Discussion of Ecotrust Methodology in: "Commercial fishing grounds and their relative importance off the Central Coast of California"

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Report submitted to the California Marine Life Protection Initiative in Partial Fulfillment of Contract No. 2006-0014M

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"Commercial fishing grounds and their relative importance off the Central Coast of California" (Report to the California Marine Life Protection Act Initiative, Contract No. 2005-0067M, 20 April 2006)

This report summarizes and critiques the methods employed by Ecotrust in the above named report. The purpose of this summary and critique is to provide an outside review of the methods used by Ecotrust to collect use pattern data and to assess the usefulness of these methods for this and future studies of MPA site selection processes. Our report is divided into 5 sections. In the first section, we briefly discuss the purpose and objectives of the methods used by Ecotrust. This is followed by a more detailed summary of their methods. In the third section we discuss the "ideal" methodology that might be used if one were not time-, budget-, and data-constrained. The fourth section compares the Ecotrust methods with the ideal methodology, and the fifth section concludes with thoughts about future data gathering and analysis.

I. Purpose/Obejctives of Ecotrust Study

Ecotrust was retained in May 2005 to gather original data using fishermen interviews, to develop a flexible data base for compiling the data, and to provide analysis of the data. While the analysis that was to be provided is not specifically outlined in the Scope of Work, the survey cover page suggests that the main goal of the data collection effort was to provide a comprehensive picture of commercial fishing use patterns using fishermen knowledge. This comprehensive picture of use patterns was designed to: 1) incorporate fishermen's knowledge into MLPA deliberations; 2) use the new information to improve on existing CDFG spatial landings and logbook data; and 3) develop accurate maps of the local fishing grounds and their economic importance to local fleets.

Of particular importance to this review was the additional task to use the primary data collected to predict the potential impacts of various MPA packages on commercial and recreational fisheries in the Central Coast Study Region. Ecotrust's efforts to accomplish this task are contained in the report "Summary of potential impacts of the February '06 MPA packages on commercial and recreational fisheries in the Central Coast Study Region", dated March 8, 2006. We discuss this in some detail below.

II. Summary of Methods Used by Ecotrust

The Ecotrust study accomplishes a great deal under considerable time and budget constraints. It is important to recognize at the outset that the Ecotrust study is essentially trying to replace data that might have been available through a more comprehensive and more accurate landings ticket data program. After several years of extensive experience using existing PACFIN data derived from landings tickets, Ecotrust has concluded that the California entries are deficient for potential use in MLPA negotiations. In the first place, the landings ticket system over-aggregates spatially in that landings blocks contained in landings ticket data are too large to examine some of the small-scale MPA options. In addition, the veracity of the actual entries appears to be in question. A preliminary check shows that many of the landings block entries (apparently filled out by processors rather than fishermen) appear to contain distortions that compromise the potential usefulness for MLPA discussions.

The procedure used by Ecotrust involves: 1) identifying a non-random sample of fishermen to interview in face-to-face interviews; 2) conducting interviews using a visual- and map-based system for identifying fishing grounds; 3) compiling the data within an existing GIS data base program; sand 4) using the data assembled to make projections of maximum impacts.

III. The Ideal Impact Analysis Study

As discussed above, the Ecotrust study is essentially an attempt to provide a low-cost proxy for data that would have been collected in an ideally designed catch monitoring system. Most modern fisheries management employs some form of catch monitoring, and systems differ in detail and accuracy of data gathered. In the Bering Sea groundfish fishery, for example, observers are placed on every boat over 124 feet in length, and these observers follow very rigorous procedures to sample a substantial percentage of hauls for all species. These observers record latitude and longitude and depth information about each tow, together with other data to yield a data set that is exhaustive and continuous over time and space. These kinds of program are expensive, however, and have only been introduced in large scale fisheries such as the Bering Sea groundfish fishery. A step back in costliness and coverage would be a random sampling program of the same sort that records catch, place and time with observers that are assigned randomly to specific vessels. This type of system is used in New Zealand in some of its ITQ fisheries. The consistency between behavior when observers are present and behavior when they are not is checked using forensic statistical analysis similar to that used by the IRS to check tax returns. Finally, the method used by many management systems is similar to that used on the Pacific Coast in the PACFIN system, namely a system of landings tickets and/or logbook systems. In most systems, commercial fishermen are required to record landings at the point of landing, including data on where fish were caught. In addition, many (if not most) fishermen keep their own logbooks that record detailed information about catch, time and place. Some groups are required by regulations to keep such logbooks and submit information to managers for use in harvest management and others simply keep records for their own personal and private use.

The ideal data set for an economic impact study would be one that records effort, catch and landings in a continuous over time and space in a manner identical to full coverage observer programs. This kind of data then **reveals** fishermen's preferred fishing grounds by using the choices they actually make about where to fish. By having detailed actual spatial decisions, there is no need to question fishermen individually about their favorite grounds. With such data in hand, it is possible to do a robust analysis of how specific spatial closures that are part of various MPA proposals might impact fishermen. Economists, have in fact, recently begun to do develop methodologies that are designed to predict the impacts of spatial closures and other policies (Smith, 2001, Wilen, 2004, Smith and Wilen 2003a, 2003b, 2004). These studies combine economic theory with econometric model fitting and statistical hypothesis testing, in order to construct models that predict the probability that a "representative" fishermen will choose any particular patch among a set of alternatives. The basic idea builds on the assumption that the choices we see fishermen making at any point in time are rational in the sense that they represent the best choice given the information that the fisherman has about his/her respective potential fishing locations. Given this assumption, it is possible to describe a probabilistic model of choice by the average or representative fisherman, and then estimate the parameters of that model by using actual choice data to fit the model. This is similar to the manner in which virtual population models are estimated that maximize the likelihood of observing the catch and size-at-catch data that is measured at the point of landing. In the case of economic models of spatial choice, we estimate a model that maximizes the likelihood of observing the actual choices made.

Using this modeling procedure, it is possible to use the fitted model to predict how fishermen will mitigate the effects of hypothetical closures. Fishermen can mitigate their losses by 1) increasing their effort in non-closed sites, 2) traveling greater distances to harvest in previously un-exploited areas, 3) altering their choice of ports, 4) altering their choice of gear or targeted species (if permitted by law), or 5) leaving the study area or leaving fishing altogether. Modeling procedures recently developed by economists simulate closures and then predict how a rational fishermen facing a restricted set of choices will reallocate available effort among remaining open areas.

As an example of how such analysis is done, we report some output from a model that we developed and estimated to predict the impacts of closures in the Northern California sea urchin fishery (Smith 2001, Smith and Wilen 2003a). In this example, we utilized logbook information from the fishery that extended from 1987 to 2000. Logbook data gave information about latitude, depth, and catch for each day trip taken by several hundred divers over a period that encompassed all closed and open seasons for the 14 year period. Our analysis divided the Northern California fishery into 11 distinct patches. We then estimated what economists call a *nested logit discrete choice model* that depicts each daily choice as: 1) a choice about whether to go out (dependent upon weather, expected revenues from all fishing opportunities, location) and if so, 2) another choice about which of the 11 patches to dive in (dependent upon relative expected revenues and distance from port for each patch). The parameters of the probabilistic model were estimated by pooling all of the logbook data to estimate models of a choices made single representative fisherman. We then used the model to simulate a closure of a single patch among the 11 potential patches. The table below shows the kind of results that were generated.

Table 4

Nested Logit Policy Simulations for October/November 1996

Open Fishing Days = 49

Total Active Divers in Bodega, Point Arena, Albion, and Fort Bragg = 93

		Nested Logit Predictions	
Decision	**Actual Choices**	**No Closure**	**Close Patch 8**
Based on Probabalistic Framework			
No Dive	2891	2760	2774
Farallon Islands	10	11	11
Patch 1	0	1	1
Patch 2	12	26	26
Patch 3	95	81	81
Patch 4	68	82	83
Patch 5	116	255	258
Patch 6	94	123	135
Patch 7	212	183	223
Patch 8	171	119	**0**
Patch 9	69	94	142
Patch 10	0	3	4
Total Choice Occasions	**3738**	**3738**	**3738**

The above table is a sample of the kind of simulation output possible from these economic models. The first column shows the actual distribution of effort over the region during a particular 2 month period and the second and third columns depict predicted distributions based on the statistical model. Note first that the model does a relatively respectable job of predicting a difficult set of actual choices. This is more notable given that, on any given day, the choice about whether to dive or not is a somewhat rare event, occurring only 14% of the available days on average. Conditional on the choice that the representative fisherman chooses to go out, many of the patches visited are only infrequently visited. The compound event is summed up in the predicted number of total trips taken by 93 divers over the two month period modeled above, compared with the actual number.

We used the statistical model to simulate a closure of one patch, namely patch 8. Our model predicts two fundamental kinds of impacts. The first is a reallocation of effort among the remaining open patches. As can be seen in the above table in the last two columns, effort is predicted to reallocate around the closed patch, so that effort in patch 7 increases from 183 diver days to 223. This absorbs some of the 119 potential pre-closure trips that are reallocated, and an additional reallocation is to nearby patch 9, which sees an increase from 94 to 142. This is as expected in that most of the reallocation occurs to nearby patches that are open, but there is also a cascading reallocation even to more distant patches that occur. A second fundamental impact is that the closure of a patch reduces the overall attractiveness of fishing and hence the total number of dives goes down. This can be seen in the first line which shows the number of "no dive" events increasing from 2760 to 2774 overall.

The example of these new methods applied to the sea urchin fishery shows that, in principle, there are techniques by which an economic model could be developed and used to do the analysis that the MLPA analysis needs, if only there were adequate high quality and high resolution spatial and temporal data to fit the model. Unfortunately, as the Ecotrust study makes clear, these high quality data are not readily available from existing sources for fishermen likely to be impacted by the MLPA process—hence the need to gather proxies and use them in approximately ideal analyses.

IV. The Ecotrust Methodology: Assessment

An important objective of the Ecotrust analysis is to provide purely descriptive information about fishing grounds used in the Central California Coastal Study Region. The manner in which fishermen are free to define the spatial extent of their fishing grounds seems a positive feature of this methodology. Given the essential continuity of the ocean environment and the necessity of utilizing the spatial information from the surveys at a variety of scales, it seems desirable to allow fishermen to freely define the shape and extent of their favored grounds. This is also an attractive scheme given the fact that fishermen, as individuals whose very likelihood depends on their ability to navigate to particular grounds and effectively utilize nautical charts, are likely to be far more comfortable with such an open-ended elicitation method than would other people of similar educational and socioeconomic status. Furthermore, given the purpose of this information to inform the formation of marine protected areas, it seems important to avoid any possible framing effects in the minds of fishermen that might come about from presenting choices at a level of spatial aggregation that leads them to a strong reaction either for or against a perceived reserve design.

In addition to providing a mapping of fishing grounds, a secondary objective of this study is to predict the maximum possible impacts from a suite of different MPA packages. The Ecotrust study uses data gathered in the survey process to estimate maximum impacts (whether economic or otherwise) that are defined in such a way that whatever values derive from a particular fishing ground (whether these values are direct or indirect) are assumed completely lost when an area is closed. Fishermen are therefore presumed unable or unwilling to substitute their time and resources to other fishing grounds or to other non-fishing related pursuits, substitutions that are incorporated in the above-discussed ideal methodology. The values derived from this type of analysis are thus likely to form an upper bound, but a high upper bound, on possible impacts since compensating behavior on the part of harvesters would likely mitigate the impacts in reality. Nevertheless, the concept of impact and the measures of it used here is useful as a rough measure of the relative burden of various MPA proposals. In this section we discuss data gathering methods and the application to maximum impact analysis.

A. Interview Protocol.

On the whole, the interview process appears to have been conducted with professionalism and attention to common best practices in the field of survey administration. The use of one-on-one interviews was wise given the sensitivity of the spatial information subjects were asked to reveal in the interviews. We would expect that the result is higher quality of data than would have been obtainable in a less time-consuming and less costly group setting or phone or mail surveys. Asking fishermen to reveal their personal fishing grounds is a difficult endeavor and the care given to the preservation of confidentiality through careful aggregation (and the communication of this information to fishermen) most likely improved the chances of fishermen speaking candidly.

B. Participation Rate.

The overall participation rate of 50%, while not exceptional, is quite respectable for this type of survey, given the timing of the survey's administration, the relatively high costs of participation, and the potential of some fishermen to distrust the intentions of such a survey. Clearly, some fisheries are not as well covered as would be desired, and it is difficult to say exactly why this occurred for some fisheries and not others. (The timing of the survey and the failure to include the Vietnamese fleet are leading candidates, however.) Nevertheless, we concur with the impression given by Ecotrust that the results are sufficiently representative of the experienced fishermen of the central coast fleet to be of use in assessing the impacts of spatially-delineated policy measures.

C. The Non-random Sample

The purposeful selection of "highliners" is both a strength and potential weakness of the survey. Its strength is that the most productive fishermen with higher incomes derived from fishing are more likely to care about policy changes and thus be good survey participants. They are also likely to have much better spatial knowledge of the fishery than less successful or more intermittent participants in the fishery. However, the deliberate over-sampling of this group may lead to biased inferences about impacts about whole-fleet impacts if they are highliners because of superior vessel capital. Larger and newer vessels might allow access to more distant, less exploited, grounds or greater flexibility in their choice of base port or port of landing than competitors. If this were the case, the unsampled portion of the fleet might have a quite different set of spatial preferences than their sampled competitors. On the other hand, if the sampled fishermen are highliners simply because they are responsible for a higher proportion of total effort in the fisheries in question, then this sampling scheme need not result in a non-representative picture of the attractiveness of various fishing grounds. It may be possible to investigate the question by analysis of vessel registration data (if available). However, if there is reason to think that the unsampled vessels may have different spatial preferences then this might suggest future use of a random sampling scheme or (more cost effectively) a stratified sampling scheme.

D. Possible Strategic Bias

All social science data gathering that relies on elicitation (eg. surveys) rather than actual observed behavior has the potential to be influenced by strategic bias or gaming behavior on the part of respondents. Surveys that ask about prospective policies are potentially subject to respondents gaming by giving responses that they think will influence the policies chosen. For example, in the context of this study, suppose that a fisherman places a high value on a particular fishing ground, and that he is worried that this revelation will lead regulators to strongly consider incorporating the site into a MPA.

Then he might choose to not reveal the site and skew the location of his "pennies". Alternatively, he might answer truthfully about the site's value and instead conceal its location by drawing the ground as a much larger area than is truly the case. As a result of this strategic bias, the assigned value to the true site would be downward biased. The overall result would be a map of site values that is much *more* spatially diffuse and *lower* in variability than is true in reality.

Alternatively, fishermen may consider a number of sites of nearly equal importance to the success of their business. However, if they perceive that particular areas are likely to face closures in the future then they may shift pennies to these sites to send a signal that these areas are too personally costly to close, not because of any real differences in their importance. They may also choose to define these areas in a falsely precise manner to drive home the point. In this case, the map of site values would be *less* spatially diffuse and *more* variable than is really the case. It is hard a priori to know how pervasive either of these incentives was when the survey was administered. Some of these potential problems could be mitigated by careful wording of questions, training of survey elicitors and the building of cooperative relationships between regulators and the fleets. But if fishermen perceive that their answers may have a bearing on future policies the potential for strategic bias is an issue.

E. Hotspot Bias

Perhaps more important than strategic bias is the possibility that fishermen are simply trying to avoid revealing their favorite "hotspots". This is a potential problem particular to fishing, where fishermen do have sites that consistently yield them high returns and that they take pains to avoid revealing to other fishermen. If this is the case, we might expect skewing the pennies away from that site, similar to what we might expect if he/she was trying to conceal the location because of strategic bias. Absent actual information on spatial choices it is difficult to check the degree to which this might be happening. We would expect, however, that the incentives for such behavior might differ based upon the fishery in question. Fishermen pursuing sessile species that are highly clustered in space (for instance many species of rockfish) would be expected to be much more protective of their information than fishermen who target species found homogenously everywhere, or that exhibit high temporal variability and ephemerality.

F. The Importance Measure

The most novel feature of the Ecotrust method is their derivation and use of the "importance measure". This is a clever way to frame a question about the relative importance of various spatial patches or fishing grounds to each fisherman. It is done by asking fishermen to allocate 100 pennies across their grounds as a means intended to elicit a ranking.

1. Fishermen's Framing.

In addressing how well we might expect this budgeting scheme to work, one important issue is what the responses to this experimental game really signify. The documents do not make it clear exactly what Ecotrust believes their measure of importance fishermen means, and we are left to wonder if the nature of the task was equally vague to fishermen. One's first thought is that the "100 pennies" seems to invite fishermen to allocate the weights in a way that is roughly proportional to the grounds' contributions to their net revenue. If this is the case, then this metric is readily convertible to an economic indicator of "value". However, these weights may alternatively describe fishermen's allocations of the proportions of total effort devoted to a particular location. Although one may expect the patterns of effort and relative profitability to be correlated, this need not be the case in a variety of situations. For instance, highly desirable grounds may be well-known and crowded, so that some fishermen choose to devote a relatively small amount of effort to them. Exactly which measure was truly extracted from the fishermen is important. If one is interested in economic impact, an interpretation of grounds "profitability" would probably be best, but measures of effort concentration could be employed as well. What is important, and probably not knowable, is whether fishermen consistently knew what measure was expected of them, and whether they each treated the assignment task in a similar way.

2. Multiple Species

A related issue concerns situations in which fishermen are participants in several different fisheries either contemporaneously or at different points of the year. Many if not most fishermen in California move between fisheries as abundance, weather and season/area openings permit. If this is the case then there are at least two issues to consider. First, if multiple species are pursued simultaneously then asking fishermen to separately define the grounds of each single species may be prone to difficulty. The ranking of economic importance when species are targeted jointly may not be a cleanly separable endeavor. Second, and more important, there may be incentive problems similar to those mentioned earlier but now working through false reporting of fishing areas and values for one species due to concerns over another target species.

3. Footprint Weighting

Another important issue has to do with the way in which individual site values were aggregated to obtain total importance measures. The scheme devised by Ecotrust has two potential problems. First, the weighting scheme does not ensure that the total of the weighted values add up to the total "budget". It appears that the budgets of some fishermen carry more weight than the budgets of others in computing fishery-wide importance measures. In particular, the method of aggregation used by Ecotrust seems to down-weight the values of fishermen who attributed their pennies to a relatively small number of sites. This can be seen by the fact that in the second stage of determining a site's relative importance, the initial value per cell computed by allocating pennies is multiplied by a term like $G_{f,A} / G$. In the example given in the report, this value is given as 0.6 for fisherman A and 0.4 for fisherman B. But fisherman B's values are down-weighted in this example simply because he is assumed to fish in fewer cells than fisherman A. Assuming that fishermen actually truthfully reveal their fishing grounds and properly value them, and we want to interpret the sum of these weighted values as the total "impact" (economic or otherwise), then we are implicitly assuming, with this weighting scheme, that fishermen with small fishing grounds exhibit smaller-than-average total profits or smaller-than-average total effort. A better way to weight these values so that everyone's "pennies" are properly weighted might be to multiply the values by the proportion of in-sample landings recorded by that vessel (a crude revenue-based measure) or by the proportion of trips made by that vessel in a particular fishery (an effort-based measure). Landings tickets may be useful for this purpose.

V. Summary and Future Considerations

Our overall assessment is that if the goal is to assess the upper bound of impacts from MPAs by utilizing the knowledge of fishermen through survey methods, then the current methodology designed by Ecotrust serves as a good start. It should be possible to begin with the impact analyses conducted by Ecotrust, and extend that analysis to something approximating maximum economic impacts. If similar analyses are done in the future, however, there may be opportunities to address considerations of 1) the sample of fishermen surveyed, 2) how truthful fishermen are likely to be in terms of revealing the scale and location of their grounds and their relative values, and 3) how the individual values from the survey are aggregated into an impact measure. The first consideration can be addressed to some degree by careful sample design (subject of course to budget restrictions and the vagaries of response rates). The third point can be addressed relatively easily by careful thought about what is desired in an impact measure and can probably draw upon outside data sources to help define the relative weighting of values. The second concern is much more difficult to understand or control but careful analysis of the response patterns across fishermen within given fisheries and across fisheries may be enlightening in determining the extent of the problem. Where it is available, logbook or other fishery-dependent data may help to validate the results. Exit surveys and careful pre-testing may also help reveal areas of concern and help reduce this problem in future surveys.

At another level, however, this endeavor raises important questions about the landings ticket system employed by CDFG for fisheries management. Most fisheries scientists and fisheries managers believe that future management will involve more use of spatial policies that account for new knowledge about the spatial patchiness of abundance, and that account for the new political reality of using mosaics of reserves and other spatial closures for management (Wilen, 2004). If the current system is not collecting useful information about the spatial distribution of fishing effort, some policy deliberations ought to be directed toward thinking about redesigning the data collection effort. In many ways, the system that exists has been in place because managers have not had needs for spatial information. But this is bound to change, and these deliberations on reserve placement are likely the leading edge of new demands for more precise and reliable spatially delineated fisheries data. The Ecotrust study is a sensitive and competently done effort that compensates for severe data deficiencies by developing reasonable proxies for data that ought to exist already, but in the future, it would be better to be able to call on data systems designed directly to provide spatial information.

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