

## Summary of potential impacts of the March 2008 MPA proposals on commercial and recreational fisheries in the North Central Coast Study Region

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### 1. Introduction

In order to conduct an analysis of the relative effects of MPA proposals on commercial fisheries that are conducted in the waters in the North Central Coast Study Region (NCCSR), we use data layers characterizing the spatial extent and relative stated importance of fishing grounds for eight commercial fisheries (California halibut, coastal pelagics, market squid, deeper nearshore rockfish, nearshore rockfish, urchin, Dungeness crab and salmon). This information was collected during interviews in the summer of 2007, using a stratified, representative sample of 174 commercial fishermen whose individual responses regarding the relative importance of ocean areas for each fishery were standardized using a 100-point scale and normalized to the reported fishing grounds for each fishery.

Additionally, we conduct an assessment of the relative effects of the MPA proposals on key recreational fisheries conducted in the waters in the North Central Coast Study Region. In order to complete that analysis we use data layers characterizing the spatial extent and relative stated importance of recreational fishing grounds for four recreational fisheries (California halibut, Dungeness crab, salmon, rockfish/lingcod complex, and striped bass – pier/shore only). Recreational fishermen are also broken out by user group (i.e. commercial passenger fishing vessels, private vessels, kayak based, and pier/shore based) and by sub-region (i.e. Region 1 - Ocean Beach in San Francisco County, Region 2 - San Francisco Bay access points to Point Reyes and Region 3 - Point Reyes north to Alder Creek). This information was collected during interviews in the summer of 2007, using a stratified solicited sample of 101 recreational fishermen whose individual responses regarding the relative importance of ocean areas for each fishery were standardized using a 100-point scale and normalized to the reported fishing grounds for each fishery.

Using the normalized data described above, we 1) evaluate the potential impacts on the commercial and recreational fishing grounds and 2) conduct a socioeconomic impact analysis on commercial fisheries in order to assess the relative effects of the three MPA proposals (Proposal 1–3, Proposal 2–XA and Proposal 4). Results are reported at both the study region and port group levels for the commercial fisheries. Port groups have been defined as: Bodega Bay, Point Arena, Bolinas, San Francisco and Half Moon Bay. Recreational fishery results are reported by user group and sub-region.

It should be noted that, with respect to the recreational fishery analysis, the use of a stratified solicited sample limits the use of traditional statistical measures—for example, confidence intervals—meaning they may not deliver their advertised precision. Nevertheless, this approach does allow us to make broad generalizations about preferences of the overall recreational fishing population and the four user groups within the study area, adding increased thematic resolution to the MLPA decision-making process.

### 2. Overview of Commercial Fisheries

The commercial fisheries considered in this analysis are of varying importance in terms of ex-vessel revenues. Table 1 provides estimates of each fishery's share of NCCSR and California commercial fishing revenues, using a 7-year average of ex-vessel revenues (in 2006 dollars) between 2000 and 2006.<sup>1</sup> For example, Dungeness crab accounts for 52.8% of the NCCSR landings (ex-vessel revenue), but only 9.9% of the state totals. Furthermore, 31.2% of all Dungeness crab landed in California was landed in NCCSR ports. Tables 2–6 provide the same information as Table 1 at the port group level.

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<sup>1</sup> A review of NCCSR fishery trends in terms of 1) pounds landed, 2) ex-vessel value and 3) ex-vessel value per fisherman over the 7-year period showed that while fluctuations have occurred, neither upward nor downward trends appear to dominate the fisheries as a whole. Given this, and the need to choose a metric representative of all fisheries being considered in this analysis, a simple average approach was chosen.

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**Table 1: Summary of NCCSR fisheries considered in analysis**

<b>Fishery</b>	<b>% of total NCCSR fisheries revenues, 7-year average (2000–2006)</b>	<b>% of total CA statewide fisheries revenues, 7-year average (2000–2006)</b>	<b>% of CA statewide fisheries revenues landed in NCCSR, 7-year average (2000–2006)</b>
California Halibut	1.8%	0.3%	20.3%
Coastal Pelagics	0.2%	0.0%	0.4%
Market Squid	1.9%	0.4%	1.2%
Deeper Nearshore Rockfish	0.7%	0.1%	24.0%
Nearshore Rockfish	1.0%	0.2%	7.1%
Urchin	5.5%	1.0%	8.6%
Dungeness Crab	52.8%	9.9%	31.2%
Salmon	36.3%	6.8%	52.7%

**Table 2: Summary of Point Arena fisheries considered in analysis**

<b>Fishery</b>	<b>% of total NCCSR fisheries revenues, 7-year average (2000–2006)</b>	<b>% of total CA statewide fisheries revenues, 7-year average (2000–2006)</b>	<b>% of CA statewide fisheries revenues landed in Point Arena, 7-year average (2000–2006)</b>
California Halibut	—	—	—
Coastal Pelagics	—	—	—
Market Squid	—	—	—
Deeper Nearshore Rockfish	0.0%	0.0%	0.3%
Nearshore Rockfish	0.4%	0.1%	3.0%
Urchin	3.8%	0.7%	6.0%
Dungeness Crab	0.3%	0.1%	0.2%
Salmon	0.5%	0.1%	0.7%

**Table 3: Summary of Bodega Bay port group fisheries considered in analysis**

<b>Fishery</b>	<b>% of total NCCSR fisheries revenues, 7-year average (2000–2006)</b>	<b>% of total CA statewide fisheries revenues, 7-year average (2000–2006)</b>	<b>% of CA statewide fisheries revenues landed in Bodega Bay, 7-year average (2000–2006)</b>
California Halibut	0.1%	0.0%	1.4%
Coastal Pelagics	—	—	—
Market Squid	—	—	—
Deeper Nearshore Rockfish	0.2%	0.0%	5.5%
Nearshore Rockfish	0.3%	0.0%	1.9%
Urchin	1.6%	0.3%	2.5%
Dungeness Crab	14.6%	2.7%	8.6%
Salmon	12.6%	2.3%	18.3%

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**Table 4: Summary of Bolinas fisheries considered in analysis**

<b>Fishery</b>	<b>% of total NCCSR fisheries revenues, 7-year average (2000–2006)</b>	<b>% of total CA statewide fisheries revenues, 7-year average (2000–2006)</b>	<b>% of CA statewide fisheries revenues landed in Bolinas, 7-year average (2000–2006)</b>
California Halibut	0.1%	0.0%	1.7%
Coastal Pelagics	—	—	—
Market Squid	—	—	—
Deeper Nearshore Rockfish	0.0%	0.0%	0.5%
Nearshore Rockfish	—	—	—
Urchin	—	—	—
Dungeness Crab	0.7%	0.1%	0.4%
Salmon	0.1%	0.0%	0.2%

**Table 5: Summary of San Francisco port group fisheries considered in analysis**

<b>Fishery</b>	<b>% of total NCCSR fisheries revenues, 7-year average (2000–2006)</b>	<b>% of total CA statewide fisheries revenues, 7-year average (2000–2006)</b>	<b>% of CA statewide fisheries revenues landed in San Francisco, 7-year average (2000–2006)</b>
California Halibut	1.3%	0.2%	14.7%
Coastal Pelagics	—	—	—
Market Squid	—	—	—
Deep Nearshore Rockfish	0.4%	0.1%	13.2%
Nearshore Rockfish	0.3%	0.1%	2.1%
Urchin	0.1%	0.0%	0.1%
Dungeness Crab	22.7%	4.2%	13.4%
Salmon	13.4%	2.5%	19.5%

**Table 6: Summary of Half Moon Bay fisheries considered in analysis**

<b>Fishery</b>	<b>% of total NCCSR fisheries revenues, 7-year average (2000–2006)</b>	<b>% of total CA statewide fisheries revenues, 7-year average (2000–2006)</b>	<b>% of CA statewide fisheries revenues landed in Half Moon Bay, 7-year average (2000–2006)</b>
California Halibut	0.2%	0.0%	2.5%
Coastal Pelagics	0.1%	0.0%	0.2%
Market Squid	1.3%	0.2%	0.8%
Deeper Nearshore Rockfish	0.1%	0.0%	4.5%
Nearshore Rockfish	0.0%	0.0%	0.2%
Urchin	—	—	—
Dungeness Crab	14.5%	2.7%	8.6%
Salmon	9.6%	1.8%	14.0%

### 3. Impact on Commercial Fishing Grounds: Approach

The three MPA proposals under review vary according to their spatial extent and the commercial fisheries they affect. More specifically, they vary by the number and types of fisheries permitted within the boundaries of particular MPAs within a network. Furthermore, study area fisheries themselves vary in spatial extent and frequently overlap. Most of them are conducted in fishing grounds that extend beyond the state waters of the NCCSR, and we report the effects both in terms of total fishing grounds (G) and those that fall within the study area (SA). Since any one MPA may have different effects on different fisheries, and different fisheries may be affected differently by all MPAs, it is necessary to consider single MPAs and single fishery uses independently. Note that because current fishery closures affect all proposals equally, they have no differential effect.

A key assumption of this analysis is that each of the MPA proposals completely eliminates fishing opportunities in areas closed to specific fisheries and that fishermen are unable to adjust or mitigate in any way. In other words, the analysis assumes that all commercial fishing in an area affected by a MPA would be lost completely, when in reality it is more likely that effort would shift to areas outside the MPA. The effect of such an assumption is most likely an overestimation of the impacts, or a “worst case scenario.”

We conduct an overlay of each MPA with each fishery considered in this study. MPAs are grouped according to level of protection, using the same levels of protection as elsewhere in the Science Advisory Team (SAT) evaluations. In other words, for each MPA and protection level within each proposal, we assess the commercial fisheries that would be affected.

We compile results in a series of spreadsheets, summarizing the effects of the various MPA proposals on commercial fisheries, both in terms of the area affected and the relative value lost. We use the same analytical methods as those developed in the Central Coast process (see Scholz et al., 2006), creating a weighted surface that represents the stated importance of different areas for each fishery. More specifically, we multiply these stated importance values by the proportion of in-study region landings (by landing port and by fishery). The percentage of area and value affected is calculated based on the grounds identified within the NCCSR, not for the whole state of California. These estimates then feed into the socioeconomic impact analysis.

### 4. Impact on Commercial Fishing Grounds: Assessing MPA Proposals

The percentage change in area and value for each of the commercial fisheries (both for the study region and by port group) were determined by the intersection of each MPA proposal and the fishing grounds specific to that fishery. Each MPA within a proposal was classified by whether it would affect the fishery or not. If a fishery was affected by a MPA, the area and value were summarized and then divided by the total area and value for the entire fishing grounds (G) as derived from interviews with fishermen, and the total study area (SA).

The total percentage of area and value affected for the total fishing grounds and the grounds inside the study area are then summarized for all MPAs affecting each fishery per proposal. MPA proposals vary considerably in their effects, both between and across fisheries, as illustrated in the Tables 7–10.

For example, Proposal 4 has lesser effects (both in terms of study area grounds and value) on the salmon fishery in San Francisco than on either the nearshore rockfish or deeper nearshore rockfish fisheries for this port. Illustrating another set of effects, Proposal 1–3 affects 2.8% of the total Dungeness crab fishing grounds (area) for Bodega Bay, but affects 16.3% when considering only those fishing grounds that fall into the (nearer to shore) study area waters. In addition, from Table 3, the Dungeness crab fishery in Bodega Bay constitutes approximately 15% of study area commercial fisheries. In some cases, alternatives can have markedly different effects on area and relative “value”. For example, for the Point Arena salmon fishery, Proposal 2–XA affects 9.3% of the study area fishing grounds, but 26.5% of stated importance.

For the commercial deeper nearshore and nearshore rockfish fisheries, we evaluate the additional impacts that potentially occur when considering the existing fishery management area closures and/or fishery exclusion zones, specifically the 2007 and 2008 Rockfish Conservation Area Non-Trawl persistent closure (30 fm – 150 fm) and the closure between the shoreline and 10 fm around the Farallon Islands (Southeast Farallon Island, Middle Farallon Island, North Farallon Island, and Noon Day Rock). We also consider the proposed 2009 Rockfish Conservation Area Non-Trawl persistent closure (20 fm – 150 fm).

The fishing grounds, as defined by the fishermen through the interview process, represent the total area and value regardless of these existing or potential fishery management closures and/or fishery exclusion zones. In order to evaluate the effect of such closures, the fishing grounds that fall inside those areas were removed, and the value associated with the removed area redistributed to the remaining fishing grounds outside the closed areas. In other words, values were redistributed across only what could be considered the available fishing grounds in proportion to their relative value as derived from the interviews. Table 11 represents the percentage of the total fishing grounds value impacted when considering just these fishery management closures, not including any additional impacts of proposed MPAs. For example, after the value associated with the fishing grounds that fall inside the 2007 closure is removed, the impact to the Bolinas deeper nearshore rockfish fishing grounds is 60.8%, in terms of value. Similarly, 72.3% impact to the fishery from the 2008 fishery closures and 81.2% impact in 2009.

Using the same method described above, we determine the percentage change in value by the intersection of each MPA proposal with the total fishing grounds now constrained to areas not inside the closed areas, i.e., the "available fishing grounds". Table 12 compares the percentage of value affected for the available fishing grounds summarized for all MPAs affecting each rockfish fishery per proposal with the same effects for those fisheries without consideration of fishery management closures reported in Table 9. Similar to the results presented in Tables 7–10, MPA proposals vary considerably in their effects, specifically across ports. For example, marginal decrease or no increase in impact is shown to occur for the deeper nearshore fisheries in Point Arena and Half Moon Bay. This is due to the fact that identified fishing grounds are almost entirely in waters less than 30 fathoms. This is also true for the nearshore fishery in all NCCSR ports. Conversely, we see a substantial increase in impacts to the deeper nearshore rockfish fishery for Bolinas across all proposals. This increase in impacts is largely due to the value that Bolinas deeper nearshore rockfish fishermen associate with the Farallon Islands, specifically North Farallon Island. When comparing the impacts of a proposal between the total fishing grounds and the available fishing grounds (Table 12), where there is marginal or no difference also indicates that there is a high degree of overlap between the proposed MPAs and the existing closed areas. Where there is a large difference between the impact of the total fishing grounds and the available fishing grounds indicates that the MPA proposal is impacting additional fishing grounds that are not already impacted by the existing fishery management closures.

We also evaluate if there are individual fishermen that would be disproportionately affected by each MPA proposal (i.e. 100% or a large portion of their grounds are inside a proposed MPA that would restrict fishing), see Tables 13–15. To assess this impact we conducted an analysis which removed the area of each proposed MPA from an individual fisherman's fishing grounds as derived from interviews. The individual's North Central Coast (NCC) ex-vessel revenue values and the area of the fishing grounds were summarized after the removal and percentages were calculated to show any potential losses. The "worst-case scenario" still applies in that individual fishermen are assumed not to adjust to different fishing grounds. For this analysis the potential impact was calculated for each fishery as well as for all fisheries.

For example, under Proposal 4 the largest individual impact for a single fishery is to a Dungeness crab fisherman, who stands to lose \$15,000–\$20,000 annually. When summarized across all eight fisheries, however, two individuals face a more than \$20,000 loss. Another example is that under Proposal 4, one urchin fisherman is estimated to lose more than 80% of his annual revenue from that fishery. That said, from a dollar perspective, no urchin fisherman is estimated to lose more than \$10,000 in annual income from this fishery.

It should be noted that the results of the individual impact analysis suggest that one fisherman will be disproportionately impacted by all three proposals being considered. In other words, according to the information he provided for all fisheries in which he participates, his annual individual impact under each of the proposals is estimated to be:

- Proposal 1-3: between 20-40% loss of ex-vessel revenue and \$15K-\$20K loss
- Proposal 2-XA: between 20-40% loss of ex-vessel revenue and \$15K-\$20K loss
- Proposal 4: between 40-60% loss of ex-vessel revenue and > \$20K loss

According to our analysis, this fisherman is the only individual who appears to fall into higher categories of both percentage and dollar value loss.

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 7: Percentage area of total commercial fishing grounds affected by proposed MPAs by landing port**

Fisheries		1-3	2-XA	4
Point Arena	California Halibut	—	—	—
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	32.0%	16.9%	33.9%
	Nearshore Rockfish	16.9%	10.6%	18.1%
	Urchin	6.8%	5.7%	9.4%
	Dungeness Crab	7.7%	6.4%	11.0%
	Salmon	1.7%	1.3%	1.9%
Bodega Bay	California Halibut	17.7%	19.2%	27.7%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	11.5%	9.8%	13.0%
	Nearshore Rockfish	7.3%	4.0%	8.7%
	Urchin	10.9%	9.8%	15.3%
	Dungeness Crab	2.8%	2.4%	3.8%
	Salmon	0.7%	0.5%	0.8%
Bolinas	California Halibut	18.2%	19.7%	28.1%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	27.5%	23.4%	29.5%
	Nearshore Rockfish	—	—	—
	Urchin	—	—	—
	Dungeness Crab	0.1%	0.6%	4.0%
	Salmon	1.4%	1.3%	1.3%
San Francisco	California Halibut	5.6%	6.0%	9.3%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	10.8%	8.0%	14.0%
	Nearshore Rockfish	10.8%	7.5%	15.4%
	Urchin	21.3%	16.1%	30.1%
	Dungeness Crab	2.5%	2.1%	3.5%
	Salmon	0.7%	0.5%	0.8%
Half Moon Bay	California Halibut	5.3%	6.1%	16.7%
	Coastal Pelagics	0.8%	0.5%	0.8%
	Market Squid	3.3%	2.5%	20.5%
	Deeper Nearshore Rockfish	12.8%	9.1%	22.7%
	Nearshore Rockfish	9.5%	9.5%	9.5%
	Urchin	—	—	—
	Dungeness Crab	3.6%	3.0%	4.9%
	Salmon	0.8%	0.6%	1.0%

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 8: Percentage area of commercial fishing grounds within the study area affected by proposed MPAs by landing port**

Fisheries		1-3	2-XA	4
Point Arena	California Halibut	—	—	—
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	32.0%	16.9%	33.9%
	Nearshore Rockfish	28.4%	17.7%	30.4%
	Urchin	19.1%	16.1%	26.6%
	Dungeness Crab	13.5%	11.1%	19.2%
	Salmon	11.9%	9.3%	12.8%
Bodega Bay	California Halibut	17.7%	19.2%	27.7%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	22.8%	19.6%	26.0%
	Nearshore Rockfish	25.9%	14.2%	30.9%
	Urchin	18.8%	16.9%	26.4%
	Dungeness Crab	16.3%	13.7%	21.7%
	Salmon	11.8%	9.3%	14.4%
Bolinas	California Halibut	18.2%	19.7%	28.1%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	31.2%	26.5%	33.5%
	Nearshore Rockfish	—	—	—
	Urchin	—	—	—
	Dungeness Crab	0.1%	1.1%	7.3%
	Salmon	11.6%	11.2%	10.7%
San Francisco	California Halibut	8.8%	9.3%	14.5%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	18.3%	13.5%	23.8%
	Nearshore Rockfish	17.8%	12.2%	25.3%
	Urchin	21.5%	16.2%	30.4%
	Dungeness Crab	15.6%	13.2%	21.3%
	Salmon	11.8%	9.3%	14.4%
Half Moon Bay	California Halibut	6.2%	7.2%	19.7%
	Coastal Pelagics	9.9%	6.2%	9.8%
	Market Squid	3.3%	2.5%	20.5%
	Deeper Nearshore Rockfish	15.1%	10.8%	26.8%
	Nearshore Rockfish	9.5%	9.5%	9.5%
	Urchin	—	—	—
	Dungeness Crab	15.8%	13.3%	21.6%
	Salmon	11.8%	9.3%	14.4%

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 9: Percentage value of total commercial fishing grounds affected by proposed MPAs by landing port**

Fisheries		1-3	2-XA	4
Point Arena	California Halibut	—	—	—
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	30.6%	7.0%	31.4%
	Nearshore Rockfish	27.0%	10.7%	28.1%
	Urchin	6.7%	9.9%	11.0%
	Dungeness Crab	13.9%	11.4%	16.8%
	Salmon	12.4%	13.9%	13.9%
Bodega Bay	California Halibut	7.7%	10.2%	11.1%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	20.6%	14.9%	23.4%
	Nearshore Rockfish	12.4%	12.6%	23.8%
	Urchin	17.0%	6.1%	39.0%
	Dungeness Crab	6.0%	5.3%	9.1%
	Salmon	3.9%	3.1%	4.0%
Bolinas	California Halibut	12.3%	15.2%	13.2%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	26.8%	23.8%	28.5%
	Nearshore Rockfish	—	—	—
	Urchin	—	—	—
	Dungeness Crab	0.1%	0.5%	3.1%
	Salmon	4.1%	4.5%	4.1%
San Francisco	California Halibut	0.7%	0.8%	1.0%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	20.0%	15.1%	22.8%
	Nearshore Rockfish	12.0%	5.8%	15.1%
	Urchin	18.1%	7.1%	34.0%
	Dungeness Crab	2.3%	2.1%	4.1%
	Salmon	2.0%	1.6%	2.3%
Half Moon Bay	California Halibut	0.2%	0.3%	27.0%
	Coastal Pelagics	0.9%	0.5%	0.8%
	Market Squid	0.9%	0.8%	24.9%
	Deeper Nearshore Rockfish	11.0%	6.7%	19.4%
	Nearshore Rockfish	1.9%	1.9%	1.9%
	Urchin	—	—	—
	Dungeness Crab	2.8%	2.3%	3.1%
	Salmon	2.8%	2.2%	3.1%

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 10: Percentage value of commercial fishing grounds within the study area affected by proposed MPAs by landing port**

Fisheries		1-3	2-XA	4
Point Arena	California Halibut	—	—	—
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	30.7%	7.0%	31.5%
	Nearshore Rockfish	29.3%	11.5%	30.5%
	Urchin	7.9%	11.7%	13.0%
	Dungeness Crab	30.1%	24.5%	36.1%
	Salmon	23.6%	26.5%	26.6%
Bodega Bay	California Halibut	7.7%	10.2%	11.1%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	31.0%	22.5%	35.2%
	Nearshore Rockfish	12.9%	13.1%	24.7%
	Urchin	17.9%	6.4%	41.0%
	Dungeness Crab	10.0%	8.8%	15.3%
	Salmon	9.5%	7.7%	9.9%
Bolinas	California Halibut	12.3%	15.2%	13.2%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	30.1%	26.7%	32.0%
	Nearshore Rockfish	—	—	—
	Urchin	—	—	—
	Dungeness Crab	0.1%	1.2%	7.9%
	Salmon	6.8%	7.5%	6.8%
San Francisco	California Halibut	0.8%	0.8%	1.1%
	Coastal Pelagics	—	—	—
	Market Squid	—	—	—
	Deeper Nearshore Rockfish	24.9%	18.8%	28.4%
	Nearshore Rockfish	20.9%	10.1%	26.4%
	Urchin	18.3%	7.2%	34.3%
	Dungeness Crab	5.3%	5.0%	9.6%
	Salmon	8.8%	7.2%	9.9%
Half Moon Bay	California Halibut	0.2%	0.3%	27.1%
	Coastal Pelagics	22.5%	14.0%	22.2%
	Market Squid	0.9%	0.8%	24.9%
	Deeper Nearshore Rockfish	14.4%	8.7%	25.4%
	Nearshore Rockfish	1.9%	1.9%	1.9%
	Urchin	—	—	—
	Dungeness Crab	14.7%	12.4%	16.5%
	Salmon	9.2%	7.3%	10.1%

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 11: Percentage of the total fishing grounds value impacted by the existing fishery management area closures and/or fishery exclusion zones (i.e., RCAs)**

Fisheries		2007	2008	2009
Point Arena	Rockfish - Deeper Nearshore	16.3%	16.9%	30.2%
	Rockfish - Nearshore	17.0%	17.7%	32.4%
Bodega Bay	Rockfish - Deeper Nearshore	47.3%	54.4%	69.3%
	Rockfish - Nearshore	1.2%	1.3%	9.3%
Bolinas	Rockfish - Deeper Nearshore	60.8%	72.3%	81.8%
	Rockfish - Nearshore	-----	-----	-----
San Francisco	Rockfish - Deeper Nearshore	15.6%	18.1%	50.3%
	Rockfish - Nearshore	13.7%	14.4%	49.9%
Half Moon Bay	Rockfish - Deeper Nearshore	0.6%	0.7%	6.5%
	Rockfish - Nearshore	0.1%	0.1%	0.1%

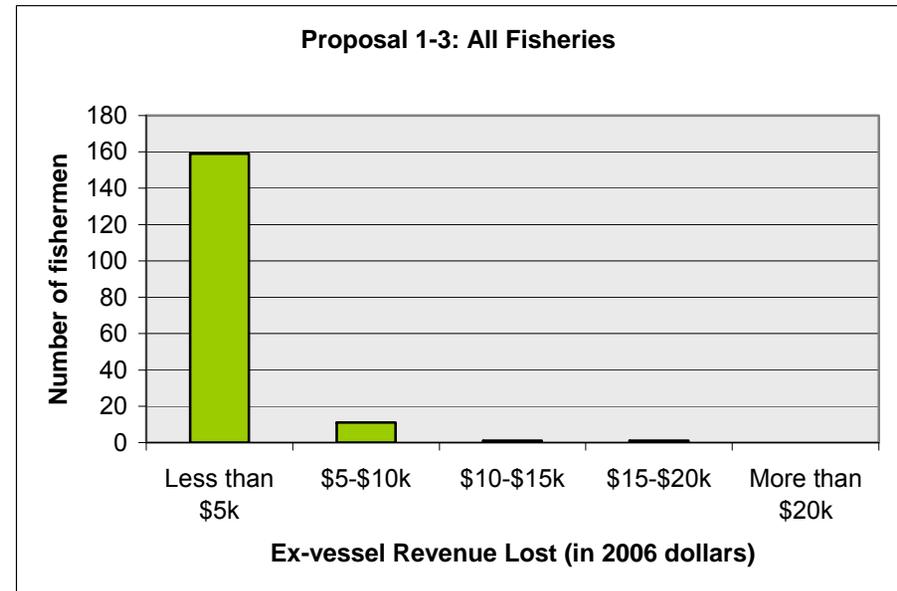
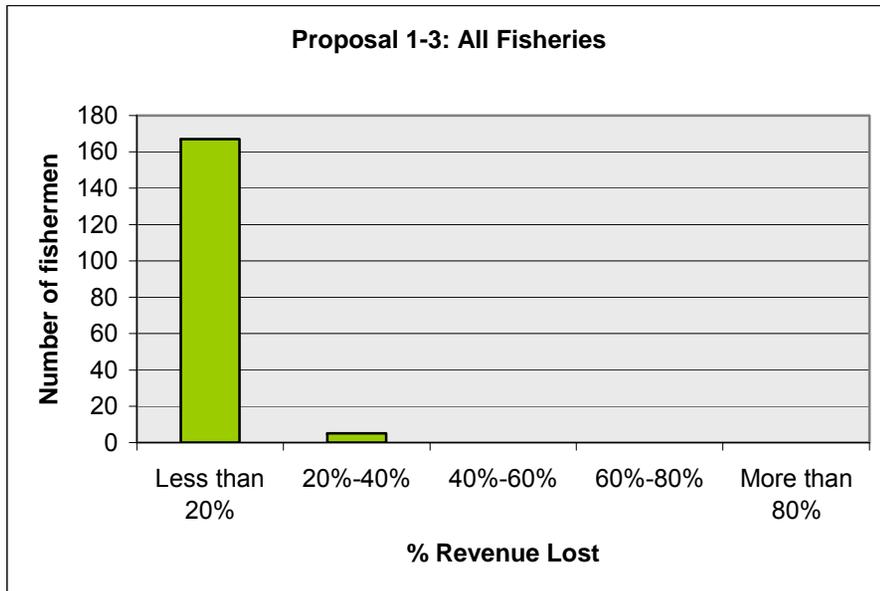
**Table 12: Percentage value of commercial deeper nearshore and nearshore rockfish fishing grounds by landing port affected by MPA proposals without and with consideration of existing fishery management area closures in 2008 (i.e., total fishing grounds, versus available fishing grounds after RCA in place)**

Fisheries		Area considered	1-3	2-XA	4
Point Arena	Deeper Nearshore Rockfish	total fishing grounds	30.6%	7.0%	31.4%
	<b>Deeper Nearshore Rockfish</b>	available grounds outside RCA	31.6%	5.1%	32.2%
	Nearshore Rockfish	total fishing grounds	27.0%	10.7%	28.1%
	<b>Nearshore Rockfish</b>	available grounds outside RCA	27.0%	10.0%	28.0%
Bodega Bay	Deeper Nearshore Rockfish	total fishing grounds	20.6%	14.9%	23.4%
	<b>Deeper Nearshore Rockfish</b>	available grounds outside RCA	23.4%	13.3%	27.7%
	Nearshore Rockfish	total fishing grounds	12.4%	12.6%	23.8%
	<b>Nearshore Rockfish</b>	available grounds outside RCA	12.3%	12.4%	23.5%
Bolinas	Deeper Nearshore Rockfish	total fishing grounds	26.8%	23.8%	28.5%
	<b>Deeper Nearshore Rockfish</b>	available grounds outside RCA	35.2%	24.5%	40.4%
	Nearshore Rockfish	total fishing grounds	—	—	—
	<b>Nearshore Rockfish</b>	available grounds outside RCA	—	—	—
San Francisco	Deeper Nearshore Rockfish	total fishing grounds	20.0%	15.1%	22.8%
	<b>Deeper Nearshore Rockfish</b>	available grounds outside RCA	20.3%	15.1%	23.8%
	Nearshore Rockfish	total fishing grounds	12.0%	5.8%	15.1%
	<b>Nearshore Rockfish</b>	available grounds outside RCA	11.7%	6.1%	15.4%
Half Moon Bay	Deeper Nearshore Rockfish	total fishing grounds	11.0%	6.7%	19.4%
	<b>Deeper Nearshore Rockfish</b>	available grounds outside RCA	11.0%	6.8%	19.6%
	Nearshore Rockfish	total fishing grounds	1.9%	1.9%	1.9%
	<b>Nearshore Rockfish</b>	available grounds outside RCA	1.9%	1.9%	1.9%

Available fishing grounds are defined as the fishing grounds that exist after removing the fishing grounds that are inside an existing fishery management closure (i.e., 2008 RCA)

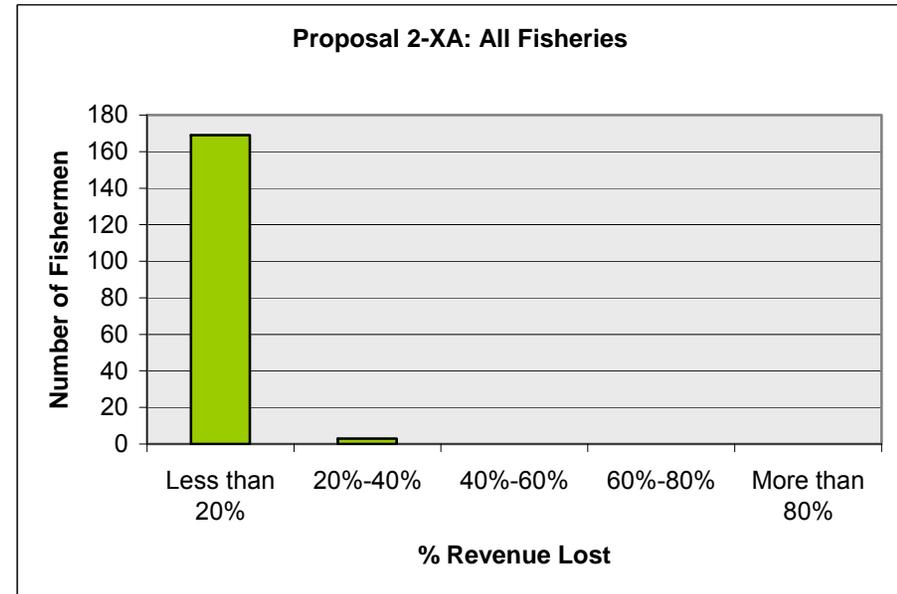
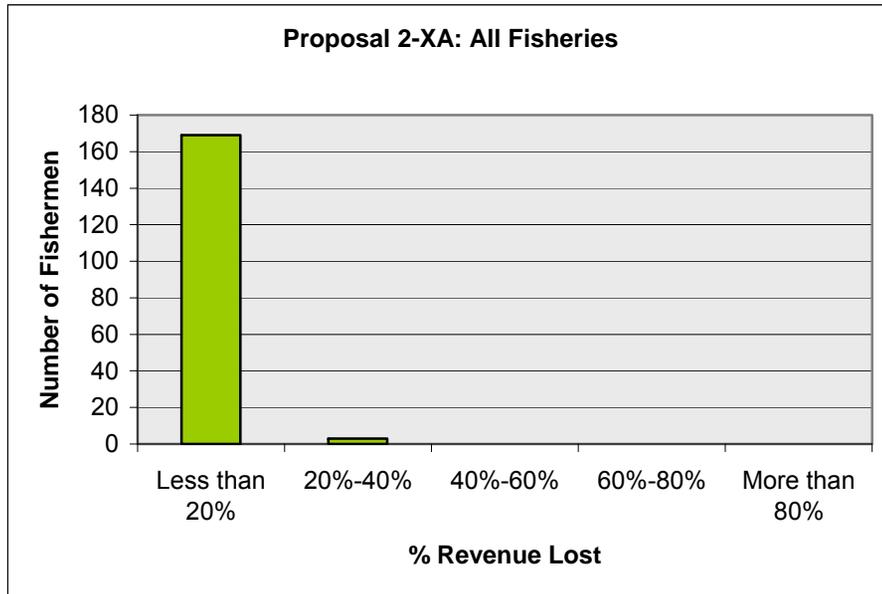
**Table 13: Individual Impacts for Proposal 1–3**

Fishery	n=	Annual Ex-vessel Revenue Loss (%)					Annual Ex-vessel Revenue Loss (\$ 2006)				
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	Less than \$5k	\$5-\$10k	\$10-\$15k	\$15-\$20k	More than \$20k
C. Halibut	14	13	1	0	0	0	14	0	0	0	0
Coast. Pelagics	1	1	0	0	0	0	1	0	0	0	0
Market Squid	1	1	0	0	0	0	1	0	0	0	0
D.N. Rockfish	15	8	6	1	0	0	15	0	0	0	0
N. Rockfish	9	4	5	0	0	0	8	1	0	0	0
Urchin	22	21	1	0	0	0	21	1	0	0	0
D. Crab	102	98	4	0	0	0	94	7	1	0	0
Salmon	136	134	2	0	0	0	135	1	0	0	0
<b>All Fisheries</b>	<b>172</b>	<b>167</b>	<b>5</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>159</b>	<b>11</b>	<b>1</b>	<b>1</b>	<b>0</b>



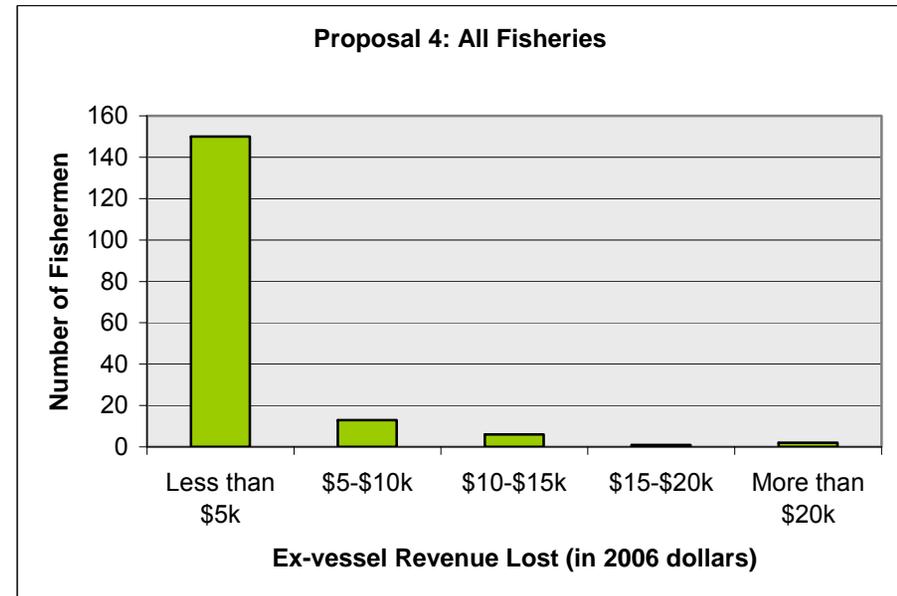
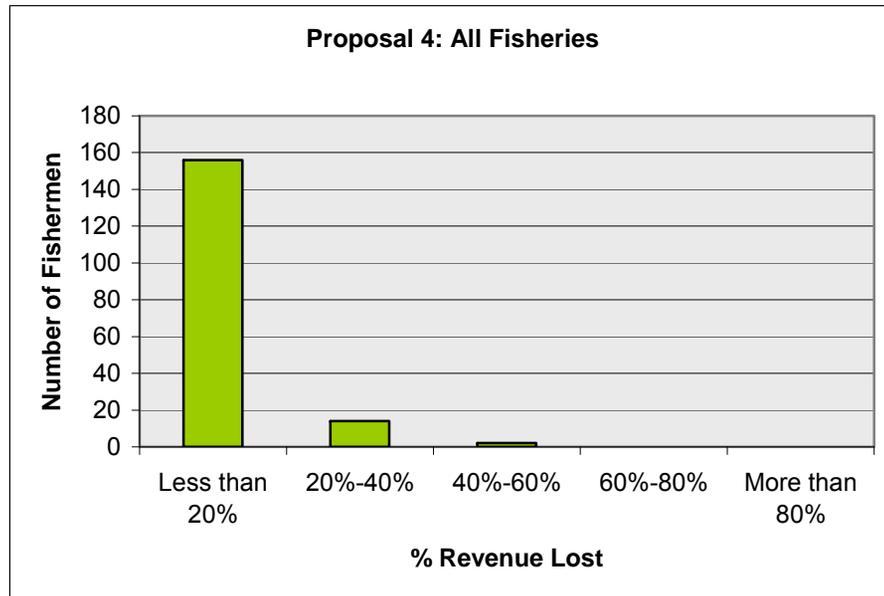
**Table 14: Individual Impacts for Proposal 2-XA**

Fishery	n=	Annual Ex-vessel Revenue Loss (%)					Annual Ex-vessel Revenue Loss (\$ 2006)				
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	Less than \$5k	\$5-\$10k	\$10-\$15k	\$15-\$20k	More than \$20k
C. Halibut	14	13	1	0	0	0	14	0	0	0	0
Coast. Pelagics	1	1	0	0	0	0	1	0	0	0	0
Market Squid	1	1	0	0	0	0	1	0	0	0	0
D.N. Rockfish	15	11	4	0	0	0	15	0	0	0	0
N. Rockfish	9	9	0	0	0	0	9	0	0	0	0
Urchin	22	20	2	0	0	0	21	1	0	0	0
D. Crab	102	99	3	0	0	0	95	6	1	0	0
Salmon	136	134	2	0	0	0	135	1	0	0	0
<b>All Fisheries</b>	<b>172</b>	<b>169</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>163</b>	<b>7</b>	<b>0</b>	<b>2</b>	<b>0</b>



**Table 15: Individual Impacts for Proposal 4**

Fishery	n=	Annual Ex-vessel Revenue Loss (%)					Annual Ex-vessel Revenue Loss (\$ 2006)				
		Less than 20%	20%-40%	40%-60%	60%-80%	More than 80%	Less than \$5k	\$5-\$10k	\$10-\$15k	\$15-\$20k	More than \$20k
C. Halibut	14	10	4	0	0	0	14	0	0	0	0
Coast. Pelagics	1	1	0	0	0	0	1	0	0	0	0
Market Squid	1	1	0	0	0	0	0	0	0	1	0
D.N. Rockfish	15	7	7	1	0	0	15	0	0	0	0
N. Rockfish	9	4	5	0	0	0	8	1	0	0	0
Urchin	22	11	9	1	0	1	20	2	0	0	0
D. Crab	102	94	8	0	0	0	89	8	4	1	0
Salmon	136	133	2	1	0	0	135	1	0	0	0
<b>All Fisheries</b>	<b>172</b>	<b>156</b>	<b>14</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>150</b>	<b>13</b>	<b>6</b>	<b>1</b>	<b>2</b>



## 5. Socioeconomic Impact Analysis: Approach

We also estimate "worst-case scenario" or maximum potential economic impact of each MPA proposal (for description of methods, please refer to Appendix A). To accomplish this, we use methods similar to those utilized in the Central Coast process by Wilen and Abbott (2006). This analysis for the North Central Coast, however, differs in a very important respect, that is, by having original survey data on fishermen operating costs collected through the interview process. Wilen and Abbott estimated costs as 65% of gross revenue for all fisheries based on New Zealand and British Columbia data (Wilen and Abbott 2006, pg 7), although costs are known to vary by fishery. The 65% figure was applied as a uniform conservative (high) estimate, since specific data for the study region were not available.

Ecotrust employs a new methodology for estimating fishery costs. The approach is a refinement of the uniform 65% method. As mentioned previously, this refinement is possible due to new data gathered during the interview process on fishery specific operating costs in the study area. As part of the fishermen interview process, field staff asked several questions related to operating costs, including:

- What percentage of your gross revenue goes towards overall operating costs?
- Of your overall operating costs, what percentage goes towards crew share or labor?
- Of your overall operating costs, what percentage goes towards fuel?

With the opportunity to interview NCCSR fishermen directly, information specific to the study region is gained. There is also the opportunity for data resolution regarding types of costs fishermen face. Using data from the fishermen knowledge interviews, two cost categories were created: fixed and variable. Fixed costs include costs that are independent of the number of trips a fishing vessel makes or the duration of these trips. For example, vessel repairs and maintenance, insurance, mooring and dockage fees are typically considered fixed costs. On the other hand, variable costs include costs that are dependent on the number of trips a vessel makes and the duration of these trips. Variable costs typically include fuel, maintenance, crew share, and gear repair/replacement. For the purpose of this study, however, in order to account for sunk costs, we assume the only variable costs to be crew/labor and fuel costs. All other costs will be considered fixed costs.

As mentioned previously, a total of 174 fishermen were interviewed. The same eight fisheries analyzed in the commercial fishing grounds analysis are also considered here. Within these fisheries, the participation patterns of interviewed fishermen yielded 28 possible combinations. For example, 138 of those interviewed participated in the salmon fishery, but of those, only 48 (or 35%) exclusively fish salmon; the remainder fish salmon as well as various combinations of the other fisheries (e.g. salmon and Dungeness crab; salmon, Dungeness crab and deeper nearshore rockfish).

Initially, we calculated fishery costs using data from fishermen that only participate in the fishery in question; however, there were some fisheries having no exclusive participants. Furthermore, this would have ignored interview data from fishermen participating in multiple fisheries, the general case. Given this, we calculated costs for a particular fishery based on all fishermen that participate in that fishery; a single fisherman's data may therefore have been used numerous times. This explains why summing observations "n" across the fisheries does not sum to 174 in Table 16, which also shows summary cost data based on fishermen responses.

The mean estimated total operating costs for all fishermen as a percentage of overall gross revenue was 47.5%. Fixed costs comprise just over half of these costs, while variable costs (i.e. crew and fuel) make up the remainder. Grouped by fishery, the highest overall operating cost as a percentage of gross revenue was 60.0% (Market Squid and Coastal Pelagics) and the lowest was 39.7% (Urchin). While not included here, tables similar to Table 15 were also compiled at the port group level for the NCCSR (i.e. for Point Arena, Bodega Bay, Bolinas, San Francisco, and Half Moon Bay).

**Table 16: Estimated Operating Costs**

Name	n=	Mean % of Gross Economic Revenue			
		Crew	Fuel	Fixed	Total
California Halibut	19	5.4%	13.9%	26.6%	45.9%
Coastal Pelagics	1	40.0%	15.0%	5.0%	60.0%
Squid	1	40.0%	15.0%	5.0%	60.0%
Deeper Nearshore and Nearshore Rockfish	18	5.3%	17.3%	28.3%	50.9%
Dungeness Crab	101	14.8%	10.3%	23.3%	48.5%
Urchin	21	7.6%	10.7%	21.4%	39.7%
Salmon	138	9.8%	11.8%	25.0%	46.6%
All Fisheries Combined	174	10.9%	12.1%	24.4%	47.5%

## 6. Socioeconomic Impact Analysis: Assessing MPA Proposals

The net economic impact (NEI) of each MPA proposal is calculated for each port group, and for the NCCSR as a whole. The NEI results are presented as revenue reductions in both dollar terms (\$ 2006) and percentage terms. The starting point for calculating NEI is baseline gross economic revenue (Baseline GER), which is based on a 7-year average (as previously described as described in Section 2). Baseline GER is gross revenue for the fishery in question absent any MPA proposal.

The baseline net economic revenue (Baseline NER) is found by subtracting the fishery-specific fixed and variable costs described in Section 5 from Baseline GER. A similar net economic revenue calculation is performed for each MPA proposal and is then compared with Baseline NER to yield NEI. Please refer to Appendix A for a more detailed methodology. Figure 1 shows the estimated percentage reduction in profit across the study region under a given proposal. As can be seen in Tables 17–22, proposals vary considerably in their effects on ports and fisheries:

- For the NCCSR, the economic impact on the squid fishery is estimated to be 0.6% under Proposal 2–XA, but 18.8% under Proposal 4.
- For the NCCSR, the lowest estimated economic impact on nearshore rockfish from any proposal (Proposal 2-XA) is 15.1%. The highest estimated maximum economic impact from any proposal on deeper nearshore rockfish is 35.5% (Proposal 4).

Additionally, use of both dollar and percentage impacts convey perspective:

- For the port of Point Arena, the economic impact on deeper nearshore rockfish from Proposal 1–3 is estimated to be 48.3%, yet this only translates to an estimated \$377 in dollar terms (annually).

**Figure 1: Annual Net Economic Impact of MPA Proposals for the NCCSR**



Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 17: Estimated Annual Net Economic Impact (NEI) for Point Arena**

Fishery	Baseline GER	Baseline NER (Profit)	Estimated Annual Net Economic Impact of MPA Proposals (\$ reduction in Profit)		
			1-3	2-XA	4
Ca. Halibut	—	—	—	—	—
Coastal Pelagics	—	—	—	—	—
Squid	—	—	—	—	—
D. N. Rockfish	\$1,424	\$699	\$337	\$77	\$346
N. Rockfish	\$64,259	\$31,544	\$13,440	\$5,296	\$13,977
Urchin	\$608,226	\$366,963	\$33,273	\$49,288	\$54,609
Dungeness Crab	\$46,951	\$24,201	\$4,901	\$4,004	\$5,888
Salmon	\$77,890	\$41,610	\$7,558	\$8,474	\$8,511
<b>All Fisheries</b>	<b>\$798,750</b>	<b>\$465,016</b>	<b>\$59,510</b>	<b>\$67,139</b>	<b>\$83,332</b>

Fishery	Estimated Annual Net Economic Impact of MPA Proposals (% reduction in Profit)		
	1-3	2-XA	4
Ca. Halibut	—	—	—
Coastal Pelagics	—	—	—
Squid	—	—	—
D. N. Rockfish	48.3%	11.1%	49.5%
N. Rockfish	42.6%	16.8%	44.3%
Urchin	9.1%	13.4%	14.9%
Dungeness Crab	20.2%	16.5%	24.3%
Salmon	18.2%	20.4%	20.5%
<b>All Fisheries</b>	<b>12.8%</b>	<b>14.4%</b>	<b>17.9%</b>

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 18: Estimated Annual Net Economic Impact (NEI) for Bodega Bay**

Fishery	Baseline GER	Baseline NER (Profit)	Estimated Annual Net Economic Impact of MPA Proposals (\$ reduction in Profit)		
			1-3	2-XA	4
Ca. Halibut	\$19,928	\$10,772	\$1,244	\$1,641	\$1,787
Coastal Pelagics	—	—	—	—	—
Squid	—	—	—	—	—
D. N. Rockfish	\$24,772	\$12,160	\$3,943	\$2,860	\$4,480
N. Rockfish	\$40,634	\$19,946	\$3,908	\$3,965	\$7,474
Urchin	\$247,530	\$149,343	\$34,369	\$12,306	\$78,979
Dungeness Crab	\$2,322,504	\$1,197,122	\$103,992	\$91,819	\$158,770
Salmon	\$1,998,838	\$1,067,809	\$60,320	\$48,726	\$62,984
<b>All Fisheries</b>	<b>\$4,654,206</b>	<b>\$2,457,152</b>	<b>\$207,776</b>	<b>\$161,318</b>	<b>\$314,474</b>

Fishery	Estimated Annual Net Economic Impact of MPA Proposals (% reduction in Profit)		
	1-3	2-XA	4
Ca. Halibut	11.6%	15.2%	16.6%
Coastal Pelagics	—	—	—
Squid	—	—	—
D. N. Rockfish	32.4%	23.5%	36.8%
N. Rockfish	19.6%	19.9%	37.5%
Urchin	23.0%	8.2%	52.9%
Dungeness Crab	8.7%	7.7%	13.3%
Salmon	5.6%	4.6%	5.9%
<b>All Fisheries</b>	<b>8.5%</b>	<b>6.6%</b>	<b>12.8%</b>

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 19: Estimated Annual Net Economic Impact (NEI) for Bolinas**

<b>Fishery</b>	<b>Baseline GER</b>	<b>Baseline NER (Profit)</b>	<b>Estimated Annual Net Economic Impact of MPA Proposals (\$ reduction in Profit)</b>		
			<b>1-3</b>	<b>2-XA</b>	<b>4</b>
Ca. Halibut	\$22,897	\$12,376	\$2,266	\$2,809	\$2,438
Coastal Pelagics	—	—	—	—	—
Squid	—	—	—	—	—
D. N. Rockfish	\$2,147	\$1,054	\$445	\$396	\$474
N. Rockfish	—	—	—	—	—
Urchin	—	—	—	—	—
Dungeness Crab	\$109,192	\$56,282	\$41	\$384	\$2,535
Salmon	\$16,978	\$9,070	\$544	\$603	\$542
<b>All Fisheries</b>	<b>\$151,214</b>	<b>\$78,783</b>	<b>\$3,297</b>	<b>\$4,192</b>	<b>\$5,988</b>

<b>Fishery</b>	<b>Estimated Annual Net Economic Impact of MPA Proposals (% reduction in Profit)</b>		
	<b>1-3</b>	<b>2-XA</b>	<b>4</b>
Ca. Halibut	18.3%	22.7%	19.7%
Coastal Pelagics	—	—	—
Squid	—	—	—
D. N. Rockfish	42.3%	37.5%	44.9%
N. Rockfish	—	—	—
Urchin	—	—	—
Dungeness Crab	0.1%	0.7%	4.5%
Salmon	6.0%	6.6%	6.0%
<b>All Fisheries</b>	<b>4.2%</b>	<b>5.3%</b>	<b>7.6%</b>

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 20: Estimated Annual Net Economic Impact (NEI) for San Francisco**

Fishery	Baseline GER	Baseline NER (Profit)	Estimated Annual Net Economic Impact of MPA Proposals (\$ reduction in Profit)		
			1-3	2-XA	4
Ca. Halibut	\$203,044	\$109,750	\$1,179	\$1,228	\$1,621
Coastal Pelagics	—	—	—	—	—
Squid	—	—	—	—	—
D. N. Rockfish	\$59,192	\$29,056	\$9,179	\$6,912	\$10,439
N. Rockfish	\$44,442	\$21,816	\$4,113	\$2,001	\$5,203
Urchin	\$8,827	\$5,326	\$1,309	\$515	\$2,451
Dungeness Crab	\$3,608,592	\$1,860,029	\$61,335	\$57,282	\$111,321
Salmon	\$2,135,290	\$1,140,703	\$33,307	\$27,449	\$37,826
<b>All Fisheries</b>	<b>\$6,059,387</b>	<b>\$3,166,680</b>	<b>\$110,421</b>	<b>\$95,387</b>	<b>\$168,861</b>

Fishery	Estimated Annual Net Economic Impact of MPA Proposals (% reduction in Profit)		
	1-3	2-XA	4
Ca. Halibut	1.1%	1.1%	1.5%
Coastal Pelagics	—	—	—
Squid	—	—	—
D. N. Rockfish	31.6%	23.8%	35.9%
N. Rockfish	18.9%	9.2%	23.9%
Urchin	24.6%	9.7%	46.0%
Dungeness Crab	3.3%	3.1%	6.0%
Salmon	2.9%	2.4%	3.3%
<b>All Fisheries</b>	<b>3.5%</b>	<b>3.0%</b>	<b>5.3%</b>

**Table 21: Estimated Annual Net Economic Impact (NEI) for Half Moon Bay**

Fishery	Baseline GER	Baseline NER (Profit)	Estimated Annual Net Economic Impact of MPA Proposals (\$ reduction in Profit)		
			1-3	2-XA	4
Ca. Halibut	\$33,896	\$18,322	\$55	\$71	\$7,377
Coastal Pelagics	\$16,757	\$6,703	\$64	\$40	\$63
Squid	\$204,407	\$81,763	\$865	\$736	\$22,876
D. N. Rockfish	\$20,367	\$9,998	\$1,734	\$1,051	\$3,057
N. Rockfish	\$3,262	\$1,601	\$48	\$48	\$48
Urchin	—	—	—	—	—
Dungeness Crab	\$2,299,793	\$1,185,416	\$47,871	\$40,295	\$53,382
Salmon	\$1,532,405	\$818,633	\$33,512	\$26,545	\$36,635
<b>All Fisheries</b>	<b>\$4,110,888</b>	<b>\$2,122,436</b>	<b>\$84,149</b>	<b>\$68,786</b>	<b>\$123,439</b>

Fishery	Estimated Annual Net Economic Impact of MPA Proposals (% reduction in Profit)		
	1-3	2-XA	4
Ca. Halibut	0.3%	0.4%	40.3%
Coastal Pelagics	1.0%	0.6%	0.9%
Squid	1.1%	0.9%	28.0%
D. N. Rockfish	17.3%	10.5%	30.6%
N. Rockfish	3.0%	3.0%	3.0%
Urchin	—	—	—
Dungeness Crab	4.0%	3.4%	4.5%
Salmon	4.1%	3.2%	4.5%
<b>All Fisheries</b>	<b>4.0%</b>	<b>3.2%</b>	<b>5.8%</b>

**Table 22: Estimated Annual Net Economic Impact (NEI) for the NCCSR<sup>2</sup>**

Fishery	Baseline GER	Baseline NER (Profit)	Estimated Annual Net Economic Impact of MPA Proposals (\$ reduction in Profit)		
			1-3	2-XA	4
Ca. Halibut	\$279,764	\$151,220	\$4,744	\$5,750	\$13,224
Coastal Pelagics	\$29,804	\$11,926	\$69	\$45	\$68
Squid	\$303,466	\$121,386	\$865	\$736	\$22,876
D. N. Rockfish	\$107,902	\$52,967	\$15,638	\$11,296	\$18,796
N. Rockfish	\$152,597	\$74,907	\$21,510	\$11,310	\$26,703
Urchin	\$867,381	\$523,320	\$68,950	\$62,109	\$136,040
Dungeness Crab	\$8,387,032	\$4,323,049	\$218,139	\$193,783	\$331,896
Salmon	\$5,761,401	\$3,077,826	\$135,242	\$111,798	\$146,497
<b>All Fisheries</b>	<b>\$15,889,359</b>	<b>\$8,336,602</b>	<b>\$465,157</b>	<b>\$396,826</b>	<b>\$696,099</b>

Fishery	Estimated Annual Net Economic Impact of MPA Proposals (% reduction in Profit)		
	1-3	2-XA	4
Ca. Halibut	3.1%	3.8%	8.7%
Coastal Pelagics	0.6%	0.4%	0.6%
Squid	0.7%	0.6%	18.8%
D. N. Rockfish	29.5%	21.3%	35.5%
N. Rockfish	28.7%	15.1%	35.6%
Urchin	13.2%	11.9%	26.0%
Dungeness Crab	5.0%	4.5%	7.7%
Salmon	4.4%	3.6%	4.8%
<b>All Fisheries</b>	<b>5.6%</b>	<b>4.8%</b>	<b>8.3%</b>

<sup>2</sup> It should be noted that the "all fisheries" estimates for annual net economic impact for the NCCSR do not equal the sum of all port's "all fisheries" estimates due to rounding differences.

## 7. Impact on Recreational Fishing Grounds: Methods

The methods used to assess the impact of the various MPA proposals on recreational fisheries are identical to those used to assess the impact on commercial fisheries (please refer to Section 3 of this document for a description of those methods) with one exception. The commercial fishery impact analysis assessed fishing grounds that were weighted by multiplying stated importance values from the interviews by the proportion of in-study region landings (both by landing port and by fishery), and more specifically, by ex-vessel values for those landings. In contrast, no weighting occurs in the calculation of recreational fishing grounds, but rather, the analysis is done using only stated importance values from the interviews. No weighting occurs for the obvious reason that ex-vessel values do not exist for recreational fishery landings.

## 8. Impact on Recreational Fishing Grounds: Approach

The approach used for the recreational fishing grounds analysis, like the methods, is identical to those used in the commercial fisheries analysis (please refer to Section 4 of this document for a description) with one exception—the analysis is done using only stated importance values from the interviews.

The recreational data presented here should be used with the following caveats:

1. The data are not representative of the entire population of recreational fishermen due to the less than desirable (less than statistically significant) sample size.
2. The data should only be considered at the sub-region level, not at the entire study region level.
3. There was little or no data collected from recreational fishermen north of Bodega Bay.
4. The data represents interviewees' areas of value, not areas of effort.
5. The data represents interviewees' areas that are important to them over their entire recreational fishing experience, not necessarily the areas that are important to them currently.

That said, Ecotrust and the recreational fishing community believe that the information and the manner in which it was acquired allows us to produce results that are able to speak broadly to both the preferences of the overall recreational fishing population and also each user group and sub-region of anglers.

The total percentage of area and value affected for the total fishing grounds and the grounds inside the study area are then summarized for all MPAs affecting each fishery per proposal. MPA proposals vary considerably in their effects, both between and across fisheries, as illustrated in the Tables 23–26.

For example, Proposal 2-XA has lesser effects (both in terms of study area grounds and value) on the CPFV Dungeness crab fishery in Region 2 (San Francisco Bay access points to Point Reyes) than on any other CPFV fishery (i.e. salmon and rockfish) for this region. Illustrating another set of effects across sectors for the recreational rockfish fishery in Region 1 (Ocean Beach in San Francisco County), Proposal 1–3 affects 12.4% of the total value for the CPFV sector, 14.3% for private vessels, 5.2% for kayak-based and 8.7% for shore/pier-based anglers. For the recreational fisheries considered in this analysis, results indicate that most, if not all of the fisheries fishing grounds are located in state-waters, especially for kayak-based and shore/pier anglers. For example, Proposal 4 affects 6.7% of the total CPFV California halibut fishing grounds in Region 3 (Point Reyes north to Alder Creek) and the same 6.7% when considering only those fishing grounds that fall into the (nearer to shore) study area waters.

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 23: Percentage area of total recreational fishing grounds affected by sub-region**

		Fisheries	1-3	2-XA	4
CPFV	Region 3	California Halibut	6.3%	4.6%	6.7%
		Dungeness Crab	9.9%	6.9%	15.3%
		Rockfish	12.7%	10.5%	14.7%
		Salmon	2.4%	2.0%	2.1%
	Region 2	California Halibut	11.4%	12.0%	21.7%
		Dungeness Crab	1.0%	0.7%	1.4%
		Rockfish	15.8%	7.2%	18.7%
		Salmon	3.3%	2.9%	4.0%
	Region 1	California Halibut	0.8%	2.3%	16.4%
		Dungeness Crab	3.6%	2.3%	3.7%
		Rockfish	14.7%	12.1%	19.3%
		Salmon	3.0%	2.8%	3.7%
Private Vessel	Region 3	California Halibut	5.1%	4.9%	8.9%
		Dungeness Crab	4.0%	3.4%	7.7%
		Rockfish	14.1%	11.3%	16.4%
		Salmon	4.8%	3.8%	5.1%
	Region 2	California Halibut	3.3%	3.6%	5.9%
		Dungeness Crab	3.5%	3.2%	5.9%
		Rockfish	9.9%	8.6%	12.2%
		Salmon	3.1%	2.6%	3.5%
	Region 1	California Halibut	4.3%	6.1%	13.1%
		Dungeness Crab	2.3%	1.5%	2.1%
		Rockfish	14.1%	11.0%	18.5%
		Salmon	1.9%	1.6%	2.5%
Kayak Anglers	Region 3	California Halibut	0.0%	0.0%	0.3%
		Dungeness Crab	0.0%	0.0%	0.2%
		Rockfish	6.4%	7.3%	10.1%
		Salmon	3.9%	4.2%	8.7%
	Region 2	California Halibut	0.1%	0.0%	0.0%
		Dungeness Crab	—	—	—
		Rockfish	21.8%	12.1%	23.8%
		Salmon	15.4%	10.1%	17.9%
	Region 1	California Halibut	0.1%	1.6%	6.1%
		Dungeness Crab	5.7%	3.5%	5.6%
		Rockfish	6.4%	6.4%	7.6%
		Salmon	1.9%	1.6%	1.8%
Pier/Shore	Region 3	California Halibut	—	—	—
		Dungeness Crab	—	—	—
		Rockfish	4.8%	0.3%	15.2%
		Salmon	—	—	—
		Striped Bass	17.7%	16.9%	34.3%
	Region 2	California Halibut	0.0%	0.0%	0.0%
		Dungeness Crab	0.0%	0.0%	0.0%
		Rockfish	18.0%	11.7%	21.5%
		Salmon	—	—	—
		Striped Bass	13.9%	13.9%	24.6%
	Region 1	California Halibut	3.9%	3.9%	12.4%
		Dungeness Crab	21.0%	12.9%	18.5%
Rockfish		10.3%	5.3%	21.3%	
Salmon		0.0%	0.0%	0.0%	
Striped Bass		10.9%	6.2%	19.2%	

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 24: Percentage area of recreational fishing grounds within the study area affected by sub-region**

		Fisheries	1-3	2-XA	4
CPFV	Region 3	California Halibut	6.3%	4.6%	6.7%
		Dungeness Crab	12.6%	8.7%	19.4%
		Rockfish	14.2%	11.7%	16.4%
		Salmon	7.8%	6.5%	6.7%
	Region 2	California Halibut	11.9%	12.5%	22.6%
		Dungeness Crab	6.6%	4.7%	9.7%
		Rockfish	22.7%	10.3%	26.9%
		Salmon	11.1%	10.1%	13.8%
	Region 1	California Halibut	0.9%	2.6%	18.3%
		Dungeness Crab	21.5%	13.6%	21.9%
		Rockfish	24.9%	20.4%	32.5%
		Salmon	11.7%	10.6%	14.4%
Private Vessel	Region 3	California Halibut	8.2%	7.8%	14.2%
		Dungeness Crab	8.7%	7.3%	16.5%
		Rockfish	23.4%	18.8%	27.2%
		Salmon	11.8%	9.2%	12.4%
	Region 2	California Halibut	4.9%	5.4%	8.8%
		Dungeness Crab	10.0%	9.1%	16.6%
		Rockfish	20.1%	17.4%	24.7%
		Salmon	11.0%	9.6%	12.6%
	Region 1	California Halibut	7.3%	10.4%	22.5%
		Dungeness Crab	10.4%	6.8%	9.5%
		Rockfish	24.6%	19.1%	32.3%
		Salmon	9.9%	8.8%	13.5%
Kayak Anglers	Region 3	California Halibut	0.0%	0.0%	0.3%
		Dungeness Crab	0.0%	0.0%	0.2%
		Rockfish	6.5%	7.4%	10.3%
		Salmon	3.9%	4.2%	8.7%
	Region 2	California Halibut	0.1%	0.0%	0.0%
		Dungeness Crab	—	—	—
		Rockfish	21.8%	12.1%	23.9%
		Salmon	15.4%	10.1%	17.9%
	Region 1	California Halibut	0.3%	3.0%	11.4%
		Dungeness Crab	10.9%	6.7%	10.8%
		Rockfish	12.1%	12.1%	14.3%
		Salmon	3.6%	3.1%	3.6%
Pier/Shore	Region 3	California Halibut	—	—	—
		Dungeness Crab	—	—	—
		Rockfish	4.9%	0.3%	15.5%
		Salmon	—	—	—
		Striped Bass	17.7%	16.9%	34.3%
	Region 2	California Halibut	0.0%	0.0%	0.0%
		Dungeness Crab	0.0%	0.0%	0.0%
		Rockfish	18.1%	11.7%	21.6%
		Salmon	—	—	—
		Striped Bass	13.9%	13.9%	24.7%
	Region 1	California Halibut	4.0%	4.0%	12.7%
		Dungeness Crab	21.0%	12.9%	18.6%
Rockfish		10.3%	5.3%	21.3%	
Salmon		0.0%	0.0%	0.0%	
Striped Bass		10.9%	6.2%	19.3%	

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 25: Percentage value of total recreational fishing grounds affected by sub-region**

		Fisheries	1-3	2-XA	4
CPFV	Region 3	California Halibut	3.7%	2.4%	3.9%
		Dungeness Crab	12.6%	7.0%	16.7%
		Rockfish	6.4%	5.1%	7.5%
		Salmon	2.9%	2.3%	2.1%
	Region 2	California Halibut	5.4%	5.8%	10.6%
		Dungeness Crab	0.0%	0.0%	0.0%
		Rockfish	17.6%	12.8%	18.9%
		Salmon	3.2%	3.1%	3.3%
	Region 1	California Halibut	0.5%	2.2%	10.3%
		Dungeness Crab	6.7%	4.2%	6.8%
		Rockfish	12.4%	13.1%	18.2%
		Salmon	3.1%	2.4%	3.5%
Private Vessel	Region 3	California Halibut	5.7%	5.6%	9.3%
		Dungeness Crab	5.2%	3.5%	8.0%
		Rockfish	13.6%	11.1%	16.6%
		Salmon	4.2%	3.2%	3.5%
	Region 2	California Halibut	2.9%	3.3%	5.4%
		Dungeness Crab	0.5%	0.4%	1.0%
		Rockfish	23.7%	19.7%	25.8%
		Salmon	2.6%	2.4%	2.9%
	Region 1	California Halibut	4.2%	5.8%	13.9%
		Dungeness Crab	3.7%	2.0%	3.6%
		Rockfish	14.3%	13.9%	21.3%
		Salmon	1.2%	0.9%	2.0%
Kayak Anglers	Region 3	California Halibut	0.0%	0.0%	0.2%
		Dungeness Crab	0.0%	0.0%	0.1%
		Rockfish	2.4%	0.9%	9.4%
		Salmon	0.5%	0.6%	6.5%
	Region 2	California Halibut	0.1%	0.0%	0.0%
		Dungeness Crab	—	—	—
		Rockfish	17.0%	7.6%	19.1%
		Salmon	12.7%	8.4%	14.4%
	Region 1	California Halibut	0.1%	0.3%	4.2%
		Dungeness Crab	20.3%	12.0%	20.3%
		Rockfish	5.2%	5.7%	6.5%
		Salmon	0.7%	0.6%	0.6%
Pier/Shore	Region 3	California Halibut	—	—	—
		Dungeness Crab	—	—	—
		Rockfish	4.1%	1.2%	24.2%
		Salmon	—	—	—
		Striped Bass	15.1%	14.1%	28.9%
	Region 2	California Halibut	0.0%	0.0%	0.0%
		Dungeness Crab	0.0%	0.0%	0.0%
		Rockfish	14.7%	11.5%	19.6%
		Salmon	—	—	—
		Striped Bass	6.2%	6.2%	10.7%
	Region 1	California Halibut	4.0%	4.0%	12.2%
		Dungeness Crab	4.8%	0.8%	4.7%
Rockfish		8.7%	4.9%	16.6%	
Salmon		0.0%	0.0%	0.0%	
Striped Bass		11.3%	7.4%	20.6%	

Summary of potential impacts on commercial and recreational fisheries in North Central Coast Study Region

**Table 26: Percentage value of recreational fishing grounds within the study area affected by sub-region**

		Fisheries	1-3	2-XA	4
CPFV	Region 3	California Halibut	3.7%	2.4%	3.9%
		Dungeness Crab	14.6%	8.2%	19.5%
		Rockfish	6.8%	5.5%	8.0%
		Salmon	9.6%	7.4%	6.7%
	Region 2	California Halibut	5.7%	6.0%	11.1%
		Dungeness Crab	0.1%	0.0%	0.1%
		Rockfish	20.5%	14.9%	22.0%
		Salmon	7.7%	7.5%	8.1%
	Region 1	California Halibut	0.6%	2.4%	11.3%
		Dungeness Crab	28.2%	17.9%	28.7%
		Rockfish	17.5%	18.5%	25.7%
		Salmon	13.1%	10.2%	14.7%
Private Vessel	Region 3	California Halibut	6.9%	6.8%	11.4%
		Dungeness Crab	9.2%	6.2%	14.0%
		Rockfish	15.0%	12.3%	18.4%
		Salmon	9.6%	7.3%	8.1%
	Region 2	California Halibut	3.7%	4.4%	7.1%
		Dungeness Crab	2.1%	1.7%	4.4%
		Rockfish	31.4%	26.2%	34.2%
		Salmon	4.5%	4.2%	4.9%
	Region 1	California Halibut	6.8%	9.2%	22.1%
		Dungeness Crab	16.0%	8.6%	15.4%
		Rockfish	19.7%	19.2%	29.3%
		Salmon	5.7%	4.2%	9.6%
Kayak Anglers	Region 3	California Halibut	0.0%	0.0%	0.2%
		Dungeness Crab	0.0%	0.0%	0.1%
		Rockfish	2.4%	0.9%	9.5%
		Salmon	0.5%	0.6%	6.5%
	Region 2	California Halibut	0.1%	0.0%	0.0%
		Dungeness Crab	—	—	—
		Rockfish	17.1%	7.6%	19.2%
		Salmon	12.8%	8.4%	14.4%
	Region 1	California Halibut	0.2%	0.5%	6.7%
		Dungeness Crab	34.8%	20.6%	34.8%
		Rockfish	8.1%	9.0%	10.2%
		Salmon	1.0%	0.9%	0.9%
Pier/Shore	Region 3	California Halibut	—	—	—
		Dungeness Crab	—	—	—
		Rockfish	4.2%	1.2%	24.7%
		Salmon	—	—	—
		Striped Bass	15.1%	14.2%	28.9%
	Region 2	California Halibut	0.0%	0.0%	0.0%
		Dungeness Crab	0.0%	0.0%	0.0%
		Rockfish	14.7%	11.6%	19.7%
		Salmon	—	—	—
		Striped Bass	6.2%	6.2%	10.8%
	Region 1	California Halibut	4.0%	4.0%	12.4%
		Dungeness Crab	4.8%	0.8%	4.7%
Rockfish		8.7%	5.0%	16.6%	
Salmon		0.0%	0.0%	0.0%	
		Striped Bass	11.3%	7.4%	20.6%

## APPENDIX A: Socioeconomic Impact Assessment: Methods

The primary goal of this analysis is to estimate the socioeconomic impact to the commercial fishery sector associated with each of the MPA proposals. To accomplish this, we will estimate the maximum potential economic impact for each of the MPA proposals using methods developed in the Central Coast process (see Wilen and Abbott, 2006). This analysis assumes that each of the MPA proposals completely eliminates fishing opportunities in areas closed to specific fisheries and that fishermen are unable to adjust or mitigate in any way (Wilen and Abbott, 2006). The results can then be used by each group (i.e. stakeholders, SAT, BRTF, Initiative staff, FGC) to site and evaluate MPA proposals. The remainder of this paper describes the steps needed to complete the maximum potential economic impact analysis.

### 1. Generate Baseline Estimates of Gross Economic Revenue

The first step involves calculating a baseline estimate from which to derive estimates of the socioeconomic impact associated with changes in commercial fisheries that might be induced by each MPA alternative and against which to compare those estimates. We generate the baseline estimate using gross fishing revenues from regional landing receipts. We use a 7 year average, 2000–2006, derived from the California Department of Fish and Game (CDFG) landing receipts reported for ports in the North Central Coast region and then convert these values into real dollars (i.e. 2006 dollars).

More specifically, to generate baseline estimates of gross economic revenue (GER), for any fishery,  $f$ ,  $BGER_f$  is

the average ex-vessel value of the fishery in 2006 dollars, where  $BGER_f = \sum_{p \in P} BGER(f, p)$ , the sum of the baseline estimates of GER for this fishery over all ports.

We also define the fisheries specific to each port, or in other words, create a baseline estimate of gross economic revenue for each port. For a specific port,  $p$ , being considered in the North Central Coast region the baseline estimate ( $BGER_p$ ) can be calculated as the sum of the baseline estimates of GER for this port over all fisheries:

$$BGER_p = \sum_{f \in F} BGER(f, p).$$

The baseline gross economic revenue ( $BGER_{TOT}$ ) for all commercial fisheries ( $f \in F$ ) being considered in the North Central Coast region is therefore

$$BGER_{TOT} = \sum_{f \in F} BGER_f = \sum_{f \in F} \sum_{p \in P} BGER(f, p) \text{ or equivalently,}$$

$$BGER_{TOT} = \sum_{p \in P} BGER_p = \sum_{p \in P} \sum_{f \in F} BGER(f, p).$$

### 2. Generate Gross Economic Revenue for the Various MPA Alternatives

The next step involves using results from the Ecotrust mapping exercise, specifically stated importance indices from the fishing grounds, to estimate the socioeconomic impact associated with changes in the commercial fisheries that might be induced by each MPA alternative. For a description of the methods used to create stated importance indices, please see Scholz et al. (2006).

For any fishery,  $f$ , port,  $p$ , and any MPA alternative,  $a$ :

$$GER(f, p, a) = BGER(f, p) - GEI(f, p, a)$$

where  $GEI(f, p, a)$  is the estimated gross economic impact on fishery,  $f$ , at any port,  $p$ , under any alternative,  $a$ .

Therefore, we define

$$GER_f(a) = \sum_{p \in P} GER(f, p, a) \text{ and } GER_p(a) = \sum_{f \in F} GER(f, p, a)$$

as well as

$$GEI_f(a) = \sum_{p \in P} GEI(f, p, a) \text{ and } GEI_p(a) = \sum_{f \in F} GEI(f, p, a).$$

Gross economic revenue under any alternative,  $a$ , ( $GER_{TOT}(a)$ ), for all commercial fisheries ( $f \in F$ ) being considered in the North Central Coast region can be calculated as:

$$GER_{TOT}(a) = \sum_{f \in F} GER_f(a) = \sum_{p \in P} GER_p(a) = \sum_{f \in F} \sum_{p \in P} GER(f, p, a) = \sum_{p \in P} \sum_{f \in F} GER(f, p, a)$$

From this we can say for any MPA alternative,  $a$ ,

$$GEI_{TOT}(a) = BGER_{TOT} - GER_{TOT}(a)$$

where  $GEI_{TOT}$  is defined as the total gross economic impact on all commercial fisheries under any alternative,  $a$ . Therefore,

$$GEI_{TOT}(a) = \sum_{f \in F} GEI_f(a) = \sum_{p \in P} GEI_p(a) = \sum_{f \in F} \sum_{p \in P} GEI(f, p, a) = \sum_{p \in P} \sum_{f \in F} GEI(f, p, a).$$

### 3. Generate Baseline Estimates of Net Economic Revenue

In order to compute net economic benefits, we need to 1) estimate the share of gross fishing revenues represented by costs, and 2) scale the baseline estimate (i.e. gross fishing revenues) calculated in Step 1 using the estimated cost shares. In the Central Coast process, an estimate of 65% was used across all fisheries (Wilens and Abbott, 2006). For the North Central Coast process, we plan to ask several cost related questions during interviews with fishermen in an effort to improve on this estimate as well as allow for the ability to account for cost variability between different fisheries in this analysis. After all interviews have been completed, we anticipate breaking the cost data out by fishery or fisheries. For example, cost data for a fisherman who fished both salmon and crab would be aggregated with only other interviewees participating in both those fisheries. We then calculate a mean or median cost estimate for each category.

Costs will be broken into two categories: fixed costs and variable costs. Fixed costs include costs that are independent of the number of trips a vessel makes or the duration of these trips. For example, vessel repairs and maintenance, insurance, mooring and dockage fees typically considered fixed costs. On the other hand, variable costs include costs that are dependent on the number of trips a vessel makes or the duration of these trips. Variable costs typically include fuel, maintenance, crew share, gear repair/replacement. For the purpose of this study, however, to account for sunk costs, we assume the only variable cost to be crew wages and fuel costs. All other costs will be considered fixed costs.

For any fishery,  $f$ , net economic revenue is calculated as:

$$BNER_f = BGER_f - C_{X_f} - C_{V_f}$$

where  $C_{X_f}$  is the fixed cost associated with any fishery,  $f$ , and is set as a fixed dollar value, and  $C_{V_f}$  is the variable cost associated with any fishery,  $f$ , and is a fixed percentage of  $BGER_f$ . For further explanation, please see the Appendix.

Baseline net economic revenue ( $BNER$ ) for all commercial fisheries ( $f \in F$ ) being considered in the North Central Coast region can be calculated as:

$$BNER_{TOT} = \sum_{f \in F} BNER_f$$

#### 4. Generate Estimates of Net Economic Revenue for the Various MPA Alternatives

In order to compute net economic revenue for each of the various MPA alternatives, we also need to 1) estimate the share of gross fishing revenues represented by costs under each MPA alternative, and 2) scale the estimated gross fishing revenues for that alternative accordingly. Costs will be calculated using the methods described in Step 3.

For any fishery,  $f$ , and any MPA proposal,  $a$ ,

$$NER_f(a) = GER_f(a) - C_{X_f} - C_{V_f} .$$

For any MPA alternative,  $a$ , net economic revenue for all commercial fisheries ( $NER_{TOT}(a)$ ) can be calculated as:

$$NER_{TOT}(a) = \sum_{f \in F} NER_f(a)$$

#### 5. Generate Estimate of the Potential Primary Economic Impact for the Various MPA Alternatives

Using the results from the previous steps, the potential primary net economic impact (NEI) of a particular MPA alternative,  $a$ , on a particular fishery,  $f$ , can then be calculated as:

$$NEI_f(a) = BNER_f - NER_f(a).$$

The potential primary NEI of any MPA alternative,  $a$ , on all commercial fisheries ( $f \in F$ ) can then be calculated as:

$$NEI_{TOT}(a) = BNER_{TOT} - NER_{TOT}(a).$$

#### References

- Scholz, Astrid, Charles Steinback and M. Mertens. 2006. Commercial fishing grounds and their relative importance off the Central Coast of California. Report submitted to the California Marine Life Protection Act Initiative. May 4, 2006.
- Wilen, James and Joshua Abbott, "Estimates of the Maximum Potential Economic Impacts of Marine Protected Area Networks in the Central California Coast," final report submitted to the California MLPA Initiative in partial fulfillment of Contract #2006-0014M (July 17, 2006)

#### Example of Estimate Costs

For fishery  $f$ , assume the following proportion of gross economic revenue goes to the following costs:

- 20% = fixed costs
- 20% = crew wages
- 10% = fuel costs → 30% = variable costs

Assume that baseline gross economic revenue equals \$10,000.00. Under the baseline, fixed costs equal \$2,000 and variable costs equal \$3,000, resulting in total costs of \$5,000. Assume that under MPA alternative  $a$ , gross economic revenue now equals \$5,000. Under this alternative, fixed costs will still equal \$2,000; however, variable costs will be recalculated as:

$$\$5,000 * 0.3 = \$1,500$$

This results in total costs of \$3,500 under MPA alternative  $a$ .