The West Coast Trawl Buyback Program and Ex-Vessel Revenues at Monterey Bay Ports

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Summary

This report describes recent work that relies heavily on PacFIN data for socio-economic analysis of commercial fisheries in Monterey Bay, California. We demonstrate how PacFIN data are used to frame a research question, identify a sample and population, and evaluate results. We apply this research methodology, in a limited way, to the recent West Coast groundfish trawl buyback program. Results show this program had modest effects on total ex-vessel revenues of the trawlers that landed at Monterey Bay ports in 2003 and 2004, with a total loss of about $230,000, or 19% from 2003 levels, but the distribution of revenues among vessels changed substantially. In particular, 4 of the 5 groundfish trawlers with landings at Monterey Bay ports in 2003, and successful bids in the buyback auction, were among the most active trawlers at these ports in 2003, with average ex-vessel revenues nearly double those of other trawlers in that year. These 5 vessels were permanently retired at the end of 2003, which appears to have created an opportunity for other trawlers. The group of 8 trawlers that landed at Monterey Bay ports in 2003 and 2004 saw their average ex-vessel revenues nearly double in 2004 from 2003 levels, while the group of 9 that landed at these ports in 2004, but not 2003, had substantially lower average ex-vessel revenues. These results raise questions about the range of factors that affect trawlers' coastwide fishing patterns, and how they adapt to and are affected by those changes, and whether similar effects occurred at other ports. These questions are beyond the scope of this report, but could be addressed using PacFIN data, coupled with targeted field research to tap into the experience and knowledge of people that participated in the buyback program, and those that remained in the fishery.

1. Introduction

Recent and pending federal marine management actions on the U.S. West Coast, from groundfish regulations to marine reserves and National Marine Sanctuary management plan revisions, have highlighted the critical need for socioeconomic information on marine resource uses and associated communities. The need for this information is both practical and legal. In practical terms, because resource users affect and are affected by management, socioeconomic information can be used to inform and enhance the effectiveness of management design, implementation and evaluation. In legal terms, the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA, and amendments), the National Environmental Policy Act (NEPA), and the Regulatory Flexibility Act (RFA) require consideration of the "human dimensions" in the design and implementation of federal actions that affect the human and biophysical environments.

In central California, the site of three National Marine Sanctuaries (NMSs) and diverse federally- and state-managed fisheries, socioeconomic information to assess the impacts of management actions has been critically lacking. Among the types of information needed are qualitative and quantitative analyses of the social and economic characteristics of and relationships among fishing operations, processors and providers of goods and services, and the economic value they generate. Data to support these analyses are not readily available from any single source. Rather, they must be collected from a diversity of primary sources such as fishery participants and support businesses (e.g., through interviews and observation), and secondary sources including grey and refereed literatures on fisheries and communities, management documents, federal census and labor statistics, and records of fish landings.

Landings data are especially important because they uniquely account for the landing and receiving patterns of fishing vessels and buyers. They provide information on each trip or landing for each vessel including the date, vessel, species, gear, port and buyer, landed weight and ex-vessel value. For the US West Coast, landings data are collected and managed by each state (California, Oregon and Washington). In addition, the data for all three states are maintained by the Pacific States Marine Fisheries Commission in the Pacific Fisheries Information Network (PacFIN) database, to support the coordination of interstate and federal fishery management. Access to these data is essential to i) the design of valid and scientifically robust research strategies; ii) the complete and valid assessment of impacts on fisheries, fishery participants and fishing communities; and iii) the evaluation of research results for their validity, reliability, representativeness and generalizability.

To address the socio-economic information needs outlined above, we conducted a series of socio-economic studies on the fisheries of the Monterey Bay in Central California. For these projects, PacFIN data were necessary in the design and evaluation of our survey methods, and in particular, the data collection instruments (e.g. interview forms, economic worksheets). The first project, sponsored by the Monterey County Office of Economic Development, estimated the direct economic value of the commercial fishing industry at Moss Landing Harbor, characterized its fisheries and fishery participants, and identified a set of issues that affect the local fisheries' viability and vitality (Pomeroy and Dalton 2003). We expanded on the initial Moss Landing project for Monterey County in two subsequent studies: Market Channels and Value Added to Fish Landed at Monterey Bay Area Ports[1], and Measuring Impacts on Fishing Communities: A Framework for Integrated Socioeconomic Assessment, supported, respectively, by California Sea Grant (SG) and NOAA's Saltonstall-Kennedy (SK) program.

For the initial Moss Landing project, we were unable to obtain permission to use the disaggregated PacFIN data to generate a sample of fishery participants, but were able to use PacFIN data to compute benchmark summaries of landings and revenues for the sample of skippers, fish buyers, and fishery related business operators we interviewed. We integrated summary expenditure data from the interviews with revenue summaries from PacFIN to calculate input-output (I/O) coefficients. These coefficients and port level revenue summaries from PacFIN enabled us to estimate total expenditures at the port on different inputs for fishing operations for the SK study. For the SK project, we also collected field data on the characteristics, and expenditures of households and other businesses at Moss Landing. We are using these and our commercial fishery field data to construct a social accounting matrix (SAM) for Moss Landing, and compare it to the IMPLAN SAM for Monterey County. This comparison is important because the IMPLAN SAM is the source of economic impact multipliers that are used, for example, in the Fisheries Economic Assessment Model (FEAM). However, work in the SK project shows the county-level IMPLAN SAM misses important economic differences in the fishing industry and other components of the economies at Moss Landing and port of Monterey.

For the SG and SK projects, we also expanded our field data collection to include a larger sample of fish buyers. This work required updating the benchmark to reflect recent changes in all fisheries. However, individual features of the sample data needed to be well understood before results from the sample can be

[1] The overarching goal of this study was to help inform the assessment of potential social and economic impacts of fishery management and other measures and events on the fisheries and fishing communities of the three major Monterey Bay Area (MBA) ports: Moss Landing, Monterey and Santa Cruz. Specific objectives were to: i) describe the spatial organization of processing activities for fish landed at MBA ports; and ii) estimate value added in Monterey and Santa Cruz Counties to fish landed at Monterey Bay ports.

credibly used to estimate port level economic patterns. As a census, PacFIN data are the only source of information available to evaluate the general properties of these samples relative to the behavior of the entire population.

The goal of the present report is to demonstrate and evaluate the use of PacFIN data in socio-economic analyses of the impacts of fishery management actions on fishing communities. Specifically, we sought to: i) identify populations in the fishing community, ii) develop samples from the population, iii) evaluate whether the sample is representative of the population, and iv) integrate field and landings data to extrapolate expenditures and other economic information from the sample to the entire population.

This report begins with a brief description of the three Monterey Bay Area (MBA) ports and associated fishery activities. The following section discusses our methodology, beginning with an overview of our field and archival data collection and analysis. We then focus on the procedures used with the PacFIN data, from identifying and sampling fishing populations to integrating field and landings data. In the following section, we present the results of applying these procedures to assess the impacts of the groundfish trawl buyback on MBA ports. Next, we discuss the key findings related to the use of PacFIN data for this analysis. We then conclude with a discussion of the implications of these results locally, and their application to other locations and contexts.

2. The Three Monterey Bay Area Ports and Associated Fishery Activities

As can be seen in Fig. 1, Santa Cruz, Moss Landing and Monterey harbors mark the northern, eastern and southern edges, respectively, of Monterey Bay. Each of these ports has long played a role in commercial and recreational fisheries, as well as the larger community, but has a distinctive history, make-up and emphasis.[2] In general, Monterey Bay has been the site of diverse commercial fisheries since the mid 1800s. These fisheries have included albacore, groundfish, salmon, sardine and squid, among others, developed and carried out by Anglo, Chinese, Italian, Japanese, Portuguese and Vietnamese fishermen and buyers.

Moss Landing Harbor

Prior to the 1930s, only small-scale fishing was conducted at Moss Landing, as whaling and shipping dominated its activities up to that point (Scofield 1954). However, the growth of the sardine fishery, and a 1935 "cannery boom," prompted the construction of jetties and dredging of the harbor entrance "so that fishing boats could enter the slough and have protected water for unloading at the canneries" (Scofield 1954: 92). In the mid 1940s, the California Legislature created the Moss Landing Harbor District as a political subdivision of the State. Work then proceeded on the harbor channel and the development of sardine canneries and reduction plants on the "Island,"[3] along with shipbuilding and repair yards, and other support services (Francis 1997). Scofield (1957) reports that by 1952, there were eight canneries and reduction plants, with 30 to 40 purse seiners, occasional trawlers, dozens of small salmon and albacore trollers and a few setline boats. Others report live bait operations as well. When the Monterey Bay sardine fishery collapsed in 1952, many purse seiners went south to San Pedro, only to have the fishery there collapse a few years later (McEvoy 1986). The smaller seiners that remained in the Monterey Bay area continued to fish for sardine, even though it was scarce. Many also shifted some of their effort to squid and other "wetfish" species (i.e., anchovy and mackerel) and herring.

[2] The information that follows is based primarily on our recent report on the commercial fishing industry at Moss Landing Harbor (Pomeroy and Dalton 2003), which included a comparison of commercial fishing activities at the three harbors, augmented by new information from our SG and SK projects and other sources.

[3] The Island is a narrow spit of land that extends northwest from the mainland at Moss Landing.

Fig. 1: Map with California Ports and Other Geographical Features Cited in this Report.

The commercial fishing industry has played a prominent role at Moss Landing Harbor since its establishment in 1947. The Harbor has supported multiple, diverse fisheries, the relative importance of which has varied over time with changes in environmental, social and economic and regulatory conditions. As of 2002, Moss Landing Harbor hosted seven resident commercial fish receivers, about 125 resident and 175 non-resident commercial fishing vessels, and over a half dozen businesses that provide goods and services to the commercial fishing industry. That year an estimated 13 vessels made groundfish trawl landings to 10 buyers. In 2006, six resident fish buyers remained. A small number of commercial fishing boats offer off-the-boat sales to visitors, and one operation specializes in providing bait locally and to retailers beyond Moss Landing.

Recreational fishing also plays an important role at Moss Landing. Two primary commercial sportfishing operations are based at the harbor, one that carries up to six fishing passengers, and a second that operates two vessels, with capacities of 6 and 25 fishing passengers. Moss Landing harbor also hosts many private sport fishing operations. Many of these boats, and many more from outside the harbor, use its launch ramps to access Monterey Bay fishing grounds for salmon, rockfish and albacore.

An important function of Moss Landing is to host several fishery-support businesses, many of which have served commercial and recreational fisheries for at least two decades. All of these businesses are based at Moss Landing, and are locally- and in most cases family-owned. Moss Landing's fishery-support businesses include a fuel dock that has a small marine supply and general store, a boatyard that also sells marine supply items, a marine covers/upholstery shop, electrical, diesel, hydraulic, metalwork and other service providers, and a dry storage facility. In addition to these businesses, which play a direct role in the maintenance and operation of commercial fishing operations, fishermen and staff of fish receiving operations frequently eat at Moss Landing restaurants, including one on the Island and several on the mainland. In addition, many other businesses in the larger Monterey Bay area and beyond support and depend on the harbor's fisheries.

In 2002, the harbor employed 10 individuals including a harbor manager/master, an assistant harbormaster, and other administrative and maintenance staff, and engaged outside contractors for legal, end-of-year accounting and some other services. The Harbor provides a number of goods and services to the commercial fishing industry, as well as other harbor users. Primary items provided to the industry are berthing for commercial fishing vessels and associated amenities. Of the approximately 743 berths at the harbor, some 455 (Superior Court 2002) are located in South Harbor, where commercial fishing activity is concentrated. (The harbor has no moorings.) Because Moss Landing is a commercial port, commercial fishing vessels that demonstrate at least $5,000 in commercial fishing revenues for the year are given a discount on berthing fees. Occupancy rates vary considerably throughout the year, especially because of the seasonality of several fisheries in the Monterey Bay area and in other areas fished by Moss Landing fishermen. However, priority is given to commercial fishing vessels. As of 2002, about 100 vessels were on the Harbor's berth waiting list, but none were commercial fishing vessels.

Monterey Harbor

Although Monterey Harbor's history dates back to the early 17th century, the development of the present day commercial fishing industry and related facilities began in the latter 19th century. Among the early fisheries that operated at the Harbor and stimulated its growth were the salmon, sardine and squid fisheries. In 1916, the City of Monterey purchased the original wharf (known as Fisherman's Wharf") from the Pacific Coast Steamship Company, largely to better provide for the needs of the growing sardine industry as well as the existing freight business there (Monterey Harbor 2003). In 1926, a second wharf, Municipal Wharf II, was completed. With the collapse of the sardine fishery after World War II, Fisherman's Wharf shifted focus to accommodate growing tourism in the area, while Wharf II became the focus of commercial fishing activity. Additional development continued through the 1960s and 1970s. A marina with 367 berths was completed in 1960, with 29 berths added in 1975. Bulkheads, launch ramps and others facilities were added as well. In late 1996, further improvements were completed as part of a $5 million Marina Reconstruction Project (Monterey Harbor 2003). The Harbor falls under the jurisdiction of the City of Monterey, which provides guidance to the Harbormaster and 11 additional permanent, full-time staff, who mange the Harbor's day-to-day operations including marine operations, maintenance and security.

Monterey Harbor provides a range of goods and services to commercial and recreational fisheries (and other harbor users). As of 2002, the Monterey Municipal Marina had 413 slips, 6 end ties, 180 to 185 moorings, and an open anchorage where additional vessels may anchor for up to 30 days in any 6-month period. The Harbor also has 45 to 50 dry storage spaces, which are managed by the Monterey Peninsula Yacht Club. Harbor amenities and services also include electricity, water, pump-out stations, two public launch ramps, two public hoists, restroom, shower and laundry facilities, trash disposal, recycling and parking. The wharf also includes a parking area where fishermen can work on gear.

In 2002, Monterey Harbor hosted seven resident wholesale fish companies, 140 commercial fishing vessels, two major sportfishing operations, and several providers of goods and services for commercial and sportfisheries. The seafood wholesalers that operate on the wharf included four multi-species buyers, two operations that focus primarily on wetfish, and one live fish buyer.[4] Commercial fishing vessels include wetfish seiners and squid light boats, salmon trollers, groundfish trawlers (five with recorded landings that year) and a few hook-and-line, longline and trap vessels that target rockfish, halibut and other species. Two marine supply businesses, two boatyards and a fuel dock that serve the industry are located at the harbor as well.

Santa Cruz Harbor

The Santa Cruz Port District was created pursuant to a County election in 1950, to "provide and manage small craft harbor facilities in Santa Cruz County" (Santa Cruz Grand Jury 2002), to operate as a regional facility for "recreation, commercial fishing and as a harbor of refuge" (Santa Cruz County Grand Jury 2002: 7-11). The harbor was not built, however, until after the 1958 passage of federal legislation that authorized the Santa Cruz Small Craft Harbor and Beach Erosion Project (Santa Cruz Harbor 2003). Construction of the South Harbor was completed in 1964; construction of the North Harbor was completed in 1973. The Port District comprises the City of Santa Cruz and most of Live Oak and Pasatiempo.

The commercial fishing industry has had a relatively small but consistent presence at Santa Cruz Harbor. In 2002, about 100 boats delivered fish at Santa Cruz Harbor, including an estimated 6 groundfish trawlers (who sold to 7 buyers). The Harbor was homeport to about 45 of these commercial fishing operations, 10 of which sell at least some of their catch directly to the public off the boat. The commercial fleet consists primarily of salmon trollers, along with a smaller number of crab, albacore, halibut, rockfish and sablefish fishing operations. In 2002, the Harbor hosted one resident full-service, multi-species fish buyer and two fresh fish retail markets. In addition, three to four other buyers regularly purchased fish from boats at Santa Cruz Harbor, and another 30 to 40 did so less frequently each year between 1998 and 2005.

Recreational fishing has a significant presence at the harbor as well. Four fishing charter businesses presently operate out of the harbor (Santa Cruz Harbor 2006). In addition, an estimated 1,200 private boats, many of them geared for recreational fishing, have permanent berths at the harbor. [5] Port Director Brian Foss recently estimated that the harbor sees 10,000 launches per year for recreational salmon fishing alone.

The fishery-support businesses based at the harbor included a boatyard, electrical, hydraulic and metal work services, a marine covers shop, a marine supply store, a fuel dock, and two dive firms. The resident buyer also manages ice sales on behalf of the harbor. A marine surveyor and a small grocery store are located a block from the harbor. The harbor itself provides many goods and services and has made several improvements over the past few years that are useful to the commercial and recreational fisheries. These include electricity, water, trash disposal, recycling and sewage disposal, oil recycling and dump stations, a dry storage lot and parking. Among recent capital improvements at the harbor are an ice production plant, a new lighthouse and an oil reclamation facility. In addition, and in contrast to Moss Landing and Monterey Harbors, Santa Cruz owns and maintains a dredging vessel to help address substantial annual

[4] The number of groundfish buyers is not disclosed to insure confidentiality.
[5] The information presented in this paragraph is based largely on Port Director Brian Foss' April 5, 2006 letter to the PFMC regarding the proposed salmon fishery closures for the 2006 season.

dredging needs.[6] Berthing at the harbor includes 950 wet slips (split between south and north harbor), 280 dryberths and 150 small boat racks. Of the harbor's approximately 1,090 vessels that used these spaces, 15% were commercial fishing vessels, 35% were pleasure powerboats, and 50% were pleasure sailboats (Santa Cruz Port District 2002). About 1,200 vessels are on the waiting list for slips.

Monterey Bay area Commercial fish landings, 1998-2005

The total annual ex-vessel value of landings at Monterey Bay area (MBA) ports for 1998-2005, shown in Fig. 2, ranged from $11.1 to 25.4 million (mean = $18 million). The top five MBA fisheries by the same measure were squid seine, salmon troll, CPS seine, groundfish trawl and non-trawl groundfish. Groundfish trawl landings (non-whiting) accounted for between about $700,000 and $2.4 million, or 9 to 28% (mean = 13%) of total MBA ex-vessel revenues. Groundfish trawl landings declined from about 25 to 7% of the ex-vessel value of MBA landings from 1998 to 2005, with values of $2.4 million in 1998 and a little more than $700,000 in 2003. Landings of non-trawl-caught groundfish have also declined in absolute and relative terms, whereas squid and CPS seine and salmon landings have varied with no clear trend.

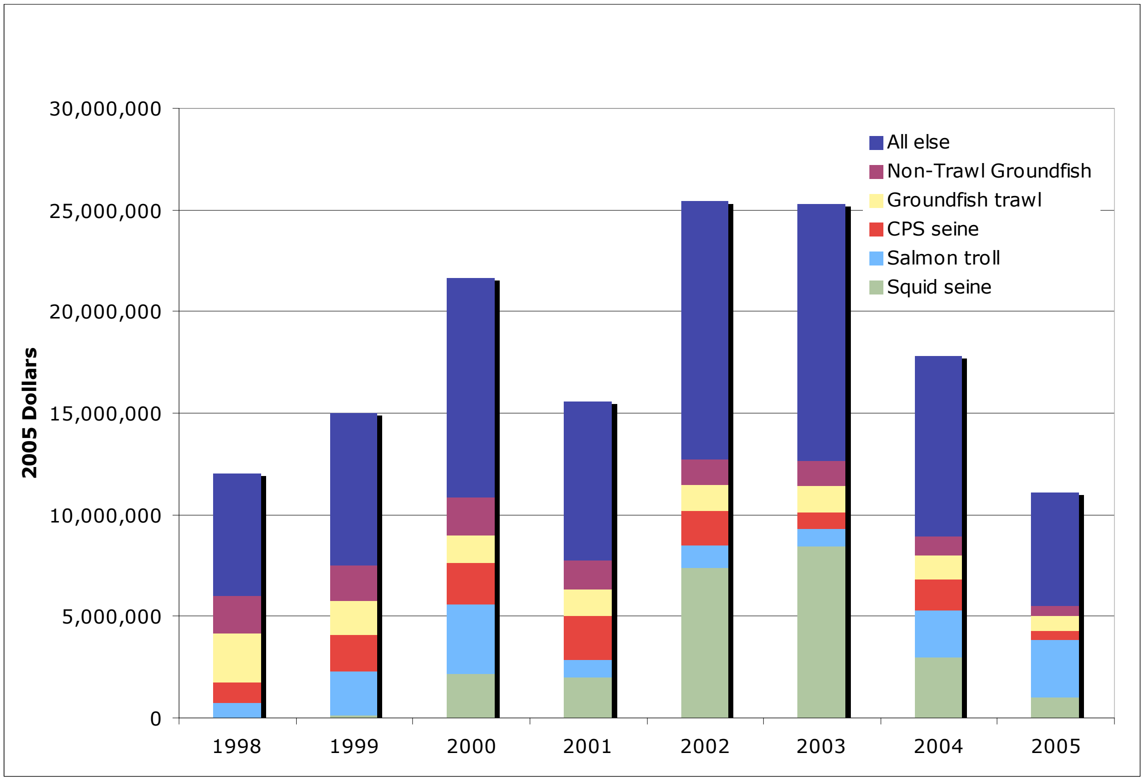
The number of boats and buyers that participated in the region's groundfish trawl fishery relative to the total number of participants was small, with an average of 21 vessels and 16 buyers involved in the groundfish trawl fishery, compared to averages of 415 vessels and 99 buyers receiving for all fisheries in the MBA.

The three MBA ports differ markedly in terms of their fisheries overall, and in their groundfish trawl activity from 1998 through 2005. Moss Landing consistently had the greatest ex-vessel value of landings among the three ports, followed by Monterey and Santa Cruz. Somewhat surprisingly, the groundfish trawl fishery ranked second in average landed value for both Santa Cruz (after salmon troll) and Monterey (after squid seine), and fourth for Moss Landing. At Moss Landing, the squid seine, CPS seine and salmon troll fisheries exceeded the groundfish trawl fishery in average landed value. Monterey's top fisheries were: squid seine, groundfish trawl, non-trawl groundfish, salmon troll and shrimp/prawn pot. At Santa Cruz, the salmon troll fishery ranked first, followed by groundfish trawl, crab pot, halibut set net and albacore troll.

Groundfish trawl landings account for different proportions of landed value for each port, and this measure has varied over time. They have accounted for between 9 and 46% of total landed value at Monterey, 3 and 29% at Santa Cruz, and 8 and 19% at Moss Landing. Groundfish trawl landings as a proportion of all landings have declined by more than 80% at Monterey and Santa Cruz since 1998. At Moss Landing, the change has been less dramatic, with a decline of about 30% since 1998.

[6] According to harbormaster Brian Foss, Santa Cruz harbor is the only harbor in California that is financially responsible for its own dredging, which it finances with user fees.

Fig. 2: Ex-vessel value of landings at Monterey Bay area ports for top 5 fisheries and all else, 1998-2005.



The MBA ports differ also in terms of the numbers of fishery participants. The number of boats delivering to Moss Landing ranged from 196 to 352 (mean = 272), and the number of dealers ranged from 37 to 72 (mean = 55). Of these, an average of 17 vessels and 11 buyers were active in the groundfish trawl fishery between 1998 and 2005. Santa Cruz had, on average, 130 vessels with landings, and 38 buyers with receipts, each year, with an average of five vessels and buyers involved in the groundfish trawl fishery each year. For its fisheries as a whole, Monterey had an average of 123 vessels and 25 dealers per year. The number of participants in the groundfish trawl fishery averaged five vessels and three buyers dealers.

3. Using the PacFIN Data to Inform Fisheries Social Science

As described above, the PacFIN data are a critical source of information to support multiple aspects of fisheries social science research including: i) identifying and sampling populations of fishery participants (i.e., vessels, vessel owners and buyers), ii) evaluating samples achieved in field data collection, iii) developing basic understanding of fishing and receiving patterns in space and time, and iv) establishing benchmarks of landing and receiving patterns for evaluating and predicting management outcomes.

The PacFIN data are the only comprehensive source of information available to identify populations of active fishing vessels and buyers along the US West Coast. By analyzing the data, one can identify, characterize and count fishery participants (i.e., fishing operations or vessels, and buyers) within and across ports, fisheries and time periods. This information can be used to shape or refine research questions and approaches, and to inform and support sampling design. This, in turn, can enhance the efficiency and efficacy of field research efforts, enabling the researcher to focus limited resources on fishery participants of greatest relevance to the research, and significantly reducing the costs of identifying populations as part of the field effort. Having a complete sampling frame of vessels and buyers is a critical step toward identifying the *people* involved in these fishing and receiving operations, which still requires field effort because the landings data do not reliably identify vessel operators or those who run buying operations (or crew and receiving/processing labor). Because the success of field sampling can be highly variable, the PacFIN data are also useful for determining the extent to which the sampling goal was achieved, and the ways in which the sample does or does not represent the population.

Analysis of the disaggregated PacFIN data is also instrumental for developing basic understanding of fishing and receiving patterns in space and time. This information is useful not only in its own right, but as a facilitator of field research. By studying fishing patterns within and across fisheries and communities over time, field researchers can develop a basic literacy about the fishery, which is often critical for meaningful interactions with fishery participants. In addition, this knowledge enhances the field researcher's ability to critically evaluate information gained in the field.

In addition, the PacFIN data play a key role in economic analyses by providing benchmark values of ex-vessel revenues for landings by port, and the dollar value there of fish inputs to both the fishing and processing sectors. This information can be linked with field data on expenditures and revenues to develop and refine social accounting matrices at the community level to enable the assessment of management impacts. In addition to providing benchmark data, PacFIN may also be used as a rich source of panel data, providing a census of individual vessels over time.

In addition to those described above, we have used PacFIN data in other projects in a variety of ways. For example, for studies of the California squid and wetfish fisheries (Pomeroy and FitzSimmons 2001, Pomeroy et al. 2002), we used the PacFIN data to identify and sample the population of vessels and buyers engaged in the squid and CPS finfish fisheries for field interviews. We also used the data to build our preliminary understanding of fishing activity in time and space, which enabled us to better engage and learn from fishery participants. In our study for California Sea Grant of market channels and value added to fish landed at Monterey Bay ports (Pomeroy and Dalton 2005), we used the PacFIN data as a key source in integrated archival data analysis in order to describe the fish receiving, processing and other value-adding activities for the region's primary fisheries including groundfish, squid and wetfish, salmon and albacore, and crab. When PacFIN data were not available to develop a sampling frame of MBA fish receivers, we resorted to a more labor-intensive and far less reliable approach that combined review of our previous research and archival sources, discussions with industry contacts and others knowledgeable of fish receiving and handling in the area, and interviews with the Santa Cruz, Moss Landing and Monterey harbormasters. Once we obtained permission to use the disaggregated PacFIN data, we were able to evaluate the sample for its representativeness. We used the data similarly to evaluate the sample of fishing operations in our recent studies of the commercial fishing industry at Moss Landing harbor and of the larger Moss Landing community (Pomeroy and Dalton 2003).

4. An Application of PacFIN Data to Investigate Effects of the Groundfish Trawl Buyback on Ex-Vessel Revenues at Monterey Bay Ports

Introduction

This section of the report describes a simple method and results of estimating economic effects of the West Coast groundfish trawl buyback program in 2003 on ex-vessel revenues of vessels with landings at Monterey Bay ports. The method compares information from PacFIN on landings and ex-vessel revenues in 2003 and 2004. According to the Limited Entry Permit database managed by NMFS Northwest Regional (NWR) Office, 274 vessels held permits in the West Coast limited entry groundfish trawl fishery at the start of 2003. The November 2, 2003 Federal Register notice indicates that 92 groundfish trawl vessels were permanently retired at the end of the year through the Fishing Capacity Reduction Program, also known as the buyback. This type of program reduces the number of vessels, and all else equal, could imply a loss in total ex-vessel revenues. However, trip limits changed from 2003 to 2004, due to both a reduction in the number of vessels and because trip limits for individual groundfish trawlers are set in bi-monthly increments to meet a total allowable catch (TAC) for the entire West Coast. Therefore, changes in the trips may be decomposed into effects due to changes in the number of vessels, and effects due to changes in the TAC. The TAC varies because of rebuilding plans, and information from new or updated stock assessments. In addition, ex-vessel prices may have responded to the buyback, and thus, also affected ex-vessel revenues. The combined effects of the reduction in trawl permits after the 2003 fishery, changes in the TAC for various species, and ex-vessel prices imply that effects at a port (or group of ports) are ambiguous.

To analyze effects of the buyback on the three Monterey Bay ports (Moss Landing, Monterey, and Santa Cruz), we used PacFIN data to produce distributions of landings and ex-vessel revenues for groundfish species covered by trip limits in the years before and after the trawl buyback. For analysis, we selected vessels that recorded landings at the three MBA ports with groundfish trawl gear in 2003 and 2004. The most important statistic in our analysis is total ex-vessel revenues for this group. In total, 20 vessels fit this description in 2003; of these, 5 (25%) had winning bids in the buyback program and were permanently retired from fishing after the 2003 season. Nine of the 20 groundfish trawlers (45%) had landings at Monterey Bay ports again in 2004, and 8 more recorded landings there that did not in 2003, for a total of 17 active groundfish trawl vessels in 2004. Overall, ex-vessel revenues for these vessels decreased by about $230,000 (all values in year 2000 dollars) from the end of 2003 to the end of 2004, or by about 18% compared to the 2003 value. We decomposed the change in ex-vessel revenues between 2003 and 2004 into effects of ex-vessel prices and landings. This decomposition shows that ex-vessel prices generally went up after the buyback, but most of the change in ex-vessel revenues was due to a decrease in landings, and a direct effect of the buyback may have been 3 fewer groundfish trawlers with landings at Monterey Bay ports in 2004.

The most striking result of this analysis is the change in the competitive ranking of trawlers in the analysis. In 2003, 4 of the 5 vessels with winning bids were among the most active trawlers at Monterey Bay ports, with average ex-vessel revenues from groundfish trawls in California of about $110,000, while other trawlers that landed at Monterey Bay ports in 2003 had revenues closer on average to $60,000. However after the buyback, 9 trawlers from the group that landed at Monterey Bay ports in 2003 landed there again in 2004, and this time earned average revenues of $110,000. The average of the other 8 trawlers that landed there in 2004 was closer to $40,000. Although an investigation of how and why these changes occurred is beyond the scope of this report, several factors should be considered. The group of trawlers with recent landings likely had a competitive edge over other vessels, in terms of both knowledge of, and access to, the fishing grounds and markets. To take this line of reasoning a step further, an increase in trip limits that followed the buyback may have been an opportunity for the group of vessels with landings in the prior year to gain a greater share of the market, which could explain the change in their revenues from 2003 to 2004.

To analyze the potential economic effects of the increase in trip limits from the buyback, we evaluated the different sets of trip limits in 2003 and 2004. Potential ex-vessel revenues (i.e. the value of the trip limits under prevailing ex-vessel prices) under the 2004 trip limits are greater than in 2003, by about 7% if the differences are evaluated using 2004 real ex-vessel prices, and by about 20% if 2003 real prices are used. These results suggest that effects of the increase in trip limits on landings were probably modest, and thus, effects on landings were small in comparison to other factors. The final stage of our analysis confirms this point by developing a simple microeconomic model of what happens if one trip limit is binding on profit maximizing behavior in a multi-species fishery. PacFIN data show that trip limits were only filled by the most active trawlers during a few periods of the year. Thus, trip limits did not appear to be a binding constraint for vessels with landings at Monterey Bay ports in 2003 and 2004.

Based on these results, we conclude that the buyback program had at most modest effects on the value of total ex-vessel revenues for landings at Monterey Bay ports, with a reduction of landings that was partly offset by an increase in prices. However, the buyback program did have important effects on the market structure at these ports by removing some of the most active vessels. The rest of this part of the report contains sections that describe data and the analysis, which is divided into subsections that describe a decomposition of changes in ex-vessel revenues, potential ex-vessel revenues under alternative sets of trip limits, and an economic model that compares average landings to trip limits.

Data

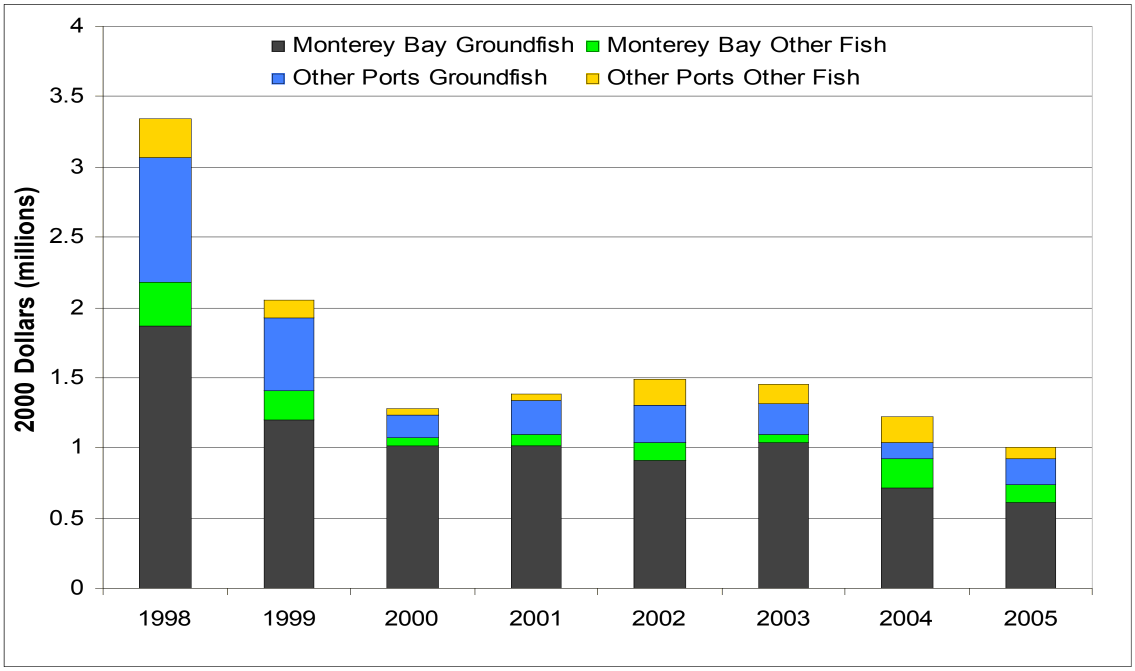
To conduct our analysis, we used three sources of archival data. Data on landings and ex-vessel revenues used in this report include the fish ticket data for all landings at California ports (shown in in Fig. 1) from 1998 through 2003, extracted from the PacFIN database in July 2006. Vessels with winning bids in the trawl buyback program were published in the Federal Register in November 2003. Electronic data on the 2003 and 2004 bi-monthly cumulative trip limits, including the final in-season adjustments, for West Coast groundfish were obtained from NMFS NWR Office.

Analysis

We compared a benchmark based on the 2003 PacFIN data to the observed (i.e. actual) outcome in 2004, and calculated several hypothetical outcomes for 2004 that are based on simple decompositions of observed data and trip limits. We compared landings of each vessel in each trip period to the trip limit, and observed differences among vessels, but these differences may be consistent with our assumptions. Our economic analysis takes a simple view of the fishery in 2003, and assumes the group of 20 trawlers that landed at Monterey Ports (Moss Landing, Monterey, Santa Cruz, and other Monterey Bay area ports in PacFIN) in the benchmark period is a representative sample of vessels that may be summarized in terms of average values for variables that are included in the analysis. By representative, we mean that each vessel is assumed to have solved an identical optimization problem in terms of its responses to regulatory constraints, ex-vessel prices, climate, and other factors. With this type of assumption, the aggregate distribution of landings for a group of vessels may be similar over species and ports, if and only if, the underlying dynamic optimization problem solved by each vessel operator in the model has an equivalent structure.

Dalton and Ralston (2006) formally tested this type of hypothesis for several California ports as part of a study of spatial management in California's groundfish trawl fishery. They considered the assumption of using pooled time series data in a dynamic microeconomic model of fishing effort for 10 ports in California's limited entry groundfish trawl fishery. That analysis of covariance, which used data from 1981-2001, did not reject the model with pooled data for either Moss Landing or Monterey, and Santa Cruz did not receive a sufficient number of landings to conduct the test. The number of observations (i.e. nonzero landings) in a given sample period is an important property of the data for this report, and the most apparent difference among time series for individual vessels is the presence and frequency of zero values. This issue is common to all data on West Coast trawlers. Developing a rigorous statistical approach for situations where time series data are ridden with zero values was a goal of the Dalton and Ralston study, but in this report, we settle for descriptive statistics (i.e. means), over all values including zeros for each selection of vessels from PacFIN, and these statistics are used with basic microeconomics to analyze the data. The simpler approach is acceptable here because we are concerned mainly with two consecutive years of data, before and after a major structural change in the fishery (i.e. the reduction of 92 vessels, or 1/3 of the total coastwide fleet), and our interest for this report is not yet in long run dynamic effects.

Fig. 3: Total Ex-Vessel Revenues in California of Trawlers that Landed at Monterey Bay Ports, 1998-2005.



We queried PacFIN to select a separate group of vessels for each year 1998-2005 with landings at the three major MBA ports and other ports in the Santa Cruz/Monterey area (OCM). We examined landings for each group at these ports and at other California ports. Our analysis is limited to groundfish trawlers, and in particular, the selection criteria were narrowed to three specific gear codes: Groundfish Trawl (GFT), Large Footrope (GFL), and Small Footrope (GFS). For the group of trawlers in each year, we calculated ex-vessel revenues for species covered by the groundfish regulations, and for all other species, which include crabs, sandabs, and sharks, among others. Fig. 3 shows these distributions for each year. Major restrictions were imposed on the West Coast groundfish fishery after 1998, and ex-vessel revenues were similar during the period 2001-2003. However after the buyback, ex-vessel revenues fell by about $230,000 or 19% from 2003, and to 2004. The reduction in landings of groundfish in Monterey Bay from groundfish trawling is noticeable, and the increase in landings of other species is not enough to compensate for this loss. Below, we investigate whether the reduction in revenues from 2003 to 2004 appears to be primarily due to the buyback, regulations, or changes in ex-vessel prices.

Buyback Winners and Vessels with Landings at Monterey Bay Ports in 2003

As a first step of our analysis, we linked the trawl buyback winner's list to the group of 20 vessels in PacFIN with landings at Monterey Bay ports in 2003, and identified 5 vessels that were on both lists. One of these reported zero groundfish landings in 2003, but the other 4 were active and came close to the trip limits in some periods on Dover sole, Flatfish, Sablefish, Thornyheads, or other targets. Landings patterns are complementary across vessels in some cases. For example, three vessels were close to the trip limit on Dover sole in some periods. In contrast, another vessel did not come close to the limit for Dover, but did come close to trip limits on Flatfish. A general result is that while the most active vessels were constrained by one or more trip limits in different periods, total landings for these 5 vessels were well below the sum total of their trip limits for each period.

Fig. 4: Average 2003 Ex-Vessel Revenues of Buyback Winners (5) and Other Trawlers (15) from Grounfish Landings with Trawl Gear at All California Ports.

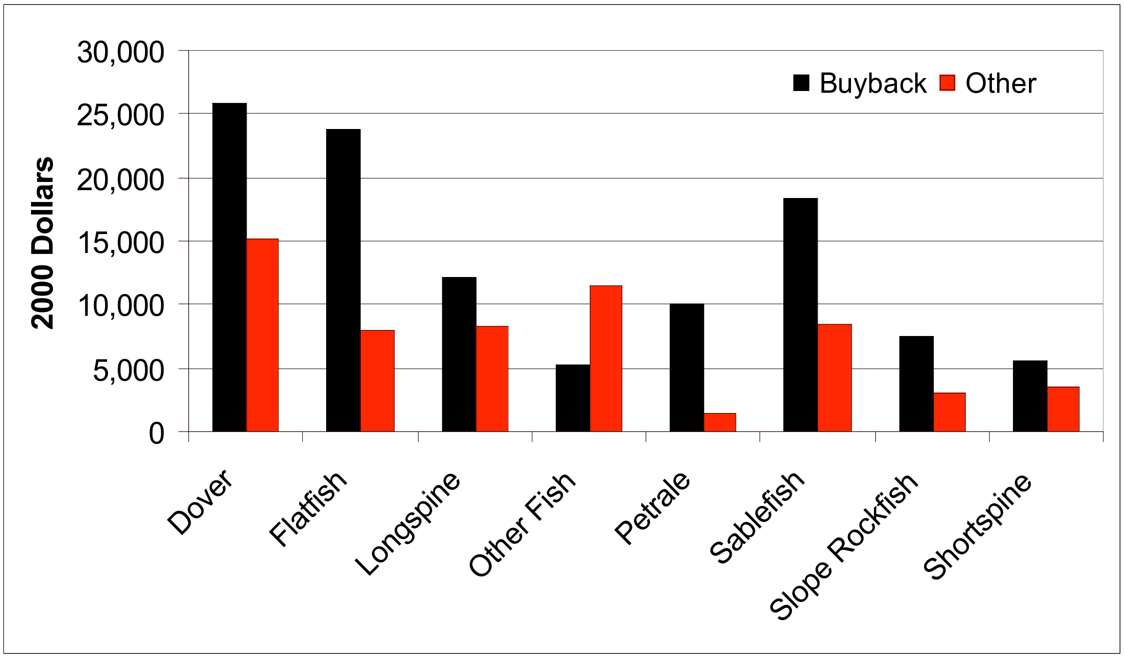
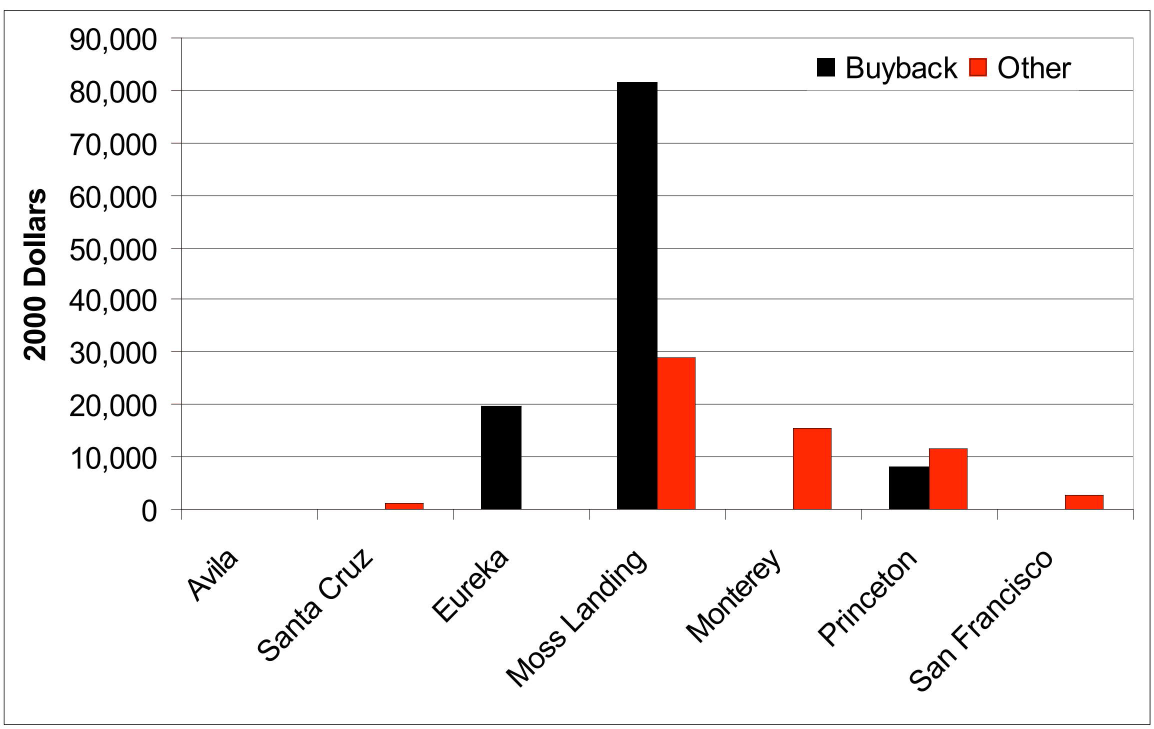


Fig. 5: Average 2003 Ex-Vessel Revenues of Buyback Winners (5) and Other Trawlers (15) from Grounfish Landings with Trawl Gear at California Ports for All Fish.



Results in Fig. 4 compare average ex-vessel revenues for the major species (or species groups) landed by the 5 buyback winners to other trawlers that landed at Monterey Bay ports during 2003. The major species are those with an average value of at least $1,000 per vessel in 2003. Species and species groups not presented in Fig. 4 are Arrowtooth, Bocaccio, Chilipepper, Canary Rockfish, Lingcod, Nearshore Rockfish, Shelf Rockfish, Splitnose Rockfish, and Widow Rockfish. The most interesting result in Fig. 4 is that buyback winners earned more on average in every category except all other fish. Overall, winners' average ex-vessel revenues in 2003 were almost $110,000 per vessel, while other trawlers' ex-vessel revenues averaged about $60,000. Total ex-vessel revenues for the entire group of trawlers that landed at Monterey Bay ports in 2003, for the three specific gear types listed above, are $1.2 million.

Results in Fig. 5 show the geographic distribution of average ex-vessel revenues among California ports for the 5 buyback winners and for the other 15 vessels with landings at Monterey Bay ports in 2003. Note that 75% of the winners' ex-vessel revenues occurred at Moss Landing, 18% at Eureka, 7% at Princeton, less than 1% Avila and Santa Cruz, and zero at Monterey and San Francisco. For the other vessels in Fig. 5, 48% of their revenues occurred at Moss Landing, 26% at Monterey, 20% at Princeton, 5% at San Francisco, 2% at Santa Cruz, and none at Avila or Eureka.

Vessels with Landings at Monterey Bay Ports in 2004

In 2004, 17 trawlers landed at Monterey Bay ports, and 9 of these had landings there in 2003, but the other 8 did not. Results in Fig. 6 show that distinct changes occurred after the buyback. The total number of trawlers to land at these ports in 2004 was 15% lower than in 2003. The 9 trawlers that landed at these ports both in 2003 and 2004 had, on average, much higher revenues in 2004 than those of the group of 8. Species presented in Fig. 6 yielded average ex-vessel revenues of at least $1,000 to one of the groups in 2004. Average ex-vessel revenues in 2004 were about $110,000 for the group that landed at Monterey Bay ports in both 2003 and 2004, and $30,000 for the group that did not.

Results in Fig. 6, combined with those in Fig. 4, imply that the group of trawlers with landings at Monterey Bay ports in 2003 and 2004 had below average revenues in 2003, and then moved up to replace vessels retired under the buyback. In fact, average ex-vessel revenues of this group in 2004 are equal in real terms to the buyback recipients in 2003. Since 5 buyback recipients landed at Monterey Bay ports in 2003, and 9 trawlers are in the group that landed at these ports in both 2003 and 2004, this difference contributed to higher ex-vessel revenues at these ports in 2004. However, the group of 8 trawlers that landed at these ports in 2004 but not 2003 had much lower average ex-vessel revenues, and as stated above, total ex-vessel revenues for these vessels as a group fell in real terms, by about $230,000 between 2003 and 2004.

Results in Fig. 7 show the geographic distribution of ex-vessel revenues for trawlers that landed at Monterey Bay ports in 2004. The groups of vessels that are compared in Fig. 7 and Fig. 6 are the same, between the group that had landings at Monterey Bay ports in 2003, and a group that did not. Note that trawlers with landings at Monterey Bay ports in both 2003 and 2004 in Fig. 6 and Fig. 7 are a subset of the other trawlers in Fig. 4 and Fig. 5. Some properties of the geographic distribution of landings by this subset in 2003 apparently carried over to 2004. For example, 45% of ex-vessel revenues for the group with landings in both 2003 and 2004 occurred at Moss Landing in 2004, 26% at Monterey, 20% at Princeton, and less than 2% at Santa Cruz, which are similar to values for this same group in 2003. Otherwise, 13% of revenues for this group of trawlers occurred at San Francisco in 2004, compared to 5% the previous year. The other trawlers with landings at Monterey Bay ports in 2004, but not 2003, recorded 84% of their ex-vessel revenues at Moss Landing in 2004, which is similar to the buyback winners the year before, followed by 7% at Santa Cruz, 5% at Princeton, 3% at Avila, and less than 2% at Ventura, Santa Barbara, and Monterey.

Fig. 6: Average 2004 Ex-Vessel Revenues from Grounfish Landings at All California Ports of the 2004-Only Group of Trawlers (9), and the 2003-04 Group of Trawlers (8).

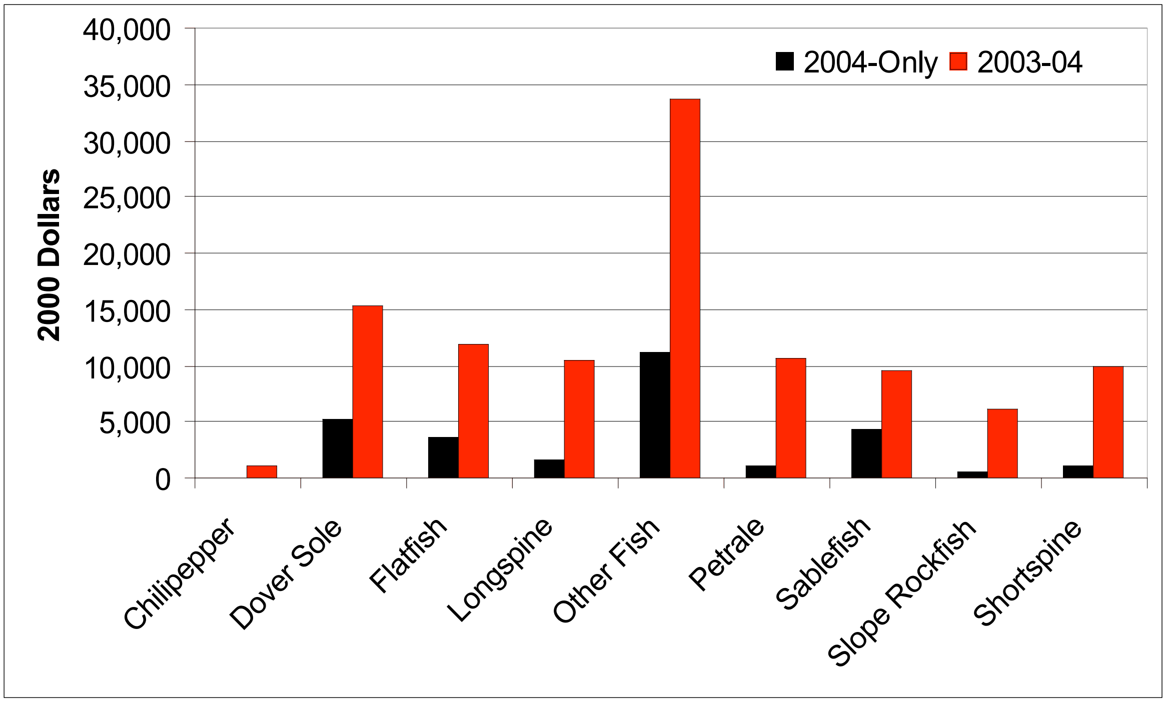
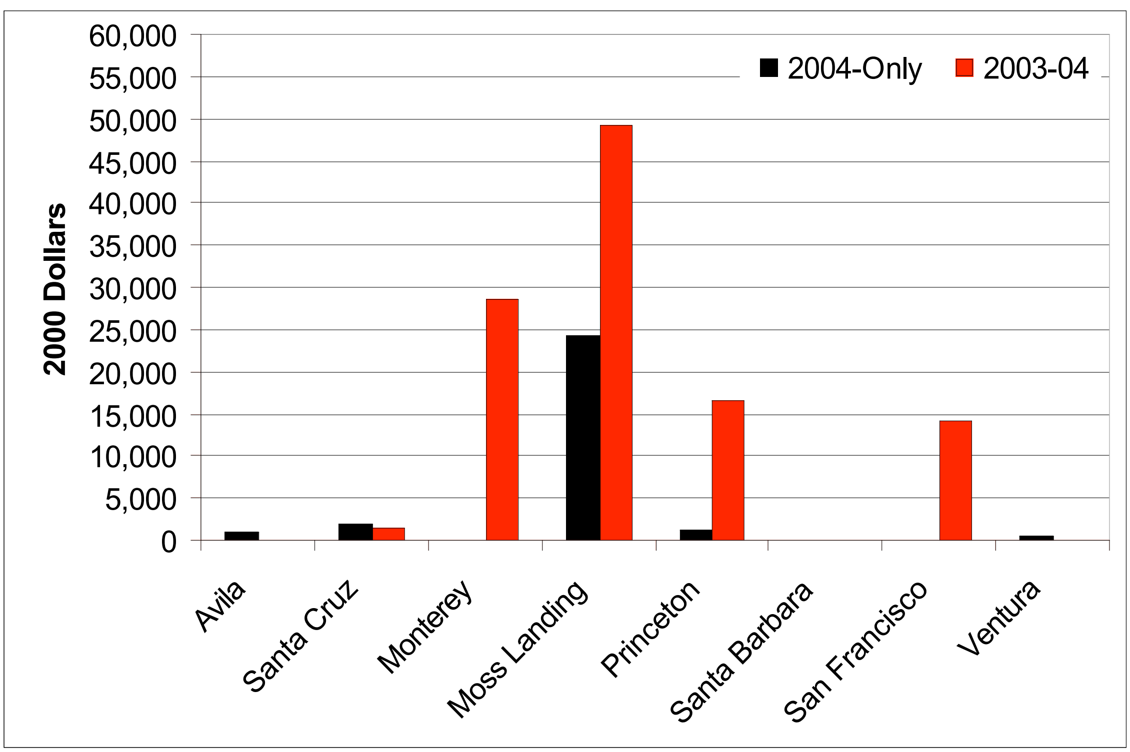


Fig. 7: Average 2004 Ex-Vessel Revenues from All Fish at California Ports of the 2004-Only Group of Trawlers (9), and the 2003-04 Group of Trawlers (8).



Results above compare actual (i.e. observed) outcomes in terms of landings and ex-vessel revenues in 2003 and 2004. The next set of results uses data from 2003 as a benchmark for analyzing what might have happened in 2004 if the buyback had not occurred (i.e. the counterfactual). We use the simplest standard empirical methodology that is available for this purpose, namely an algebraic decomposition of the observed change in total ex-vessel revenues from 2003 to 2004 into effects of a change in prices, compared to a change in landings.

Decompositions of the Change in Revenues from 2003 to 2004 with Ex-Vessel Prices

Effects of the buyback program on ex-vessel prices at Monterey Bay ports does not seem predictable from first principles because of the ambiguity due to geographic factors described in the introduction. In general, trip limits for trawlers changed both because of the buyback (i.e. fewer vessels over which to allocate TAC), and because of factors unrelated to the buyback program such as changes in the TAC due to new information about the stock, or due to changes in information about bycatch rates from the observer program.

Tab. 1: Total Real Ex-Vessel Revenues, Landings, and Ex-Vessel Prices 2003-2004 (Year 2000 $; landings in pounds, round weight; values not reported where N<3 to protect confidentiality).

	2003				2004			
Species	Trawlers	Revenue	Landings	Price	Trawlers	Revenue	Landings	Price
Arrowtooth	4	2,501	8,376	0.30	0			
Bocaccio	1				3	2,820	5,578	0.51
Chillipepper	11	3,183	5,201	0.61	5	9,776	21,143	0.46
Canary	4	307	337	0.91	3	219	327	0.67
Cowcod	0				1			
Dover	13	356,040	1,203,756	0.30	9	180,324	709,479	0.25
Flatfish	18	239,611	763,199	0.31	17	134,953	310,112	0.44
Lingcod	16	6,655	7,301	0.91	12	8,635	9,946	0.87
Longspine	14	186,238	278,975	0.67	8	106,506	164,773	0.65
Other Fish	18	198,137	141,977	1.40	17	392,386	284,665	1.38
Nearshore Rockfish	7	1,065	1,050	1.01	2			
Petrale Sole	16	70,432	79,578	0.89	13	104,728	121,608	0.86
Sablefish	14	218,635	253,917	0.86	8	121,123	175,111	0.69
Shelf Rockfish	9	867	1,415	0.61	8	1,849	2,189	0.84
Slope Rockfish	14	83,850	261,384	0.32	8	60,502	178,869	0.34
Splitnose	3	3,859	17,489	0.22	1			
Shortspine	14	80,565	95,379	0.84	8	96,940	61,893	1.57
Widow Rockfish	6	204	320	0.64	4	563	1.210	0.46

Results in Tab. 1 summarize information from the query of PacFIN fish tickets for trawlers with landings at Monterey Bay ports. Ex-vessel prices in Tab. 1 exhibit substantial variation from 2003 to 2004, with several changes on the order of 25% or more. The largest changes are price increases for Shortspine Thornyheads (85%), Flat Fish (39%), and Shelf Rockfish (38%). As a result, ex-vessel prices are generally greater in 2004 than in 2003, and the effect of higher prices is to offset part of the revenue loss from lower landings.

The total change in ex-vessel revenues from 2003 to 2004 may be decomposed into an effect of the change in landings, and an effect of the change in ex-vessel prices. For example, let P_t denote the price level, and Q_t landings, in year *t.* An algebraic decomposition of the change in ex-vessel revenues into a sum of changes in terms of P_t and Q_t is given by the formula:

$$P_{2004}Q_{2004} - P_{2003}Q_{2003} = P_{2003}(Q_{2004} - Q_{2003}) + Q_{2004}(P_{2004} - P_{2003}). \quad (1)$$

After omitting species with landings by fewer than 3 trawlers in either 2003 or 2004, the total change in ex-vessel revenues for the two years is a decrease of about $226,000. Evaluating the changes in landings using 2003 ex-vessel prices (i.e. the first term on the right-hand side of Eq. 1) in the decomposition formula above implies a decrease in ex-vessel revenues of about $238,000. The offset from the increase in prices using 2004 landings (i.e. the second term on the right-hand side) must add up to the total change, and so the offset term is equal to about $12,000. However, the choice of base year weights in the formula above was arbitrary, and the years used to compare the changes in landings and prices makes a difference. Using P_{2004} in the first term, and Q_{2003} in the second term, implies the first term is equal to a decrease of almost $288,000. Again, the second term must add up to the total change, and its value in this case is an increase of about $62,000, which makes sense because 2003 landings are greater for several species.

Trip Limits in 2003-2004 and Potential Ex-Vessel Revenues

As discussed previously, vessels that hold a permit in the West Coast Limited Entry Groundfish Trawl Fishery are managed using a system of bi-monthly trip limits for each vessel that are set by the Council and NMFS not to exceed a TAC for the entire coast. Consequently, a direct effect of the 33% reduction in the number of trawl permits (and vessels) was a 51% increase in the level of trip limits during 2004. In addition, trip limits were affected by changes in managers' perceptions of stock status (e.g. rebuilding plans for overfished stocks, new stock assessment results), and by updates in estimates of bycatch rates from the West Coast Observer Program. A direct measure of these differences is obtained by comparing potential ex-vessel revenues under the trip limits in 2003 and 2004.

We conducted a detailed analysis of trip limits in 2003 and 2004 with information in documents that are available on the NMFS NWR website (http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/Regulations). Tables in these documents are complicated, particularly in 2004, because trip limits vary by area, gear type, and species. Consequently, we used a few simplifying assumptions to make sense of the trip limits in our analysis. First, we only considered trip limits in the southern area (typically south of Cape Mendocino, and south of Point Reyes for Slope Rockfish in 2003), and applied these to all vessels in our analysis, despite some landings that occurred at Eureka in 2003 (see Fig. 5). Compared to 2004, calculating annual total trip limits was relatively straightforward in 2003, because these did not distinguish among gear types.

In 2004, trip limits for large and small footrope types of trawl gear were different during parts of the year for species or species groups in Tab. 2 that included, or were closely associated with, overfished stocks, specifically Bocaccio, Chilipepper, Canary Rockfish, Lingcod, Nearshore Rockfish, Shelf Rockfish, and Widow Rockfish. To make the situation even more complicated, different categories of fish or gear were combined during some parts of the year. For example, Widow Rockfish was included with Shelf Rockfish in the July-September period, and there was no distinction between different size foot ropes for Chilipepper during the October-December period, but a distinction was made during other parts of the year. Finally, adjustments were made in some cases to the trip limits in the middle of the bi-monthly trip period, as occurred at the September 2004 Council meetings. These complications made a precise comparison of annual trip limits in 2003 and 2004 at a disaggregated level impossible. Our major simplifying assumption was to use the trip limit in 2004 for either the large or small footrope, based on whichever had the greater value. We also ignored issues related to seasonal variations of trip limits, and simply added up the six bi-monthly trip limits to get a vessel-level value for total landings of each species over the course of a year. These assumptions mean that caution should be used in interpreting the results below, but even an intra-annual analysis (e.g. at the level of bi-monthly trip limits) would face similar aggregation problems.

Annual trip limits presented in Tab. 2 are the totals of the bi-monthly limits over the course of a year. Annual trip limits for trawlers at Monterey Bay ports are presented in the first two columns of the table, and the third column has the 2004 values scaled to match 2003 levels. The simplest, and perhaps most natural, candidate for a scaling factor is the ratio of 2004 trawlers divided by the number of 2003 trawlers, or about 2/3. This scaling factor implies a set of counterfactual trip limits.

Tab.2: Per Vessel Annual Trip Limits (pounds), Potential Revenues in 2003 and 2004 Ex-Vessel Prices (XP; Year 2000 $/pound).

	Trip Limits		Potential Revenues				
	2003	2004	2003	2004 XP	2004	2004*2/3	2003 XP
Arrowtooth							
Bocaccio	0	1,500	0	0	758	501	668
Chillipepper		44,000			20,345	13,427	17,775
Canary	2,000	1,700	1,822	1,342	1,141	753	1,022
Cowcod	0	0	0	0	0	0	0
Dover	181,000	271,000	53,535	46,004	68,878	45,460	52,902
Flatfish	420,000	248,000	131,862	182,774	107,924	71,230	51,388
Lingcod	5,200	4,900	4,740	4,515	4,254	2,808	2,948
Longspine	58,500	102,000	39,053	37,813	65,931	43,514	44,942
Other Fish							
Nearshore Rockfish	3,600	3,000	3,651	8,120	6,767	4,466	2,008
Petrale Sole							
Sablefish	47,000	84,000	40,469	32,510	58,102	38,348	47,737
Shelf Rockfish	3,600	3,600	2,205	3,040	3,040	2,007	1,455
Slope Rockfish	180,000	280,000	57,743	60,884	94,709	62,508	59,282
Splitnose	180,000	280,000	39,715	70,723	110,014	72,609	40,774
Shortspine	58,500	24,800	49,414	91,626	38,843	25,636	13,826
Widow Rockfish		2,600			1,209	798	1,092
Total			424,209	539,351	581,915	384,064	337,818
Per Vessel Difference from 2003			0	115,143	157,707	-40,144	-86,390
Group Total			8,484,173	10,787,028	9,892,563	6,529,091	5,742,911
Group Difference from 2003			0	2,302,855	1,408,390	-1,955,081	-2,741,262

There are several ways to calculate potential ex-vessel revenues based on the trip limits in Tab. 2. The most obvious way is to assume a hypothetical efficient vessel that lands the full limit of each species, and evaluate those landings at contemporaneous ex-vessel prices. We present values in both 2003 and 2004 real prices to reflect our underlying uncertainty about whether the observed price changes were directly due to the buyback, or to other factors. A column with potential ex-vessel revenues for 2003, evaluated with 2003 prices, is given in Tab. 2, followed by a column with the 2003 trip limits evaluated at 2004 ex-vessel prices (XP). The next column gives potential revenues of 2004 trip limits and prices, followed by a column with the counterfactual trip limits in 2004 prices, and finally to complete the table, the last column of Tab. 2 has the counterfactual trip limits evaluated at 2003 prices.

The bottom part of Tab. 2 calculates total ex-vessel revenues in each case, ignoring undefined values (e.g. Arrowtooth), and the difference of each value from the 2003 benchmark. Since ex-vessel prices were higher in 2004, the value of 2003 benchmark trip limits, evaluated at 2004 prices, is greater than with 2003 prices, in total by about \$115,000. In fact, the 2004 trip limits are potentially worth more than those in 2003 to an individual vessel by almost \$158,000, but the counterfactual trip limits (i.e. scaled to 2003 levels) are worth about \$40,000 less. Using 2003 prices decreases their value further.

Next in Tab. 2, recall that 20 groundfish trawlers recorded landings at Monterey Bay ports in 2003, and there were 17 such vessels in 2004. Scaling per vessel values in the first two columns of the revenues portion in Tab. 2 by a factor of 17, and other values in this portion by 20, gives estimates of total ex-vessel revenues for an entire group of vessels with landings at Monterey Bay ports under various combinations of regulations and prices in 2003 and 2004. The bottom line of Tab. 2 gives the difference of total ex-vessel revenues for a group of 17 trawlers in 2004 under the various cases, and total revenues of the 20 vessels in 2003. Note that using 2004 prices adds \$2.3 million to the value of 2003 trip limits, and using 2004 trip limits adds another \$1.4 million to potential ex-vessel revenues.

Scaling 2004 trip limits in Tab. 2 to a counterfactual level that matches the number of trawlers in 2003 reduces potential ex-vessel revenues by almost \$2.0 million, and the value of this modification to trip limits, evaluated in 2003 prices, is \$2.7 million less than the benchmark value of potential ex-vessel revenues for 2003. Corresponding values are relatively close for the effects of prices, and the direct effect of the buyback, in terms of the change in the number vessels, on trip limits. These results imply that, at least in terms of potential ex-vessel revenues, the change in ex-vessel prices from 2003 to 2004 had about the same size effect on potential ex-vessel revenues as did the change in trip limits between these years, scaled by the appropriate number of active trawlers. Similar calculations could be done for each species.

Multi-Species Production Model and Projections of Ex-Vessel Revenues

In the final stage of analysis, we formulated a simple multi-species model of ex-vessel profits under trip limits, and calibrated the model to data for 2003, with the intent of using the model to project MBA ex-vessel revenues in 2004 without the buyback. Unfortunately, an assumption in the model, that a trip limit for at least one species is binding, fails to be satisfied (even approximately) for the vessels included in this analysis. Nonetheless, the model is useful for demonstrating how economic theory applies to the analysis in this report, and in particular, how the purely empirical result of a relatively small impact on ex-vessel revenues from the buyback is probably accurate.

We describe the model for two species, which is sufficient because it easily generalizes. Assume that landing $y_1 \geq 0$ and $y_2 \geq 0$ pounds of species 1 and 2 (respectively) has costs given by a function $f(y_1, y_2) = (y_1)^{\alpha}(y_2)^{\beta}$ such that $\alpha, \beta > 1$. We use the behavioral assumption of profit maximization, and data on landings from the 2003 benchmark, to calibrate parameters in the cost function. This assumption may not be satisfied in practice, which is something to explore in fieldwork.

Given ex-vessel prices for each species of p_1 and p_2, the profit function of an individual trawler is

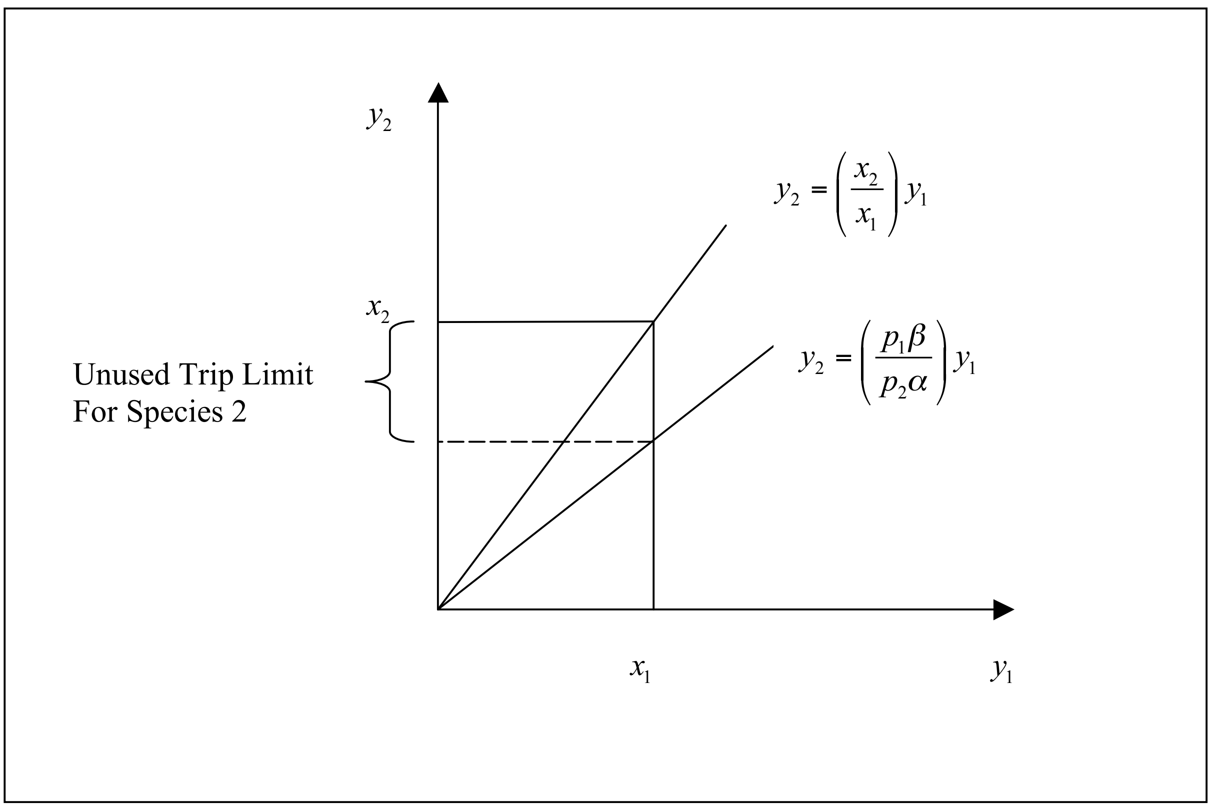
$$\Pi(y_1, y_2) = p_1 y_1 + p_2 y_2 - (y_1)^{\alpha}(y_2)^{\beta}. \tag{2}$$

We assume that each trawler maximizes profits subject to trip limits $x_i \geq 0$, which implies constraints $y_i \leq x_i$ for $i = 1, 2$. Unconstrained solutions to this maximization problem must satisfy a first-order condition that implies y_1 and y_2 are on a ray through the origin of the form

$$y_2 = \left(\frac{p_1 \beta}{p_2 \alpha}\right) y_1. \tag{3}$$

In a deterministic model, a vessel operator would maximize profits by increasing y_1 and y_2 along the ray implied by profit maximization until $y_i = x_i$ for at least one species. An example is represented graphically in Fig. 8. In the figure, there are two rays from the origin. The slope of one ray is given by the ratio of trip limits, x_2 / x_1, and the slope of the other is defined in equation (3) above. In the figure, the slope defined by the ratio of trip limits is greater than the slope of the ray implied by profit maximization, and thus, the optimal choice is to fill the trip limit for species 1, and to leave part of the trip for species 2 unused.

Fig. 8: Geometric Representation of Profit Maximization and Trip Limits for 2 Species.



The general condition for filling the trip limit of species 1 may be expressed in terms of a ratio of potential ex-vessel revenues:

$$\frac{\beta}{\alpha} \leq \frac{p_2 x_2}{p_1 x_1}. \tag{4}$$

In this case, $y_1 = x_1$ is optimal and the unused portion of the trip limit for species 2 is given geometrically by the residual amount in Fig. 8, or algebraically by

$$z_2 = x_2 - \left(\frac{p_1\beta}{p_2\alpha}\right)x_1. \tag{5}$$

Data in Tab. 1 on total ex-vessel revenues in 2003 are used to calibrate the ratio β / α. Without loss of generality, we use Dover sole as the numeraire (i.e. Dover is used as species 1 for each comparison to the other species listed in Tab. 1), and note that (2) implies that

$$\frac{\beta}{\alpha} = \frac{p_2 y_2}{p_1 y_1}. \tag{6}$$

A comparison of the calibrated values from (5) to the test condition in (3) implies that, on average in 2003, the calibrated value of β / α is less than the corresponding ratio of potential ex-vessel revenues for each of the species, or groups of fish, that were considered in this part of the analysis: Canary, Flatfish, Lingcod, Longspine, Nearshore Rockfish, Sablefish, Shelf Rockfish, Slope Rockfish, Splitnose, and Shortspine. In other words, this analysis implies that trawlers on average were more constrained by the trip limit for Dover sole in 2003 than the others. Similarly, the calibrated value of β / α is less than the corresponding ratio of potential ex-vessel revenues for each of the species, or groups of fish in 2004. Note that scaling the 2004 trip limits by 2/3, a counterfactual without the buyback, would not affect this result.

The upshot of comparisons using the test condition (3) is that the geometric reasoning illustrated in Fig. 8 may be translated into a simple algebraic projection of ex-vessel revenues by rearranging (2), and substituting in the trip limit for Dover sole:

$$p_2 y_2 = \left(\frac{\beta}{\alpha}\right) p_1 x_1. \tag{7}$$

As above, the projection in (6) can be based on ex-vessel prices from 2003 or 2004, but note that only the price of the numeraire, in this case Dover sole, is used to project ex-vessel revenues for the other species. Obviously, (6) represents an extremely simple projection methodology, and its primary virtue is a transparent link to economic theory. While theoretically sound, there is an empirical flaw in (6) because the aggregate trip limit for Dover, x_1, is not close to being met in the benchmark, which is another area to explore in field work. A summary of the aggregate experience with trip limits of trawlers that landed at Monterey ports is provided below.

Tab. 3: Percentage (%) of Trip Limits Filled by Average Landings at Monterey Bay area ports in 2003 for trawlers with non-zero landings in each species (group). Species without trip limits, or for which average landings are less than 10% of the respective trip limit, in one or more periods in 2003 (e.g. Petrale sole), are not included in the table.

	Number	T1	T2	T3	T4	T5	T6	Total
Dover	12	46.1	65.2	48.5	41.4	58.7	48.5	51.2
Flatfish	18	12.0	12.1	15.0	3.3	12.2	6.0	10.1
Lingcod	16	13.4	8.3	9.2	7.9	12.7	1.2	8.8
Longspine	14	49.4	32.0	28.9	26.8	38.3	34.6	34.1
Sablefish	14	45.0	48.2	30.7	39.4	38.4	35.2	38.6
Shelf Rockfish	12	16.6	19.5	25.9	7.7	14.2	12.5	16.1
Slope Rockfish	14	25.3	10.2	4.7	2.6	9.6	9.8	10.4
Shortspine	14	19.7	15.7	10.3	7.0	9.8	10.1	11.6

Results in Tab. 3 show the percentage of each trip limit that is filled by the average amount of landings in 2003, only for vessels that reported landings. The last column in Tab. 3 adds the mean values for each trip period, and divides these by the corresponding aggregate annual trip limit for 2003 from Tab. 2. The main point of Tab. 3 is to show that trawlers with landings at Monterey Bay ports in 2003 were not constrained in many cases by trip limits. Other factors that may have been constraining include demand for fish landed at these ports, the costs of fishing, environmental conditions, or other factors. However, an analysis of these factors is beyond the scope of this report.

Conclusions

This report discusses and illustrates the use of disaggregated PacFIN data to assess the impacts of management actions. We have used a few simple empirical methods to evaluate the effects of a trawl buyback program in 2003 for the West Coast limited entry groundfish fishery. Overall, ex-vessel revenues for landings of groundfish by trawlers at Monterey Bay ports decreased after the buyback but several factors were involved. First, the number of vessels that landed groundfish using trawl gear went down by 15%, which we presume is a direct effect of the buyback. However, the potential effect on ex-vessel revenues of changes in trip limits used to regulate individual trawlers was smaller, and in general, the corresponding expansion of trip limits does not appear to have noticeably affected ex-vessel revenues, primarily because the trip limits only appear to be binding for a few of the most active vessels, and only then, during some time periods. A decomposition of the change in ex-vessel revenues from the end of 2003 through 2004 showed that ex-vessel prices on average went up, and thus, a decrease in landings due to the change in the number of vessels seems to be the primary explanation for the modest loss in the ex-vessel value of groundfish landings by trawlers at Monterey Bay ports.

The analysis in this report raises some interesting questions that deserve further attention. The most interesting is about the trawlers that landed at Monterey Bay ports in both 2003 and 2004. These vessels had some of the lowest ex-vessel revenues in 2003 of the entire group of groundfish trawlers that landed at Monterey Bay ports in that year, while vessels that went on to have winning bids in the buyback program had some of the highest. Trawlers that landed at Monterey Bay ports in both years went on to have ex-vessel revenues on par with the buyback winners the year before, and trawlers that had not landed at MBA ports in 2003 took their place as the low-revenue vessels. An interesting question to follow up this analysis is whether this same pattern occurred at other ports, and to investigate the newcomers' fishing activities in 2003. A related set of questions pertains to investigating the cause of the weak effects that we observed in response to the increased trip limits, and whether these were specific to Monterey Bay ports. These ports received fewer landings by groundfish trawlers than some ports further north, and thus, demand for groundfish there might be limited. Alternatively, unfilled trip limits may have been a temporary state of affairs, but data in the report show that ex-vessel revenues of groundfish trawlers that landed at Monterey Bay ports fell again in 2005.

Pursuit of these questions through expanded analysis of the landings data together with interviews of buyback winners and those who remained in the fishery would be a logical next step in this process. The expanded landings data analysis would focus on the longer-term (retrospective and prospective) and broader spatial patterns of buyback winners and remaining trawlers for both groundfish and non-groundfish species. The landings data analysis (in concert with other archival data used here) could be used to address several questions, including:

- What were the fishing patterns (i.e., distribution of landings among ports) for trawlers during the six years prior to the buyback, and in the period after the buyback?
- What was the distribution of landings across ports before and after the buyback?
- Did participants deliver to different subsets of ports before and after the buyback?
- How did these two sets of patterns vary within the pre-buyback and post-buyback periods?

Fieldwork would then entail interviews with those who participated in the buyback and those who did not, to characterize both groups of fishery participants and their operations, their fishing strategies (in terms of species targeted, timing and location), the factors that influence their use of those strategies, including how, if at all, the buyback led them to alter their strategies, and how their social and economic well-being has changed since the buyback. Questions to guide this work include:

- How do buyback participants and those who remain in the fishery compare in terms of their demographics, fishing experience, fishing practices and operations (e.g., vessel size, gear, crew size).
- Have the buyback participants remained in fishing or left?
- What fisheries or other activities are they engaged in?
- What factors (e.g., environmental conditions, regulations, market access and prices) influence where they fish and the species they target, and how?
- How has the buyback affected their strategies for adapting to change in these factors?
- How have their operating costs changed since the buyback?

Although a focused, region-specific study would be fruitful, a larger study of the statewide or, better, coastwide trawl fishery would afford the most reliable and valid understanding of buyback impacts.

In addition to further illuminating the implications of this buyback (and perhaps other management actions), this work would further demonstrate the efficacy of using the landings data to inform field studies to measure management impacts, and in turn, the development of better models to predict fishery responses to management actions.

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