

I. INTRODUCTION

Fisheries managers in California must consider the economic effects of management changes and plans on individuals, businesses, fishing communities, and local economies. Currently there is a gap in our understanding of the economic characteristics of California's commercial fishing fleet. This stems from a lack of current information that can be used to assess the economic impact of proposed management measures. From the standpoint of economic impact assessment, the last authoritative and comprehensive analysis of California's commercial fishing fleets occurred in the early 1980's (King and Flagg 1982), and is now outdated.

The California Department of Fish and Game (CDFG) requested this research and provided the funds to implement it. The project has two distinct elements. The first was a statewide survey of all the marine capture fisheries in California, conducted by Hackett and Hansen. These data were then merged with landings receipt and license datasets, which allowed for comprehensive estimation of both unit and item non-responses. The result was a dataset that includes estimated costs, revenues, and other descriptive statistics for each of the state's marine capture fisheries. Data were then aggregated by operational configuration (OC) and by location (county, region, and state overall). A description of the data sources, methods of analysis, and operational configurations is given in section II below. Summary cost, revenue, and other descriptive statistics are provided in tabular form in section III below.

The second element of this project was the creation of customized IMPLAN input/output models, multipliers, and economic impact assessments for California's marine capture fisheries (Minnesota IMPLAN Group 2008). This component of the project was supervised by King and Associates. Cost data from the survey, and revenue data from CDFG landings receipts, were used to identify input/output coefficients that were then used to create the customized IMPLAN models for each OC. The impact models are also differentiated by location (county, region, and state overall). The resulting California Ocean Fish Harvester Economic (COFHE) Model, which updates and expands the commercial fishing sector for California's economic impact modeling system, is introduced in section IV below. Supplementing this report are the COFHE models (in IMPLAN format) and Excel-based "look-up" tables that can be used by non-IMPLAN experts to estimate economic impacts related to California's commercial fisheries. Both sets of supplemental materials are available from CDFG.

II. BACKGROUND INFORMATION

This portion of this report is divided into four subsections – data sources and methods of analysis, a description of the operational configurations, a list of cost categories, and a discussion of ex-vessel revenue.

II.1 Data Sources and Methods of Analysis

The analysis presented in this report derives from data gathered from a California commercial fisherman mail survey (the survey instrument and a detailed discussion of survey methods are available in the appendix). Pre-survey meetings were held in various fishing ports in California, and project endorsements were received from the Pacific Coast Federation of Fishermen's Associations (PCFFA), the California Sea Urchin Commission, and the California Wetfish Producers Association. Survey questions were pre-

tested with fisheries leaders identified from the pre-survey port meetings. All fishermen who made landings in 2006 in California received a survey requesting economic and demographic data. The total research design method (Dillman 1978) was used to encourage fishermen to complete and return the survey. This included a pre-survey letter, the survey, a follow up postcard, and a second survey with a new cover letter and an additional letter provided by the Pacific Coast Federation of Fishermen's Association. Surveys were sent to all fishermen on August 20, 2007. A second mail out was sent on September 26, 2007 to those fishermen who had not yet responded. December first was chosen as the cutoff date for receiving surveys. By following this method, 1,946 commercial fishermen received a survey and 405 viable surveys were received, amounting to a 20.8 % response rate.

Quality assurance and quality control methods helped limit potential errors in responses and data tabulation. This included a random check of 30 % of tabulated surveys that were compared with the paper survey responses. "Ground truthing" the data was then implemented with assistance from thirteen commercial fishermen spanning the major fisheries in California. This process involved identifying a number of commercial fishermen having substantial experience among the state's various fisheries and who were also willing to assist the research project. These volunteers were provided with anonymous summary data showing mean, maximum, and minimum reported survey responses by cost category for each specific fishery, and by each vessel size class. Other data they reviewed included the reported range of days fished, and a list of other fisheries that respondents reported to have participated in during 2006. The "ground truthing" fishermen reviewed the information and provided information on likely ranges of costs by category. This information was then used to either confirm survey results or to identify unusual responses that may require adjustment. Data outliers were deleted if no supporting information was provided, modified if a mean value could be applied from survey responses of fishermen of similar characteristics, or left alone if other information provided on the questionnaire appeared to support the outlier value.

Mean survey response values by vessel size category were used to estimate unit and item non-responses for some fixed costs categories, including slip fees, interest costs, and certain vessel-related costs (hull, engine, electronic gear, and other gear). CDFG 2006 fees (boat registration, permit fees, commercial license fees) were calculated for each fisherman active in 2006 based on fishing activity recorded on fish landing receipts. CDFG fish landing receipts were also used to estimate landing taxes for all fishermen by applying 2006 tax rates for type of and amount of fish landed. Commodity board assessments for all salmon and urchin fishermen were applied using CDFG landing receipts as well.

The disaggregated survey data were then merged with license and landings receipt datasets provided by CDFG. These additional data provided observations on all active fishermen, and could thus be used to infer both unit and item non-responses. Regression models were used to estimate some fixed and variable costs for unit and item non-respondents based on the merged dataset. Regression estimates for fixed and variable operating costs include insurance, membership fees, state and federal taxes, fuel and lube, harbor fees, transportation costs, ice, bait, food, and crew wages. By combining the survey respondent cost data with the cost estimates addressing unit and item non-responses, and with CDFG's ex-vessel revenue dataset, a complete dataset was created that represents estimated costs and revenues for all 1,946 California commercial fishermen active in 2006.

As noted above, costs were estimated for each fisherman based on observable characteristics from the merged database. These characteristics include 2006 home port and landing port locations, 2006 OC participation, individual 2006 landings by OC, and vessel size and gear type circa 2006. After each category of cost was estimated (or tabulated from the survey) for each fisherman, these cost totals by category for each fisherman were then aggregated by OC. In the great majority (67%) of cases, fishermen only participate in one OC, in which case their costs are simply aggregated into that OC. In the minority of cases where fishermen participate in more than one OC, the aggregation process worked as follows. If, for example, a fisherman made 40 % of his total 2006 fishing trips in OC 1, and 60 % of his fishing trips in OC 2, then the estimated totals for each cost category for this fisherman were allocated 40 % to OC 1 and 60 % to OC 2. Moreover, costs were further aggregated by county in order to facilitate spatial economic impact modeling and assessment. In particular, fixed costs were attributed to a fisherman's home port county, and variable costs were assigned to a fisherman's landing port county.

The method of cost estimation and aggregation by OC implies a small amount of cost blending across OC, due to the minority of cases (33%) of fishermen who participate in more than one OC. Blending raises some issues for some potentially large cost categories, such as bait and ice, which are not incurred in all OCs. Bait and ice costs are tabulated from (survey respondents) or estimated for (non-respondents) a fisherman due to their activity in an OC in which these fishing inputs are used. But for the minority of cases in which that fisherman also participates in an OC where bait and ice are not used, nevertheless a share of his bait and ice costs are allocated to that OC where they are not used. The OC that do not require bait include CPS, Gillnet, Harpoon/Spear, Herring, Sea Urchin, Tuna/Other Seiner, and Trawlers. Likewise ice is not used in the Dungeness Crab, Lobster & Crab, and Sea Urchin OCs.

To remedy the bait and ice cost issue, two assessments were made. First, if the total estimated bait or ice costs for an OC that does not use these inputs appeared relatively high, those costs were zeroed out. While this policy results in a small underestimate of total bait and ice costs across all the OCs, it is likely to provide a more accurate portrayal of these costs in the OCs that do not use these inputs. In the remainder of cases, bait or ice costs were deemed to be relatively small, and these costs were retained. Thus when bait or ice costs are seen in the tables that follow in this report for some OC that clearly do not utilize these inputs, these costs will tend to be relatively small, and can be attributed to modest levels of activity in OCs that utilize these inputs. Other cost categories that are not common to all OCs (such as association membership fees) are also blended to a minor degree, but these costs are generally much smaller and were not modified. The bait and ice costs that were removed from OCs that do not use these inputs were added back to the statewide totals in Table 5 below.

II.2 Operational Configurations

Commercial fishermen are categorized into distinct **operational configurations (OCs)** that were constructed in collaboration with Terry Tillman of CDFG. Commercial fishermen are grouped into 20 OCs depending on species landed, size of vessel, and gear type used to land the targeted species. The result of this process is illustrated in Table 1 and in the following summaries.

Table 1: California's Operational Configurations

Operational Configuration	Vessel Size	Gear Types
Coastal Pelagic Species (CPS) Seine (includes Squid)	Any	Seine, Brail/Dip Net, Lampara Net
Dungeness Crab– Medium and Large Vessels	26' and Larger	Crab Trap
Dungeness Crab - Small Vessels	< 26'	Crab Trap
Harpoon/Spear	Any	Harpoon, Spear
Herring Gillnet	Any	Gillnet - set or drift
Hook & Line	Any	Hook and Line
Hook & Line Live	Any	Hook and Line
Lobster & Crab	Any	Crab or Lobster Trap
Longline	Any	Longline
Nearshore & Groundfish Trap	Any	Fish Trap, Crab Trap
Other Gillnet	Any	Gillnet Set and Drift
Prawn Trap	Any	Prawn Trap, Fish Trap
Salmon	Any	Salmon Troll, Hook and Line
Salmon & Albacore	Any	Salmon and Albacore Troll, Hook and Line, Jig
Salmon & Dungeness Crab – Medium and Large Vessels	26' and Larger	Salmon Troll, Hook and Line, Crab Trap
Salmon & Dungeness Crab – Small Vessels	< 26'	Salmon Troll, Hook and Line, Crab Trap
Sea Urchin	Any	Dive/Hook
Trawl - Northern California (north of Santa Barbara)	Any	Trawl
Trawl - Southern California (south of Santa Barbara)	Any	Trawl
Tuna/Other Seine	Any	Purse and Danish/Scottish Seine

Coastal Pelagic Species (CPS) Seine

A majority of “CPS Seine” fishermen are associated with very large vessels (> 40’) and are active primarily in southern California. Additionally, the fishery operates in central California, but in a lesser extent. The gear associated with the CPS fishery includes: purse seine, Danish/Scottish seine, lampara nets, and brail and dip nets. The target species include anchovies, sardines, smelt, mackerel, and market squid. These species are fished nearshore or in the open ocean; as far as 600 miles from shore (Hill and Klingbeil 2001). Trips range between one to five days. Volume of landings for the majority of the bigger vessels are generally very large (80,000 lbs. or greater). The CPS fishery is a limited entry fishery.

Dungeness Crab

Of the vessels operating in the Dungeness crab fishery, medium and large vessels dominate (>26'). These larger vessels are better able to accommodate the space needed for transporting the 3.5-foot diameter crab trap gear (Hankin 2001). However, there is a small contingent fishing with vessels less than 26'. The fishery is active in central and northern California. The Dungeness crab season begins in the late fall and continues into the early summer of the following year. Trips for medium and large vessels range from one to four days, while small vessels tend to stay out for only one day. The Dungeness crab fishery is a vessel based restricted access fishery.

Harpoon/Spear

Most "Harpoon/Spear" fishermen fish from large vessels (> 36'). The harpoon/spear is handheld and is propelled towards its target specie, swordfish, from the fishing vessel (Holts 2001). As swordfish reside in warmer waters, the fishery operates in southern California. "Harpoon/Spear" fishermen fish from May to December. Trips range upwards to seven days. This very selective fishery is being displaced by the drift net fishery. In 2006, less than 30 fishermen made landings using harpoon/spear gear.

Herring Gillnet

Medium and large vessels ($\geq 26'$) predominate in the "Herring Gillnet" OC. These larger vessels are required to accommodate the gillnet gear and the high volume of catch (generally between 1,000 to 6,000 lbs.). The fishery operates in California's four largest herring spawning areas: San Francisco Bay, Tomales Bay, Humboldt Bay, and Crescent City Harbor. Duration of a single trip can last between one and five days. Pacific herring is the targeted species; however, the fish sac-roe (ovary) is the product sought after and is mainly supplied to the Japanese market (Watters, Oda, and Mello 2001). The herring gillnet is a highly competitive fishery due to the small fishing area and short season (January and February). The sac-roe fishery is a limited entry fishery and is managed by a catch quota system.

Hook & Line

Over 500 fishermen made landings using hook and line gear. These fishermen primarily fish from small to medium sized vessels ($\leq 36'$). "Hook & Line" gear consists of: rod and reel, and vertical and horizontal set lines. "Hook & Line" fishermen target lingcod, rockfish, flounder, sole, tuna, shark, sablefish, California halibut, seabass, croaker, and surfperch. A majority of trips lasts from one and two days but can span up to four. This fishery primarily operates in central and northern California.

Hook & Line Live

In the late 1980s the live fishery for the restaurant market began taking shape in southern California and extended to northern California in the 1990s, and is now a common fishery in central California (McKee-Lewis 1996). The live/ premium fish fishery targets smaller "plate size" fish which concern fisheries managers, as these fish are likely juveniles and have not reach reproductive age (Cailliet 2000). As with the "Hook & Line" OC, these fishermen predominately fish from small and medium sized vessels ($\leq 36'$). However, the "Hook & Line Live" fishermen primarily use rod and reel gear. In 2000, 70 % of live fish landings were made by hook and line gear (Schultze 2001). The primary variety of fish landed live include: sheephead, lingcod, California halibut, and rockfish. Nearshore fishery species are regulated through a restricted access program. The groundfish fishery is generally managed as an open access fishery although restrictions apply to specific species.

Lobster & Crab

All size classes of vessels operate in the “Lobster & Crab” OC. The fishery relies on crab and lobster traps. Fishermen operating medium and larger vessels can have between 100 to 300 set traps at one time. The fishery mainly fishes in the shallow rocky areas of southern California (Barsky 2001). It is considered a highly lucrative fishery where ex-vessel prices for lobster hovered around \$10/lbs. in 2006. “Lobster & Crab” fishermen target the California spiny lobster, rock crab, and spider crab. Trips range between one and three days. The season runs from fall to spring of the following year. It is a restricted access fishery.

Longline

“Longline” fishermen fish from a variety of vessel lengths and are active along the entire coast of California. Longline gear consists of baited hooks attached to a long main line (miles long) that can either be buoyed or laid on the ocean floor (Leet et al 2001). Due to the structure of longline gear, multiple species of fish are caught such as: tuna, mackerel, shark, sablefish, sole, rockfish, croaker, and swordfish. As “Longline” fishermen can target an assortment of species, they operate throughout the year. The pelagic longline fishery (tuna, mackerel, and shark) is a restricted access fishery and the groundfish longline fishery is a limited entry fishery.

Nearshore & Groundfish Trap

“Nearshore and Groundfish Trap” fishermen mainly fish from medium and large vessels ($\geq 26'$). The gear associated with the fishery includes fish and crab traps. These fishermen also a participant in the live fish fishery, as a majority of their catch is landed live (Schulteze 2001). The trap fishery targets nearshore and groundfish species which includes: sheephead, sablefish, scorpionfish, and Cabazon. Fishermen in this OC are mainly active in central and southern California. Two to three day trips are common. The groundfish and the nearshore trap fisheries are both limited entry fisheries.

Prawn Trap

Medium and large vessels ($\geq 26'$) are the common vessel sizes used in the “Prawn Trap” OC. The prawn fishery operates throughout the year and is located in southern and central California. The primary harvested species is the spot prawn and coonstriped shrimp, however, crayfish fishermen are also included in this OC as they use prawn traps as well. Prawn traps targeting spot prawns are deployed as deep as 600 to 1,000 feet along submarine canyons or shelf breaks. The trap gear allows for a majority of spot prawn catches to be landed live, which is principally sold to the local Asian and overseas markets (Larson, 2001). Fishermen fish for two to three days. The spot prawn trap fishery is a restricted access fishery.

Other Gillnet

The “Other Gillnet” OC incorporates both set and drift net gear types. Medium and large vessels ($\geq 26'$) are the predominate vessel sizes using gillnet gear. The fishery mainly operates in southern California, but a small fishery exists in central California. Drift gillnet gear generally targets tuna, swordfish, shark, seabass, and opah. Set gillnets largely catches barracuda, shark, California halibut, and seabass. Trip duration ranges between one and six days. The general gillnet fishery is a restricted access fishery.

Salmon

The “Salmon” OC employs a variety of vessel sizes, however medium and small vessels are the most numerous ($\leq 36'$). Gear types include: salmon troll and hook and line. The salmon season generally spans from early summer to fall. The fishery is concentrated in central and northern California. Fishermen can spend up to four days at sea on a single trip. The salmon fishery is a restricted access fishery. It should be noted that NOAA Fisheries Service closed the commercial 2006 salmon season north of Pt. Arena in California, and much of the rest of California saw an abbreviated season (NOAA Fisheries Service 2006). The closure and restricted season likely affects the cost and revenue data for the salmon OCs presented in this report.

Salmon & Albacore

Fishermen who fall under this OC usually fish with large vessels. “Salmon & Albacore” fishermen use hook and line, and salmon and/or albacore troll gear types. The season runs from early summer to early fall. Fishing activity occurs in northern California and off the coast of Oregon; however fishermen primarily make their landings in central and northern California. Fishing trips range between one and 20 days. It should be noted that within the “Salmon & Albacore” OC, a large number of the fishermen only landed albacore in 2006, though many used salmon troll gear. In collaboration with Terry Tillman it was determined that the albacore-only fishermen should fall under the “Salmon & Albacore” OC since albacore and salmon gear types are similar, and many salmon fishermen target albacore as well.

Salmon & Dungeness

Since the salmon and Dungeness crab seasons follow and overlap each other, a number of fishermen fish both fisheries throughout the year. Most “Salmon & Dungeness” fishermen operate medium and large ($\geq 26'$) vessels, though a minority group fish from small vessels ($< 26'$). “Salmon & Dungeness” gear types include: hook and line, salmon troll, and crab trap. Fishermen fish central and northern California waters. Fishermen who fall under this OC are able to fish from winter to the following fall. Small vessel fishermen generally fish for a single day, and medium and large vessel fishermen can stay out up to four days. The salmon and Dungeness crab fishery are both restricted access fisheries.

Sea Urchin

Sea urchin fishermen tend to fish from medium sized vessels (26' to 36'), but all size classes participate in the fishery. Many fishermen who are deemed “unclassified” as a vessel size class category (section III) are most likely walk-on-divers and have their own individual landings recorded. The fishery is split into two localities – southern and northern California (Mendocino being the most northern county). Sea urchin fishermen gear consists of an air compressor, dive suit, and hand rakes. Target species include red sea urchin and sea cucumber (warty sea cucumber in the south and giant red sea cucumber in the north). Fishing trips range from one to three days. The sea urchin fishery is a restricted access fishery.

Trawl – Northern California

Northern California trawler fishermen are fishermen who landed a majority of their catch north of Santa Barbara County. Northern California trawlers are chiefly large vessels (>36'). The gear implemented in this OC spans the trawling gear selection – general, mid water, bottom, less than and greater than 8' footrope, and selective flat fish trawl. The species landed consists of: ocean shrimp, shark, skate, sablefish, lingcod, sole, California halibut, flounder, rockfish and whiting. Northern California trawlers are active in central and northern California and fish throughout the year. Trips range from one to three days.

Trawl – Southern California

Southern California trawler fishermen land a majority of their catch south of Santa Barbara County. Southern California trawlers fish with medium and large sized vessels ($\geq 26'$). Gear for this OC mainly includes single rigged and bottom trawls. Fishermen target shark, skate, sole, California halibut, giant red sea cucumber, and ridgeback prawn. Fishermen can operate throughout the year.

Tuna/Other Seine

Very large vessels (> 45') make up the "Other Seine" OC fleet. Fishermen participating in this OC use purse and Danish/Scottish seine gear types. Purse seine fishermen fish in southern California and target Pacific bonito, yellowfin tuna, and skipjack tuna. Danish/Scottish seiners land lingcod, croaker, sole, rockfish, and sanddab primarily in central California. Both seiners make multiple day trips. Tuna purse seiners can land up to 200,000 lbs from a single trip. Purse seiners operate from summer to fall. Danish/Scottish seiners fish from spring to fall.