Commercial fishing grounds and their relative importance off the Central Coast of California

Report to the California Marine Life Protection Act Initiative

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I. Introduction

Ecotrust was retained by Marine Life Protection Act Initiative (MLPAI) in May of 2005 to collect, compile and analyze fishery data in support of the Central Coast Project (see Appendix 1, scope of work).

During the summer of 2005, our research team developed and deployed a local knowledge interview instrument, using an interactive, custom computer interface, to collect geo-referenced information about the extent and relative importance of central coast commercial fisheries. In the fall and winter of 2005/06, we compiled these data in a geographic information system (GIS) that we delivered to the MLPAI for integration into a central geodatabase housed at the University of California at Santa Barbara. We analyzed the fishery data and additional data provided to us by the California Department of Fish and Game to estimate first-order maximum potential impacts of proposed marine protected area networks developed in the MLPA process.

This report completes our deliverables, complementing the data and analytical deliverables already forwarded to the MLPAI under the terms of our contract. It details the approach and methods used for collecting, compiling and analyzing commercial fisheries data in the central coast. We further discuss the results and deliverables from this project. It is important to note, however, that the analysis conducted under the scope of this contract is not the sum total of everything that could be done with the database and the information contained therein. Indeed, the analysis conducted to date is suggestive of many more questions and research directions than could be pursued in the timeframe. We hope that this project not only makes a useful contribution to the MLPA process, but also opens the door to further inquiry drawing on the expert knowledge of fishermen and other mariners.

Conducting qualitative research in coastal communities is as challenging as it is rewarding. Asking sensitive questions about people's livelihoods, and doing so at the height of the summer fishing season and during a frequently contentious policy process should have been daunting. That it wasn't speaks to the commitment and generosity of the fishing community. We have learned a tremendous amount from the participants in this study, and the countless other community members, stakeholders, and observers of the MLPA process.

We are deeply thankful to the 109 fishermen who participated in the interviews—making time in their busy schedules, overcoming sometimes considerable reservations, and sharing their knowledge and experience with us. We thank all the members of the Central Coast Regional Stakeholder Group and the MLPAI staff, and are especially grateful to Jeremiah and Trudi O'Brien and Kirk Sturm for facilitating several project meetings in Morro Bay, Rick Algert, Jay Elder, and Tom Ghio for memorable boat trips, Steve Scheiblauer for the use of his office for project meetings in Monterey, and Paul Reilly for countless close readings of our data and results.

We believe that this project makes a significant, new contribution to the knowledge base on the coast—not just for marine protected area planning, but for enhancing the public's and decision-makers' understanding of the importance of the coastal ocean to coastal communities and economies.

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In addition to serving as the Principal Investigator on this study, Astrid Scholz is also a member of the Master Plan Science Advisory Team of the Marine Life Protection Act Initiative (http://www.dfg.ca.gov/mrd/mlpa/mpsat.html) and serves on the Ecosystem Protection – Marine Protected Areas working group of the Monterey Bay National Marine Sanctuary as part of the Joint Management Plan Review process (http://sanctuaries.noaa.gov/jointplan/mb_mpa.html).

II. Background – why map the fishing grounds?

In California as elsewhere on the Pacific Coast, commercial and recreational fisheries support coastal communities and economies; they are pursued by vessels of all shapes and sizes, using a variety of gear types and fishing strategies, and covering a large part of the coastal ocean. In general, this spatial extent of fishing activities is relatively poorly understood.

While a variety of data are collected by state and federal agencies to monitor and enforce fisheries and set harvest allocations, the thematic, temporal and spatial resolution of these data sets varies considerably. Data range from agency observer data in some fisheries to voluntary reports in others, from mandatory daily logbooks with detailed location information in some fisheries, to landing receipts using large statistical reporting blocks. With marine and fisheries management becoming more focused on ecosystem-based approaches, using tools such as time and area closures, accurate spatial information about coastal fisheries is central to informing policy decisions.

These spatial information gaps in coastal fisheries can be filled using existing data or collecting new information, and this report describes one such effort undertaken to redress the spatial information gaps in commercial fisheries in the context of the Marine Life Protection Act (MLPA), and its implementation in the Central Coast Study region. In previous iterations of the MLPA processes, the use of existing data was controversial since these data are riddled with artifacts. This is especially prevalent in landing receipts, the only source of data consistently available for all commercial fisheries. Landing receipts are typically filled out by fish buyers at the point of landing, and the data collection forms contain a field for statistical reporting blocks. Fishermen report, and agency staff working with landing receipts confirm, that the block information is typically filled in by the buyer irrespective of the actual provenance of the catch, making the spatial information contained in landing receipts unreliable. For example, most of the catch of Dungeness crab, according to information extracted from landing receipts, would appear to come from depths greater than 2,000 fathoms—waters well past the reach of the San Francisco crab fleet—while the grounds of most economic importance to the fleet look virtually unfished.

Clearly, basing management decisions on the spatial information contained in existing data sources would be undesirable. The alternative, then, is to collect new information about the spatial extent of fishing activities. In the absence of comprehensive observer coverage, vessel monitoring systems or other fishery-independent data collection devices, by far the best source of information about the fishing grounds is the fleet itself.

In this project, therefore, we built on existing approaches to collect fishermen's expert knowledge about the fishing grounds. The goal was to develop maps of the fishing grounds and characterize their relative importance for various fisheries. The next section contains a detailed description of the methods used and the analysis conducted.

III. Methods

In this project, we built on methods developed in previous projects on the coast (Scholz et al. 2004; 2005; 2006), using a computer interface to administer a survey, collecting information from fishermen[1] and analyzing the responses in a geographic information system (GIS). The key innovation in this project was the use of California Department and Fish and Game (CDFG) landing receipts to structure a representative sample.

While the use of GIS technology and analysis in marine and fishery management has expanded steadily over the past decade (Meaden 1996; Kruse et al. 2001; Breman 2002; Valavanis 2002; Fisher and Rahel 2004), its use for socioeconomic research is still somewhat limited. Many of the applications reviewed in the recent literature focus on urban populations or natural resource use in developing countries (Gimblett 2002; Goodchild and Janelle 2004; Anselin et al. 2004). Nevertheless, there are several good examples to build on for improving the spatial specificity of the West Coast knowledge base and data landscape. Some of the most pertinent applications of GIS technology to socioeconomic questions in fisheries concern the spatial extent of fishing effort and intensity (Caddy and Carocci 1999; Green and King 2003), and use participatory methods similar to the ones employed here (Wedell et al. 2005; St. Martin 2004, 2005, 2006).

We built on these approaches and adapted them for the California context, following best practices for the use of participatory GIS in natural resource management (Quan et al. 2001), as described in the remainder of this section.

III.1 The study region

The study region of this project is congruent with the Central Coast Project of the MLPAI, spanning approximately 200 miles of coast between Pigeon Point, north of Santa Cruz, to Point Conception northwest of Santa Barbara (for details of the Central Coast Project, see http://www.dfg.ca.gov/mrd/mlpa/centralcoast.html).

Unlike the Central Coast Project, however, the western extent of our study region is not bounded by the state water boundary. Rather, we considered the entire Exclusive Economic Zone (EEZ) in this project, although in reality most fisheries are confined to within 50 miles offshore. Similarly, we did not impose the southern and northern extent of the Central Coast Project. Methodologically this means that we did not "cut off" the area for fishermen to consider, but asked them to draw their fishing grounds irrespective of political boundaries.

In keeping with the convention adopted by the MLPAI, we stratified our study region into a Northern and Southern part. The Northern section extends from Pigeon Point to the southern border of Monterey County, and includes the ports of Santa Cruz, Moss Landing and Monterey. The Southern section spans the remainder of the coast, from the northern border of San Luis Obispo County to Point Conception, and includes the ports of Morro Bay, Port San Luis and Avila. We considered primarily landings made in these ports for

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[1] In keeping with the usage in the fishing community, we use "fisherman" to talk about both male and female members of the fishing industry.

identifying fishermen and describing the resulting sample. It is, however, the case that many fishermen fishing in the study region also make landings outside of it.

III.2 Fisheries studied

In consultation with MLPAI and CDFG staff, we initially selected 19 fisheries to study, listed in Table 1. They are all fisheries that are at least partially conducted in state waters, are of some economic importance in the study region, mostly involve fishing gear that is expected to have some benthic habitat interactions, and are not well captured spatially by existing fisheries-independent data sets. That is to say, the best fishery-independent spatial information available for them is contained in the statistical blocks reported in landing receipts.

Table 1 Fisheries studied

No.	Fishery	Study region landings (1999-2004 average pounds)	Rank by value of study area landings (1999-2004 average nominal ex vessel revenues)	Percentage of total study area landings (in terms of 1999-2004 average nominal ex vessel revenues)
1	Anchovy	9,936,324	12	2.17%
2	Butterfish	14,169	30	0.10%
3	Cabezon	91,359	11	2.73%
4	California Halibut	123,495	14	1.95%
5	*Chinook Salmon*	975,800	2	12.57%
6	Dungeness Crab	103,547	15	1.66%
7	Jacksmelt	28,096	32	0.05%
8	Kelp Greenling	6,731	26	0.25%
9	Lingcod	36,997	23	0.33%
10	Mackerel	294,720	29	0.13%
11	*Market Squid*	22,615,304	1	24.49%
12	Rock Crab	89,200	20	0.78%
13	Rockfish Nearshore	157,573	7	4.83%
14	*Rockfish Deep Nearshore*			
15	Rockfish Shelf	226,369	19	0.87%
16	Rockfish Slope	438,030	16	1.63%
17	Sablefish	758,397	6	5.53%
18	Sardines	26,354,126	5	7.19%
19	Spot Prawn	129,237	4	7.38%
20	Surfperch	15,413	28	0.20%
21	Thornyheads	694,106	8	4.49%
22	White Seabass	33,608	22	0.47%
	Totals	***63,122,597***	***n/a***	***79.81%***

Notes: Fisheries No.'s 5, 11, and 14 salmon, squid, and deep nearshore rockfish, were added upon inception of interviews. The fishery for No. 7, jacksmelt, takes place in the Northern part of the study region, the fishery for No. 10, surfperch, in the Southern part.

We expanded this list by three additional fisheries (salmon, squid, and deep nearshore rockfish, indicated in italics in Table 1).

The inclusion of salmon was prompted by the realization that it would be odd to omit the second most valuable fishery in the study region from this project even though eventual marine protected areas are anticipated to have relatively minor impacts on this particular fishery. Squid was added on the suggestion of the fleet. Initially the thought had been to just use the very well geo-referenced logbooks that exist for this, the most valuable fishery in the study region. Once interviewees begun in some of the other coastal pelagic fisheries, however, participants from these sectors—many of whom also participate in the squid fishery—expressed a desire to incorporate their squid fishing grounds into the analysis. Finally, we treated the deepwater segment of the nearshore rockfish fishery as a separate fishery. This is because species caught in deeper waters require a special permit that is only held by a subset of the fishermen participating in this fishery.

As is apparent from Table 1, the 22 fisheries considered in this study comprise 63,122,597 pounds in average landings, which amounts to almost 93% of all fish landed in the study area between 1999 and 2004. Similarly, in terms of revenues, they comprise nearly 80% of average revenues in the same time period.

Among the fisheries studied, several are significantly larger, in terms of landings or revenues or both, than others. For example, the coastal pelagic species such as squid, sardines and anchovies account for the greatest volume of landings. Of those, squid accounts for the greatest ex vessel value, followed by salmon and the comparatively low volume spot prawn fishery.

III.3. Sampling the fishing fleet

Using CDFG landing statistics, we identified fishermen to interview about the fishing grounds for each of the 22 target fisheries. Given the expert nature of the information we were interested in for this project, a random sample would not have been the appropriate choice. Instead, we constructed a purposive, proportional quota sample that was designed to be representative of the overall fisheries. CDFG staff generated a list of fishermen by landings for the initial 19 fisheries of interest and salmon. We inspected this list to identify participants such that, for each fishery

- both Northern and Southern segments of the study region; <u>and</u>
- at least 50% of landings in 2003-2004; <u>or</u>
- at least 5 fishermen were represented.

We diverged from this strategy in the case of the squid and deep nearshore rockfish fisheries, which were both added in the course of interviewing. In those two cases the sampling was *de facto* a snowball approach, with members of the Regional Stakeholder

Group as well as participants in wetfish and rockfish fisheries making referrals to other fishermen to contact.

Together, these strategies resulted in 218 fishermen whom we contacted to solicit participation in the project. Of those, 108 provided information used in the subsequent fishing grounds analysis, making for an overall response rate of 50%.

We will discuss challenges and confounders associated with this project in more detail in the next section. Among those are the following:

- difficulties experienced contacting the 26 Vietnamese fishermen (12% of the total sample);
- lack of contact information;
- poor timing for setting up interviews during the summer fishing season.

The 108 successfully completed interviews do, however, give a comprehensive picture of most of the fisheries studied, as summarized in Table 2. Several observations stand out:

- Fisheries added on the suggestion of fishermen had some of the highest response rates of the fisheries studied;
- A total of 3 fisheries—butterfish, jacksmelts, and thornyheads—yielded no information and were eliminated from further analysis. The first two of these account for negligible landings and ex vessel revenues, but thornyheads account for close to 5% of study area revenues on average (see Table 2);
- 12 of the remaining fisheries—including the highest value ones for squid, salmon and spot prawns—met at least one of our sampling criteria in the Northern and Southern parts of the study region.

While there are no hard and fast rules for what constitutes a representative sample of central coast fisheries, and a census of the entire fleet is impractical, the performance of the sample vis-à-vis the sampling criteria is informative of the confidence in the data. Fisheries that scored one or both criteria, and ideally in both regions, and amounted to a large part of landings for the study region as a whole are likely better represented in the data than those for which only one of the two regions is represented.

A	B	C	D	E	F	G	
No.	**Fishery**	**Fishermen contacted**	**Fishermen interviewed**	**Response rate**	**% of total study region landings represented by fishermen sampled (2003-2005)**	**Performance in terms of sampling criteria** **++ = both criteria met** **+ = one criterion met** **- = neither criterion met** **0 = no interviews**	
						North	**South**
1	Anchovy	11	8	73%	50%	++	Not fished here
2	Butterfish	4	0	0%	---	0	0
3	Cabezon	35	24	69%	46%	+	++
4	California Halibut	45	32	71%	32%	+	+
5	*Chinook Salmon*	89	56	63%	22%	+	+
6	Dungeness Crab	28	14	50%	22%	+	++
7	Jacksmelt	5	0	0%	---	0	0
8	Kelp Greenling	33	17	52%	35%	+	+
9	Lingcod	50	28	54%	33%	+	+
10	Mackerel	11	7	64%	39%	-	Not fished here
11	*Market Squid*	17	16	94%	35%	+	++
12	Rock Crab	21	7	33%	54%	-	+
13	Rockfish Nearshore	45	32	71%	42%	+	+
14	*Rockfish Deep Nearshore*	19	19	100%	31%	+	+
15	Rockfish Shelf	33	6	18%	6%	-	-
16	Rockfish Slope						
17	Sablefish	20	7	35%	7%	-	-
18	Sardines	19	8	42%	46%	+	Not fished here
19	Spot Prawn	9	6	67%	92%	++	++
20	Surfperch	11	3	27%	6%	Not fished here	-
21	Thornyheads	10	0	0%	---	0	0
22	White Seabass	19	6	32%	0%	-	-

Table 2 Description of the fishermen sample

III.4. Collecting and analyzing the fishing ground information
During the summer months of 2005 (June through August) Ecotrust personnel interviewed 108 fishermen along the central coast. Fishermen were selected based on CDFG data and recommendations by the Regional Stakeholder Group, as described above.

Ecotrust personnel contacted fishermen by phone, explained the project and obtained written consent of participants (see Appendices 2 and 3 for sample consent forms). The project was also described on a web page, at http://www.ecotrust.org/mlpa, which included a toll free phone number and on-line form for submitting any questions. Staff at Ecotrust's office in Portland arranged for interviews with contracted field staff based in Santa Cruz, Monterey, Morro Bay and Santa Barbara. The format included one-on-one or small group interviews, with follow-up meetings by fishery and/or gear group during which the information collected was validated by fishermen.

Throughout the project we strove to protect the confidentiality of the information provided by fishermen. In addition to obtaining the explicit consent of individual participants, we undertook several additional steps for protecting sensitive information. These include masking all names and identifying characteristics of shapefiles; showing the aggregated maps for each fishery to no-one outside that fishery; developing a mechanism for incorporating the information into the MLPAI geodatabase at sufficiently aggregated levels; and devising a display format that maintains the information content without making it visible, for use in stakeholder group meetings.

Data were entered into a GIS using a custom-built ArcView interface known as OceanMap originally developed by Environmental Defense, and modified for the Central Coast study region. The interface allows field staff to enter fishing grounds identified by respondents directly into a spatial database, and standardize this information across a number of respondents or fisheries. It is programmed to allow fishermen to draw shapes in their natural sizes (polygons) rather than confining responses to a grid. Although data are summarized to a variety of grids for the subsequent analysis, the raw data are entered in natural shapes and at whatever spatial scale makes sense to respondents.

All interviews follow a shared protocol:

1. Maximum extent: Using electronic and paper nautical charts of the area, fishermen are asked to identify, by fishery, the maximum extent north, south, east and west they would forage or target a specie(s).
2. Scaling: They are then asked to identify, within this maximum forage area, which areas are of critical economic importance, over their cumulative fishing experience, and to rank these using a weighted percentage—an imaginary "bag of 100 pennies" that they distribute over the fishing grounds;
3. Port association: Based on the areas the fisherman have identified, they are then asked about the northern and southern range of ports that they would land their catch, and specific ports within that range. They are also asked for their license number.

The first step establishes the maximum extent of the fleet in each fishery. This differs for all fisheries, some of which range far along the entire West Coast, while others are confined to inshore waters. In the subsequent analysis this allows us to distinguish between fisheries that take place wholly in the MLPAI central coast region from others that take place inside and outside.

The second step serves to scale respondents' reporting of the relative importance of the fishing grounds to a common scale. This is important for making inter and intra fishery comparisons. We chose 100 pennies as an intuitive common sum scale for scoring the relative importance of subareas identified within the larger fishing grounds. It also provides us with a convenient accounting unit for aggregating the stated importance per unit area in the intermediary steps of the various analyses performed.

The port association is relevant for linking the fishing grounds to landing ports, since not all landings are necessarily made in ports adjacent to the grounds. Indeed, several fisheries that are conducted within the study area make significant landings outside the study area. For this project, we had direct use of the fishermen's license numbers, which are also recorded in the CDFG landing receipts.

The analysis of the fishing ground information follows a series of discrete steps:

1. Determining the Fishing Grounds
Through a set interviews following the above protocol, fishermen are asked to identify their fishing grounds for a specific fishery. In order to determine the fishing grounds G for any given fishery, the fishing grounds identified by the fishermen (i.e. the area of all the shapes, j) is summarized. Each fisherman f interviewed, identifies his/her fishing grounds G_f, per fishery as one or more shapes $G_f = \sum j$, where j = 1,…,…n. The number of shapes differs for each respondent and by fishery. If there is only one shape, then $G_f = j$.

Each shape j in fisherman's f's fishing grounds is then converted to a grid with a 100m-cell size. For example, in the Dungeness crab fishery, each shape identified by a fisherman now equals some multiple of 100m cells, so the total number of cells in one shape, C_j = n, where n = 1,…,C. The crab fishing grounds for each fisherman G_f, is now represented by the total number of cells for all of his\her shapes:

$$G_f = \sum_{n=1}^{j} C_j$$

But, in order to normalize each shape by the total area, the entire crab fishing grounds G_{crab}, need to be determined. This will be used in a later step that effectively weights the response according to the relative size of the respondent's fishing footprint to the composite fishing grounds. The composite fishing grounds G_{crab}, is based on all the shapes provided by all fishermen, and it is necessary to account for the possible overlap of shapes identified by multiple fishermen. This is done by expressing whether a cell exists for j in any given location (cell) through the following equation:

$$G = \sum b$$

Where b = result of the Boolean expression:
does j exist for any i for location x, y. 1 = true, 0 = false.

If we were to just sum the number of cells of every j, identified by every f, the resulting sum would not be for a unique x, y location and count multiple occurrences in the same location. In other words, the fishing grounds of any one fisherman G_f, are smaller or equal to the total grounds for that fishery.

2. Determining the Relative Importance (RI)
Each respondent allocates a budget, Ω, of 100 "pennies," representing his or her total effort for that fishery, by allocating some portion of pennies, P, to each shape, j, on their fishing grounds, G_f, such that $\sum P_j = 100$. Each shape j is now associated with a distinct number of cells, C_j, and a weight, P_j.

The value of each cell in the shape is then the number of pennies allocated to the shape divided by the number of cells in the shape. So as not to overstate the relative importance of cells associated with shapes identified by fishermen who reported smaller fishing grounds (thus concentrating value in a sub-section of the composite grounds, G), we multiply the value of each cell (P_j / C_j), by the number of cells for that fisherman's grounds, G_f, divided by the total number of cells in the composite fishing grounds for the entire shape (G_f / G). This weights the response according to the relative size of the respondent's fishing footprint, C_j, to the composite fishing grounds, G, or normalizes by the total area.

Each cell for every given shape is now represented by the relative importance value normalized by the total area, or V.

$$V_j = (P_j / C_j) * (G_f / G)$$

Where:
P = the stated importance value
C = the number of cells
j = the shape
G = the total number of cells in the entire fishery
G_f = the total number of cells in the fishing grounds of one fisherman

Consider this example:

For this example there are only two respondents. Collectively they have drawn five shapes: respondent A has identified three shapes and respondent B has identified two shapes. They have each allocated their budget of pennies accordingly.

Respondent A identifies three shapes, which cover 50, 100 and 10 cells, respectively. She then weighs them 20, 75, and 5 pennies each, for a total budget of 100 pennies.

Shape *j*	**No. of cells C_j**	**No. of pennies P_j**	**Value per cell (P_j / C_j)**
$j_{A,1}$	50	20	20/50 = 0.4
$j_{A,2}$	100	75	75/100 = 0.75
$j_{A,3}$	10	5	5/10 = 0.5
A's total grounds $G_{f,A}$	160 cells	100 pennies	

Respondent *B* identifies two shapes, which cover 20, and 100, respectively. He then weighs them 80 and 20 pennies each, for a total penny budget of 100.

Shape *j*	**No. of cells C_j**	**No. of pennies P_j**	**Value per cell (P_j / C_j)**
$j_{B,1}$	20	80	80/20 = 4
$j_{B,2}$	100	20	20/100 = 0.2
B's total grounds $G_{f,B}$	120 cells	100 pennies	

All of respondent B's first shape ($j_{B,1}$), overlaps with a portion of respondent *A*'s second shape ($j_{A,2}$). The total number of cells in the composite fishing grounds, *G,* thus equals 260. In order to account for the relative size of each respondent's fishing footprint, $C_{(j)}$, to the composite fishing grounds, *G*, the value per cell (P_j / C_j) is multiplied by the number of cells for that shape, divided by the total number of cells in the composite fishing grounds (C_j / G).

Respondent A

Shape j	**Value per cell** (P_j / C_j)	**Relative Importance Value** $V_j = (P_j / C_j) * (G_{f,A} / G)$
$j_{A,1}$	20/50 = 0.4	0.4 * 0.6 = 0.24
$j_{A,2}$	75/100 = 0.75	0.75 * 0.6 = 0.45
$j_{A,3}$	5/10 = 0.5	0.5 * 0.6 = 0.3

Respondent B

Shape j	**Value per cell** (P_j / C_j)	**Relative Importance Value** $V_j = (P_j / C_j) * (G_{f,B} / G)$
$j_{B,1}$	80/20 = 4	4 * 0.46 = 1.84
$j_{B,2}$	20/100 = 0.2	0.2 * 0.46 = 0.092

For each cell shared between the two shapes, such that $C_{sA,2} = C_{sB,1}$, the relative importance value of the cell is the sum of the values assigned by each fisherman whose shapes (i.e. fishing grounds) overlap in that cell.

$$O_{x,y} = \sum_{n=1}^{i} V_{x,y}$$

Where O = the sum of all Vs for any given location (cell).

So for the 20 cells in respondent B's shape $(j_{B,1})$, with a REI value of 1.84, which overlap with 20 of the 100 cells in respondent A's shape $(j_{A,2})$, with a RI value of 0.45, the aggregate value equals 2.29.

The aggregate value, O, is the share of the total fishing effort budget, $B = i * 100$, where $i = 2$ for this example, that is apportioned to $O_{x,y}$. In the case of our example, 2.29 pennies out of a total of 200 would get assigned to each of the 20 cells where there is overlap. The remaining area that comprises the rest of the fishing grounds is assigned the RI values that are calculated for each cell for each shape, $O_{x,y} = V_{x,y}$.

The result of this analysis is a weighted surface of the extent and stated importance of the fishing grounds for each fishery.

In September and October of 2005, we went back to ports in the southern and northern parts of the study region. There we met with groups of representatives of the fisheries studied, which included participants in the project as well as other knowledgeable and longtime fishermen designated by members of the Regional Stakeholder Group. We reviewed paper maps of the aggregated fishing grounds for each fishery in these groups, as well as the digital files for any participant who wanted to review and/or make changes to his or her information. Several revisions resulted from these meetings, and the final versions of the fishing grounds were used in the subsequent analysis, which we describe in the following two sections.

IV. Results and deliverables

There are two data products and one analytical product, all of which we forwarded to the MLPAI, resulting from this research to date.

The data products were conveyed to the MLPAI's geodatabase housed at UC Santa Barbara. The first was a shapefile of all fishing grounds information summarized to the 1-minute microblocks used by CDFG. This was intended for use by staff and/or stakeholders in designing marine protected area arrays, and the microblocks were chosen as a convenient spatial unit that maintains consistency with the spatial resolution of the other data layers contained in the geodatabase. Examples of how this information could be analyzed are elaborated in the next section.

The other data product was the detailed raster data of all fisheries examined at the 100m cell size, and which served as the basis for the impact analysis further described below. Both datasets were accompanied by metadata conforming to the Federal Geographic Data Committee (FGDC) standards (**http://www.fgdc.gov/standards**).

During the fall and winter 2005/2006, Ecotrust staff conducted a series of analyses of the first-order maximum potential impacts of MPA packages under consideration. The goal was to assess the relative maximum potential impacts of packages, both in terms of the area of the fishing grounds affected and the stated importance of those areas. Since our research showed that not all areas are equal, and some are more important to fisheries than others, the effects typically vary: even a small closure can have a large impact, expressed in units of stated importance. The summary of these analyses was forwarded to Blue Ribbon Task Force in March 2006, and is included in Appendix 4.

Ecotrust is committed to keeping as much information about our methods and tools used in the public domain as possible, and will make available the specific Arc Macro Language (AML) code used for interpreting and analyzing the data to researchers interested in replicating this research.

As we will discuss further in the next section, these products do not cover all that can be done with the fishing grounds information.

V. Discussion and Conclusion

There are several methodological and process lessons that are worth reflecting on, in the hope of informing future iterations or applications of this approach. We also describe some opportunities for further analysis.

V.1 Timing

Conducting detailed, fieldwork based, participatory research concurrently with a sometimes contentious policy process, is ambitious—especially when the work period coincides with the summer fishing season. Ideally, detailed information about the fishing grounds and their relative importance would be available to decision-makers prior to the beginning of a policy process. In the case of this project, the timing between the field, verification, and data compilation stages of this work and the information needs of the MLPAI's Central Coast Project process never fully aligned. For example, the data—although it was integrated into the geodatabase used in the process and could have been rendered in formats that maintained confidentiality—was not made available to stakeholders to inform the design of MPA alternatives directly, contributing to the palpable frustration of some stakeholders that they did not have desirable information at their fingertips. Similarly, time constraints and the timing of the project made expanding the sample to achieve a greater proportion of the local fleet difficult. In the future, timing can be improved considerably by making explicit arrangements to either conduct research prior to the policy process and at times more convenient for participants.

V.2 Scale

One issue of key importance in the endeavor to map the fishing grounds is that of scale. Given the paucity of data about the footprint and spatial behavior of the various fishing fleets operating in California, there was no logical choice of what scale to use for this project. We deliberately chose not to restrict respondents to a particular chart of map scale, but rather opted to let them draw the fishing grounds and the various subareas of greater importance at whatever level of detail made most sense to them. Not surprisingly, most respondents opted to draw their grounds at the scale of familiar nautical charts. Some drew large shapes indicating the relatively equal importance of large areas of the ocean, for example in the salmon fishery, while others made highly site specific and localized distinctions between the grounds and their relative importance, for example in fisheries like that for spot prawns. Based on the 108 interviews, we are now in a position to analyze the distribution of these natural shapes, allowing an inference about a best scale to use in subsequent work. This will be particularly helpful for aligning the spatial scale of research efforts such as this with the spatial scale at which policy measures, in this case MPAs, are designed. Given the concurrent nature of this work with the Central Coast Project, it was not possible to align the spatial scales, creating the perception—at least among some stakeholders—that the fishing ground information is not informative at the scale of the eventual MPA alternatives whose boundaries sometimes differ by mere feet.

Another caveat to our analysis is entailed by the geographic extent of the project. The fishing grounds used by the fleet extend farther north, south, and west than the study region. Several respondents noted that, for example, the area between Point Arguello and Point Conception is important for many fisheries, including the Southern Fleet. Effectively, because of the delineation of our study region in congruence with the MLPAI's Central Coast Project, areas on the northern and southern boundary could not be completely analyzed. Some care would need to be taken to integrate data and analytical results from this project with subsequent characterizations of fishing grounds to the north and south.

V.3 Quality assurance and quality control

This project contains valuable lessons for improving quality assurance and control mechanisms. Two of the most important ones center on questions of confidentiality and verifying the information collected.

Confidentiality

The protocol we developed for this project conforms to human subject standards used at the University of California and elsewhere in academic research. Given the sensitive nature of fishing ground maps and the economic information they contain, at least implicitly, we took additional measures to mask individual informants, and gave the fleet control over what, if any, information they wanted to display publicly, in the Central Coast Project stakeholder meetings.

An incident involving a well-intentioned field staff is illustrative of the special nature of this information and the extra care required in working with it: wanting to illustrate the mapping protocol, she showed the anonymized shapes of a previous respondent (A) to a second respondent (B). Even though no identifying information was shared, respondent B thought he recognized the fishing grounds, and called A, who promptly called Ecotrust staff demanding an explanation. We were able to reassure A, and he opted to continue his participation in the project. Since it is not generally the case that fishermen can recognize each other's grounds, we had not foreseen this possibility, and used this incident to sharpen our protocols for field staff. Specifically, they were instructed to never use actual shapes for demonstration purposes.

Data verification

The main mechanism for verifying the data collected were individual and group meetings with respondents and others in each fleet, conducted in both Monterey and Morro Bay towards the end of the field period. This provided sometimes very detailed verification and sign-off on the extent and relative importance of the fishing grounds for each fishery. Internally, at Ecotrust, we employ several QA/QC protocols that are designed to catch inconsistencies and other problems with the data. For example, we run an automated check to make sure each respondent's shapes and weights add up to the 100 pennies. These protocols notwithstanding, there are several ideas for process improvements coming out of this project.

There was one instance of the wrong file being used for the impact analysis, a circumstance we only discovered after the fact. This involved a respondent who had previously participated in another project, and who edited his previous shapefile for this project. We inadvertently used the file containing the edits—essentially a small number of shapes representing both additions and subtractions—rather than the previous file. We offered, and he accepted, to remove his shapes from the analysis. While this was an isolated case, in conversation with this participant, we conceptualized a mechanism for giving each respondent remote access to his or her shapefiles either through an on-line interface or by email, allowing for individual verification of data even in short timeframes. We will implement this mechanism in subsequent iterations or applications of this approach.

V.4 Improving the sample

While our approach of constructing a proportionate quota sample based on the CDFG landing statistics provided a satisfactory representation of central coast fisheries, there remain formidable challenges in ensuring all sectors are adequately represented. This is illustrated by the difficulties we had in engaging what is frequently referred to as "the Vietnamese fleet" in this project. Every mode of contacting this subset, which constituted 12% of our sample population and represents considerable fishing expertise and success on the central coast, failed. We tried several modes:

- We had the project description and consent form translated in Vietnam, by people working on coastal management issues (see Appendix 3);
- A native speaker on contract contacted all fishermen in the sample by phone, with very limited success. Typically phone calls, if answered at all, would go unreturned, or messages left with family members were apparently disregarded;
- We worked with a fish buyer who has business relations with a large segment of the fleet, explained the purpose of the project, and asked him to relay this information to the fishermen he buys from; we also posted the project information on his dock, and attempted to talk to fishermen at the receiving dock, to no avail;
- Made contact with the president of the Vietnamese Buddhist Association in Monterey, explained the importance of project and the need to represent the Vietnamese fleet; left Vietnamese documents with her to post at temple and to send to fishermen, garnering very little response: the one fisherman whose number she provided in the hopes that he would make referrals to additional fishermen did not respond to repeated calls; her overall assessment was that they would not participate, partially due to the time period, and because it would require a long time to persuade them to participate; and
- An employee of the Monterey Bay Aquarium contacted several fishermen he knows in the community but they did not want to participate.

The experience with the Vietnamese fleet in this project illustrates the need for a concerted effort to reach out to various language and cultural groups that participate in California fisheries, to ensure their effective participation—whether in research projects such as this or in policy processes such as the MLPAI.

V.6 Further analysis

To date, the information provided by the fishermen participating in this project was used to estimate the first order maximum potential impacts of a suite of MPA alternatives. The focus on averages in that analysis masks the sometimes considerable effects on individual fleets or fishermen. While the policy process can use these estimates and other information for coming to a decision on which alternative to implement, we would like to conclude this report with a discussion of the kinds of additional questions that can be answered with the data collected in this project. When linked with CDFG landing statistics, for example, it is possible to identify particular fishermen who would be affected in a particular area, yielding insights into any disproportionate effects on particular people or fleets.

The following two figures contain examples of additional analyses that would likely be of interest to decision-makers and stakeholders involved in the MLPA process. Figure 1 shows the number of fisheries present in any one ocean area, summarized to the microblock level. The darker the color, the greater is the number of fisheries that take place in a block. Not surprisingly, nearshore waters are utilized by more fisheries, but there is some variegation. This is not to suggest that all areas are equally important to all fisheries that take place there. Rather, this sort of analysis provides a count of the number of fisheries likely to be affected by a management measure, and can be combined with counts of other user groups. Again, this information can be summarized at smaller spatial scales, too, essentially allowing a user of the database to determine how many fisheries occur in any one area under consideration.

Figure 2 summarizes some of the information about the relative importance of different ocean areas. So as not to compromise confidentiality regarding the "hot spots" of any particular fishery, we show here all the areas that scored in the top 20% of importance for a fishery, again summarized to the microblock level. The darker the color, the more fisheries a particular block is most important to. A large part of the study region is most important to at least 1-2 fisheries, but there are clearly some areas that are very important to several fisheries studied. It stands to reason that stakeholders would want to examine those areas with extra care.

There are many more analyses possible using the data collected in this project. The 108 interviews with fishermen yielded a very rich and deep data set about the fishing grounds, which we hope will continue to inform the MLPA process as it unfolds in the Central Coast Project region and beyond.

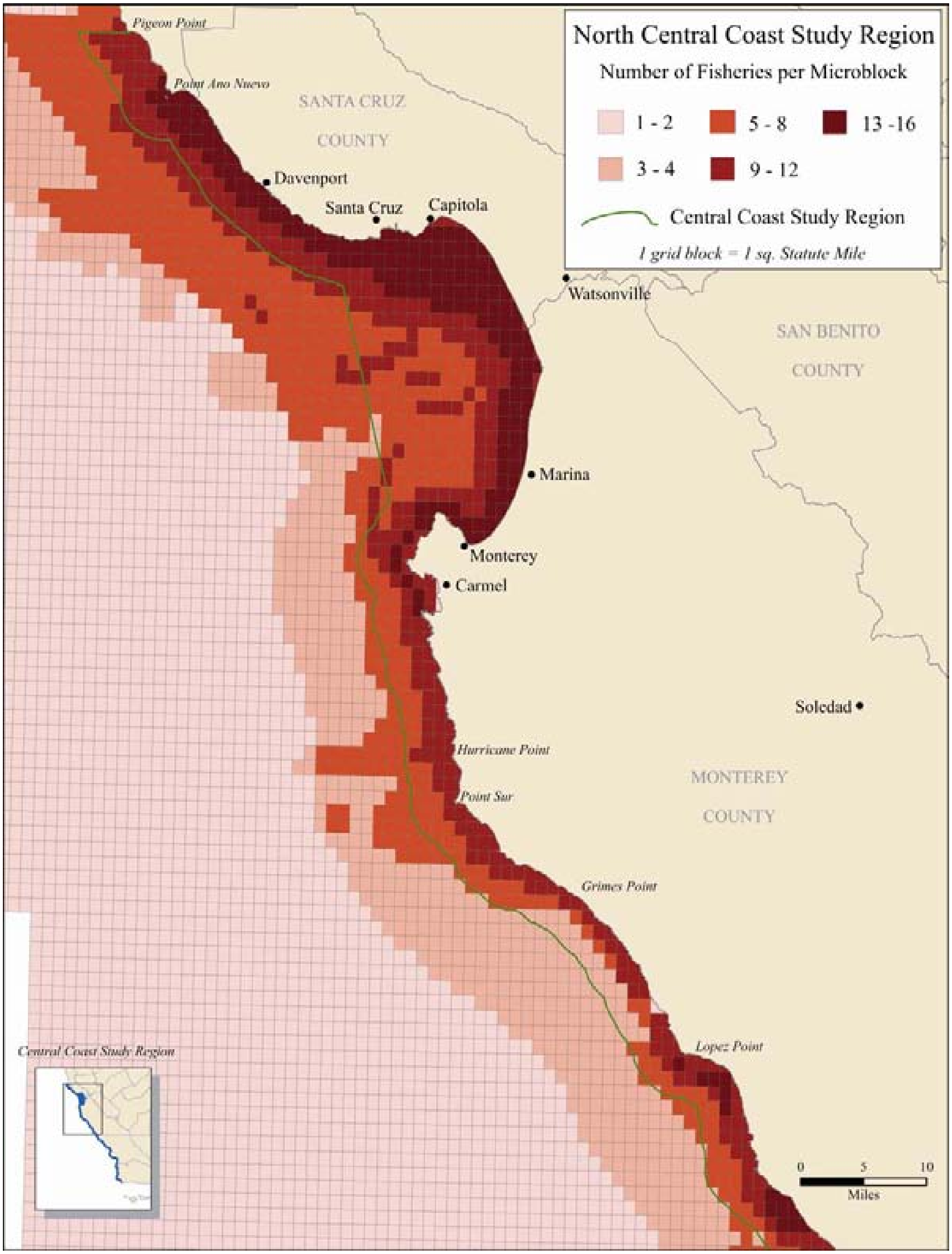

Figure 1a Number of fisheries per unit area (microblocks) in the Northern part of the study region

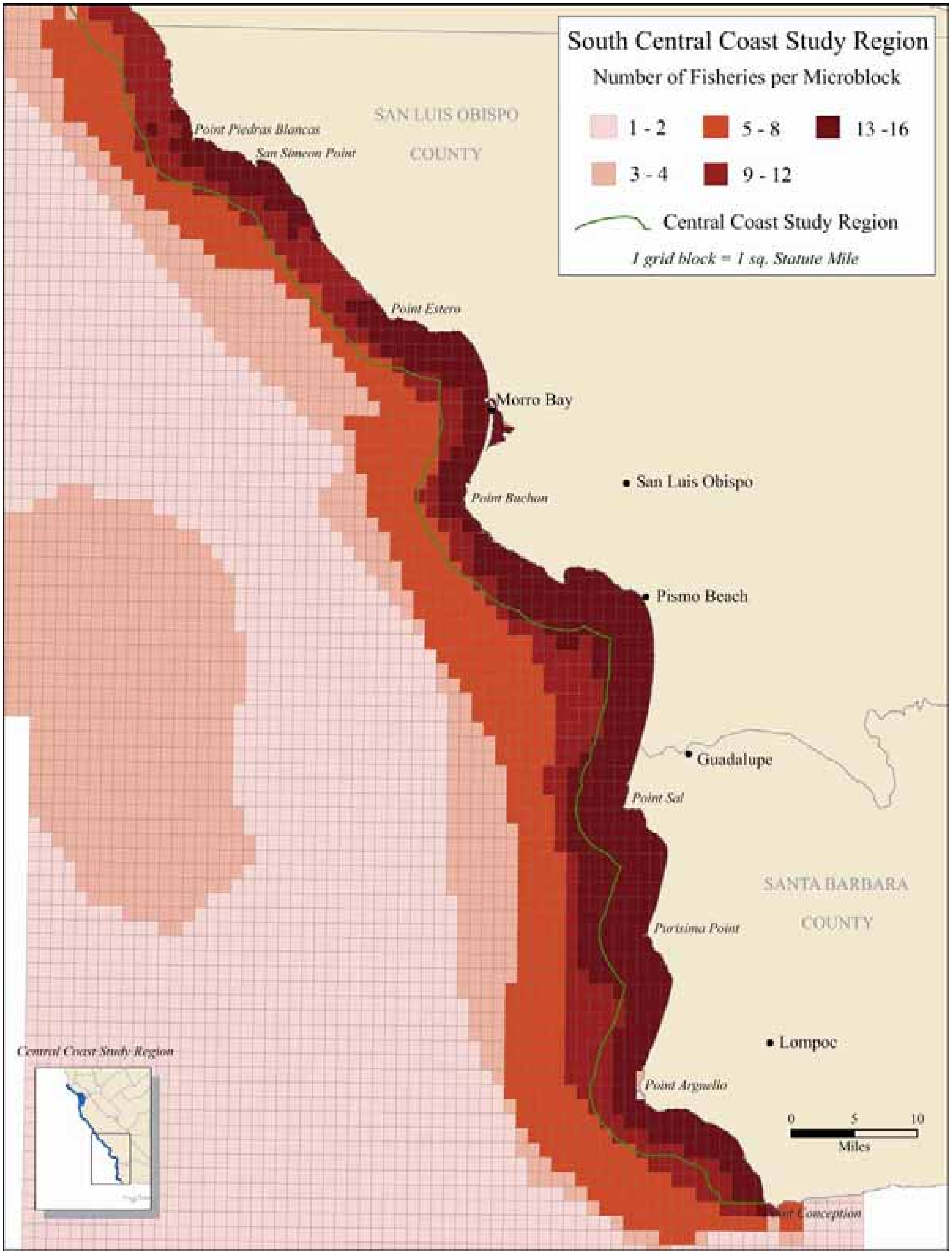

Figure 1b Number of fisheries per unit area (microblocks) in the Southern part of the study region

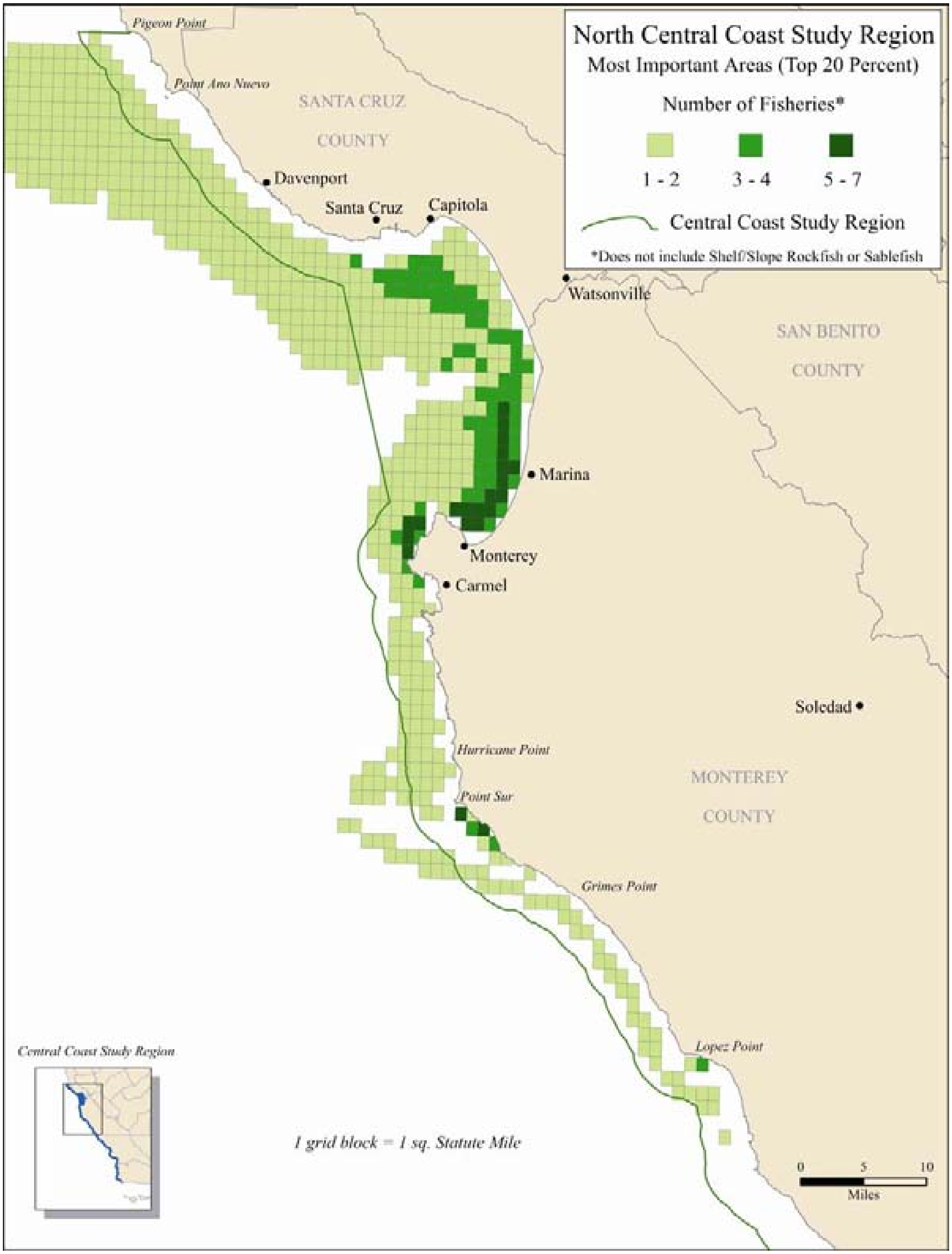

Figure 2a Most important areas (top 20% of stated importance) by number of fisheries in the Northern part of the study region

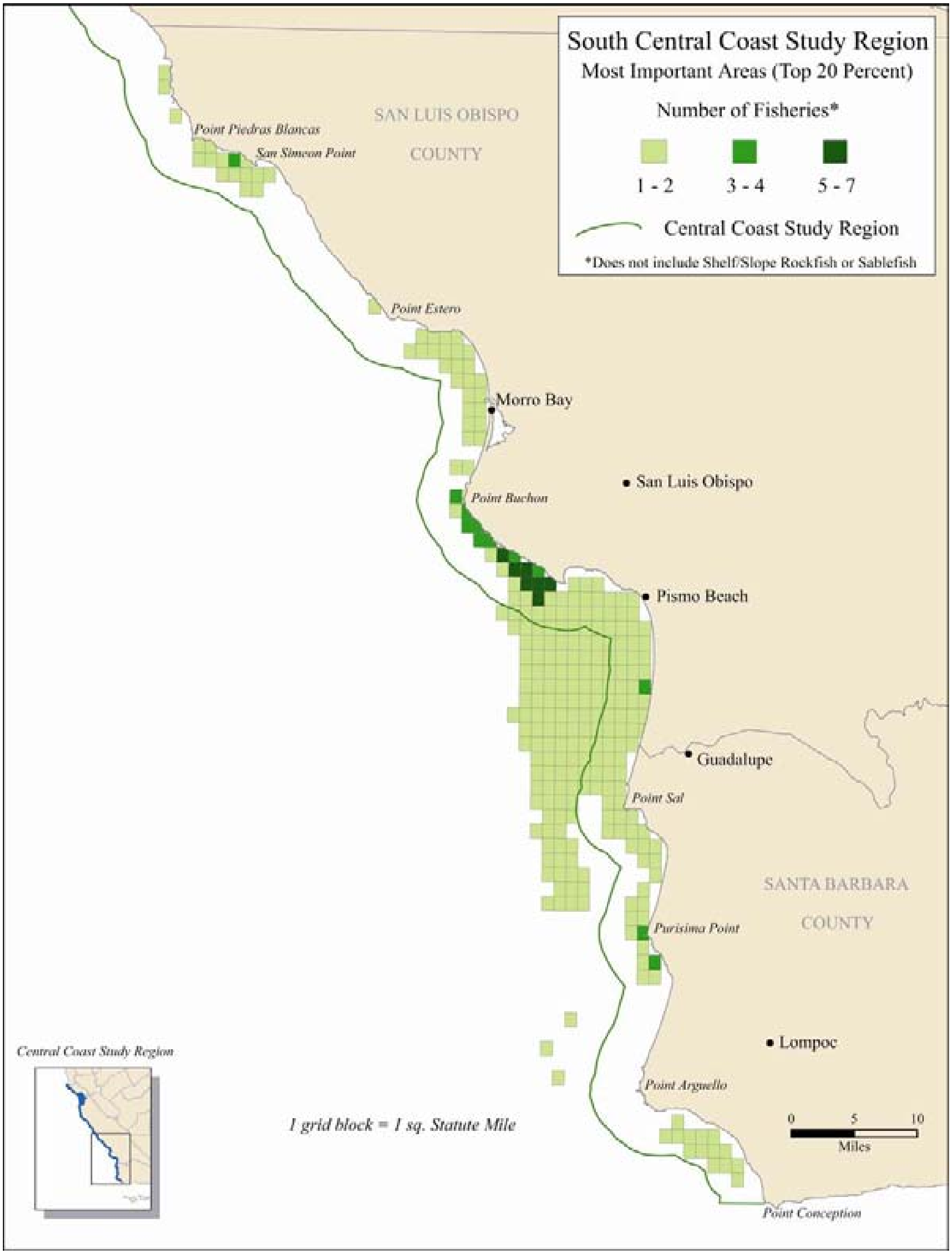

Figure 2b Most important areas (top 20% of stated importance) by number of fisheries in the Southern part of the study region

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VII. Appendices

1. Scope of work
2. English language consent form
3. Vietnamese language consent form
4. Final Executive Summary of impact analyses conducted, forwarded to the Blue Ribbon Task Force in March 2006, as an example of analyses of proposed packages of MPAs in the Central Coast.

EXHIBIT A

SCOPE OF WORK

ACCORDING TO THE SEPARATE MEMORANDUM OF UNDERSTANDING (“MOU”) BETWEEN THE RESOURCES AGENCY (“AGENCY”), THE DEPARTMENT OF FISH AND GAME (“DEPARTMENT”) AND RESOURCES LEGACY FUND FOUNDATION (“RLFF”), RLFF HAS AGREED TO FUND PROFESSIONAL SERVICES FOR FISHERY DATA COLLECTION AND ANALYSIS FOR THE MARINE LIFE PROTECTION ACT (MLPA) INITIATIVE, A PUBLIC-PRIVATE PARTNERSHIP BETWEEN THE AGENCY, THE DEPARTMENT, AND RLFF.

<u>Professional Services and Deliverables</u>

- Identify and collect data using OceanMap through local and knowledge interviews
    - Consult with MLPA science team and Monterey Bay National Marine Sanctuary staff to identify fisheries to assess in the central coast region
    - Define sample population within each fishery and use California Department of Fish and Game data to target fishermen to represent each fleet
    - Set up interviews with fishermen
    - Deploy three teams into the field to collect data

- Analyze data collected through local knowledge interviews using existing socioeconomic information (landing receipts and logbooks, etc.); design a shared database structure that will house this data and other pertinent data sets
    - Develop an automated approach for incorporating new data gathered through OceanMap
    - Provide analysis of data generated from interviews with other socioeconomic information derived from landing receipts and logbooks
    - Develop documentation and quality assurance protocols for analyzing data with existing confidential datasets (landing receipts and logbooks)
    - Design a shared database (clearinghouse) to consolidate data with the upload and download capability to capture local knowledge. Database to be housed on the servers at the University of California at Santa Barbara
    - Identify, integrate and document additional data layers with input from MLPA Science Advisory Team GIS subcommittee and Resources Agency GIS departments

- Copies of the final drafts of deliverables, delivered to RLFF and the Central Coast MLPA Program Manager, with the final invoice at the end of the Professional Services Period, or, if there are no deliverables, a summary of services provided.

<u>Expenses</u>

The total amount for all reimbursable expenses is not to exceed the amount specified in paragraph 4 of the Agreement.

Reimbursable expenses include reasonable costs for travel from contractor's principal place of business, meals and incidentals, lodging, printing/copying (if required), and other reasonable costs with appropriate documentation.

Key Staff

- **Michael Mertens**
- **Sarah Klain**
- **Aaron Racicot**
- **Charles Steinback**

Point of Contact

Contractor will work at the direction of the MLPA Initiative Central Coast MLPA Manager for matters pertaining to services and work products. For matters pertaining to compensation and reimbursement associated with this contract, Contractor will report to California Coastal and Marine Initiative (CCMI) Program Analyst Robin Jenkins at (916) 442-4880 or rjenkins@resourceslawgroup.com.

ecotrust

The Marine Life Protection Act (MLPA) is a state law directing the California Department of Fish and Game (CDFG) to design and manage an improved network of marine protected areas off California's coast. To implement this law, a public-private partnership has been formed between the California Resources Agency, CDFG, and Resources Legacy Fund Foundation—the MLPA Initiative. As part of this effort, Ecotrust has been retained to collect, compile and analyze socioeconomic information pertaining to commercial fisheries on the central coast. The project is designed to provide spatially explicit socioeconomic information for both the MLPA Initiative and the Monterey Bay National Marine Sanctuary (MBNMS).

The goal of the Fisheries Uses and Values Project is to compile a comprehensive picture of the commercial fishing use patterns along the central California coast, using the expert knowledge of fishermen themselves. The purpose of this project is threefold:

1. Incorporate commercial fishermen's knowledge into the deliberations of the Regional Stakeholder Group in the MLPA Central Coast Study Region and of the MBNMS Marine Protected Areas Working Group;
2. Use this information to improve on the spatial resolution and accuracy of CDFG landings and logbook data; and
3. Develop accurate maps of the local fishing grounds and their economic importance to the local fleets.

This kind of spatially explicit information on commercial fisheries and their value can ensure representation of socioeconomic values in the design, implementation and management of marine protected areas.

During the summer months of 2005 (June through August) Ecotrust personnel will interview approximately 100 fishermen along the central coast. Fishermen will be selected based on CDFG data and recommendations by the Regional Stakeholder Group. The sample is designed to capture the majority of landings in 10-12 of the most significant regional fisheries, as well as the depth of expertise of longtime and successful fishermen.

Results from this project will be made available to CDFG and MBNMS for use in the context of the MLPA Initiative and the discussion, implementation, and management of marine protected areas in state and federal waters off California—specifically the Central Coast Regional Stakeholder Group and the Sanctuary's MPA Working Group.

Ecotrust personnel will contact fishermen directly, and arrange for interviews with contracted staff based in Santa Cruz, Monterey, Morro Bay and Santa Barbara. The format includes one-on-one or small group interviews, with follow-up meetings by fishery and/or gear group. Due to the sensitive nature of commercial fishing information, only Ecotrust staff (operating under a strict confidentiality protocol) will handle the raw data generated during the interviews. All information collected in the interviews is anonymous and confidential on the individual level. All analyses and results will be presented in aggregate form, and will be reviewed in aggregate form by participating fishermen from each fishery. The information will be used to create a comprehensive picture of the commercial fishing use patterns and values along California's central coast, and may also be written up in a peer-reviewed journal. As a participant, you agree to let your information be used in this manner.

Your willingness to participate is appreciated. If you have any questions or concerns, please contact Ecotrust at 1-866-872-1333, or fish@ecotrust.org, or Paul Reilly of CDFG at 831.649.2879, preilly@dfg.ca.gov

If you agree to participate under the conditions described above, please print and sign your name.

Participant's name ________________________ Signature ______________________________

Field Staff signature _____________________________ Date ______________

Appendix 2 – English language consent form ecotrust

Luật bảo vệ Tài nguyên biển (MLPA) là luật của bang liên quan trực tiếp đến cơ quan nghề cá và vui chơi giải trí của bang California (CDFG) được soạn thảo ra để quản lý và hoàn thiện hệ thống quản lý các khu bảo tồn ở khu vực biển của California. Để thực hiện được luật này, một sự hợp tác giữa cá nhân và cộng đồng đã được hình thành giữa California Recourse Agency; CDFG và Resource Legacy Fund Foundation với MLPA Initiative. Một phần của nỗ lực này, Ecotrust đã được thuê để thu thập, tập trung và phân tích những thông tin kinh tế xã hội đi đôi với thông tin nghề cá thương mại ở vùng bờ chủ yếu. Dự án đưa ra không gian rõ ràng thông tin KTXH cho cả MLPA Initiative và Khu bảo tồn biển (KBTB) Monterey Bay National Marine Sanctuary (NBNMS).

Mục tiêu của Dự án Sử dụng và Giá trị Thuỷ sản là để hoàn thiện một bức tranh toàn diện về việc nghề cá thương mại điển hình ở vùng đánh bắt chủ yếu của biển California, qua việc sử dụng những kiến thức của các chuyên gia và những ngư dân. Muc đích của dự án tập trung vào 3 điểm sau:

1. Kết hợp chặt chẽ hiểu biết của ngư dân nghề cá thương mại vào những cân nhắc, suy tính của Nhóm các bên liên quan trong khu vực của MLPA khu vực vùng bờ nghiên cứu chủ yếu (central coast study region) và MBNMS nhóm làm việc của KBTB.
2. Sử dụng những thông tin này để hoàn thiện về nghị quyết không gian (on the spatial resolution) và sự chính xác của khu vực CDFG (CDFG landings) và thông tin số liệu của nhật ký hàng hải; và
3. Xây dựng bản đồ phù hợp của những ngư trường và những ngư cụ đánh cá kinh tế quan trọng của địa phương

Loại thông tin không gian rõ ràng này về đánh cá thương mại và những giá trị của nó có thể đảm bảo sự có mặt của những giá trị KTXH, việc thực hiện và quản lý KBTB.

Trong mùa hè 2005 (tháng 6 đến tháng 8) nhân viên của Ecotrust sẽ phỏng vấn khoảng 100 ngư dân ở khu vực dựa vào dữ liệu CDFG và được giới thiệu đến nhóm các bên liên quan khu vực. Phỏng vấn dựa vào việc đánh giá đồng cấp (peer reviewed), dựa vào phương pháp khoa học xã hội để thu thập các hiểu biết của dân địa phương. Mẫu được thiết kế để thu được thông tin của 10-12 cảng cá chính của những vùng có nghề cá quan trọng, cũng như chuyên môn sâu trong của ngư dân thành công và trong thời gian dài.

Nhân viên của Ecotrust sẽ liên lạc trực tiếp với các ngư dân, và sắp xếp các cuộc phỏng vấn với các nhân viên tại Santa Crus, Monteray; Morro Bay và Santa Barbara. Form phỏng vấn bao gồm cho từng người một hoặc cho một nhóm phỏng vấn. Cùng với các cuộc họp tiếp theo về nghề cá và nhóm ngư cụ mà những thông tin thu thập được sẽ được công nhận (phê chuẩn) bởi ngư dân. Do sự nhậy cảm của các thông tin nghề cá thương mại, chỉ nhân viên Ecotrust (được hoạt động dưới một điều lệ nghiêm ngặt) sẽ sử dụng những số liệu phỏng vấn này. Tất cả các thông tin thu thập được trong quá trình phỏng vấn giấu tên và bí mật ở mức độ cá nhân. Tất cả các phân tích và kết quả sẽ được xem xét đánh giá bởi những ngư dân tham gia. Thông tin sẽ được sử dụng để thể hiện một bức tranh toàn diện về hình mẫu và giá trị nghề cá thương mại của California Central coast, và cũng có thể được đăng vào những Tạp chí đánh giá đồng cấp (peer reviewed). Như một người tham gia, bạn đồng ý để thông tin của bạn được sử dụng cho mục đích này.

Sự sẵn lòng trả lời các câu hỏi của bạn thật quý giá, Nếu bạn muốn biết thêm thông tin hoặc có câu hỏi gì hãy liên lạc với chúng tôi theo số: 1-866-872-1333; fish@ecotrust.org; hoặc Paul Reilly of CDFG at 831.649.2879 (preilly@dfg.ca.gov)

Nếu bạn đồng ý tham gia v ới điều kiện nêu trên, hãy ghi danh và ký tên dưới đây.

Tên người tham gia________________________________ K ý t ên

Chữ ký của nhân viên thực địa ___________________ Ngày

Appendix 3 – Vietnamese language consent form

Summary of potential impacts of the February '06 MPA packages on commercial and recreational fisheries in the Central Coast Study Region

Final version, revised 8 March 2006

Astrid Scholz, ajscholz@ecotrust.org, Charles Steinback, and Mike Mertens

Introduction

The following data sets were used in the analysis of relative effects of the MPA packages on commercial and recreational fisheries that are conducted in the waters in the Central Coast Study Region:

- For the commercial fishery, we used data layers characterizing the spatial extent and relative stated importance of fishing grounds of 19 commercial fisheries in the Central Coast Study Area (SA) previously transmitted by Ecotrust to the Marine Life Protection Act Initiative (MLPAI) under the terms of contract agreement No. 2005-0067.[2] This information was collected during interviews in the summer of 2005, using a stratified, representative sample of 100+ fishermen whose individual responses about 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;

- For the recreational fishery, we used recreational private and rental boat fishing effort data from the California Recreational Fisheries Survey (CRFS) 2004 and made available to Ecotrust by the California Department of Fish and Game (CDFG). This information consists of observed number of angler trips per mircoblock, and is grouped for trips for particular species. Of those, we analyzed the trips for rockfish and salmon in order to characterize two of the most important recreational fisheries in the study area. Similar survey data for Commercial Passenger Fishing Vessels (CPFV) were not available in time for this analysis.

Overview of fisheries considered in the analysis

The commercial fisheries considered in this analysis are of varying importance in terms of ex vessel revenues. Table 1 below lists the species or groups considered and their share of Central Coast Study Region commercial fishing revenues, using the 6-year average of nominal ex vessel revenues between 1999 and 2004. In most cases, the same fisheries account for substantially different proportions of statewide landings. For example, Dungeness crab accounts for only 1.66% of CCRS landings (by ex vessel revenue), but 17.33% of state totals.

Interestingly, private and rental boat fishing for both rockfish and salmon account for double the percentage of all trips in the Central Coast Study Region (22% and 50%, respectively) than trips for the same species statewide (10% and 23%). Corresponding data for the charter boat fleet were not available at the time of this analysis. In general, however, CPFV trips consist of several times the number of anglers as private and rental boat trips.

[2] Scholz et al., forthcoming, "Commercial fishing grounds and their relative importance off the Central Coast of California", Final report on contract No. 2005-0067.

Table 1 – Summary of fisheries considered in the analysis

Commercial			Recreational		
Species or group	*% of CCSR fisheries revenues, 6-year average (1999-2004)*	*% of CA statewide fisheries revenues,6-year average (1999-2004)*	*Species or group*	*% of CCSR observed private and rental boat recreational angler trips [No. of total trips: 84,000]*	*% of CA statewide [No. of total trips: 663,000]*
Anchovy	2.17%	0.65%	n/a	n/a	n/a
Cabezon	2.73%	0.59%	n/a	n/a	n/a
Dungeness crab	1.66%	17.33%	n/a	n/a	n/a
Halibut	1.95%	2.24%	n/a	n/a	n/a
Kelp Greenling	0.25%	0.08%	n/a	n/a	n/a
Lingcod	0.33%	0.17%	n/a	n/a	n/a
Mackerel	0.13%	1.10%	n/a	n/a	n/a
Deep Nearshore Rockfish	4.83%	1.24%	Rockfish	22%	10%
Rockfish Nearshore					
Rockfish Shelf	0.87%	0.72%			
Rockfish Slope	1.63%	0.48%			
Rock Crab	0.78%	1.03%	n/a	n/a	n/a
Salmon	12.57%	8.08%	Salmon	50%	23%
Sardine	7.19%	3.95%	n/a	n/a	n/a
Sablefish	5.53%	3.40%	n/a	n/a	n/a
White Seabass	0.47%	0.47%	n/a	n/a	n/a
Surfperch	0.20%	0.09%	n/a	n/a	n/a
Spot Prawn	7.38%	2.25%	n/a	n/a	n/a
Squid	24.49%	18.81%	n/a	n/a	n/a

Approach

The five MPA network proposals under review (Packages 1, 2, 3, AC and S) vary according to their spatial extent and the commercial and recreational fishing uses they affect. Specifically, they vary by the number and types of fisheries permitted within the boundaries of particular MPAs within a network. Furthermore, study area (SA) 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 CCSR, and we report the effects both in terms of total fishing grounds (G) and those that fall within the study area. Since any one MPA may have different effects on different uses, and different uses may be affected differently by all MPAs, it is therefore necessary to consider single MPAs and single fishery uses independently. Note that Package 0, the “no action” alternative of existing MPAs, has no differential effect on fisheries and was therefore not evaluated. Similarly, since current fishery closures such as the Rockfish Closure Area affect all proposals equally, they have no differential effect.

We conducted an overlay of each MPA with each potential use. MPAs were grouped according to level of protection, using the same levels of protection as elsewhere in the Science Advisory Team (SAT) evaluations and as described in the January 10th draft of the "Rationale for SAT categorization of MPAs by relative levels of protection" (ProtectionLevels_draft_10Jan06.doc), but uses were considered individually. In other words, for each MPA and protection level within each package, we assessed the fishery uses that would be affected.

We quantified the first order maximum effects of proposed MPAs on both commercial and recreational fishing, analyzing the percent of total fishing grounds for any one fishery included in a given MPA. This is a first-order, "worst case" analysis that is silent on the eventual behavioral response. In other words, the analysis assumed that all fishing in an area affected by an MPA would be lost completely, when in reality it is more likely that effort would shift to areas outside the MPA. There are, however, currently no data available to support an analysis of such an adaptive response.

We compiled results in a series of spreadsheets transmitted to the MPLAI and Science Advisory Team, summarizing the effects of the various MPA packages on commercial and recreational fisheries both in terms of the area affected and the relative value lost. For the purposes of this analysis, "value" was measured not in terms of Dollars, but using two proxies: 1) an index of relative, stated importance derived from interviews with fishermen in the case of the commercial fisheries, and 2) number of observed private and rental boat trips to a microblock in the case of the recreational fisheries.

For this first order evaluation, we assumed that all fishing in an area intersected by MPAs and fishing grounds would be affected. Where an MPA straddled a reporting block in the recreational data, we apportioned the number of trips associated with that block proportional to the area overlap. In the case of the commercial fisheries, data are at a sufficient spatial resolution to allow for direct summation. It is important to note that the analysis specifically does not constitute an economic impact analysis, nor account for behavioral responses such as shifts in fishing effort to other areas.

The percent of area and value affected was calculated based on the grounds identified within the Central Coast region, not for the whole state

Assessing MPA packages

The percent change in area and value for each of the commercial fisheries were determined by the intersection of each MPA package and the fishing grounds specific to that use. Each MPA within a package was classified by whether it would affect the fishery or not. If a fishery was affected by an 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 percent of the area and value affected for both the total fishing grounds and the grounds inside the study area was then summarized for all MPAs that affected each fishery per package. Packages vary considerably in their effects, both between and across fisheries, as the following table illustrates for commercial fisheries. Packages 1, 2 and 3 are based on the proponents' February 9th revisions. No revisions were made to the December 15th version of Package AC, and Package S is based on the draft of February 22, 2006.

Table 2 – Summary of effects on commercial fisheries

	Package 1	Package 2	Package 3	Package AC	Package S
Area of total fishing grounds affected					
Anchovy	4.39%	7.98%	6.01%	10.62%	4.35%
Cabezon	13.27%	16.96%	14.95%	24.31%	15.82%
Dungeness crab	3.38%	7.09%	6.75%	11.77%	7.06%
Deep Nearshore Rockfish	13.02%	16.54%	14.97%	23.86%	16.46%
Halibut	9.08%	10.09%	9.50%	18.04%	9.99%
Kelp Greenling	12.33%	17.74%	16.16%	23.82%	17.43%
Lingcod	12.61%	18.44%	16.31%	23.45%	17.40%
Mackerel	6.66%	12.30%	9.41%	16.64%	6.96%
Rockfish Nearshore	11.92%	15.39%	13.70%	23.72%	14.38%
Rockfish Shelf	5.18%	13.21%	16.13%	29.16%	11.53%
Rockfish Slope	0.64%	1.10%	0.97%	6.96%	0.96%
Rock Crab	4.79%	6.63%	6.10%	9.57%	6.23%
Salmon	0.44%	1.05%	0.91%	1.47%	0.80%
Sardine	4.38%	7.91%	5.16%	10.55%	4.30%
Sablefish	0.86%	2.26%	2.26%	2.94%	2.30%
White seabass	9.47%	7.84%	8.36%	16.56%	8.50%
Surfperch	8.07%	16.77%	22.78%	15.18%	15.65%
Spot Prawn	0.87%	2.50%	2.88%	3.70%	2.88%
Squid	6.82%	10.89%	9.76%	15.65%	9.92%
Area of fishing grounds within the study area affected					
Anchovy	10.14%	18.40%	13.88%	24.55%	9.99%
Cabezon	15.11%	19.31%	17.05%	27.73%	18.05%
Dungeness crab	6.96%	14.57%	13.87%	24.18%	14.51%
Deep Nearshore Rockfish	14.39%	18.26%	16.54%	26.39%	18.20%
Halibut	11.07%	12.30%	11.59%	21.98%	12.18%
Kelp Greenling	12.74%	18.35%	16.73%	24.61%	18.03%
Lingcod	13.32%	19.53%	17.25%	24.85%	18.38%
Mackerel	9.49%	17.58%	13.44%	23.82%	9.97%
Rockfish Nearshore	13.73%	17.70%	15.73%	27.23%	16.55%
Rockfish Shelf	5.67%	14.48%	17.68%	31.97%	12.64%
Rockfish Slope	14.33%	24.76%	21.87%	32.49%	21.64%
Rock Crab	11.28%	15.59%	14.38%	22.49%	14.63%
Salmon	6.07%	13.82%	11.85%	19.26%	10.71%
Sardine	10.14%	18.40%	11.98%	24.55%	9.99%
Sablefish	8.05%	21.22%	21.22%	27.58%	21.61%
White seabass	11.56%	9.58%	10.22%	20.24%	10.36%
Surfperch	8.07%	16.79%	22.78%	15.18%	15.65%
Spot Prawn	6.49%	18.36%	21.17%	27.08%	21.12%
Squid	9.00%	14.37%	12.88%	20.64%	13.08%

	Package 1	Package 2	Package 3	Package AC	Package S
Value of total fishing grounds affected					
Anchovy	3.65%	6.97%	5.26%	10.46%	4.16%
Cabezon	14.42%	27.34%	21.85%	32.02%	24.58%
Dungeness crab	1.92%	5.50%	5.78%	12.33%	5.61%
Deep Nearshore Rockfish	15.78%	21.81%	17.54%	35.65%	20.59%
Halibut	5.92%	9.24%	9.66%	12.59%	8.24%
Kelp Greenling	12.95%	23.60%	18.44%	30.44%	21.36%
Lingcod	12.87%	25.15%	21.30%	33.44%	23.39%
Mackerel	4.52%	8.72%	6.83%	12.94%	5.99%
Rockfish Nearshore	13.82%	24.78%	20.83%	32.74%	23.24%
Rockfish Shelf	6.99%	11.86%	15.33%	26.30%	10.57%
Rockfish Slope	0.64%	1.10%	0.97%	6.96%	0.96%
Rock Crab	5.79%	6.42%	6.78%	10.99%	6.27%
Salmon	0.77%	2.31%	1.89%	3.57%	1.53%
Sardine	3.45%	7.30%	4.57%	10.60%	4.14%
Sablefish	0.90%	3.09%	3.09%	4.15%	3.14%
White seabass	8.21%	7.38%	7.92%	11.59%	7.15%
Surfperch	2.73%	5.06%	9.41%	5.94%	4.72%
Spot Prawn	1.97%	4.19%	5.30%	8.37%	5.22%
Squid	5.87%	9.49%	7.34%	17.77%	9.10%
Value of fishing grounds within the study area affected					
Anchovy	5.72%	10.89%	8.24%	16.35%	6.51%
Cabezon	14.64%	27.72%	22.15%	32.47%	24.95%
Dungeness crab	4.50%	12.83%	13.52%	28.79%	13.10%
Deep Nearshore Rockfish	16.49%	22.82%	18.39%	37.37%	21.55%
Halibut	6.44%	10.00%	10.49%	13.68%	8.96%
Kelp Greenling	13.12%	23.91%	18.66%	30.83%	21.64%
Lingcod	13.11%	25.58%	21.68%	34.02%	23.79%
Mackerel	5.36%	10.28%	8.09%	15.30%	7.10%
Rockfish Nearshore	14.30%	25.65%	21.56%	33.91%	24.07%
Rockfish Shelf	7.46%	12.67%	16.37%	28.07%	11.28%
Rockfish Slope	14.33%	24.76%	21.87%	32.49%	21.64%
Rock Crab	11.99%	13.29%	14.07%	22.69%	12.96%
Salmon	3.42%	10.30%	8.49%	15.85%	6.84%
Sardine	5.24%	11.08%	6.94%	16.07%	6.26%
Sablefish	6.83%	23.30%	23.30%	31.41%	23.71%
White seabass	9.11%	8.16%	8.78%	12.82%	7.93%
Surfperch	2.73%	5.06%	9.41%	5.94%	4.72%
Spot Prawn	7.28%	15.48%	19.53%	30.82%	19.26%
Squid	6.27%	10.13%	7.83%	18.91%	9.70%

For example, package 1 has lesser effects (both in area and value) on fisheries such as squid and spot prawn than on, say, Kelp greenling. Illustrating another set of effects, package 3 affects 10% of the total fishing grounds for halibut, but 12% when considering those that fall into the (nearer to shore) study area waters. In this case, the effects on fishing area and importance are almost identical, with 10% and 11% of stated importance affected, respectively. In addition, from Table 1, the halibut fishery constitutes a little under 2% of study area commercial fisheries. In some cases, for example, Deep nearshore rockfish, alternatives can have markedly different effects on area and relative “value”. For example, package AC affects 26% of the study area fishing grounds for Deep nearshore rockfish, but well over 1/3, 37%, of stated importance.

Table 3 summarizes the effects on recreational fisheries. The estimated effect on trip numbers is an upper boundary, since a trip may be counted twice in the data when it covered more than one microblock. Furthermore, the analysis assumes that all trips to a block would be lost.

Table 3 – Summary of effects on private and rental boat recreational fisheries

	Package 1	Package 2	Package 3	Package AC	Package S
Recreational Salmon Area affected statute miles^2	0.05	9.68	3.72	7.08	4.51
Maximum Number of Salmon Trips affected	4	79	69	39	30
Recreational Rockfish Area affected statute miles^2	17.58	43.52	49.26	49.26	37.88
Maximum Number of Rockfish Trips affected	269	487	479	479	351

Results in terms of the percent area of the fishing grounds affected to follow.

Summary of results from the analysis of fisheries effects

There are several patterns that emerge from the analysis of the four MPA packages:

- Compared to the previous versions, packages 1, 2, and 3 are converging in terms of economic impacts: Package 1 now has 41% greater economic impacts, while Packages 2 and 3 now have 13% and 4%, respectively, lesser impacts on commercial fisheries—both in terms of grounds and relative value (stated importance) in the study area;
- All packages affect the 19 commercial fisheries differently, with the smallest effects in terms of both value and area affected generally evidenced in Package 1;
- In the commercial fishery, for 16 out of the 19 species investigated, Package 1 has the least effects on area and Package AC the most, Packages S and 3 lie between Packages 1 and 2 in 12 of the 19 fisheries;
- There are some deviations from this pattern in terms of the relative value of the affected areas, i.e., larger areas affected do not always correspond to higher stated importance;
- In the commercial fishery, for 18 out of the 19 species investigated, Package 1 has the least effects on the relative value and Package AC the most, Packages S and 3 lie between 1 and 2 in 11 of the 19 fisheries;
- Package S, has the least impact on area for 2 of the fisheries, anchovy and white seabass, with comparable impacts to Package 1 for 8 of the fisheries, (anchovy, halibut, mackerel, salmon, sardine, white seabass, and squid);
- Package S, has less than 10% impact on the stated importance within the study area for 8 of the 19 commercial fisheries, compared to 12 for Package 1, 7 for Package 3, 2 for Package 2 (5 additional fisheries for Package 2 are between 10% - 11%), and 1 for Package AC.
- Packages have similar effects on the two recreational fisheries considered, with the package that affects the smallest area of grounds being the one that affects the least number of trips;
- Package 1, followed by Package S, affects the least amount of recreational fishing area and trips for both salmon and rockfish, with Package 2 having the largest effect on the recreational

fishing area and number of trips for salmon, while Packages AC and 3 have the largest effect on the recreational fishing area and number of trips for rockfish.