and are directly affected by the state of the fishery. Much like the elements, each stakeholder may impact the fishery differently, and each had to be weighted. Weighting for stakeholders was based on allocation provided by historical catch and the outputs of the economic model. Each stakeholder was then given a score for each element as described in section 7.2: Multi-Criteria Analysis Process. The results are shown in Table 7.8.

Table 7.8. Results of environmental performance model.

Sector	Criteria	Criteria Weight	Scenario 1 Sector Weight	Scenario 1 Score	Scenario 2 Sector Weight	Scenario 2 Score	Scenario 3Sector Weight	Scenario 3 Score
	Biomass	0.3		0		1		1
	Size Distribution	0.2		0		0		0
Commercial	Habitat Impact	0.2	0.15	0	0.20	0	0.22	0
	Bycatch	0.15		0		0		0
	Discard	0.15		0		1		1
	Biomass	0.3375		1		1		1
	Size Distribution	0.2375		-1		-1		-1
Recreational Industry	Habitat Impact	0.2375	0.59	0	0.54	0	0.58	0
	Bycatch	0		0		0		0
	Discard	0.1875		-1		-1		-1
	Biomass	0.3375		0		0		1
	Size Distribution	0.2375		0		0		-1
Recreational Angler	Habitat Impact	0.2375	0.26	0	0.26	0	0.2	0
	Bycatch	0		0		0		0
	Discard	0.1875		0		0		-1
Weighted Grand Total			-0.051625		0.04275		0.03075	

Commercial Sector

In the biomass element, a score of 0 was given to the commercial industry for scenario 1 because it is not changed from the baseline scenario. For scenarios 2 and 3, the commercial industry was given a score of 1 for the biomass element. Though the commercial sector is allowed to trade in Scenario 1, the benefits of introducing catch shares to the much larger recreational industry were also attributed to the commercial sector due to the ability to trade, and the increase in total harvest that is managed under a catch share program. Catch share programs have resulted in increases in biomass and better assessment of stocks in the commercial fishery as a result of controlled entry into the fishery and better stewardship. The economic analysis shows that the allocations have not changed dramatically from the current status, which suggests that CDFG has been appropriately managing allocation of catch among sectors in the Southern California Nearshore Fishery. However, the economic analysis also shows that there would be potential gains from trade. Even though the TAC would not change under the proposed scenarios, it is possible that the commercial fishermen would desire to increase the value and exploitable biomass of the fishery by fishing below the allocated TAC. In other words, they may see value in uncaught fish, much like the commercial fishermen in New Zealand (Bray 2006, Donohue 2000, Sullivan 2004).

The commercial sector received scores of 0 across all scenarios for the size distribution element. The majority of this industry is composed of hook and line and trap fishermen selling their catch to the live fish fishery in Los Angeles. As a result, they are generally targeting smaller to mid-size, plate-sized fish rather than large fish (Lebeck 2008). Even though the commercial sector in the Santa Barbara Channel region targets mid-size fish, this would probably not change the size distribution enough to trigger a score of 1, or -1, since the commercial industry remains the smallest of the sectors despite the proportionally large increase in its catch that results from trading.

For the habitat impact element, the commercial sector was given a 0 for all scenarios. While catch share programs have resulted in reductions in the negative impacts of fishing activity on marine ecosystems by restricting access and gear deployed, the commercial sector's impact on habitat in Southern California is already fairly benign. A recent study found that most of the marine debris found in deepwater benthic habitats in the Santa Barbara Channel region was commercial fishing gear, but negative impacts due to these debris have been found to be low (Watters 2008). Since the data pertaining to debris in the nearshore is limited, the assumption was made that the impacts and distribution of derelict gear is similar in both environments. While the economic analysis shows that the commercial sector's percentage of the total harvest is predicted to increase from 15% to 20% of the TAC, which is a proportionally large increase, this is probably not enough to merit a score of -1 since the commercial sector remains a relatively small sector. Accordingly, when compared to the baseline scenario, introducing a catch share program in the recreational sector will probably not increase or decrease the commercial sector's impact on the marine environment.

The commercial sector was given a score of 0 for the bycatch element across all scenarios. Although catch share programs have been shown to reduce bycatch as a result of eliminating derby fishing, according to the Monterey Fish Market, hook and line fishermen targeting rockfish species contribute to very little fish bycatch because they are able to effectively target specific species (Monterey Fish Market 2001). Because bycatch is not a pressing issue as far as trap and hook and line fishing goes, catch shares would not impact bycatch positively or negatively.

The commercial sector was given a score of 0 for the discard element in scenario 1, and a score of 1 for scenarios 2 and 3. Because bycatch has been shown to be relatively low for the commercial sector using hook and line and traps, it follows that discards as a result of bycatch should also be minimal. However, in terms of discards as a result of TAC overages, catch shares would allow commercial fishermen to use tags to cover those overages. When tradability is allowed across sectors, more tags would be available to cover overages, thereby increasing the opportunity to buy tags to cover TAC overages.

Recreational Industry Sector

The recreational industry sector was given a score of 1 for all scenarios in the biomass element. Much like the commercial sector, the recreational industry sector may see value in fish left in the ocean to reproduce and increase exploitable biomass. Furthermore, access into the recreational industry sector would be controlled due to consolidation, leading to fewer players.

Scores of -1 were given to the recreational industry sector for the size distribution element across all scenarios. Recent studies of the Santa Barbara Channel region have shown that the size distribution of rockfish was skewed towards smaller fish in areas open to recreational fishing when compared with areas where recreational fishing did not occur (Schroeder 2002). This suggests that recreational fishing is currently negatively impacting size distribution. The CPFV survey (see Appendix I) confirmed that recreational fishermen value the quality (i.e. size of the fish) over the quantity that they catch. Moreover, under the proposed scenarios, recreational industry fishermen would be required to pay for each fish though tags, which may cause them to want to maximize the value of that tag by catching larger fish. As stated before, high-grading of size is a possibility in commercial fisheries that are operating under catch share programs as fish that meet consumer demand are sought out. In the recreational industry, consumer demand is met by larger fish, leading to a score of -1.

In the habitat impact element, the recreational industry sector was given scores of 0 across all scenarios. Despite the fact that the recreational industry dominates the Southern California Nearshore Fishery, a recent study has shown that the recreational industry's contribution to marine debris was relatively small and had little impact on habitat in southern California (Watters 2008). Tradability will not increase or decrease the recreational industry sector's habitat impact since it is already minimal in the first place.

In the discards element, the recreational industry was given score of -1 across all scenarios. While catch share programs have been shown to reduce discards in commercial fisheries, the recreational industry presents a slightly different case. As stated before, the survey indicated that CPFV fishermen and private boaters value the size of the fish more than the quantity of fish caught, and under the proposed scenarios, fishermen would be required to pay for each individual fish. These two situations may lead to increases in discards as fishermen seek to maximize the perceived value of their tag.

Recreational Angler Sector

The recreational angler sector was given a 0 for the biomass element in scenarios 1 and 2, because there is no change relative to the baseline until scenario 3, where it was given a score of 1. The possible benefit to biomass is again due to increased stewardship as a result of investment in the resource and reduced access to the fishery. A major assumption of this logic is that there would be a Recreational Angler Organization that individual fishermen would be a part of in order to make decisions such as fishing below the allocated TAC for the entire sector. Although the survey results showed that only two fishermen were a part of such an organization, the political model suggests that there would need to be more unification of recreational anglers in order to facilitate trade in scenario 3.

A score of -1 was given to recreational anglers in the size distribution element in scenario 3 for the same reasons that the recreational industry sector was given a -1 for this element. Again, recreational anglers were found to value the quality (i.e. size of the fish) over the quantity. Consequently, they are selectively targeting larger fish, leading to possible degradation of size distribution.

In the habitat impact element, recreational anglers were given scores of 0 for all scenarios. Much like the recreational industry sector, the recreational angler impact is small compared to that of the commercial fishery. Regardless of trade, the sector's environmental impact is close to negligible.

Recreational anglers were given a score of -1 for the discard element in scenario 3. The reasoning is the same as was used for scoring the recreational industry sector. Discards may increase due to the fact that recreational anglers tended to value size over quantity in terms of the fish they catch. This combined with the fact that they would be forced to purchase a license in addition to tags may cause them to discard until they catch the fish that they believe maximizes the value of their tag.

Note that mortality was not included in the analysis; predicted number of discards were used to come up with a score that captures mortality. Survivability has been shown to be higher in the nearshore and where hook and line were used, provided that exposure, handling, and temperature differentials are kept at a minimum (Jarvis et al. 2008).[12]

7.3.3 Environmental Model Results

The environmental analysis shows that scenario 2 is clearly the best choice in terms of environmental performance, followed by scenario 3, then scenario 1 (Figure 7.12). The high performance of scenario 2 is because implementing catch shares in the largest sector (the recreational industry sector) and the sector with the highest potential for environmental impact (the commercial sector) would result in the highest environmental performance based on the proposed scenarios. Ideally, environmental performance should increase as tradability is expanded to include all sectors. However, the negative scoring of size distribution and discards for the recreational industry and angler sectors ended up canceling out those gains.

[12] Fujita, R. 2008. "Weighting Elements in Environmental Model." Personal communication. S. Choy. Santa Barbara.

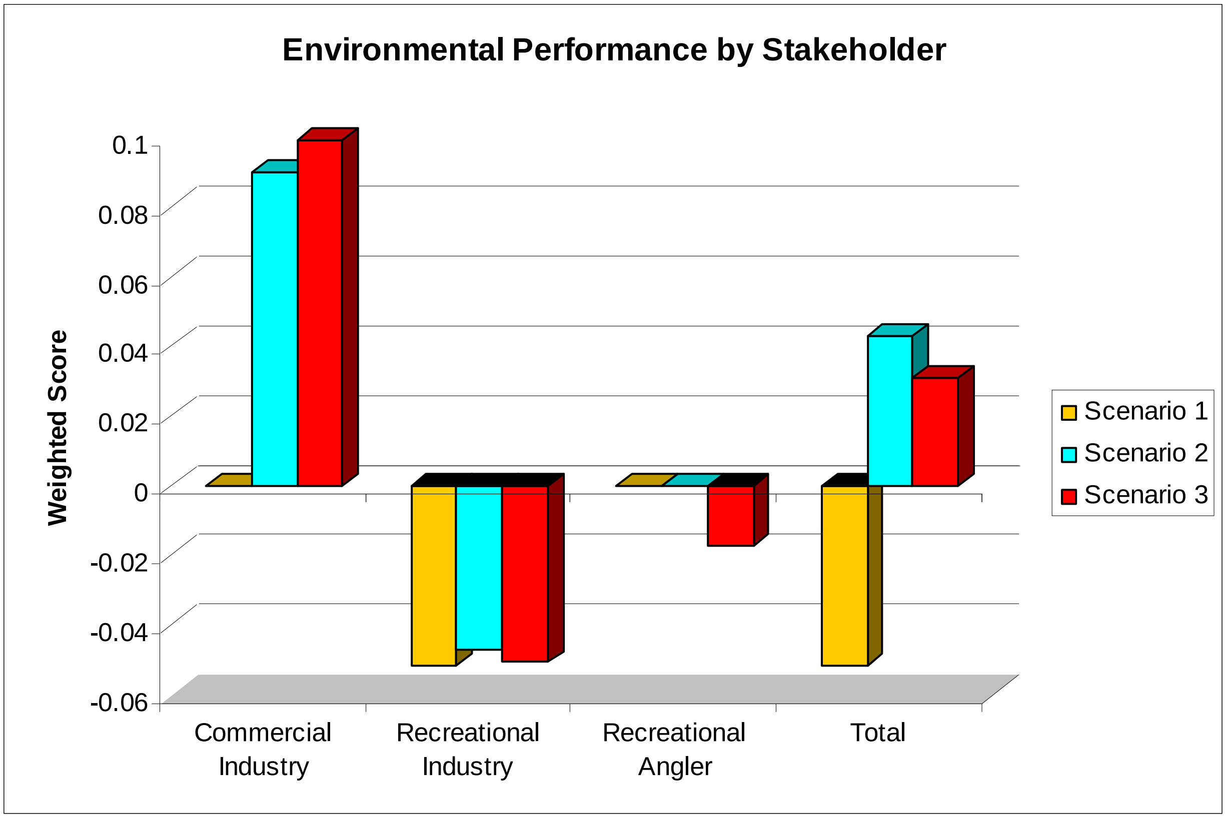


Figure 7.12. Environmental performance by stakeholder. Negative scoring a result of the possibility of high-grading of size and discards in the recreational industry and angler sectors when harvest tags are introduced. The total score, however, indicates that those negative scores are cancelled out by possible increase in biomass.

7.3.4 Environmental Model Discussion

Catch share programs are a relatively novel concept in recreational fisheries. An ITQ management program has been implemented in Alaska for Pacific Halibut, but the environmental impacts have not yet been assessed. As a result, the environmental performance analysis relies almost entirely on literature and theory. In order to more accurately score environmental performance across these elements, long-term, comprehensive data must be collected, namely from the recreational sector which is not as well studied as the commercial sector.

With regard to some of the negative scoring, namely in the discard and size distribution elements, this analysis assumed that all regulations, with the exception of seasonal closures and minimum size limits, would be removed. Issues with discard and size distribution could easily be solved through size regulations such as slot limits, but analysis of these regulations were beyond the scope of this project.

Finally, major assumptions were made in this analysis in order to score the stakeholders. In particular, the assessment of catch share effects on biomass was based on a best-case situation. Ironically, in order to quell most of the weaknesses of the environmental impact analysis, a catch share program would have to be implemented and studied extensively in order to better inform this model.

7.4 The Social Analytical Model

The Social Analytical Model attempts to compare the perceived impacts and outcomes of the implementation of the novel management scenarios on society. This MCA analyzed the impacts on three social measures, further broken down to fundamental elements whose performance in each management scenario was scored relative to the baseline. The weighting of these elements were informed by expert interviews and surveys of anglers who participate in both the recreational industry and recreational angler sectors, and people at random utilizing Stearn's Wharf and the Santa Barbara Harbor, structures of the Santa Barbara Waterfront.

Scoring was determined from review of existing literature and data available on similar types of applied catch share management. With the relatively short history of most catch share programs, some scoring was due to reasoning. The scores all rate the elements' performances relative to the baseline scenario. A score of 1 demarcates an expected increase in performance, 0 for no change, and -1 for an expected decrease in performance.

7.4.1 Aspects

The fundamental unit of the social model is the aspect, because the only stakeholder considered is society at large. There are three aspects: Jobs, Access and Opportunity, and Peripheral Effects. Each aspect is broken down into weighted elements that were used to score each aspect's performance across the management scenarios compared to the baseline scenario. This was done in a manner that allows comparison of management scenario performance among elements and aspects.

Jobs

The Job aspect was the first aspect analyzed as it is often used as a social measure of performance. Within jobs, three elements were used to further analyze the aspect. These were number of jobs, job quality and the wages associated with the work. This aspect received a weighted score of 0.35.

Number of jobs received a weight of 0.45, which was the highest proportion of weight in this aspect. This was due to the actual number of jobs being the most socially visible consideration and a regularly used social metric of performance CITE. Job quality looks at the stability and duration of work. Is it seasonal or annual, long-term career or short term job? Being an important secondary element Job Quality was weighted 0.3 behind number of jobs. The Wages element considers the value of wages received for work done on fishing vessels by both the captains and the deck hands. This is a relatively subjective category as the wages received and valued by the captains and deckhands do not include all of the outlaying benefits that they receive for their work and may be viewed differently by the public. For this reason, the Wages element was weighted the lowest at 0.25.

Most examples of catch share implementation show a consolidation of effort in a fishery as less efficient boats are marginalized and leave the fishery (Dewees 1998, Newell, Sanchirico and Kerr 2004, Hilborn 2007), either ceasing operations altogether, or moving to a less competitive fishery. This consolidation due to the implementation of catch shares would lead to a decrease in the number of boats operating in both the recreational and commercial industry sectors, and have a negative effect on the number of jobs in management scenarios 1, 2, and 3. Further consolidation and related job losses are possible with cross-sectoral trading introduced in scenarios 2 and 3 as the recreational industry is predicted to trade away a portion of their allotted tags. With rationalization, studies have shown that job quality and wages increase as the fishery is managed more efficiently and there is a greater value and availability of fresh catch (Hilborn 2007, Dewees 1998 and Environmental Defense 2007). This benefit of rationalized fisheries led to the positive scoring of the Job Quality and Wages elements in scenarios 1, 2 and 3.

Table 7.9 The Jobs Aspect portion of the Social Analytical MCA.

Aspect	Stakeholder	Element		Baseline	1	2	3	1	2	3
			weight	Score				Weighted Score		
		Number of Jobs	0.45	0	-1	-1	-1	-0.45	-0.45	-0.45
Jobs	Society	Job Quality (Stability and Duration)	0.30	0	1	1	1	0.3	0.3	0.3
		Wages	0.25	0	1	1	1	0.25	0.25	0.25
0.35								0.1	0.1	0.1
							Total	0.035	0.035	0.035

Access and Opportunity

The Access and Opportunity aspect examines the methods available to society to access the products and supporting infrastructure of the fishing industry, as well as the opportunity to fish as an active angler, to take up fishing as new participant or to take trips as a participant in the recreational industry sector. Access and Opportunity received an aspect weight of 0.4, the largest aspect weight as it is the most direct and visual means of interaction for the public with the fishery and its stakeholders.

Infrastructure is defined here as the structures associated with boating and fishing. They include Stearn's Wharf, Santa Barbara Harbor, boat ramps, and parking lots. These structures are maintained by tax funds and are free to use. Piers and wharfs are often popular fishing locations, and since they are funded publicly, do not require a fishing license. Due to heavy use by tourists, residents and anglers alike, infrastructure received the greatest proportion of weight at 0.4. The working waterfront element refers to the actual activity associated with the waterfront. This includes the offloading, processing and sale of seafood and services that cater to the needs of fishing and fishermen. The persistence of a working waterfront is important to the city both as a positive identifier of maritime heritage, but also to receive Federal Transportation Funds to support maintenance activities and channel dredging (Williams 2008, Kronman 2008). The Charter boat/CPFV element represents the availability of fishing trips to the fishing and non-fishing public. This element is an important method to introduce fishing to non-anglers and children without the capital investment of gear. Charter boat/ CPFV access received a limited portion of the weight (0.2) because only 27% of respondents in the social survey stated that access to this type of fishing trip was important to them. Openness to new anglers represents the complexity and the nature of regulation in that it could be seen to be a barrier to anglers entering the recreation.[13] It was weighted 0.2.

[13] Cook C. and T. Raftican. 2008. "Recreational Fishing Organizations." Personal Communication. S. Guerin and M. Ng. Santa Barbara.

Given the spatial bounds and geography of the Santa Barbara waterfront, infrastructure was not believed to change under any scenario and was scored 0. The Working Waterfront element was also seen to remain constant compared to the baseline as the spatial niche it operates in is fairly defined, and increased activity from a larger portion of the TAC is not expected to visibly raise effort or activity. Following this reasoning working waterfront was also seen to stay constant in all scenarios, receiving scores of 0.

Access to Charter boats/CPFVs is expected to decrease across our region as part of the consolidation of effort typically seen with the implementation of catch shares (Dewees 1998, Gislason 2006). This will presumably start in scenario 1 as the recreational industry is rationalized without trading, and exacerbate through scenario 3. So this element receives a -1 throughout all scenarios.

Openness to new anglers was only believed to be affected in scenario 3 as management does not directly include individual anglers until then. Anglers perceive tags as a potential barrier to fishing, both limiting the number of fish, and heightening the complexity, which some anglers would claim as a potential reason to cease fishing (Survey 2007, Choy et al. 2007). The perception of the Recreational Industry being managed as a discrete unit, and tags as a part of that specific bundled experience is why this negative effect is not expected until the individual anglers are managed with tags in scenario 3.

Table 7.10 The Access and Opportunity Aspect of the Social Analytical MCA.

Aspect	Stakeholder	Element		Baseline	1	2	3	1	2	3
			weight	Score				Weighted Score		
		Infrastructure (Boat Ramps, harbor, wharf	0.40	0	0	0	0	0	0	0
Access/ Opportunity		Working Waterfront	0.20	0	0	0	0	0	0	0
	Society	Open to new Anglers	0.20	0	0	0	-1	0	0	-0.2
0.4		Charter Boat/ CPFV access	0.20	0	-1	-1	-1	-0.2	-0.2	-0.2
			1.00					-0.2	-0.2	-0.4
							Total	**-0.08**	**-0.08**	**-0.16**

Peripheral Effects

The Peripheral Effects aspect attempts to capture the social effects beyond the direct connections to the fishermen, the waterfront and the fishery. These are benefits derived indirectly from fishing. They include the elements of fishing industry performance, local ideals and buy-in, fish vendor and consumer effects, and harbor effects. This aspect is weighted 0.25, the lowest aspect weight because it captures secondary effects, rather than primary effects directly tied into the managed fishery.

The Peripheral Effect Elements analyzed are: Fishing support Industry, tourist industry, Harbor services/fees, Fish market effects on the vendor and consumer and community ideals. The Fishing support Industry includes bait shops, gear vendors and fishing magazines and other publications. This support industry is linked to the performance of a local fishery, as greater business coincides with more fish being caught, and with more anglers entering the recreation or fishing in the area. They can be very influential in swaying angler opinions and gathering support.[14] Due to the ability to

[14] Cook C. and T. Raftican. 2008. "Recreational Fishing Organizations." Personal Communication. S. Guerin and M. Ng. Santa Barbara.

drive points, sway angler opinion and mobilize anglers, the fishing support industry element received a weight of 0.25. Community ideals speak to the valuation of the fishery and a working waterfront by the public. Much like the sentiment felt toward family farms, people support working waterfronts and small scale commercial fishing operations similar to the operations of the Nearshore Fishery specifically and Santa Barbara Channel Region in general. Due to the significance of this sentiment, the community ideals element received a weight of 0.25. The Harbor services/fees element deals with the amount of fees paid by the commercial and recreational fishing industries, and the services that are available at the harbor to cater to the needs of these, and other, vessels. The harbors in the channel area are mixed-use harbors, with both working vessels and pleasure craft, leading to this element receiving a lower proportion of the weight, 0.15. The Fish market effects element is split into two categories, the vendors and the consumers. Most of the commercial fish caught in the Nearshore Fishery supply the live-fish market in Los Angeles (CITE).For this reason that this element is considered a peripheral effect and not an effect of access and opportunity. The dynamics effecting the vender or supplier are seen to be similar to those that will play out for the consumer, leading to each being weighted similarly at 0.1. The tourist industry element looks at the appeal of recreational and sport fishing as a draw of tourism, or as an attraction available to visitors. Sport fishing is listed third on the Santa Barbara City Waterfront website (http://www.santabarbaraca.gov/Government/Departments/Waterfront) and is weighted 0.15.

The Fishing industry performance, gear dealers/shops is believed to be mostly driven by new entrants purchasing gear.[14] Tags were seen by many in our angler survey to be a perceived barrier to both new entrants, and also to continuing fisherman. This perceived barrier is thought to limit new entrants to the fishery, therefore, limiting the purchase of new equipment by novice anglers. It is for this reason that this element is scored a -1 in scenario 3 when individual anglers are first managed under tags.

The area's tourist industry is believed to be robust and diversified enough that changes in fishery management will not affect the level or expenditures of tourists in general and visiting anglers in particular, because the nearshore fishery does not offer many sporting target species. As a result the tourist industry element receives a 0 score for all management scenarios.

Because catch shares select for efficiency, some diversified fisherman will leave the fishery and others may sell their boats. With a number of pleasure craft on the wait list for berthing, harbor services/ fees are not expected to change throughout the three management scenarios. So this element was scored as 0 throughout.

Fish market effects look at both the fish vendor and the fish consumer after the landing fisherman has relinquished his catch. As the commercial industry expands their share of catch, beginning in scenario 2, this will increase the amount of fish available to the live fish market. Vendors will have a greater efficiency in dealing without trip limits and an increased fish supply that may lead to gaining more restaurants as clients. For consumers these same factors could lead to the greater availability and variety of live fish, and could possibly decrease prices. These alterations are perceived to be a positive change, or an increase in performance from the baseline scenario, so these elements were both scored as a 1 in scenarios 2 and 3.

The community ideals score tries to capture the way society outside of the fishery values fishing and the waterfront. The social survey (Appendix 2) addressed this point in two different questions. In the first question, respondents ordered their preference in management priority as environment first, then commercial fishing, and then recreational. Secondly, respondents were asked what they identified the Santa Barbara Channel more with, commercial or recreational fishing. Again commercial fishing was the preferred answer. For these reasons, an increase in the commercial catch in scenarios 2 and 3 is seen positively through the societal lens, and is scored as 1.

Table 7.11 The Peripheral Effects Aspect of the Social Analytical MCA.

Aspect	Stakeholder	Element		Baseline	1	2	3	1	2	3
			weight	Score				Weighted Score		
Peripheral Effects	Society	Fishing Industry (gear dealers, bait shops	0.25	0	0	0	-1	0	0	-0.25
		Tourist Industry	0.15	0	0	0	0	0	0	0
		Harbor Services/Fees	0.15	0	0	0	0	0	0	0
		Fish Market Effects - Fish Vender	0.10	0	0	1	1	0	0.1	0.1
		Fish Market Effects - Consumers	0.10	0	0	1	1	0	0.1	0.1
		Community Ideals	0.25	0	0	1	1	0	0.25	0.25
0.25								0	0.45	0.2
							Total	0	0.113	0.05

7.4.2 Social Model Results

The weighted total score for management scenario 1 was - 0.045. This is a decrease in performance from our baseline management scenario. This score was attributed directly to the Charter Boat/CPFV element in the Access and Opportunity aspect. This element was scored negatively to denote the decrease in Charter vessels due to consolidation under catch shares. In the Jobs aspect, the Number of Jobs element also received a negative score, but the gains realized in Job Quality and Wages elements was sufficient to lead to a positive performing score of 0.035. The Peripheral Effects aspect was not seen to deviate in performance from the baseline scenario.

Scenario 2 received the highest weighted total score of 0.068. This score was buoyed mostly by positive performance in the Jobs and Peripheral Effects aspects. In the Jobs aspect, the combined increases from Job Quality and Wages led to another positive aspect score of 0.035. In the Peripheral Effects aspect, positive scoring of both fish market effects, with increased commercial catch, and community ideals led to an aspect score of 0.113. In the Access and Opportunity aspect, Charter Boat/CPFV access again was scored negatively leading to an aspect score of -0.08.

Scenario 3 had the lowest weighted score total of – 0.075. This score was due to the negative perceived performance of the Access and Opportunity and Peripheral Effect aspects. In the Access and Opportunity aspect, in addition to negative scoring for the Charter Boat/CPFV access element, the Openness to new anglers element was scored negatively as tags were viewed to be a barrier to new entrants into the fishery. These negative performance scores lead to an aspect score of -0.16. In the Peripheral Effects aspect the Fishery support industry aspect received a negative performance score as tags perceived barrier to fishermen would decrease the activity and limit new sales within this industry. This aspect received an aspect score of 0.05, down from the 0.113 from scenario 2. The Jobs aspect was not seen to change from scenario 1 and was again scored at 0.035.

Overall, scenario 2 would be judged the best scenario because it had the highest weighted score total of 0.068. The elements with positive scoring for this scenario were Job Quality, Wages, both Fish

Market Effects and Community Ideals. Scenario 3 was seen to be the poorest performing scenario as social resistance was seen in the Access and Opportunity aspect in both the Open to Anglers and Charter Boat/CPFV access elements. The added perceived tag restrictions on the individual angler introduced in scenario 3 represent the lowest performance. These restrictions make scenario 2 the best performing management scenario under the social lens.

Given the known sensitivity of MCA analysis to the weighting, a test of sensitivity was performed. In the first, stakeholder and element weights were equally distributed. In the second, one element received the bulk of the weight, and the others received only a nominal portion. In both of these tests, scenario 2 still showed the greatest performance with varying scores.

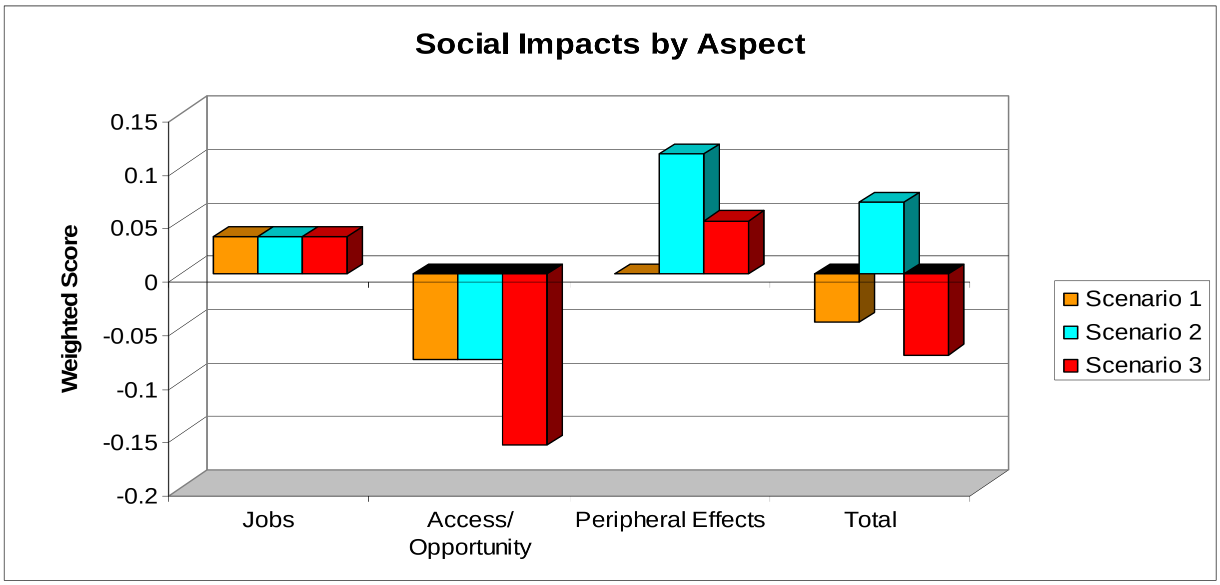


Figure 711: The distribution of weighted scores by Aspect and Total for management scenarios 1-3.

7.5 Political Models

The process of getting a fisheries management plan (FMP) drafted, accepted, and implemented is long and tedious because it must pass through several stages of agency planning and bureaucratic review before changes are seen on the ground. In California, preliminary FMPs are drafted by the Department of Fish and Game (CDFG) staff and then sent to the Fish and Game Commission (FGC) to be reviewed. The Fish and Game Commission is a decision-making body consisting of up to five members, all of whom are appointed by the Governor of California and then confirmed by the Senate. Often the FGC will send the preliminary FMP back to CDFG to revise and incorporate suggestions into the plan. Many of these revisions are politically driven by a lobbying, which originates with many of the stakeholders that are affected either directly or indirectly by the management changes to the fishery. The CDFG incorporates these changes and then sends the revised FMP back to the FGC. Once the FMP is approved by the FGC it becomes part of the Fish and Game Code which codifies the official regulations by which fisheries are managed (State of

California 2008(a).[15] This political process is often one of the most critical stages in achieving fisheries management reform and thus an integral part of analyzing any future fisheries management plan.

The two processes analyzed in the political model are "Acceptability" and "Readiness." Acceptability examines the concerns or values of each stakeholder group and scores how they will be affected by any new FMP potentially indicating the amount of political opposition associated with approval of the FMP. The output from this model is either a positive score, indicating that there would be an overall approval of the FMP, or a negative score, indicating an overall disapproval of the FMP relative to our baseline scenario.

Readiness examines the current infrastructure of each stakeholder that would be directly involved in the implementation of any FMP. The output from this model is a percentage of how "ready" all the necessary stakeholders would be to implement the FMP if it were employed today.

7.5.1 Political Acceptability Model

7.5.1.1 Methods

Analysis of political acceptability is done using a Multi-Criteria Analysis (MCA) as detailed in the MCA Process description in section 7.2. The weighted score for each stakeholder is determined by multiplying all element scores by their element weight and stakeholder weight and then summing the product. These stakeholder weighted scores are then summed to get a total weighted acceptability score for each management scenario relative to the baseline scenario. The entire model, its inputs, and results can be seen in Table 7.12.

<u>Stakeholders and Stakeholder Weights</u>

The stakeholders that would be most interested in the approval of any new FMP are those that have the greatest investment, either ideological or financial, in the resource being regulated. Therefore it is important that any new FMP is acceptable to them. These stakeholders are the same three analyzed in the other models, the commercial sector, recreational industry sector, and recreational angler sector, as well as two new stakeholders: non-governmental organizations (NGOs) and the regulatory body. In this analysis NGOs refer to organizations that advocate environmental protection, conservation, and sustainable use of natural resources. The regulatory body in this analysis refers directly to the California Department of Fish and Game.

Table 7.12. Political Acceptability Model. This figure shows the stakeholders for the acceptability model with their stakeholder weights (green), the stakeholder's elements of concern, element weights (red), the score for each scenario (blue), the weighted scores for each scenario, the summed total scores for individual stakeholders (yellow), and the combined total acceptability score (yellow).

[15] Ugoretz, J. 2008. "CDFG Management Plan Approval and Implementation." Personal Communication. J. Patterson. Santa Barbara.

Model	Stakeholders	Weight	Elements	Weight	Scores (-1,0,1) Scenarios			Weighted Scores Scenarios		
					1	2	3	1	2	3
Acceptability	Commercial Industry	0.15	1. Long Term Sustainability	0.15	0	1	1	0	0.0225	0.0225
			2. Short Term Profits	0.225	0	1	1	0	0.03375	0.03375
			3. Flexibility	0.225	0	0	0	0	0	0
			4. Complexity of Regulations	0.175	0	-1	-1	0	-0.02625	-0.02625
			5. Cost	0.225	0	0	0	0	0	0
								Commercial Industry Total		
								0	0.03	0.03
	Recreational Industry	0.15	1. Long Term Sustainability	0.245	1	1	1	0.03675	0.03675	0.03675
			2. Short Term Profits	0.145	1	1	1	0.02175	0.02175	0.02175
			3. Flexibility	0.195	1	1	1	0.02925	0.02925	0.02925
			4. Complexity of Regulations	0.195	-1	-1	-1	-0.02925	-0.02925	-0.02925
			5. Cost	0.22	0	0	0	0	0	0
								Recreational Industry Total		
								0.0585	0.0585	0.0585
	Recreational Anglers	0.15	1. Flexibility	0.235	0	0	1	0	0	0.03525
			2. Cost	0.185	0	0	0	0	0	0
			3. Quality of Fish	0.21	0	0	0	0	0	0
			4. Quantity of Fish	0.195	0	0	1	0	0	0.02925
			5. Complexity of Regulations	0.175	0	0	-1	0	0	-0.02625
								Recreational Angler Total		
								0	0	0.03825
	NGOs	0.15	1. Sustainability of Fish Stock	0.45	-1	1	1	-0.0675	0.0675	0.0675
			2. Ecosystem Health	0.55	-1	1	1	-0.0825	0.0825	0.0825
								NGO Total		
								-0.15	0.15	0.15
	Regulatory Body	0.4	1. Cost of Implementation	0.35	0	0	0	0	0	0
			2. Enforceability	0.35	0	0	0	0	0	0
			3. System Proven Elsewhere	0.125	-1	-1	-1	-0.05	-0.05	-0.05
			4. Generate EFI	0.175	1	1	1	0.07	0.07	0.07
								Regulatory Body Total		
								0.02	0.02	0.02
								Acceptability Total		
								-0.0715	0.2585	0.29675

Weights for each stakeholder were set in accordance with each group's political influence or lobbying power. Since designation of a group's "political influence" is subjective we decided to set all stakeholder weights except the regulatory body's as equal. The commercial sector, recreational industry sector, and recreational anglers sector all received a weight of 0.15 because we assumed that each group has equal ability to effectively lobby their position to the FGC members. The Regulatory Body received a stakeholder weight of 0.4 because it has the greatest influence on what FMP approves for two reasons. First CDFG actually drafts the preliminary FMP. Secondly, CDFG is directly responsible for implementing the final FMP so it must be realistically feasible for them to do so. The methods for determining each stakeholder's final weighted acceptability score are discussed below.

<u>Commercial Sector</u>

Elements and Element Weights

The elements reviewed for the commercial sector were: long-term sustainability of the fishery, short-term profits from the fishery, flexibility to fish whenever the fishermen want, complexity of the regulations, and cost to comply with regulations (permits/fees/taxes). The elements were determined through personal interviews with Chris Hoeflinger and Marcus Lebeck, two local commercial fishermen who have participated in the Santa Barbara Channel Nearshore Fishery since its informal beginning in 1986.[16][17] Once the elements were defined a short questionnaire was assembled and distributed to both fishermen asking them to rank these elements on a scale of one to five with five being the most important (see Appendix III). The numeric answers from this questionnaire were then used to determine the weight values, which can be seen in Table 7.12. Short-term profits, flexibility, and cost received the highest weights (0.225) while long-term sustainability received the lowest weight (0.15). The lower weight assigned to long-term sustainability is because the nearshore fishery is not viewed by commercial fishermen as an economically viable fishery on its own, thus long-term sustainability is not as important as the money that can be made now.[16][17] It should be noted that no one element greatly outweighed any other, indicating that all elements were seen as important issues.

Element Scores

Scores (-1,0,1) were assigned to each element based on literature review of catch share management plans applied to other fisheries in different regions (Arnason 1996, Campbell et al. 2000, and Dewees 1998) and distribution changes predicted from the economic model. Each management scenario was compared against the baseline scenario. Scenario 1 received neutral scores (0) for every element because there was no change within the commercial sector moving from the baseline to scenario 1. Scenarios 2 and 3 received positive scores (1) in the "long-term sustainability" and "short-term profits" elements because increased trading between the commercial and recreational industry sectors would lead to a shift in distribution of catch from the recreational industry sector to the commercial sector allowing them to potentially make more money. A negative score (-1) was given in the "complexity" element in Scenarios 2 and 3 as increased trading would lead to more transactions and greater perceived complexity.

<u>Recreational Industry Sector</u>

Elements and Element Weights

The elements reviewed for the recreational industry sector were the same as the commercial sector because the two sectors operate in much the same manner except that the former deals in anglers while the latter deals in fish. The elements were determined through personal interviews with local Commercial Passenger Fishing Vessel (CPFV) owners and landing managers, Jason Diamond, Merit McCrea, Chris Hanson, and Chris Callahan.[18][19][20][21] Once the elements were defined a short questionnaire was assembled and distributed to all CPFV owners asking them to rank these elements on a scale of one to five with five being the most important (see Appendix III). The numeric answers from this questionnaire were then used to determine the weight values, which can be seen in Table 7.12. Long-term sustainability (0.245) and cost (0.22) were seen as the most important elements while short-term profits (0.145) were seen as the least important. The reason the recreational industry sector values long-term sustainability over short-term profits (contrary to the values of the commercial sector) is because they see the Santa Barbara Channel Nearshore Fishery as an economically valuable resource where preservation over a long period could yield higher

[16] Hoeflinger, C. 2007. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[17] Lebeck, M. 2008. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[18] Callahan, C. 2007. "CPFV and Landing Experiences." Personal Communication. J. Patterson. Santa Barbara.
[19] Diamond, J. 2007. "CPFV Experiences." Personal Communication. J. Patterson. Santa Barbara.
[20] Hanson, C. 2007. "CPFV Experiences." Personal Communication. J. Patterson. Oxnard.
[21] McCrea, M. 2007. "CPFV Experiences." Personal Communication. J. Patterson. Santa Barbara.

economic returns.[22] It should be noted that no one element greatly outweighed any other as all elements were considered important issues.

Element Scores

Scores (-1,0,1) were assigned based on literature review of catch share management plans applied to other fisheries in different regions (Arnason 1996, Campbell et al. 2000, and Dewees 1998), distribution changes predicted from the economic model, and the specific details of each designed management scenario. It should be noted that there was only literature on commercial fisheries, but the commercial and recreational industry sectors of the nearshore fishery operate in much the same fashion. Each management scenario was compared against the baseline scenario. Scenarios 1, 2, and 3 all received positive scores (1) in "long-term sustainability" and "short-term profits" as investment in the resource is allocated to the recreational industry sector and trading is allowed. Additionally a positive score (1) was given to "flexibility" in scenarios 1, 2, and 3 because once trading is implemented daily bag limits and in-season closures are removed allowing the CPFVs to operate whenever they want as long as they have tags. A negative score (-1) was given to "complexity" in scenarios 1, 2, and 3 as increased trading would lead to more transactions and a perceived increase in complexity. Scenarios 1, 2, and 3 all received the same score because the projected changes for the recreational industry sector relative to the baseline scenario would all be the same.

<u>Recreational Angler Sector</u>

Elements and Element Weights

The elements reviewed for the recreational angler sector were: quality (size) of fish caught, quantity of fish caught, flexibility to fish whenever fishermen want, complexity of the regulations, and cost to comply with regulations (permits/ tags). The elements were determined through personal interviews with local recreational fishermen: Jeff Barr, Kurt Bellefeuille, and many anonymous fishermen met during recreational fishing trips in December of 2007.[23][24] Once the elements were defined a question asking fishermen to rank these elements on a scale of one to five with five being the most important was drafted and inserted in the CPFV survey (Question 12) conducted at the Santa Barbara Harbor in December of 2007 (see Appendix I). The numeric answers from this survey question were then used to determine the weight values, which can be seen in Table 7.12. Flexibility to fish (0.235) and the quality/size of fish caught (0.21) were the most important elements to recreational anglers while complexity of regulations (0.175) and cost to fish (0.185) were the least important elements. It should be noted that no one element greatly outweighed any other as all elements were seen as important issues.

Element Scores

Scores (-1,0,1) were assigned based the specific details of each designed management scenario and the expected outcomes of their implementation. Each management scenario was compared against the baseline scenario. Scenarios 1 and 2 received neutral scores (0) for every element because there was no change in the management of the recreational angler sector compared to the baseline scenario. Scenario 3 received positive scores (1) in "flexibility" and "quantity of fish" because when tags are introduced to the recreational angler sector, daily bag limits and in-season closures are

[22] McCrea, M. 2007. "CPFV Experiences." Personal Communication. J. Patterson. Santa Barbara.
[23] Barr, J. 2007. "Recreational Fishing Experiences. Personal Communication." J. Patterson. Santa Barbara.
[24] Bellefeuille, K. 2007. "Recreational Fishing Experiences." Personal Communication. J. Patterson. Santa Barbara.

removed allowing individual fishermen to fish whenever they want and to catch as many fish for which they have tags. A negative score (-1) was given in scenario 3 for the "complexity" element because introduction of a tag system would be perceived as another layer of regulation and therefore more complex. "Quality of fish" received a neutral score (0) for scenario 3 because catching larger or better quality fish is dependent upon many factors outside the influence of the management scenario such as individual fishing knowledge and ability and weather conditions.

Non-governmental Organizations (NGOs)

Elements and Element Weights

The elements reviewed for the NGOs were: the health/sustainability of the target species stock in the nearshore fishery and the nearshore ecosystem health. The elements were determined through personal interviews with Chuck Cook of The Nature Conservancy and Rod Fujita of Environmental Defense.[25][26] Once the elements were defined a questionnaire was drafted asking representatives of The Nature Conservancy (TNC) and the Natural Resource Defense Council (NRDC) to rank these elements on a scale of one to five with five being the most important (see Appendix III). The numeric answers for this questionnaire were then used to determine the weight values, which can be seen in Table 7.12. Both elements were viewed as equally valuable, but if one had to be weighted as more important it was ecosystem health (0.55) compared to target species health (0.45).

Element Scores

Scores (-1,0,1) were assigned based on results from the environmental model. Each management scenario was compared against the baseline scenario. Scenario 1 received negative scores (-1) for all elements because scenario 1 received an overall negative weighted score in the environmental model. Scenarios 2 and 3 both received positive scores (1) for all elements because each scenario received an overall positive weighted score in the environmental model, which covered both elements used in this model. Results of the environmental model can be seen in section 7.3: Environmental Analytical Model of this report.

Regulatory Body (CDFG)

Elements and Element Weights

The elements reviewed for the regulatory body were: cost of implementation, ability to enforce, familiarity with the type of management scenario, and ability to generate essential fisheries information (EFI). EFI is defined in the Marine Life Management Act (MLMA) as "the biology of fish, population status and trends, fishing effort, catch levels, and impacts of fishing" (State of California 2008(b)). The elements were determined through a personal interview with the manager of the Marine Habitat Conservation Program at CDFG, John Ugoretz.[27] Once the elements were defined a questionnaire was drafted asking Dr. Ugoretz to rank these elements on a scale of one to five with five being the most important (see Appendix III). This questionnaire also contained elements from the political readiness model discussed later. The numeric answers for this

[25] Cook C. 2007. "NGO Concerns with Fisheries." Personal Communication. J. Patterson. Santa Barbara.

[26] Fujita, R. 2008. "NGO Concerns with Fisheries and Political Feasibility." Personal Communication. J. Patterson. Santa Barbara.

[27] Ugoretz, J. 2008. "CDFG Management Plan Approval and Implementation." Personal Communication. J. Patterson. Santa Barbara.

questionnaire were then used to determine the weight values, which can be seen in Table 7.12. Cost of implementation and enforceability received the highest weights (0.35) while familiarity with the management system received the lowest weight (0.125). Cost and enforceability were considerably more important than familiarity and generation of EFI (0.175) because in order for a management plan to be effective it must be paid for somehow and be able to be enforced. The other two elements are desirable secondary attributes, but are not essential to a management plan being effective and hence accepted or rejected.[28]

Element Scores

Scores (-1,0,1) were assigned based on specific details from the management scenarios and real life experiences from other regulatory agencies who implemented management plans that involve some version of tradable catch shares.[29] Each management scenario was compared against the baseline scenario. Management scenarios 1, 2, and 3 all received a positive scores (1) for "generating EFI" because introducing tags into any fishing sector would result in more detailed information on fishing effort and catch levels. All management scenarios received a negative score (-1) for "familiarity with the management plan" because the concept of introducing tags to the recreational industry and especially tags to all individual in the recreational angler sector has not been attempted at this level anywhere else. Both "cost" and "enforceability" for scenarios 1, 2, and 3 were seen as equal to the baseline scenario so received a neutral score (0).

7.5.1.2 Results

The weighted stakeholder scores as well as the summed total acceptability score for each management scenario can be seen in Figure 7.13. As demonstrated in Figure 7.13, all but management scenario 1 is equally or more acceptable than the baseline scenario for every stakeholder. Scenario 1 is unacceptable to NGOs and overall because of the negative environmental impacts relative to the baseline. The summed total acceptability score indicates that scenario 3, where tags are allocated to all fishing sectors and trading across sectors is allowed, has the greatest acceptability across all stakeholders. The high performance of scenario 3 is due to the fact that in this scenario all fishing sectors have personal investment in the resource and are allotted the most freedom in how they can use their resource. While the outputs of this model predict how acceptable each management scenario will be to different stakeholders, it is important to assess how prepared these stakeholders are for the implementation of these management scenarios.

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[28] Ugoretz, J. 2008. "CDFG Management Plan Approval and Implementation." Personal Communication. J. Patterson. Santa Barbara.

[29] Savikko, H. 2007. "Tag Trading Facilitation by the Alaska Department of Fish and Game." Personal Communication. S. Choy. Santa Barbara.

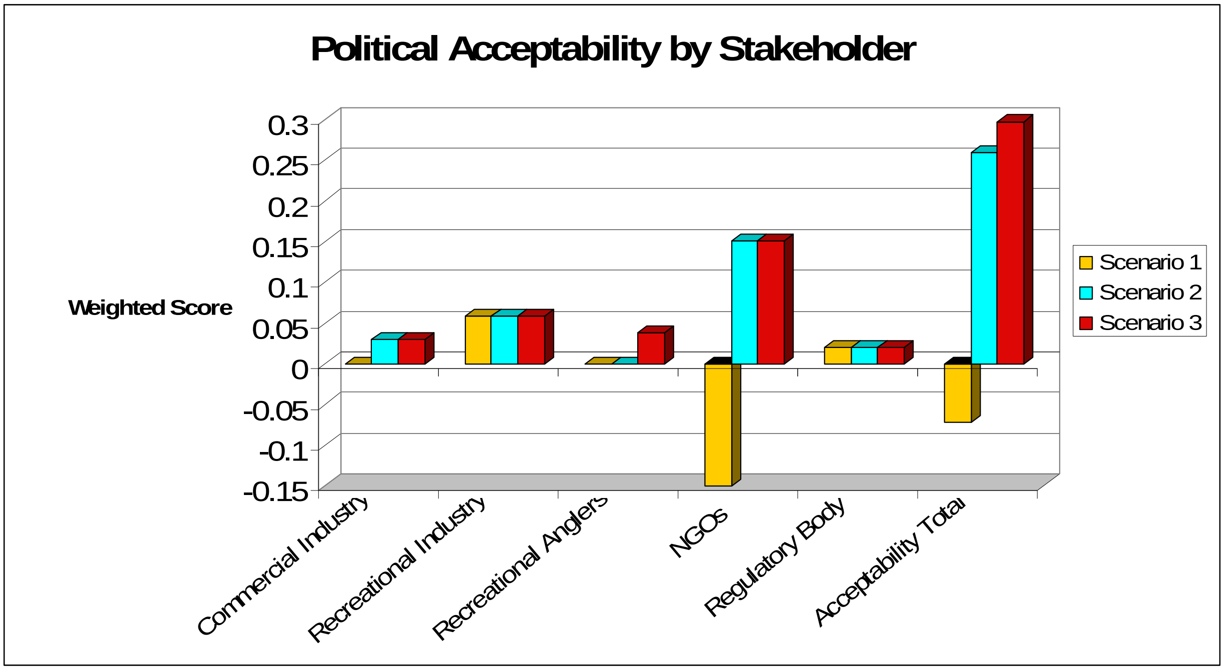

Figure 7.13. Political Acceptability Results by Stakeholder. This figure shows the summed element scores for each management scenario by stakeholder. The total acceptability score for each management scenario is also shown.

7.5.2 Political Readiness

7.5.2.1 Methods

The political readiness model looks at whether or not each stakeholder group has the infrastructure to implement a management scenario if it were employed today. Analysis of political readiness is done using a Multi-Criteria Analysis (MCA) as described in section 7.2: Multi-Criteria Analysis of this report. However, the scoring is slightly different than in the other MCA models. Instead of scoring a -1, 0 or 1 to indicate a negative, neutral, or positive change compared to the baseline scenario, scores of 1 or 0 are given for a YES or NO answer, respectively, for each element within a management scenario. Sub-elements were created for each element within a stakeholder group because YES or NO answers can be very definitive if they do not consider several factors first. In other words there are many factors (sub-elements) within each element that need to be present for that element to receive a YES score (1). For an element to receive a YES score (1) it must receive a YES score (1) for each sub-element. If any sub-element receives a NO score (0) then that entire element receives a NO score (0). This tends to bias the results toward more NO scores (0), but it is better to make sure a stakeholder group has the complete infrastructure necessary to implement a management scenario. The weighted score for each stakeholder is determined by multiplying all element scores by their element weight and then summing the product. These stakeholder weighted scores are then multiplied by the stakeholder weights and then summed to get a total weighted readiness score for each management scenario. Since weighted scores have the potential to sum to one if every scenario received a YES (1) score then the weighted scores can be interpreted as a fraction of how ready each stakeholder is to implement that scenario or a "percent ready". To convert the weighted scores into "percent ready" simply multiply them by 100. The entire model, its inputs, and results can be seen in Table 7.13.

Stakeholders and Stakeholder Weights

The stakeholders in this model are the same as in the political acceptability model except that there are no NGOs. Although it is important to recognize the values of NGOs and their influence in approving a management plan, they do not need to be "ready" in terms of infrastructure for the implementation of the management plan once it is approved. For this reason they are excluded from this model.

Stakeholder weights were based on how involved each stakeholder will be in the implementation of the management scenarios. The regulatory body is the most involved in implementation and requires the most pre-existing infrastructure so received the highest weight relative to the other stakeholders of 0.4. The other three stakeholders all received weights of 0.2 because they all require the same infrastructure to implement the management scenarios, but less than the regulatory body. The methods for determining each stakeholder's elements, element weights, and element scores are described below.

Table 7.13. Political Readiness Model. This figure shows the stakeholders for the readiness model with their stakeholder weights (green), the stakeholder's elements of concern, element weights (red), the score for each scenario (blue), the weighted scores for each scenario, the summed total scores for individual stakeholders (yellow) and the combined total readiness score (yellow).

Model	Stakeholders	Weight	Elements	Weight	Scores (0,1) Scenarios 1	2	3	Weighted Scores Scenarios 1	2	3
Readiness	Regulatory Body	0.4	1. Similarity to Current Regulations	0.275	0	0	0	0	0	0
			2. Staff Requirements	0.325	1	1	1	0.325	0.325	0.325
			3. Legality	0.4	0	0	0	0	0	0
								Regulatory Body Total Score		
								0.325	0.325	0.325
	Recreational Industry	0.2	1. Existing Organization	0.333	1	1	1	0.333	0.333	0.333
			2. Trading Structure	0.333	0	0	0	0	0	0
			3. Constituency	0.333	1	1	1	0.333	0.333	0.333
								Recreational Industry Total Score		
								0.666	0.666	0.666
	Recreational Anglers	0.2	1. Existing Organization	0.333	1	1	1	0.333	0.333	0.333
			2. Trading Structure	0.333	1	1	0	0.333	0.333	0
			3. Constituency	0.333	1	1	0	0.333	0.333	0
								Recreational Angler Total Score		
								0.999	0.999	0.333
	Commercial Industry	0.2	1. Existing Organization	0.333	0	0	0	0	0	0
			2. Trading Structure	0.333	0	0	0	0	0	0
			3. Constituency	0.333	0	0	0	0	0	0
								Commercial Industry Total Score		
								0.000	0.000	0.000
								Readiness Total Score		
								0.463	0.463	0.330

Regulatory Body (CDFG)

Elements, Element Weights, and Element Scores

The elements reviewed for the regulatory body were: similarity to current management plan, staff requirements, and legality. The elements were once again determined through a personal interview with the manager of the Marine Habitat Conservation Program at CDFG, John Ugoretz.[30] Once the elements were defined they were included in the same questionnaire used for determining weights in the political acceptability model (see Appendix III). The numeric answers for this questionnaire

[30] Ugoretz, J. 2008. "CDFG Management Plan Approval and Implementation." Personal Communication. J. Patterson. Santa Barbara.

were then used to determine the element weight values. Legality (0.4) was the most important element because if the management scenario is not currently legal and would require new legislation then it is highly unlikely that it will be implemented. Staff requirements (0.325) and similarity to current regulations (0.275) were less important, but still necessary to implement new management scenarios.

The sub-elements used were defined for each element after lengthy discussions with Maggie Ostdahl and Rod Fujita, two of our client contacts at Environmental Defense, and Michael D. DeLapa, Pacific Regional Director of Ocean Programs at Environmental Defense, all of whom are familiar with members of our stakeholder groups.[31][32][33] Below are all of the elements for the regulatory body with their associated sub-elements and the scores received for each scenario with explanations.

<u>Example of Layout for this Section:</u>

Scenarios scored.

#. Element **(Score)**

letter. Sub-element **(Score)**

Scenarios 1, 2, and 3 all received the following scores.

1. Is the proposed management scenario similar to the current management plan? **NO (0)**

   a. Does the proposed management scenario help reach the goals of the current management plan?
   YES – The proposed management scenarios help reach the Nearshore Fishery Management Plan (NFMP) goals of ensuring long-term resource conservation and sustainability, increasing constituent involvement in management, balancing and enhancing socio-economic benefits, and identifying implementation costs and sources of funding (CDFG 2003).

   b. Does the proposed management plan have all critical information to operate correctly readily available (i.e. accurate harvest limits for all species)?
   NO – Currently there is not enough EFI to set accurate harvest limits for all of the nineteen fish species regulated under the NFMP, as discussed in section 4. The effectiveness of these proposed management scenarios is directly dependent on the setting of accurate harvest limits for all fishing sectors.

[31] DeLapa, M. 2008. "Political Feasibility and Fishing Stakeholders." Personal Communication. J. Patterson. Santa Barbara.
[32] Fujita, R. 2008. "NGO Concerns with Fisheries and Political Feasibility." Personal Communication. J. Patterson. Santa Barbara.
[33] Ostdahl, M. 2008. "Political Feasibility Issues." Personal Communication. J. Patterson. Santa Barbara.

2. Is the current Regulatory Body staff sufficient to implement the proposed management scenario effectively? **YES (1)**
   There would be little to no additional staff required for enforcement or for other implementation processes. Facilitation of trade would be the responsibility of each stakeholder that was allocated quota/tags. Occasional review of the trading process, reporting of trade transactions, actual design and production of tags could be done by in-house staff or with volunteers. A personal phone conversation with Alaska Department of Fish and Game (ADFG) employee, H. Savikko, regarding the means in which ADFG facilitates trading in the Halibut fishery supports these findings.[34]

3. Is the proposed management scenario legal under current law? **NO (0)**

   a. Is the proposed management scenario legal under the California Constitution?
      YES – The only applicable statute in the California Constitution is Article 1 Section 25, which grants all California residents the "right to fish upon and from the public lands of the State and in the waters thereof" (California Constitution 2008). These management scenarios do not infringe on that right.

   b. Is the proposed management scenario legal under the California Fish and Game Code?
      YES – The only applicable statute in the California Fish and Game Code is 6.2.1.2 Section 7121, which states "Except as otherwise provided by this Code or by regulation [commercial fishing], it is unlawful to sell or purchase any *fish*…taken in, or brought into, the waters of the state, or brought ashore at any point in the state. It is unlawful to buy, sell, or possess in any place of business where fish are bought, sold, or processed, any *fish*…taken on any boat, barge, or vessel which carries *sport fishermen*" (emphasis added) (U.S. Laws 2008). Tradable tags, which can be bought and sold, only provide the *opportunity* to catch fish, not actual fish themselves, so may be interpreted as legal.

   c. Will the Regulatory Body interpret the Fish and Game Code in such a manner that the proposed management scenario will be in accordance with the Code?
      NO – According to John Ugoretz of CDFG the above mentioned Fish and Game Code would be interpreted in such a manner that tradable tags would be in violation of the Code and therefore illegal.[35]

<u>Commercial Sector</u>

Elements, Element Weights, and Element Scores

[34] Savikko, H. 2007. "Tag Trading Facilitation by the Alaska Department of Fish and Game." Personal Communication. S. Choy. Santa Barbara.

[35] Ugoretz, J. 2008. "CDFG Management Plan Approval and Implementation." Personal Communication. J. Patterson. Santa Barbara.

The elements and sub-elements for the commercial, recreational industry, and recreational angler sectors were all defined from the same conversations with Environmental Defense representatives discussed in the regulatory body methods above.[36][37][38] Element weights were all set equal (at 0.333) because each element would need to be in place for a stakeholder to be deemed "ready" for implementation. Below are all of the elements for the commercial sector with their associated sub-elements and the scores received for each scenario with explanations.

Scenarios 1, 2, and 3 all received the following scores.

1. Is there an existing organization that can be responsible for the stakeholder's harvest limit? **NO (0)**

    a. Does an organization exist that can represent this stakeholder?
    NO – There are several commercial fishing organizations such as the California Lobster and Trap Association present in the Santa Barbara Channel region, but none of these organizations directly represent the interests of all participants in the nearshore fishery.

    b. Are any of these organizations' stated goals in line with the goals of the proposed management scenario?
    NO – This question is not applicable because the answer to the first sub-element is no.

    c. Are any of these organizations effective at reaching their stated goals (i.e. do they have effective leadership)?
    NO – This question is not applicable because the answer to the first sub-element is no.

2. Does the stakeholder organization have a means for facilitating the trading of tags as described in the management scenario? **NO (0)**
The commercial sector does not even have an organization to begin attempting measures to facilitate trading.

3. Does the stakeholder organization have enough support from the individual stakeholders (constituency) to effectively implement their portion of the management scenario? **NO (0)**

    a. Are more than 50% of the stakeholder individuals in the region a member of a stakeholder organization?
    NO – The commercial fishing sector in the Santa Barbara Channel Nearshore Fishery is a diverse group with different levels of participation and dependence on the nearshore fishery. Individual fishermen often have different size boats, participate in different outside fisheries, and rely on the nearshore fishery for a

[36] DeLapa, M. 2008. "Political Feasibility and Fishing Stakeholders." Personal Communication. J. Patterson. Santa Barbara.
[37] Fujita, R. 2008. "NGO Concerns with Fisheries and Political Feasibility." Personal Communication. J. Patterson. Santa Barbara.
[38] Ostdahl, M. 2008. "Political Feasibility Issues." Personal Communication. J. Patterson. Santa Barbara.

different portion of their annual income making them a particularly difficult group to organize in the manner necessary for these proposed management scenarios.

b. Has this stakeholder organization been effective at building its constituency in the past? **NO** - This question is not applicable because the answer to the first sub-element is no.

Recreational Industry Sector

Elements, Element Weights, and Element Scores

Below are all of the elements for the recreational industry sector with their associated sub-elements and the scores received for each scenario with explanations.

Scenarios 1, 2, and 3 all received the following scores.

1. Is there an existing organization that can be responsible for the stakeholder's harvest limit? **YES (1)**

   a. Does an organization exist that can represent this stakeholder?
   YES – The Sportfishing Association of California (SAC) was formed in 1972 and represents 200 sportfishing vessels and 23 landings in California (SAC 2008).

   b. Are any of these organization's stated goals in line with the goals of the proposed management scenario?
   YES – One of the main mission statements of SAC is "supporting the health of…the marine fishery resources" (SAC 2008). This mirrors the goals of the NFMP such as ensuring long-term resource conservation and sustainability (CDFG 2003).

   c. Are any of these organizations effective at reaching their stated goals (i.e. do they have effective leadership)?
   YES – SAC played an integral part in recovering the Southern California White Seabass stock working alongside United Anglers of Southern California (UASC) and CDFG (SAC 2008, UASC 2008(a)).

2. Does the stakeholder organization have a means for facilitating the trading of tags as described in the management scenario? **NO (0)**
   The recreational industry does not currently have a means for facilitating trade, but it would not be difficult to institute some manner of accomplishing this, such as internet trading with usernames and passwords. Other means for facilitating trade in general are discussed in greater detail in section 10: Discussion of this report.

3. Does the stakeholder organization have enough support from the individual stakeholders (constituency) to effectively implement their portion of the management scenario? **YES (1)**

a. Are more than 50% of the stakeholder individuals in the region a member of this stakeholder organization?
YES – A written economic survey conducted in spring of 2007 asked specific demographic and economic questions to individuals employed in the recreational industry sector of the Santa Barbara Channel region. One question asked if they were members of any sportfishing organizations. Seven out of an estimated 14 fulltime CPFV operators in the area responded to the survey and out of the seven respondents all of them were members of SAC. Extrapolating this it is assumed that close to 100% of the CPFV operators in the region are members of SAC (Choy et al. 2007).

b. Has this stakeholder organization been effective at building its constituency in the past?
YES - In July of 2007 there was an alliance formed between the Sportfishing Association of California (SAC), the United Anglers of Southern California (UASC), the Southern California Marine Association (SCMA), the Coastside Fishing Club, and the American Sportfishing Association (ASA) to "ensure healthy marine resources while providing a robust and sustainable recreational fishery for Southern California" (UASC 2008(b)).

<u>Recreational Anglers</u>

Elements, Element Weights, and Element Scores

Below are all of the elements for the recreational angler sector with their associated sub-elements and the scores received for each scenario with explanations.

Scenarios 1 and 2 received YES scores for all elements because they were managed under the same regulations as in the baseline scenario. There was no quota in the form of tags allocated to the recreational angler sector and therefore no trading in these first two proposed management scenarios. Scenario 3 received the following scores.

1. Is there an existing organization that can be responsible for the stakeholder's harvest limit?
YES (1)

   a. Does an organization exist that can represent this stakeholder?
   YES – The United Anglers of Southern California (UASC) claim to be "the largest association dedicated to restoring California's fisheries and marine resources" while looking out for the interests of recreational fishermen (UASC 2008(a)).

   b. Are any of these organization's stated goals in line with the goals of the proposed management scenario?
   YES – One of the main goals of the UASC is to "protect fish stocks and valuable eco-systems" (UASC 2008(a)). This mirrors the goals of the NFMP such as ensuring long-term resource conservation and sustainability (CDFG 2003)

c. Are any of these organizations effective at reaching their stated goals (i.e. do they have effective leadership)?
YES – UASC played an integral part in recovering the Southern California White Seabass stock working alongside SAC and CDFG (SAC 2008, UASC 2008(a)).

2. Does the stakeholder organization have a means for facilitating the trading of tags as described in the management scenario? **NO (0)**
Recreational Anglers do not currently have a means for facilitating trade and it would be difficult to implement an effective measure for this because of the sheer number of individuals represented by this stakeholder group. Other means for facilitating trade in general are discussed in greater detail in section 10: Discussion of this report.

3. Does the stakeholder organization have enough support from the individual stakeholders (constituency) to effectively implement their portion of the management scenario? **NO (0)**

   a. Are more than 50% of the stakeholder individuals in the region a member of this stakeholder organization?
   NO – Out of 97 fishermen interviewed in the Santa Barbara Channel region during our analysis only 2 were members of any fishing organization.

   b. Has this stakeholder organization been effective at building its constituency in the past?
   YES – In July of 2007 there was an alliance formed between the Sportfishing Association of California (SAC), the United Anglers of Southern California (UASC), the Southern California Marine Association (SCMA), the Coastside Fishing Club, and the American Sportfishing Association (ASA) to "ensure healthy marine resources while providing a robust and sustainable recreational fishery for Southern California" (UASC 2008(b)).

7.5.2.2 Results

As mentioned earlier the total weighted readiness scores are in the same units as the acceptability score (decimal numbers less than 1) but have been converted here to percents by multiplying by 100. Through this means a "percent ready" of each stakeholder to implement each management scenario and the total combined "percent ready" of all stakeholders to implement each scenario can be seen in Figure 7.14. For looking at each stakeholders "percent ready" only multiply the element weight by the score and multiply that weighted score by 100. You do not include the stakeholder weight until you are looking at the "percent ready" of all stakeholders for each proposed management scenario. The regulatory body is 33% ready to implement all proposed management scenarios. The recreational industry sector is 67% ready to implement all proposed management scenarios. The recreational angler sector is 100% ready to implement Scenarios 1 and 2 because the manner in which they are managed in those scenarios remains the same as in the baseline scenario. The recreational angler sector is 33% ready to implement scenario 3. The commercial sector is not ready (0%) to implement any proposed management scenario. The total combined percent readiness across stakeholders is 46.3% for Scenarios 1 and 2 and only 33% for Scenario 3. Scenario 3 is therefore the most difficult to implement. This is largely because the recreational angler sector is integrated into a trading scheme in scenario 3, increasing the amount of infrastructure necessary and the number of transactions that need to be monitored and recorded.

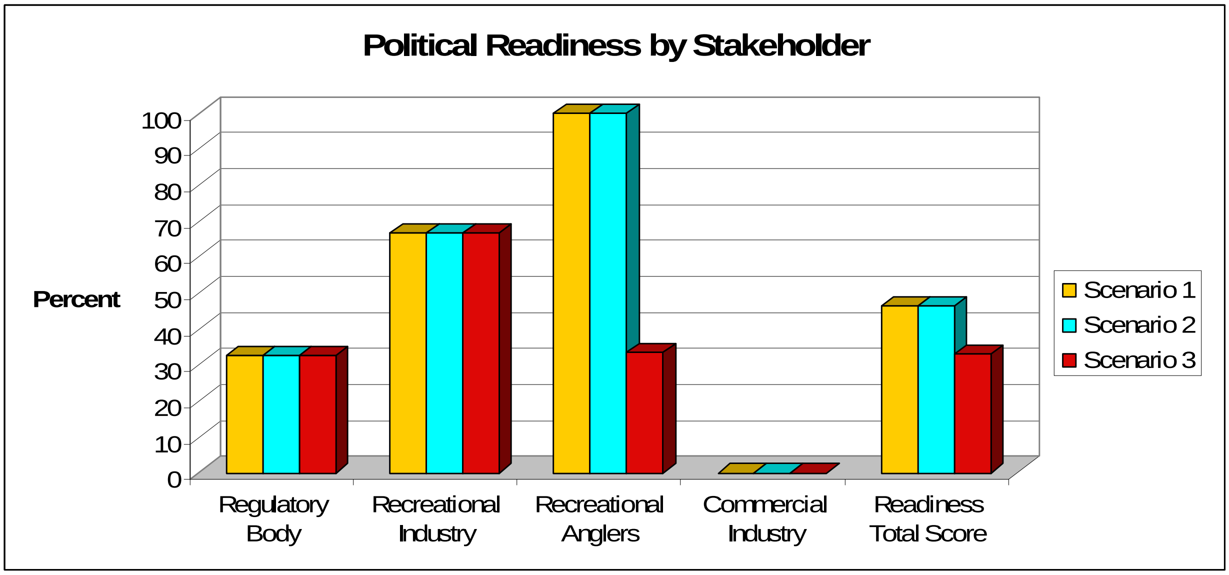

Figure 7.14. Political Readiness Results by Stakeholder. This figure shows the summed element scores as each stakeholder's percent "ready" to implement for each management scenario. The total combined percent "ready" score across stakeholders for each management scenario is also shown.

8 Results and Recommendations

In terms of gains from trade, the economic analysis shows a gain of $12,073 from the baseline in scenario 2 resulting from incorporating cross-sectoral trading between the commercial and recreational industry sectors, and a gain of $37,786 in scenario 3 from incorporating cross-sectoral trading among all sectors. The environmental model shows that the greatest potential gains in environmental performance of the fishery would also occur in scenario 2. Including the recreational angler sector in the catch share program in scenario 3 is predicted to produce a decrease in environmental performance compared with scenario 2. In addition, the positive social impacts are the highest in scenario 2. According to the social model, the implementation of scenario 1 would negatively impact stakeholders considered in the social model. Further, the positive impacts on society decrease from scenario 2 to scenario 3. Regarding political acceptability, scenarios 2 and 3 were found to be similar with scenario 3 performing slightly better than scenario 2, and both performing better than scenario 1. However, the political readiness model shows that scenario 3 is not as good of an option as scenarios 1 or 2. The results are shown in Figures 8.1 and 8.2.

When considering the management scenarios proposed in this project, scenarios 2 and 3 both outperformed scenario 1 in nearly all of the chosen criteria. Because scenarios 2 and 3 performed so similarly, the recommendation of a specific management scenario will depend on what is more important to the stakeholders. For instance, if economic gain is the sole purpose of management reform, scenario 3 is the clear winner. However, if environmental and social gains are valued most, scenario 2 shows better performance in these aspects, and would be preferred to scenario 3.

Some of the benefits of scenario 2 and 3 include:

- High gains from trade
- Increases in biomass, stewardship, and compliance to regulation
- Increases long-term sustainability and short-term profit for both the commercial and recreational industry sectors
- Generation of Essential Fishery Information (EFI)
- Improvements in local buy-in to the fishery

Some of the challenges of implementing scenario 2 include:

- Potential high-grading of size and discards in the recreational industry sector
- Setting of accurate harvest limits (TACs) for individual species and complexes
- Increasing perceived complexity of regulations

Some of the challenges of implementing scenario 3 include:

- The challenges of implementing scenario2
- Political barriers to implementation (i.e. readiness of regulatory body and stakeholders)

The first challenge, potential increases in high-grading and discards, could be met by implementing slot limits, which encourages the take of medium-sized individuals (Birkeland et al., 2005). The setting of accurate harvest limits or TACs for individual species and complexes would get better, as catch shares could result in better stock assessment (Redstone Strategy Group 2007). Finally, the increased perceived complexity of regulations would have to be addressed through public outreach and education. The major challenge in implementing scenario 3 could be overcome through intense efforts to establish the infrastructure necessary to facilitate trading across all sectors, as well as increasing the funds and manpower in the regulatory body.

Overall, this analysis suggests that a fishery management system that integrates commercial and recreational sectors can result in greater benefits than a system that manages sectors separately. This is largely a result of the potential economic, environmental, and social gains. A general recommendation would therefore be to manage the commercial and recreational industries under a single management plan. Furthermore, this analysis shows that integration of these sectors can be achieved through catch share programs. Accordingly, an additional general recommendation would be to use catch shares as a tool to integrate the commercial and recreational fishing sectors.

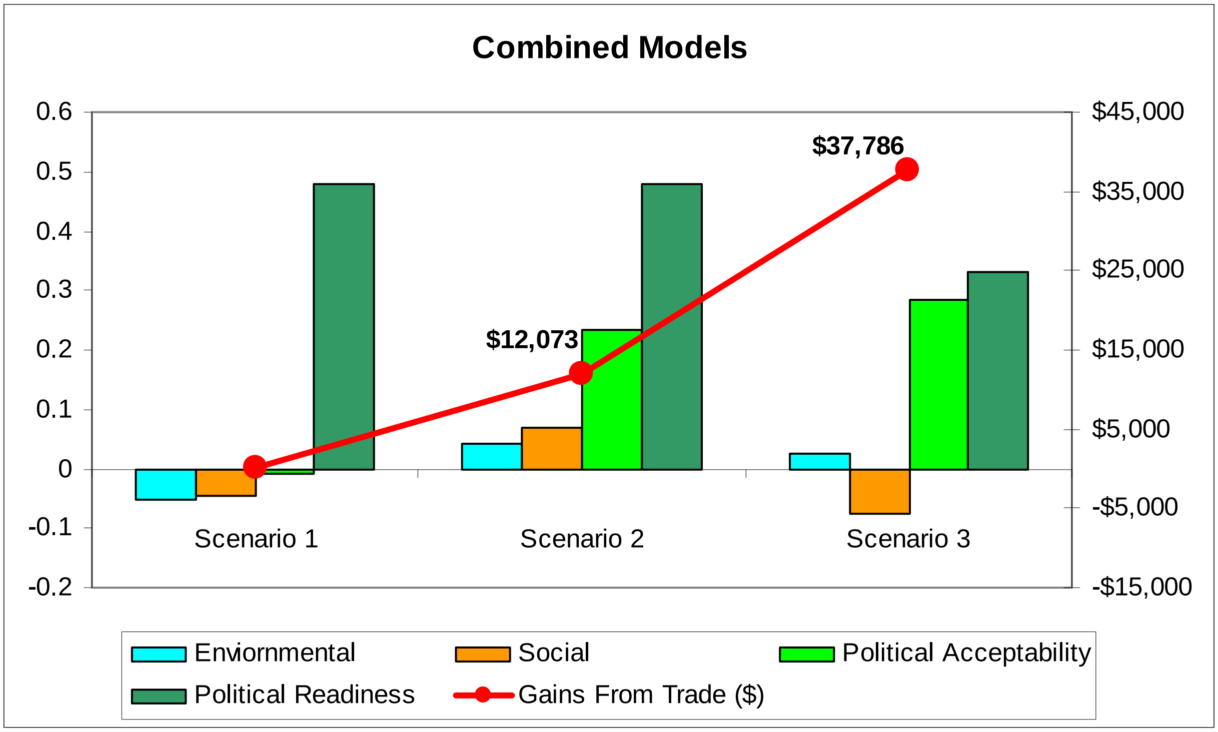

Figure 8.1. Combined Results of All Four Criteria Models.

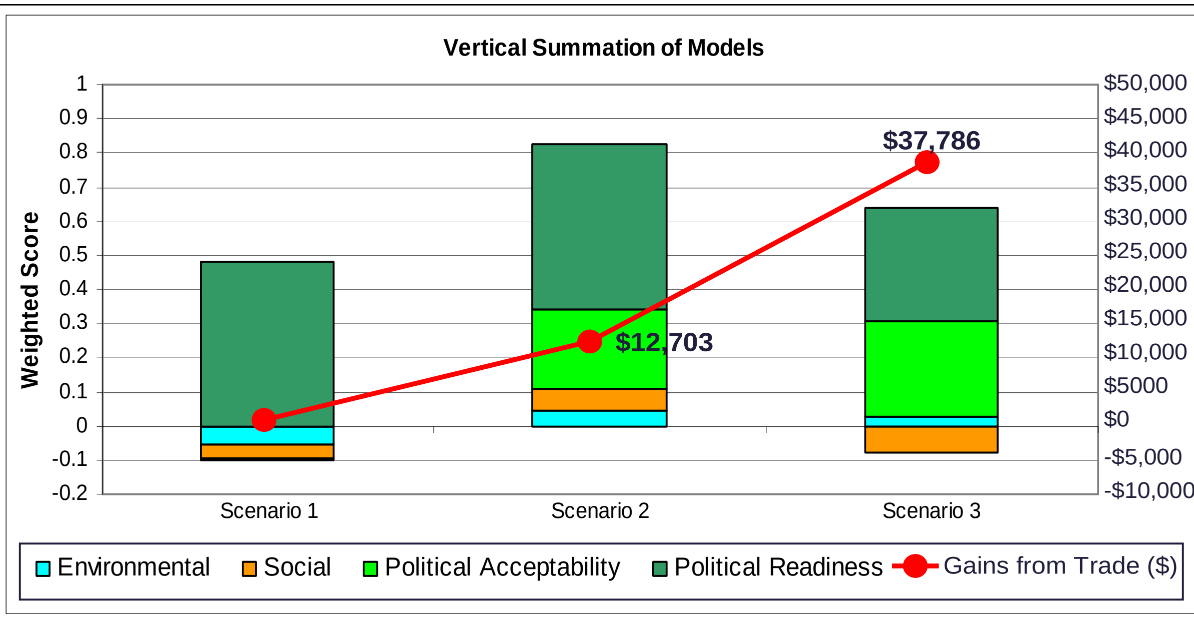

Figure 8.2. Vertical summation of models.

9 Sensitivity Analysis

Our analysis was performed using our best estimates for many variables and parameters. Some of these values, such as the value of a fish caught commercially, were derived with extensive historical data, and are fairly robust. However, other variables were estimates from other fisheries, or were derived from contingent valuation methods. We performed sensitivity analysis on the estimates used in this analysis to determine how the results are affected by changes to the estimates.

In the economic analysis, the recreational demand function for the recreational industry sector is a function of four independent variables. These independent variables are expected catch, age, number of fishing trips per year, and price per tag. The demand function for the recreational angler sector is a function of three independent variables. These independent variables are expected catch, age, and price per tag. In order to understand the relationship between tag price and quantity demanded, we used the mean values from the surveys for the other variables. We varied each of these variables by one standard deviation and generated a new set of demand functions. This produced a range of demand functions for each recreational fishing sector. The lowest and highest estimates were selected from each sector for further analysis. It is important to note that variations in the age variable produced the biggest variation in these demand functions. The demand function was most sensitive to the age variable because the standard deviation was large even though the coefficient is smaller than that of other variables.

For the commercial demand function, the cost estimate is the most uncertain variable. We used interviews with local commercial fisherman to determine a high and low case range.[39][40] The low estimate for cost is $3.99 per fish and the high estimate was $6.14 per fish as compared to the cost of $4.79 per fish used in the original model. These two estimates gave us a low demand function and high demand function for the commercial sector.

The economic analysis was repeated with each combination of demand functions. Sixteen sensitivity analysis iterations, or "runs," were performed. The combinations of demand functions used for each iteration are shown in Table 9.1.

Table 9.1: Sensitivity analysis interactions and demand functions used for each iteration.

	Demand Functions Used			
Sensitivity Analysis runs	**Commercial**	**Recreational Industry**	**Recreational Angler: Private Boaters**	**Recreational Angler: Shore**
1	low	low	low	low
2	low	low	low	high
3	low	low	high	low
4	low	low	high	high
5	low	high	low	low
6	low	high	low	high
7	low	high	high	low
8	low	high	high	high
9	high	low	low	low
10	high	low	low	high

[39] Hoeflinger, C. 2007. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.
[40] Lebeck, M. 2008. "Live-fish Fishery Experience." Personal Communication. J. Patterson. Santa Barbara.

11	high	low	high	low
12	high	low	high	high
13	high	high	low	low
14	high	high	low	High
15	high	high	high	Low
16	high	high	high	High

The changes in distribution of tags that resulted from iterations 8 and 9 gave the best and worst case results. Iteration 8 used low estimates for the commercial demand curve and high estimates for the other three demand curves. Iteration 9 used high estimate for the commercial demand function and low estimates for the other three demand functions. The distributional ranges are significantly different from the original model. The distribution ranges from the sensitivity runs are shown in Figures 9.1 and 9.2.

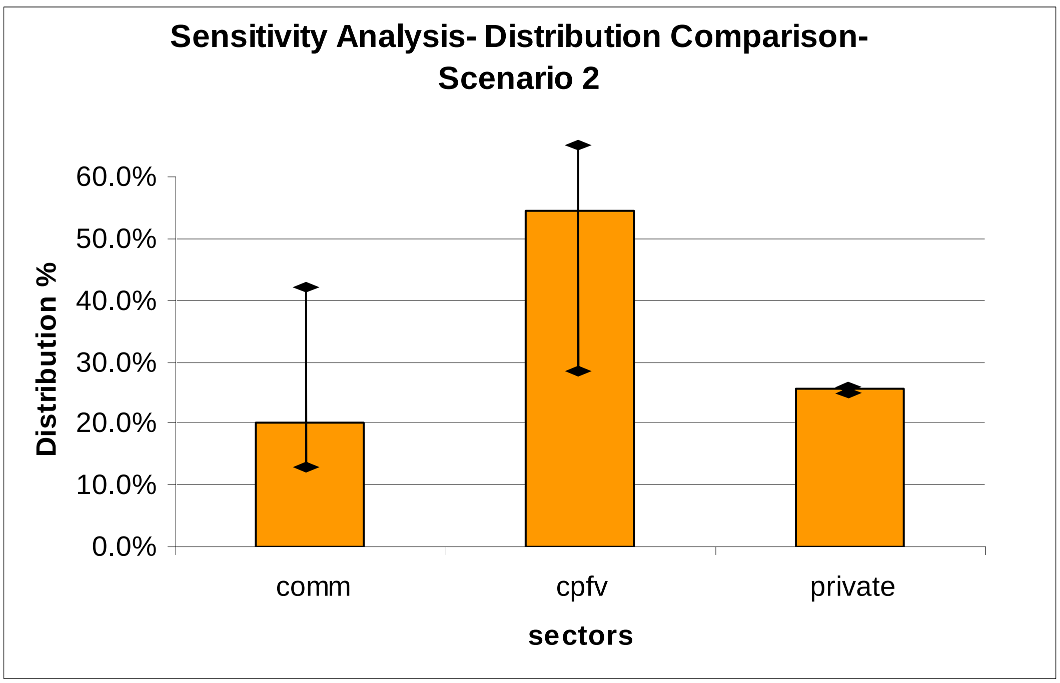

Figure 9.1. Distribution ranges with sensitivity runs for scenario 2.

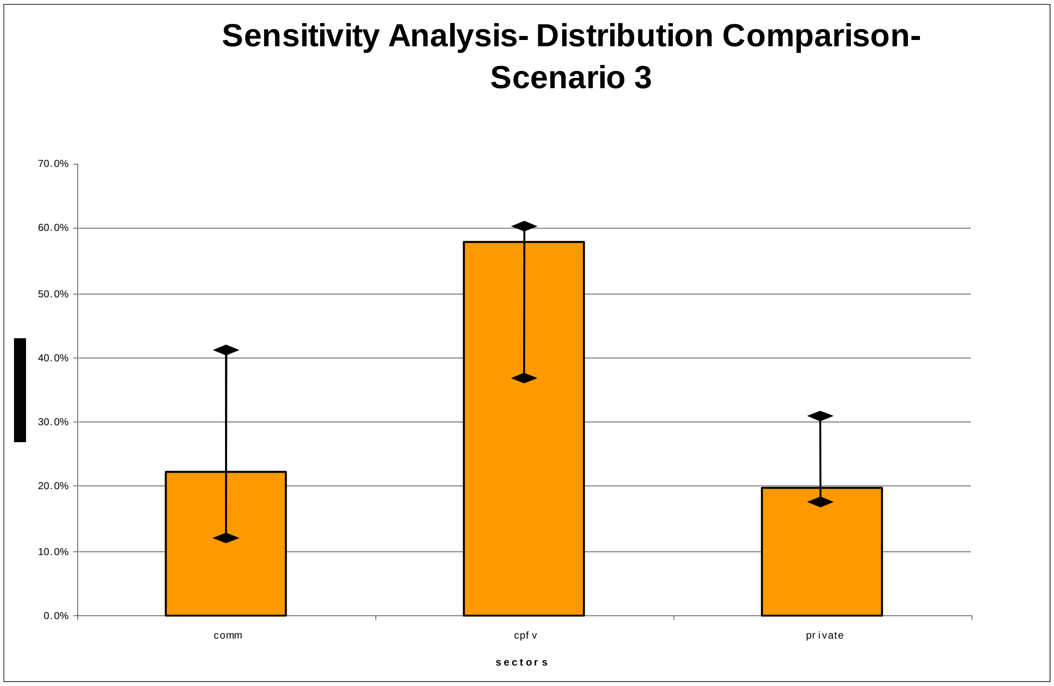

Figure 9.2. Distribution ranges from sensitivity runs for scenario 3.

These changes in distribution effects the economic gains from trade for each of the scenarios. The gain from iteration 8 becomes a quarter less in scenario 2 while the gains increased significantly with iteration 9. The comparison of the gains is shown in Table 9.2.

Table 9.2: Comparison of economic gain from sensitivity analysis run 8 and run 9 to original model.

Economic Gain	Scenario 2	Scenario 3
Model	$12,073	$14,229
Run 8	$3,413	$11,531
Run 9	$218,341	$282,151

The results from the economic gains show that our economic analysis is quite sensitive to the different estimates used in our variables. A more vigorous contingent valuation survey could reduce the level of uncertainty with some of these variables.

10 Discussion

This analysis focused on designing a catch share system that integrates the recreational and commercial sectors of a fishery, and whether this integrated fishery management system could result in greater benefits than a system that manages sectors separately. Our analysis indicates that a catch share fishery management system that integrates commercial and recreational sectors *can* result in greater benefits. Thus, the ensuing question is how the desired management would be implemented.

10.4 Implementation/Allocation Concerns

Setting accurate TACs and Initial Allocation

Setting an appropriate TAC is a fundamental process and imperative to capturing the full benefits of a catch share program. In our analysis, the TAC was calculated from a three year (2004-2006) average of catch, and assumed to remain constant over time. In practice, TACs are dynamic and set by fishery regulatory bodies in order to best balance fishery stock protection and economic return (Gislason, 2006). The ability to increase TACs in years where there is evidence of increased biomass, and decrease with poor recruitment or under environmental duress is an important mechanism to consider in a management strategy based on TACs. TAC accuracy is also an issue as they are often based on a statewide stock assessment. A regional tag system, like the one proposed here, could help produce EFI on actual regional harvest and fishing pressures and could help calibrate a more accurate TAC.

Issues of initial allocation can be very contentious (Gislason 2006, Pearse 2006, Sutinen and Johnston 2003). Often the method of initial allocation will determine how much efficiency the new management regime will actually obtain (Brandt 2004). There are several methods available to allocate shares, and it is recommended that each method be considered before implementation. The actual quota being allocated is also an important consideration. Originally New Zealand allocated by a fixed tonnage of the TAC. This led to regular harvests over TAC and expensive repurchasing by the New Zealand Ministry of Fisheries. In 2000, the quota was changed to a percentage of the TAC, effectively shifting the onus of management from the regulators to the fishermen. Since this change the catch from this fishery has routinely come in below TAC (Dewees 1998). Initial allocation is not solely an issue at implementation, as future decision making and alterations to the allocation can heavily impact the value and perceived buy-in to a fishery. In New Zealand, the shares of the commercially valuable snapper (*Pagurus auratus*) fishery near Auckland were severely devalued as the government discussed a 40% repurchase (Dewees, 1998).

Another potential problem involves equity in the initial distribution of harvest tags. Regulation or some organized system of distribution would be necessary to avoid the monopolization of harvest tags, if that is a goal. For instance, a cap on the amount of tags an individual can have in one season can help mitigate the issue, although choosing that number is outside the scope of this project. Current harvest tag management systems often rely on lotteries to distribute their tags to promote fairness. Those who do not receive tags in the lottery can receive points towards increasing their standing in the next drawing (Johnston et al. 2006).

10.4.1 Facilitation of Trade

A management system that allows inter-sectoral trading must also consider and decide how this trading will be facilitated prior to implementation. Failures in the facilitation of trade can significantly limit the efficiency of an integrated management system. In 2004 and 2005, the Pacific Halibut Management Association (PHMA) in Canada purchased 320 tons of quota from the recreational allocation. The lack of a recreational institutional structure has led the PHMA to hold the resulting $1.8 million, awaiting instructions of how to transfer it to the recreational sector. Also, without an institutional structure, the sport fish sector cannot purchase quota from the commercial sector and is capped at 12% of the allotted catch (Gislason 2006). Without an institutional structure to facilitate trading and to monitor the actions of their constituency, a tradable catch based system would be nearly impossible to implement. Angler Management Organizations have been mentioned as a potential structure to allow recreational anglers berth into catch share management (Sutinen and Johnston 2003). In the recreational industry and commercial sectors, actual fishing vessels could act on their own behalf. Some commercial fishermen active in the nearshore fishery are members of the California Lobster and Trap Fishermen's Association (CLTFA) (a commercial fishing organization) and most recreational industry CPFVs are members of the Sportfishing Association of California (SAC).

Once structural organizations are established, tag acquisition and trade distribution issues may arise. These tags could be distributed by the landings and CPFVs, or maybe through an online trading database. This database could offer different trading and transaction options and could be accessed via username and password much like the current online interface of E-Bay.

10.4.2 Equity and Consolidation

The issue of equity as it relates to consolidation is important to address in considering the implementation of a catch share program. Consolidation, which is also referred to as capitalization or concentration, occurs when a relatively small number of players procure a disproportionately large share of the total harvest, and can unfairly influence the market in their favor (Buck 1995). Consolidation of catch shares has occurred in ITQ fisheries operating along the East Coast of the United States, but it is unclear whether ITQs directly contributed to consolidation as concentration was occurring even before ITQs were implemented (Buck 1995). In New Zealand and Iceland, however, consolidation was an immediate result of ITQ implementation (Dewees 1998, Eythorsson 2000).

In the Nearshore Fishery, the social model predicts that consolidation will occur as smaller, less efficient boats leave the fishery. However, the extent to which one individual group would be able to influence the entire market in their favor remains to be determined. We found no literature on catch share concentration in recreationally dominated fisheries.

Equity should remain a priority for management. Since the fishery examined in this study is very different from the aforementioned fisheries, as it includes a large recreational industry, measures should be taken in order to ensure equity. For instance, placing a limit on consolidation may work to prevent any one player from dominating the fishery, but what those limits should be were outside the scope of this project. Another possible solution to consolidation is the allocation of catch shares to communities, not individual fishermen. Stock depletion is often seen as a failure of the market. In other words, the fishery is viewed as a common-pool resource, and thus suffers from overfishing. However, since fishermen are often raised in a community atmosphere based on values and intimate knowledge of the fishery, allocating portions of the harvest at the community level may discourage consolidation (Jentoft 2000).

10.4.3 Regional Conflict

The major conclusion of this analysis was that a fishery that manages the commercial and recreational sectors separately will not accrue as many benefits as a fishery that manages these two sectors together. Likewise, integrating fisheries to the north and south of the study area may be more efficient than keeping catch shares and harvest tags completely localized. Realistically, a far larger region would have to be included in catch share management in order to avoid conflict such as the local loss of business. Moreover, it would not be efficient for CDFG to manage such a small portion of the state under a completely separate management plan. We suggest that they at least manage at the scale of their current four management regions for California as discussed in section 4.

Should catch shares only be implemented in the Santa Barbara Channel region, fishermen who do not care to deal with harvest tags could easily go elsewhere to fish. The CPFV Survey showed that most people (42%), while not necessarily against harvest tags, preferred the current management system. If this is true, the local CPFV and tourism industries could suffer a loss in business as those who prefer the status quo fish in other locations.

Another issue that may result in regional conflict is the geographic mismatch of the resource and the consumer. For instance, with the possible increase in biomass, non-local fishermen may encroach upon the Santa Barbara Channel region to benefit from this increase. As stated before, local fishermen who prefer current regulation may travel elsewhere to fish to avoid having to deal with harvest tags, thus exacerbating the problem. A possible solution to this would be to apply the catch share program to a broader area.

There is now a window of opportunity to reform the management of fisheries. Focusing reform solely on the commercial sector has been estimated to be inefficient because areas with large recreational sectors may erode whatever gains are obtained. Examples exist of implemented catch share programs and we can learn from their tribulations and trials. For our fishery, our analysis has shown that there are significant gains in economic and environmental performance by including the commercial and recreational industries under a single rationalized management plan. These gains appear to outweigh potential snags seen in the social and political models. Although our analysis focused on a very specific fishery, it is believed that these gains are significant and can be realized in any fishery with extensive use from both sectors.

11 Further Considerations

11.4 Replicability

The methodology that was used in this report was explicitly designed such that a manager in any similar fishery could utilize the models in order to evaluate the appropriateness and possible impacts of catch shares. A program was created using Visual Basic that presents the manager with the ability to enter their fishery specific data and the software program will perform the analysis and generate the economic gain value and the scores from the environmental, political and social models. The fisheries manager can use this suite of numbers to aid in choosing an appropriate management scenario.

This management tool is also designed to be used before any implementation costs are calculated, since the program will let the manager know if a catch share is appropriate or not in the first place. A fishery manager can then make an informed decision, and decide whether to continue pursuing a catch share program, or consider other alternative management types.

Should the manager conclude that a catch share program is appropriate for the fishery in question, the next steps would be a cost benefit analysis, addressing TAC issues, and designing a system to fairly distribute and trade tags. Such issues were found to be beyond the scope of this project.

11.5 Survey Improvement

Because survey information, such as willingness to pay for a tag, is so critical to the accuracy of the findings, a well thought-out, comprehensive survey is necessary. The surveys used to inform this analysis were somewhat limited as a result of time constraints. The survey captured a fraction of fishermen and was not designed to produce a representative sample. Only 97 fishermen participating in the recreational industry sector were surveyed. Private boaters and shore anglers proved extremely difficult to survey because they are so diffuse. CPFV anglers often declined to take the survey due to its length (about 10 minutes to complete). Researchers for this study were fortunate enough to be invited aboard the CPFV *Stardust* in order to administer the survey, which greatly improved the success of survey efforts. In order to solve these issues, a shorter survey given to different types of fishermen over a larger geographic area and for a longer time period should be considered.

Another issue that hindered progress was the explanation of the catch share program. The CPFV fisherman and private boater surveys contained what was thought to be a succinct description of a hypothetical tag system. This was necessary in order to capture the willingness to pay for a tag. Nevertheless, fishermen taking the survey were often confused by the given description and answered questions inappropriately, or recorded answers that were not consistent. Solving this issue would require trial and error and persistence to come up with a more universally understood explanation of a proposed alternative management scheme.

11.6 Gains from trade within sectors

In the economic model, we could only calculate the WTP for tags at the sector level because we lacked data of a fine enough resolution to calculate the value of fish among the sub-sectors of fishermen and anglers. As a result, we did not calculate gains from within-sector trade and assumed that each sector was already operating efficiently. However, it is likely that each sector is not operating efficiently and that the introduction of tags would affect the distribution of catch among operators in a sector resulting in gains from within-sector trade that may be as great or greater than the gains from across-sector trade.

For example, Figure 11.1 illustrates three hypothetical sub-sectors that make up the recreational industry sector. The "low sensitivity to price" sub-sector has the lowest demand for tags at any price, and their demand for tags is least sensitive to changes in price. One can imagine that this group highly values the non-market goods that are bundled with fish on a fishing trip. This group probably includes tourists for whom the cost of tags is a relatively small percentage of the total costs of their vacation, and who don't have a refrigerator or cooler to keep excess fish that they cannot consume that day. Individuals in this group probably goes on few fishing trips per year. On the other end of the spectrum, the "high sensitivity to price" subsector may include avid fishermen and locals who want to maximize the amount of fish they take home at the end of the day, and who also have access to other fisheries that could act as substitutes if the cost of fishing in the nearshore fishery increases. The average subsector is represents the average angler in the recreational industry sector that we used in this study.

Assuming that in the absence of tags, each sub-sector catches the same number of fish but has a different marginal value for fish. In this hypothetical example, each sub-sector catches an equal portion of the total recreational industry harvest. Although each sub-sector catches 32,948[41] fish, their marginal value for fish range from $2.66 per fish in the low "tourist" sub-sector to $8.13 in the high "avid" sub-sector. This difference indicates that there are gains from trade to be made.

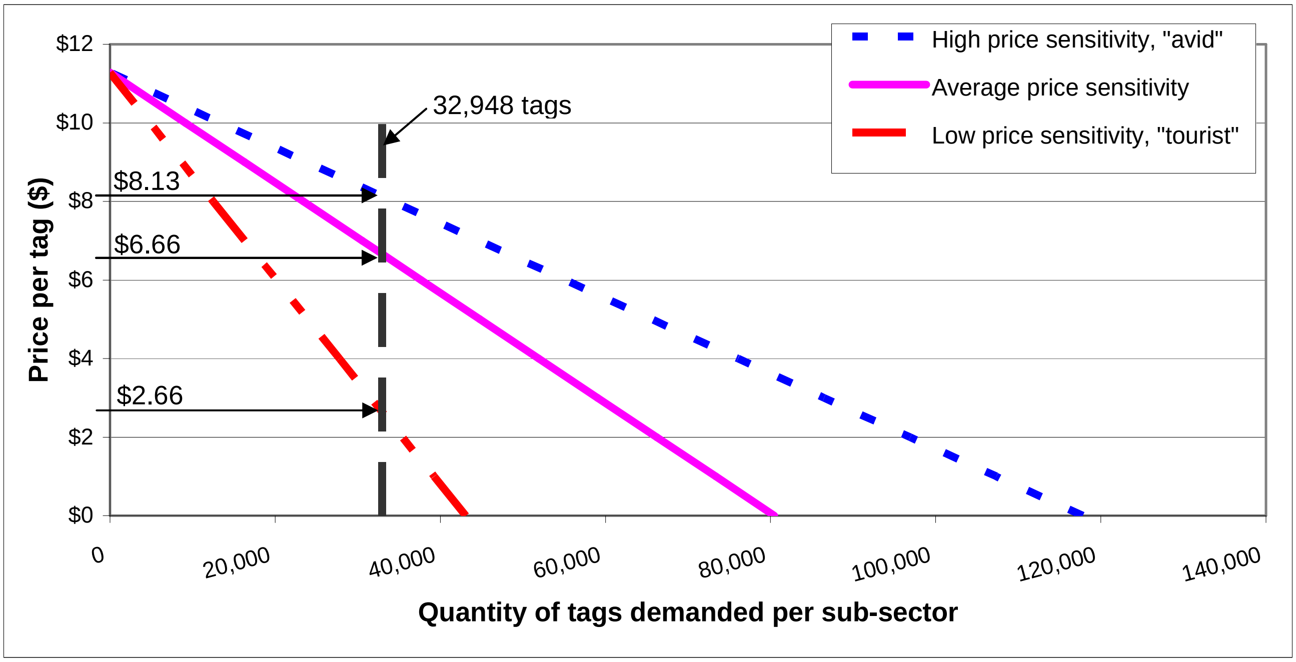

Figure 11.1. Marginal value for tags in hypothetic recreational industry sub-sectors

Recall that scenario 1 introduces tags in the commercial and recreational industry sectors. In this scenario, tags can be traded *within* each sector, but not across sectors. Because the analysis in this paper only examined gains from trade *across* sectors, there were not changes in the economic value of the fishery in scenario 1 compared to the baseline. Our analysis assumed that there was no heterogeneity in the WTP for tags among anglers in the recreational industry.

The hypothetical situation shown by Figure 11.1, may in fact illustrate a more realistic conceptualization of the recreational industry sector in which there is heterogeneity in the WTP for tags among the sub-sectors. As a result, if tags were allocated equally across sub-sectors, we expect that individuals would trade until all individuals face the same marginal cost for tags.

In this hypothetical example, the high "avid" sub-sector would buy 15,301 tags from the low "tourist" sub-sector, and tags would trade at a price of $6.66, illustrated in Figure 11.2. After trade, the avid sub-sector would have a total catch of 48,249 fish and the tourist sub-sector would have a total catch of 17,647 fish. The average sub-sector would remain at a catch level of 32,948 fish. The total gains from within-sector trade would be $41,856, and both the avid and tourist sub-sectors

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[41] 32,948 is calculated by taking one-third of the total recreational industry catch less the allocation of free tags discussed in section 7.1.2:

$$32{,}948 = \frac{TotalSectorHarvest - FreeTagAllocation}{3}$$

$$32{,}948 = \frac{166{,}162 - 67{,}319}{3}$$

would voluntarily engage in this trade because they would benefit more from trade than from their initial allocation; tourists would be happy to be compensated to catch less fish, and the avid anglers would be happy to pay to catch more fish. These hypothetical gains from within-sector trade would be higher than the gains from across-sector trade that we calculated for scenarios 2 and 3, which were $12,703 and $37,786 respectively.

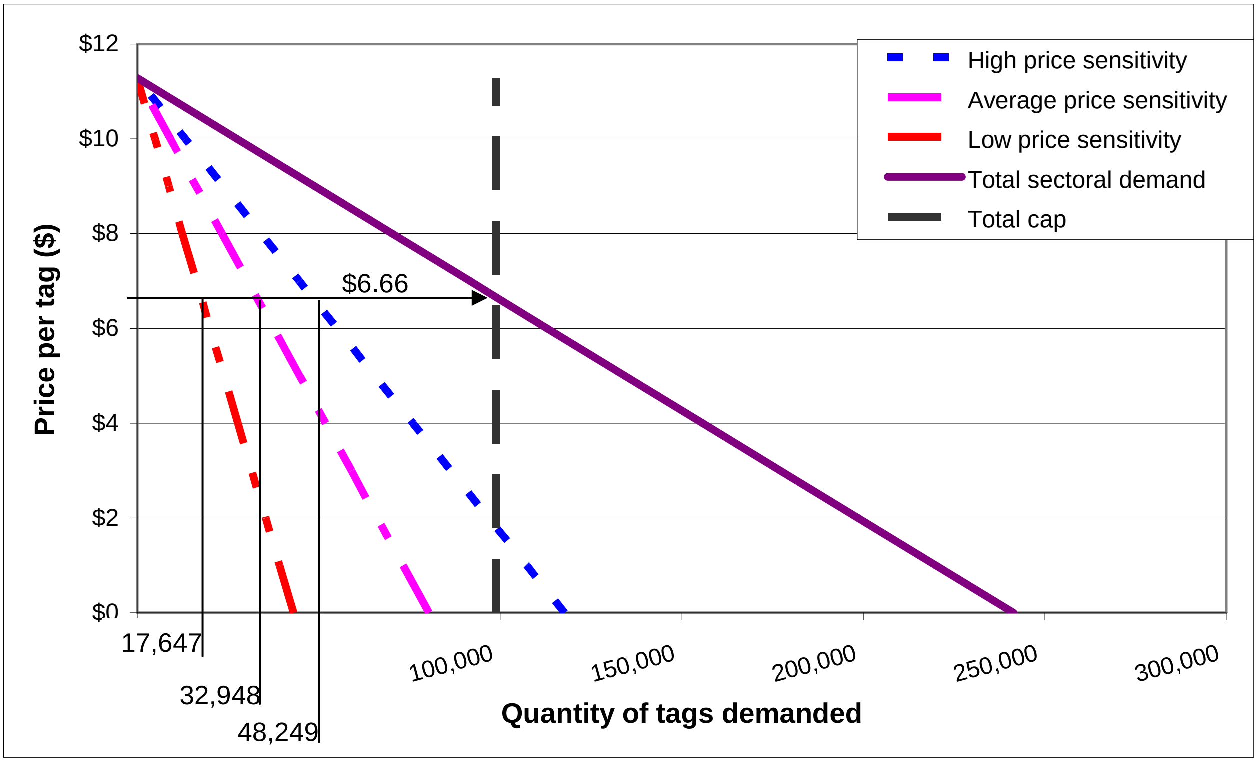

Figure 11.2. Distribution of tags after within-sector trade in recreational industry

The potential for high gains from within-sector trade indicates that in order to fully compare the economic impacts of different management scenarios, it is important to analyze the WTP for tags among different sub-sectors that make up each sector. This analysis would require data on the marginal value for fish among sub-sectors and the proportion of the total harvest caught by each sub-sector.

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Appendix I. Santa Barbara Channel Region Recreational Ocean Fishing Survey

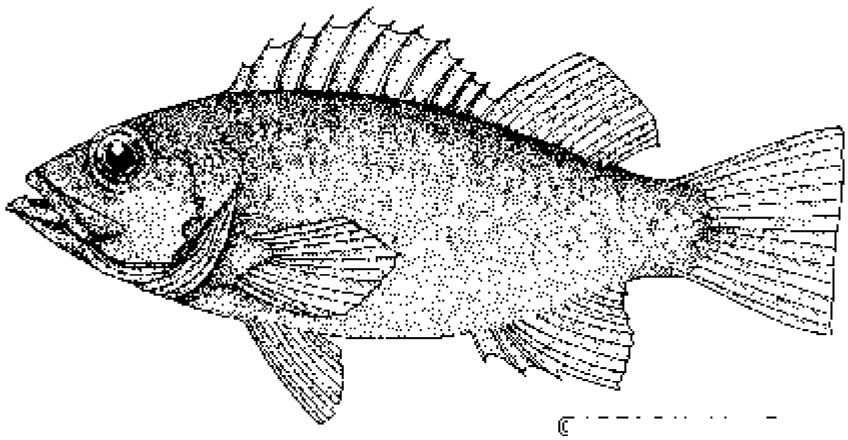
A survey was designed to gather hard-to-find data for individual recreational ocean fishermen in the Santa Barbara Channel Region. The four-page survey was conducted from December 1, 2008 through December 31, 2008 at the Sea Landing in the Santa Barbara Harbor, California. Fishermen were intercepted prior to departing on half-day or three-quarter day fishing trips on the CPFV Stardust.

The five members of this study distributed the surveys and interacted with the respondents. Respondents were told that the survey was for a master's thesis project at the University of California, Santa Barbara. Many times the surveyor was asked by the respondent if he or she worked for the California Department of Fish and Game. The answer was always "No." and that "we are working on an independent study for our master's thesis project." Other than a brief introduction there was no communication with the respondents prior to them filling out the survey. Afterwards there would often be conversation regarding the content of the survey and some ideas for improving the survey or fishery. This external information was not incorporated into the analysis of this project. Many respondents were hesitant to fill out a survey of any kind so upon completion of the survey every respondent was given a raffle ticket that granted them the chance to win a free fishing trip on the Stardust. We felt this was necessary to get any sort of reasonable response rate. Their answers to the survey questions in no way affected their chances of winning the raffle and all respondents were given a raffle ticket thus eliminating any kind of unequal response bias.

The survey gathered demographic information, fishing preferences and habits, personal values related to fishing, and some economic information. Questions 1-5 asked for general demographic information such as age, home zip code, and income. Questions 6-8 asked about specific fishing habits. Questions 9-11 asked about social preferences and were used for the Social Model. Questions 12 and 13 were used for the Political Model. Question 14 was a fishing regulation question used to determine the prior knowledge of each respondent in regards to fishing regulations. Questions 15-19 described the proposed management scenarios used in our project and answers were used for the Economic Model. The specific ways in which each answer was used for the models in this project are described in their respective methods sections.

Santa Barbara Channel Region

Recreational Ocean Fishing Survey



Donald Bren School of Environmental Science and Management
University of California at Santa Barbara

Do not write in this box
For Researchers use
Location:
Fee:

1. What is your home zip code? _____________________

2. Is today's fishing trip part of a longer trip or vacation? (Circle one) YES NO

3. What is your gender? ______Male _____Female

4. What is your age: __ <16 __16-20 __21-25 __26-30 __31-40 __41-50 __51-64 __65+

5. What is your yearly income: (including retirement pension if applicable)
__<$25,000 __$25,000-50,000 __$50,000-75,000 __$75,000-100,000 __>$100,000

The following questions ask you about your general recreational ocean fishing activities

6. Including this year, for how many years in a row have you been a recreational angler?
____

7. What type of license are you using to fish today?

____ 1-day License
____ 2-day License
____ 1-year License
____ 10-day License
____ Lifetime License
____ No license required

8. Including today's fishing trip, **how many times** did you fish in the Santa Barbara Channel region (between Point Conception and Point Mugu) in the past 12 months?
____

A. In the past 12 months, how many times did you go fishing on a **party boat, commercial passenger fishing vessel,** or **"head boat"**? (circle one of the number ranges below)

0 less than 5 5-14 15-24 25-34 35 or more

B. In the past 12 months, how many times did you go fishing on a **privately owned boat**? (circle one of the number ranges below)

0 less than 5 5-14 15-24 25-34 35 or more

C. In the past 12 months, how many times did you go fishing from the **shore** or **beach**? (circle one of the number ranges below)

0 less than 5 5-14 15-24 25-34 35 or more

D. In the past 12 months, how many times did you go fishing from **man-made structures (piers, jetties, etc.)**? (circle one of the number ranges below)

0 less than 5 5-14 15-24 25-34 35 or more

9. Do you subscribe to any fishing related magazines, publications, or online media outlets? (circle one) YES NO How many? ________

10. Why do you value a "working waterfront" (boat ramps, docks and piers, landings, bait and tackle shops, fish market, etc.)? (Check all that apply)

_____ I do not value a working waterfront
_____ The historical significance of commercial fishing
_____ Ease of access to fishing, fish, and fishing products
_____ Aesthetic value
_____ Important attraction for tourism industry
_____ No opinion

11. What do you enjoy about fishing? (mark all that apply)

_____ Recreation
_____ Family outing
_____ Food source
_____ Time with friends
_____ Historical or cultural significance
_____ Other

12. On a scale of 1-5 how important are the following items to you in determining how much you go ocean fishing? (1 = Not important at all…to…5 = Most important)

A. The ability to fish whenever you want. (Flexibility) (Circle one)
1 2 3 4 5

B. Cost to go fishing. (Circle one)
1 2 3 4 5

C. The quality of fish you expect to catch. (Size of individual fish) (Circle one)
1 2 3 4 5

D. The quantity of fish you expect to catch. (# of individual fish) (Circle one)
1 2 3 4 5

E. The complexity of fishing regulations. (Simple to follow) (Circle one)
1 2 3 4 5

13. On a scale of 1-5 what do you think are the current priorities for fisheries management agencies? (1=lowest priority…to…5=highest priority)

A. Ensure **recreational** access to fish/fishing (Circle one)
1 2 3 4 5

B. Ensure **commercial** access to fish/fishing (Circle one)
1 2 3 4 5

C. Protect natural resources such as fish, habitat, environment, etc. (Circle one)
1 2 3 4 5

14. What is your understanding of current Ocean-fishing regulations?
_____ Poor/none
_____ Below average
_____ Average
_____ Above average
_____ Excellent

The following questions ask specifically about rockfish and rockfish fishing

FISHING REGULATIONS

Currently, fishing regulations limit recreational anglers to a daily bag limit of **10** rockfish.

15. How many rockfish do you expect to catch and keep today? _______________

→ If you answered **10** to this question, go to question 15B

15B. If there were no daily bag limits how many rockfish would you expect to catch and keep today? ____________

ALTERNATIVE FISHING REGULATIONS

A different way to manage fisheries would be to require all anglers (recreational and commercial) to buy **tags** for each fish that they catch. An angler who plans to catch 5 fish may purchase 5 tags, while an angler who plans to catch 1000 fish may purchase 1000 tags. An angler could use these tags at any time during the fishing season. There would be **no daily limits** and anglers could catch as many fish as they want, as long as they bought enough tags.

Currently tag systems are being used in salmon, steelhead, halibut and sturgeon recreational fisheries in Washington and Oregon.

In the tag system, anglers would receive 10 free tags with the purchase of a yearly license. Additional tags would have to be purchased.

The following questions ask you about these alternative fishing regulations.

16. How do you like the tag system compared to the current regulations?
_____ I prefer the tag system
_____ I think the systems are equally preferable
_____ I prefer the current system

17. The tag system is one of a number of possible ways to manage fisheries. On a scale of 1-5 please indicate your level of agreement with the following statements about the tag system. (1=strongly disagree…3=neutral…5=strongly agree)

A. I like the tag system because I can catch as many fish as I want
   1 2 3 4 5
B. I like the tag system because the same rules apply to commercial fishermen and recreational anglers
   1 2 3 4 5
C. I like the tag system because I think it will improve management's understanding of the fishery because they will be able to track how many fish are caught
   1 2 3 4 5
D. I dislike the tag system because it increases costs
   1 2 3 4 5
E. I dislike the tag system because I am opposed to paying to catch fish under any system
   1 2 3 4 5
F. I dislike the tag system because it is too complex
   1 2 3 4 5

18. Suppose that the current rules were replaced with this tag system and you could catch as many rockfish as you wanted as long as you bought enough tags. Suppose that you have already used the free tags that came if your license. If the tags cost _______ each, how many tags would you buy for today's trip? (you could only use these tags for today's trip)____________

→ If you answered **0** to this question, please explain why you would not buy any tags:___________________________

19. Suppose that the current rules were replaced with this tag system and you could catch as many rockfish as you wanted as long as you bought enough tags. If the tags cost _______ how many tags would you buy for the entire fishing season? ____________

Comments:

Appendix II: Social Survey (too come later)

Appendix III. Questionnaires Used for Political Models

The following five questionnaires used ranking questions to determine element weights within the political acceptability model. The regulatory body questionnaire was also used to determine weights for the political readiness model. Additional comments provided by questionnaire respondents were considered for discussion but were not used for analysis within the political models.

Commercial Industry Questions (Political)

Rate the following items on a scale of 1-5 on how important they are to you in determining whether or not you participate in the live-fish fishery. (1 = not important at all…to…5 = most important)

A. Long Term Sustainability of Fishery (Career Opportunity-sustainable for many years)
1 2 3 4 5

B. Short Term Profits from Fishery (Making As Much Money Now as Possible)
1 2 3 4 5

C. Flexibility (Ability to Fish When You Want and How You Want)
1 2 3 4 5

D. Complexity of Regulations (Simple to Follow / Decreased Chance of Violating)
1 2 3 4 5

E. Cost (Permits, Licenses, Fees, etc.)
1 2 3 4 5

If you have any additional comments about the questions or items listed above please write them below or on the back of this sheet. If any are equally important please explain why. Thank you.

Recreational Industry Questions (Political)

Rate the following items on a scale of 1-5 on how important they are to you in determining whether or not you continue to operate as a Commercial Passenger Fishing Vessel (CPFV, Charter Boat). (1 = not important at all…to…5 = most important)

A. Long Term Sustainability (A career opportunity that you could do for 10+ years)
   1 2 3 4 5

B. Short Term Profits (Making a lot of money this year and next year only even at detriment to long term sustainability)
   1 2 3 4 5

C. Flexibility (Ability to Fish When You Want and How You Want)
   1 2 3 4 5

D. Complexity of Fishing Regulations (Simple to Follow / Decreased Chance of Violating)
   1 2 3 4 5

E. Cost to Participate in Fishery (Additional Permits / Licenses / Fees / etc.)
   1 2 3 4 5

If you have any additional comments about the questions or items listed above please write them on the back of this sheet. If any are equally important please explain why. Thank you.

NGO Questions (Political)

1) Rate the following items on how important they are to you (NGO) in determining if you would approve of (would support) a new fisheries management plan on a scale of 1 to 5. (1=not important at all…to…5=most important / must have this).

   A. Main goal of new fisheries management plan is to maintain/return the target species stock at/to a sustainable level. (Focus on target species only.)

   1 2 3 4 5

   B. Main goal of new fisheries management plan is to protect the entire ecosystem that the target species lives in. (EBM) (Does not focus just on target species.)

   1 2 3 4 5

Note: I know that it is possible for a management scenario to have both goals, but for this question just imagine they can have only one of these two goals. In other words I am trying to see what (NGO) values more of the two goals. If they are equally important please explain why.

2) Do you (NGO) think that some form of market-based management (i.e. ITQs, IFQs, effort quotas, tradable tags, etc.) can achieve one or both of these goals? Why or why not? What are the strengths and weaknesses?

Note: You do not need to go into great detail unless you want to. Just a brief answer is fine.

<u>Regulatory Agency Questions (Political)</u>

1) Rate the following items on a scale of 1-5 on how important they are in getting a new management system **approved** by the Fish and Game Commission <u>and</u> **implemented**? (1 = not important at all…to…5 = most important / will not happen without this)

A. Cost (Does it require additional funds or does it generate revenue)
1 2 3 4 5

B. Ability to enforce effectively
1 2 3 4 5

C. Current regulatory structure (Similarity to existing regulations)
1 2 3 4 5

D. System's ability to provide information (Does it collect EFI, recreational effort/take, etc.)
1 2 3 4 5

E. Legality under California Constitution (Is it legal or does it require new legislation)
1 2 3 4 5

F. Familiarity with new system (Has it been proven to work / Past experience)
1 2 3 4 5

G. Staff restrictions (Can it operate with existing staff)
1 2 3 4 5

H. Other (Please write) ____
1 2 3 4 5

2) If any of the above items have the same importance (i.e. 1A = 5 and 1E = 5) please rank them relative to each other (i.e. 1A = 1 and 1E =2, implying that 1A is slightly more important than 1E). Use the space provided below.