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Data Requirements for Integrating Socioeconomic Considerations into Regulatory Analysis: Examples from California Commercial Fisheries

Cynthia J. Thomson
NOAA National Marine Fisheries Service,
Southwest Fisheries Science Center, 110 Shaffer Road,
Santa Cruz, California, USA
cindy.thomson@noaa.gov

Abstract.—An important role of fishery regulatory analysis is to provide managers with information regarding potential implications of their decisions before those decisions are made. The ability to diagnose management problems, devise customized solutions to these problems and anticipate the implications of alternative solutions is highly contingent on the types of data available. This paper describes various commercial fishery data sources — landings receipts, observer and logbook programs, port sampling programs, vessel registration files, state and federal permit files, and socioeconomic data collections — and potential enhancements to these sources that may be beneficial for evaluating socioeconomic effects in the context of regulatory analysis. For illustrative purposes, California fishery data sources are used as a framework for considering uses of available data and contemplating future data possibilities. Various types of vessel and dealer behavior that may be relevant to regulatory analysis are depicted using landings receipt data. Recommendations are made regarding the need for additional data elements that could expand the scope and depth of current regulatory analysis and suitable venues for their collection.

Regulatory analysis serves a critical role in fishery management by informing managers of the potential impacts of management alternatives under consideration. Guidelines for federal regulatory analyses require evaluation of economic and social as well as biological and environmental effects. While these guidelines were written specifically for federal fishery management, they provide a coherent approach to understanding the implications of management alternatives that can be informative, regardless of jurisdiction.

Section II of this paper discusses (in broad outline) the analytical approach for regulatory analysis specified in the federal guidelines and identifies general types of commercial fishery data needed to address socioeconomic effects in the context of these guidelines.[1] Section III focuses on specific commercial fishery data sources and data elements that could plausibly be obtained from each source that address the regulatory requirements discussed in Section II. These data needs are discussed in a relational database framework and illustrated using California commercial fishery data sources. Section IV provides examples of the types of analyses that can be done with California data, and Section V provides recommendations for enhancing existing commercial fishery data collection for purposes of socioeconomic analysis. Section VI discusses conclusions that can be drawn from the previous sections.

Section II: Conceptual Framework for Regulatory Analysis and Associated Data Requirements

Federal guidelines for fishery regulatory analysis require that such analysis include: (1) a clearly defined management objective, (2) a description of status and trends in the fishery — including numbers and characteristics of affected entities and the nature and extent of their fishery involvement, (3) a rationale for the proposed action, (4) a description of the status quo and each alternative to the status quo, and (5) an evaluation of biological, environmental and socioeconomic (including distributional) effects of each alternative relative to the status quo (e.g., U.S. President (Clinton) 1993; NMFS 2007).

Relevant Economic Concepts

Economic concepts relevant to regulatory analysis include "regional economic impacts" and "economic value." Economic impacts include income and employment effects associated with the multiplier effect that occurs when fishery-related expenditures circulate through various sectors of the regional (e.g., county, state) economy. Economic values include producer and consumer surplus, which are the standard measures of societal benefits used in cost-benefit anal-

[1]Commercial and recreational fishery data play varying roles in regulatory analysis, depending on the management issue being considered. While this paper focuses on commercial data, recreational data are no less important and warrant similar scrutiny in terms of uses and improvements for regulatory analysis.

ysis. Producer surplus is the net economic benefit to businesses (e.g., commercial fishing vessels, processors) — measured as the difference between revenues and costs associated with the production of fishery goods and services. Consumer surplus is the net economic benefit to ultimate resource users (e.g., seafood consumers) — measured by the difference between maximum willingness-to-pay (e.g., for seafood) and the amount actually spent to obtain such goods and services.

Economic impact and economic value are fundamentally different concepts and are often affected in different ways by regulatory changes. For instance, a limited access privilege program may have negative economic impacts (by reducing employment in the affected fishery and related economic sectors), while enhancing economic value (by reducing costs associated with the "race for fish" for those who qualify for the limited access privilege).[2] Economic impacts and values are estimated with different types of models and have somewhat different data requirements. Data on costs incurred by fishery-related businesses are needed to estimate economic impacts. Revenue and cost data for fishery-related businesses and expenditure data for ultimate resource users are needed to estimate economic value for these respective entities.

Consideration of economic effects in regulatory analysis is not limited to estimation of economic impacts and economic value. Changes in impacts and value are precipitated by underlying changes in fishery behavior that also warrant explanation. Distributional effects are also a critical component of regulatory analysis in terms of who bears the costs and who reaps the benefits of management actions.

Desirable Data Characteristics

An important role of regulatory analysis is documenting the source of the management problem and identifying viable alternatives to the status quo. If the management concern is biological or environmental, problem diagnosis is facilitated by the availability of data that relate fishing activity to relevant biological and environmental indicators. Development of customized management solutions is enhanced to the extent that such indicators (e.g., landed and discarded catch by species) can be delineated by fishery sector, gear type, vessel size, geographic area and the like.

Fishery management can be particularly contentious when it involves distributional issues — quota allocation and limited access programs being obvious examples of this. Regulations can have allocational implications even when management measures are intended to address biological or environmental objectives. For instance, lower trip limits may be more advantageous for smaller vessels than larger ones, area closures may affect some fishing communities more than others, shorter seasons may have greater impacts on businesses that depend on year-round resource availability than those that do not. Allocational issues can arise at many levels: between fisheries (e.g., recreational and commercial), between fishery sectors (e.g., commercial harvesters and processors), within a sector (e.g., different gear groups or vessel sizes within the harvesting sector), or among geographic areas (e.g., ports, states). Whether allocation is the intended objective or an indirect consequence of regulation, clarifying distributional effects is an important role of regulatory analysis. Just as development of customized management solutions requires detailed data on fishing activity, similarly detailed data (e.g., by fishery sector, gear type, vessel size, geographic area and the like) are also needed to evaluate distributional effects.

Regulatory changes can have important indirect effects. For instance, regulations that restrict activity in one fishery or area may cause displacement of effort to other fisheries or areas. To the extent that such displacement is likely to create management problems elsewhere, such problems should be flagged in the regulatory analysis. Evaluation of effort displacement also includes consideration of the ability of fishery participants to mitigate the effects of regulatory restrictions — mitigation being more likely for participants who derive income from multiple fisheries than those who specialize in a single fishery. Data for individual fishermen, dealers, vessels and ports that cover the range of their involvement in all fisheries are useful for putting the effects of fishery-specific regulatory changes in context.

Regulatory analysis requires that current and likely future conditions under each management alternative be compared with current and likely future conditions under the status quo. However, while regulatory analysis is forward looking, historical data nevertheless play an important role in such analysis. For instance, historical data can provide context for a management problem in terms of documenting the extent of the problem and how it has affected the fishery over time. Historical data can inform comparisons between the status quo and other management alternatives by providing insights into how fishery participants have operated in the past under a range of biological, socioeconomic, and environmental conditions, and how they have responded to the particular incentives cre-

[2]Limited access privilege programs (LAPPs) involve allocation of shares of the total allowable catch to eligible fishery participants. These shares can be held, used or transferred within the discretionary limits set by the program. LAPPs are intended to enhance economic efficiency by removing the incentive for vessels to engage in repeated rounds of wasteful capital investment to increase their comparative advantage in the "race for fish."

ated by prior management regimes. Historical data also play a critical role in the development of management measures such as limited access programs, which typically include qualification criteria that are based on prior fishery participation. It is important that data relevant to regulatory analysis be maintained in historical databases and routinely updated.

Given the often time-consuming and costly nature of fishery data collection, the availability and quality of such data can vary widely. Some types of data may be sparse or lacking altogether. Other data may be available but not consistent in coverage for all relevant years, geographic areas, or fishery sectors. In other cases, data may be so abundant and detailed that meaningful organization of the data becomes the challenge. Interpretation of data can also be problematic. Issues can arise regarding representativeness of data collected with nonrandom methods, precision of estimates derived from small samples, or use and interpretation of data that may have been collected for another purpose and thus not fully suited to address the management issue at hand. Data collection protocols, data coverage and specific data elements may change over time, raising questions of temporal comparability. Methods of dealing with missing or inaccurate data (including imputation methods) may also need to be considered. Regulatory analysis requires careful use of existing data and transparency regarding data limitations that may contribute to uncertainty or bias in the conclusions. It is important that fishery databases include the detailed types of metadata needed to facilitate use and interpretation of such databases for regulatory analysis.

Section III: A Framework for Considering Commercial Fishery Data Needs

Managers typically do not have the luxury of postponing regulatory decisions until "better" or "more" data are collected. One strategy for anticipating management needs is to devise ongoing data collections that are sufficiently broad in scope to facilitate analysis of a wide range of issues. Such flexibility is best achieved with data that depict fishing activity at an elemental level (e.g., landing or trip) and can be aggregated and linked with other types of data in varied and useful ways.

Figure 1 depicts various commercial fishery data sources — landings receipts, observer and logbook programs, port sampling programs, vessel registration files, state and federal fishery permit files, socioeconomic data collections — and potential linkages among these sources that may be beneficial for regulatory analysis. Figure 1 is not necessarily exhaustive or relevant to all fisheries and management issues. Rather it is intended as a general framework for considering uses and enhancements of currently available data and contemplating future data possibilities. Figure 1 is discussed throughout this paper in the context of California fishery data sources, which are used to illustrate how specific data characteristics can facilitate or constrain regulatory analysis.

Each of the tables in Figure 1 is referenced in the remainder of this paper by its title (denoted in the shaded heading of each table). The attributes included in each table are not intended to be exhaustive of currently available data. Rather they represent a stylized depiction of selected data elements that could plausibly be collected and would be particularly useful for regulatory analysis. Elements that are generally available for California fisheries are indicated in regular font; elements that are less commonly available (or completely unavailable), but nevertheless desirable, are indicated in italicized font.

Relationships between tables are depicted using connectors, with the symbols attached to each connector denoting the nature of the relationship. A vertical line and crow's foot on a connector indicates that each record in the first table (attached to the plain end of the connector) is connected to one-to-many records of the second table (attached to the symbol-laden end of the connector); connectors of this type indicate a mandatory relationship between the two tables. A circle and vertical line (or circle and crow's foot) on a connector indicate that each record in the first table is connected to zero or one record (or zero-to-many records) in the second table; the circle indicates that the relationship between the tables is optional. Data element(s) in the first table that serve as the key(s) to the connection with the second table are denoted in bold font. Solid connectors denote linkages between tables originating from the same data source, with the connectors reflecting the relational structure of the data source. Dotted connectors denote linkages that are not intrinsic but sometimes made on an ad-hoc basis to suit the needs of a particular regulatory analysis.

The tables in Figure 1 can be described as follows:

- Tables with nonasterisked titles pertain to currently available sources of California commercial fishery data. Some important features of these tables are as follows:

1) The Landing_Header and Landing_Spp tables pertain to landings receipts submitted by first receivers of commercial landings (i.e., dealers) to the state of California. The Landing_Header table provides information on attributes of the landing itself (e.g., date and port of landing, vessel making and dealer receiving the landing). Each header record is linked to one or more Landing_Spp records — with each of the latter records providing informa-

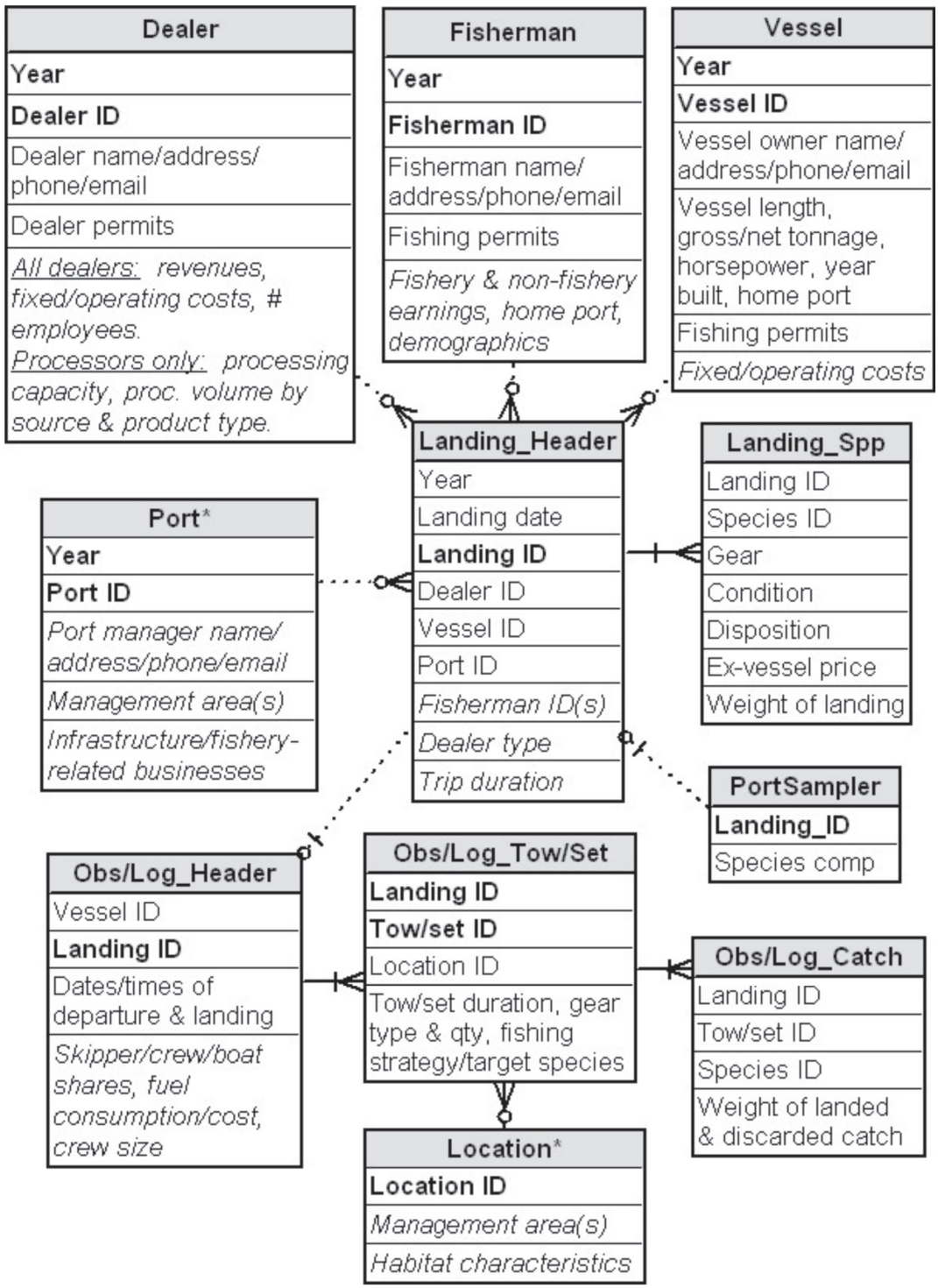

FIGURE 1.—California commercial fishery data sources, including actual and potential data elements that are useful for regulatory analysis.

tion on landed weight for each species/gear/condition/disposition/price combination occurring in the landing.[3]

"Species ID" in the Landing_Spp table is variously used to represent individual species or groups of taxonomically similar species. Complete speciation of landings on landings receipts is not always feasible, as species are not always easy to distinguish and dealers may be inclined (unless otherwise required) to group taxonomically similar species that receive the same exvessel price. This issue of speciation will be taken up later in the context of port sampling data.

"Vessel ID," "Dealer ID" and "Port ID" are consistently reported in Landing_Header. However, Landing_Header does not provide a complete accounting of all fishermen participating in each landing, as there is only one "Fisherman ID" field on the landings receipt and that field is not consistently filled out (thus the italicized font).

Other italicized attributes in the Landing_Header table are "Dealer type" and "Trip duration." "Dealer type" is intended to characterize dealers according to type of operation (e.g., processing plants, buying stations, fishermen marketing their own catch). Inclusion of "Dealer type" on landings receipts would be useful for linking buying stations to associated processing plants, determining port dependence on various types of dealer operations, and considering how value added at the port of landing varies by dealer operation. "Trip duration" is intended as a measure of fishing effort that could be used to estimate catch-per-unit effort and also enhance the explanatory power of economic analyses (trip duration being a major determinant of trip costs).

2) The Dealer, Fisherman and Vessel tables include data that could be obtained directly from dealers, fishermen and vessels. These would include attributes typically collected in state and federal permit databases, state and Coast Guard vessel registration files, and economic surveys. Each table is intended to represent an amalgamation of information from these sources.

"Dealer permits" pertains to permits required to engage in specific types of dealer activities in California (e.g., receiver, processor, wholesaler, retailer, importer, multifunction). "Fishing permits" is included as an attribute in both the Fisherman and Vessel tables, as some permits are issued to fishermen and others to vessels. Each Dealer ID, Fisherman ID and Vessel ID is linked to zero or more records in the Landing_Header table — reflecting the fact that not all dealers, fishermen and vessels that have permits are active fishery participants. The zero-to-many relationship between the Fisherman and Landing_Header tables also reflects the fact that not all fishermen who participate in a landing are reported on landings receipts.

The last row in the Dealer, Fisherman and Vessel tables (italicized font) identifies some generally unavailable economic attributes (e.g., dealer revenues, costs and employment; processor capacity and processing volume; vessel costs; fisherman earnings, demographics and home port) that are relevant to regulatory analysis. Processing volume "by source" in the Dealer table pertains to the origin of raw product utilized by processors (e.g., California fisheries, other U.S. fisheries, imports).

3) The Obs/Log_Header, Obs/Log_Tow/Set and Obs/Log_Catch tables generally represent the types of data collected in observer and logbook programs (e.g., tow-by-tow or set-by-set details of at-sea effort and catch). Discarded catch is of particular interest, as such data are not available from landings receipts. Each Obs/Log_Header record is linked to one or more Obs/Log_Tow/Set records (depending on the number of tows or sets occurring during the trip), and each tow/set record is linked to one or more Obs/Log_Catch records (depending on the number of species retained and/or discarded per tow or set). The attribute "Location ID" in the Obs/Log/_Tow/Set table pertains to at-sea catch locations (as distinguished from ports of landing, which appear as "Port ID" in the Landing_Header table). The attribute "Dates/times of departure & landing" in the Obs/Log_Header table is useful for estimating trip duration.[4] The last row of the Obs/Log_Header table includes a number of attributes in italicized font, indicating their currently limited availability. These attributes include economically important trip-level characteristics such as compensation (skipper/crew boat shares), major cost components (fuel), and fishing effort (crew size). Each Landing_Header record is linked to zero or one record in the Obs/Log_Header table,

[3]"Condition" pertains to condition of fish when landed (e.g., dressed/head off, dressed/head on, head/tail off, live). "Disposition" pertains to the use of landed fish (e.g., human food — canned, human food — not canned, bait, seized, personal consumption, reduction, research, animal food, curio).

[4]The presence of this attribute in the Obs/Log_Header table does not diminish the importance of including "Trip duration" in the Landing_Header table, which would make this information universally available for all landings.

reflecting the fact that observer/logbook programs are targeted at specific fisheries and therefore not as comprehensive in their coverage as landings receipts.

4) The PortSampler table pertains to the subsampling of landed catch conducted at selected ports to determine species composition. Such subsampling is particularly useful for mixed landings that cannot be fully speciated on the basis of Species IDs reported in the Landing_Spp table.

- The tables with asterisked titles (Port*, Location*) do not represent existing data sources but are rather intended to provide additional information on Port ID (in the Landing_Header table) and Location ID (in the Obs/Log_Tow/Set table) that would be useful for management. Some notable features of these tables are as follows:

i) The Port* and Location* tables link Port IDs and Location IDs to associated management areas. A Port ID or Location ID can be assigned to multiple management areas, as multiple fisheries with overlapping management boundaries can occur in the vicinity of a port or at-sea fishing location.

ii) The inclusion of "Infrastructure/fishery-related businesses" in the Port* table is intended to document numbers and types of port entities potentially affected by management actions. The inclusion of "Year" reflects the fact that some port attributes ("Port manager name/address/phone/email" and "Infrastructure/fishery-related businesses") are subject to change over time. Data on "Infrastructure/fishery-related businesses" are not readily available and typically require original data collection and/or extraction and synthesis of relevant information from various sources.

iii) "Habitat characteristics" (in the Location* table) is intended to link at-sea fishing locations to characteristics of the habitat in which they occur (e.g., substrate, depth). Such information is useful for addressing issues involving regulation of species with particular habitat affinities or protection of habitat itself. As with infrastructure data, obtaining habitat data typically involves original data collection and/or synthesis of relevant information from various sources.

California landings receipts comprise a census of commercial landings and provide data available first-hand to dealers at the point of landing (e.g., landed catch, exvessel prices). Observer and logbook programs are available for selected California fisheries and provide data available first-hand to skippers and observers regarding at-sea fishing activity (e.g., trip and tow/set durations, catch locations, discarded as well as landed catch). Weights of landed catch reported on landings receipts are "official" measured weights that serve as the basis for the exvessel value paid by dealers to vessels and the basis for landings taxes levied by the state. By contrast, weights of landed and discarded catch reported in logbook/observer programs are hailed weights.

Integration of landing receipt and logbook/observer data can provide insights into important aspects of at-sea fishing activity — including spatial behavior and discard of catch — that cannot be obtained from landings receipts alone. However, this integration is not seamless and requires the development of protocols for comparing, reconciling and calibrating data. For instance:

- Not all species that appear on a landings receipt necessarily appear in corresponding logbook/observer records as landed catch, and vice versa. Discrepancies between measured weights (on landings receipts) and hailed weights of landed catch (in logbook/observer records) are also common and to be expected. Integration of landings receipts with logbook/observer data requires the development of protocols to reconcile such species and weight discrepancies.[5]
- Logbook programs are typically fishery-specific and mandatory but do not always achieve 100-percent compliance. Observer programs are also fishery-specific but are more likely to be sampling programs and thus require application of sampling protocols and methods of expanding sample results to the population. Linkage between landings receipts and logbook/observer data is useful for quality control purposes (e.g., verifying the extent of logbook compliance, evaluating representativeness of logbook/observer data relative to landings receipts).

Section IV: Uses of Currently Available California Commercial Fishery Data for Regulatory Analysis

This section describes various ways in which some of the currently available data elements depicted in Figure 1 can be used for regulatory analysis.

Permit Data

"Dealer permits" — as included in the Dealer table — pertain to types of dealer activities (e.g., receiver, processor, wholesaler, retailer, importer, multifunction) and are not fishery-specific; thus potential dealer

[5]NMFS/NWFSC (2008), Sampson (2002) and Thomson et al. (2007) provide additional discussion of the complexities involved in collecting, managing and analyzing logbook and observer data.

participation in specific fisheries cannot be determined on the basis of permits. By contrast, "Fishing permits" in the Vessel and Fisherman tables are fishery-specific and thus can be used to enumerate potential vessel and fisherman participation (at least for those fisheries where permits are required). Such enumeration can facilitate regulatory analysis by providing an upper bound on the number of vessels and fishermen affected by a management action. The extent to which this upper bound approximates the actual number of participants can vary widely, depending on whether the permit is merely a prerequisite for participation in an open access fishery or a mechanism for capping or reducing entry into a fishery. Figure 2, for example, contrasts the number of trollers possessing California salmon permits with the number that actively participated in California's salmon fishery during 1981–2007. A notable gap between actual and potential participation in a fishery is suggestive of excess harvest capacity — a management problem that is easier to quantify when the attribute "Fishing permits" is available to define the universe of potential participants.

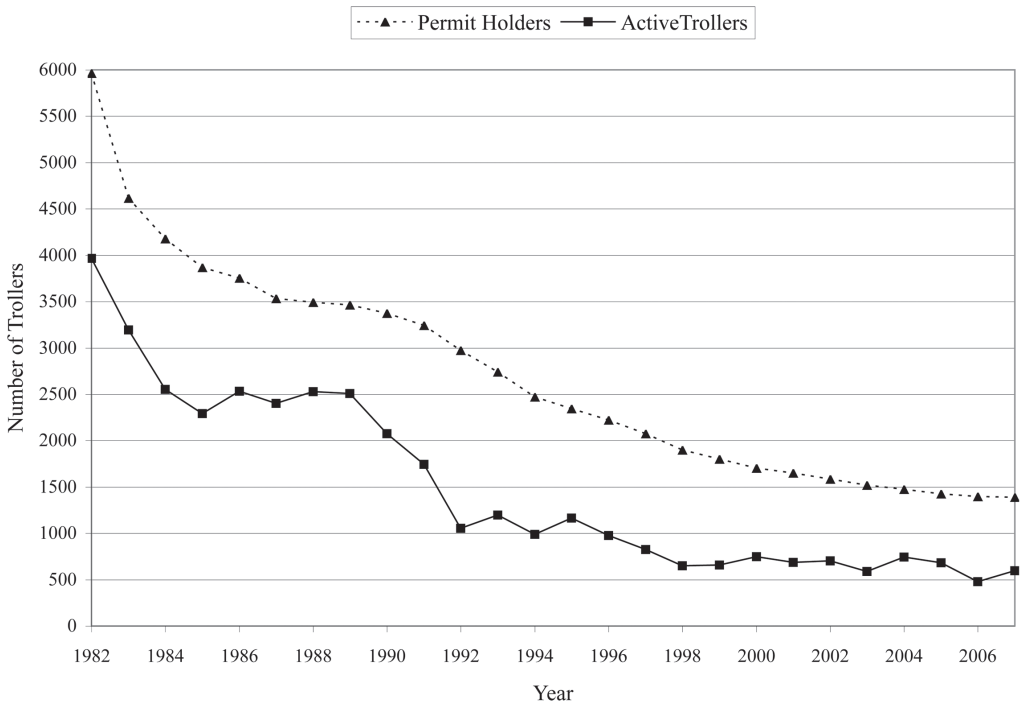

FIGURE 2.—Number of salmon permit holders and number of active salmon trollers in California, 1981–2007

While "Fishing permits" is useful for enumerating potential fishery participants, contact information collected in conjunction with permit data — as described in the Dealer, Fisherman and Vessel tables in Figure 1 — can serve management needs of a more personal nature. Contact information allows managers to target fishery participants for notification regarding public hearings, pending management actions, current regulations and the like, and can also be used to identify the target population for specialized surveys (including economic surveys). Contact information for dealers, fishermen and vessel owners is available from a number of state and federal permit databases and vessel registration files — although not inclusive of all modes of contact suggested in Figure 1 (address, phone number, email). Contact information for port managers is similarly desirable for inclusion in the Port* table. Multiple modes of contact provide more avenues for notifying fishery participants regarding management changes and soliciting potential respondents for specialized surveys.

PacFIN Landings Receipts

The Pacific States Marine Fisheries Commission's PacFIN program provides regional coordination and management of landings receipts collected by California, Oregon and Washington.[6] An important function of PacFIN is to standardize data elements such

[6]Information on the PacFIN program is available at www.psmfc.org/pacfin/.

as "Vessel ID," "Gear type" and "Species ID" as they appear in the three states' landings receipts.[7] Because fisheries are typically defined as combinations of species/species groups and gear type, standardization of "Gear type" and "Species ID" allows fisheries to be defined in common across the three states. Additionally, the standardization of "Vessel ID" allows individual vessel activity to be tracked among states. PacFIN landings receipts are well suited to the needs of federal regulatory analysis, which typically focuses on fisheries that cross state boundaries. In situations where vessels that participate in a state-managed fishery also engage in fisheries outside the state, use of PacFIN data allows the effects of state regulations on a particular fishery to be considered in the context of all fisheries targeted by the affected vessels.[8]

To illustrate uses of PacFIN landings receipts for regulatory analysis, the receipts were first configured as follows:[9]

- For purposes of regulatory analysis, assignment of landings to fisheries is best done at the level of the fishing trip — the trip being the basic unit of vessel behavior. However, each record in the Landing_Header table (Figure 1) represents a delivery by a vessel to a dealer and does not necessarily correspond to a fishing trip, as vessels may deliver their catch to multiple dealers upon returning from a trip. To facilitate characterization of fishery-specific vessel behavior, landings receipt data were reconfigured to represent fishing trips, with each unique combination of "Vessel ID" and "Landing date" in the Landing_Header table constituting a trip.
- Thirty-three major fisheries — each based on a particular combination of species/species group and gear type — were identified as follows: (1) coastal pelagic species (CPS) seine, (2) squid seine/dip-net, (3) salmon troll, (4) salmon net, (5) herring gillnet/dive, (6) swordfish drift gillnet, (7) swordfish longline, (8) swordfish harpoon, (9) albacore troll/hook-and-line (H&L), (10) tuna seine, (11) tuna longline, (12) shark gillnet, (13) shark H&L, (14) nonwhiting groundfish trawl, (15) whiting trawl, (16) rockfish gillnet, (17) halibut H&L, (18) halibut set net, (19) rockfish/lingcod H&L/pot, (20) sablefish H&L/pot, (21) cucumber net/trawl/dive, (22) urchin dive, (23) crab pot, (24) lobster pot, (25) shrimp/prawn trawl, (26) shrimp/prawn pot, (27) abalone dive, (28) other shellfish trawl/dredge/digger, (29) sturgeon gillnet, (30) white sea bass/yellowtail gillnet, (31) white croaker gillnet, (32) eulachon net, and (33) hagfish pot. These 33 categories include fisheries that are specific to particular states or years, as well as more ubiquitous fisheries.
- All records in the Landing_Spp table (Figure 1) were assigned to one of the 33 fisheries (or a 34th "all else" category), based on the combination of "Species ID" and "Gear type" appearing in the record. Landings and revenues appearing on all records associated with the same trip and fishery were summed, and each trip was assigned to one of the 34 fisheries, based on the fishery accounting for the plurality of revenue earned on the trip. Depending on the year, the 33 fisheries identified above collectively represented 94.0%–98.1% of trips, 98.1%–99.8% of landings and 98.5%–99.5% of revenue during 1981–2007 (all remaining trips, landings and revenues placed in the "all else" category).

The above standardization of fisheries — in conjunction with PacFIN's standardization of vessel IDs — makes it possible to determine the extent of individual vessel activity in all fisheries in the three states. Three to 7 percent of vessels (Figure 3) that fished in California during 1981–2007 also fished in Oregon and/or Washington. Categorizing vessels that fished in California according to their "major fishery" (the fishery accounting for the plurality of the vessel's annual revenue), vessels assigned to some major fisheries (e.g., albacore troll/H&L, nonwhiting groundfish trawl, crab pot) tend to be disproportionately involved in interstate fishing activity. The advantages of using PacFIN landings receipts are particularly apparent for regulatory analyses involving such fisheries.

Figures 4–9 and Table 1 illustrate some additional ways that PacFIN landings receipts can be used in regulatory analysis. For purposes of illustration, all landings are reported in metric tons (mt) round weight and all exvessel revenues are reported in US$ (base year=2007).

[7]PacFIN replaces vessel registration numbers in the state landings receipts with a unique identifier consisting of (1) the Coast Guard documentation number for vessels of five net tons or more, or (2) the state marine board number assigned by the state's Department of Motor Vehicles for vessels less than five net tons (which are not subject to Coast Guard documentation).

[8]Some likely small but unknown number of California vessels also participate in Alaska fisheries, but the extent of this participation cannot be determined due to lack of access to vessel-level Alaska landings receipts.

[9]Complete documentation on procedures used to reconfigure landings receipts is available from Thomson and Rizzo (in review).

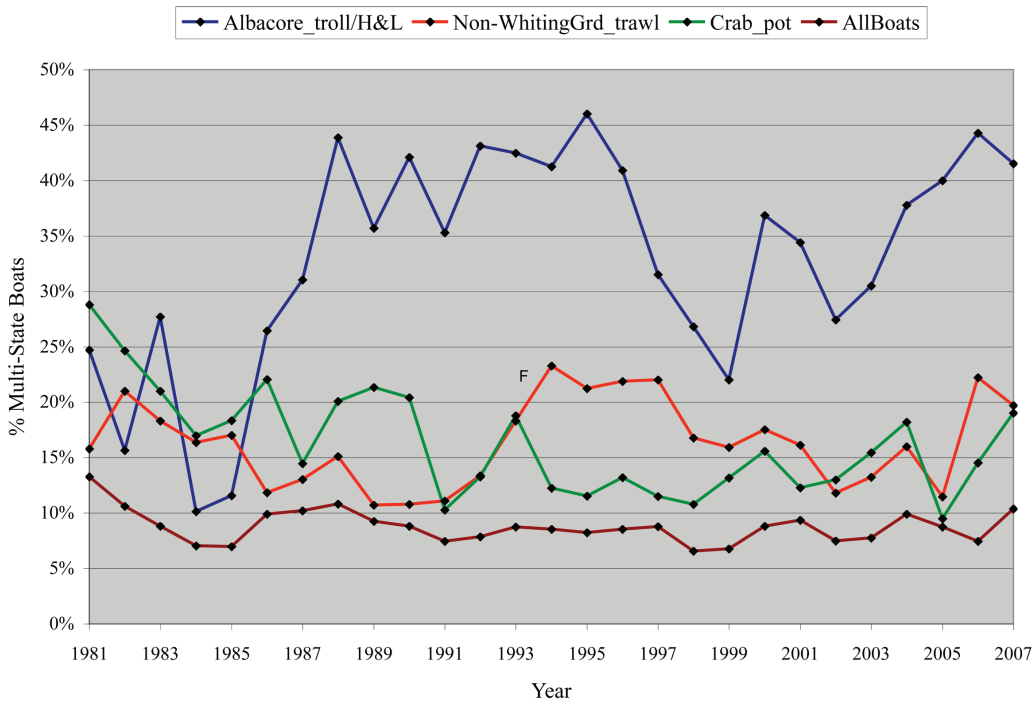

FIGURE 3.—Percentage of California vessels that also made landings in Oregon and/or Washington, statewide and for selected major fisheries, 1981–2007.

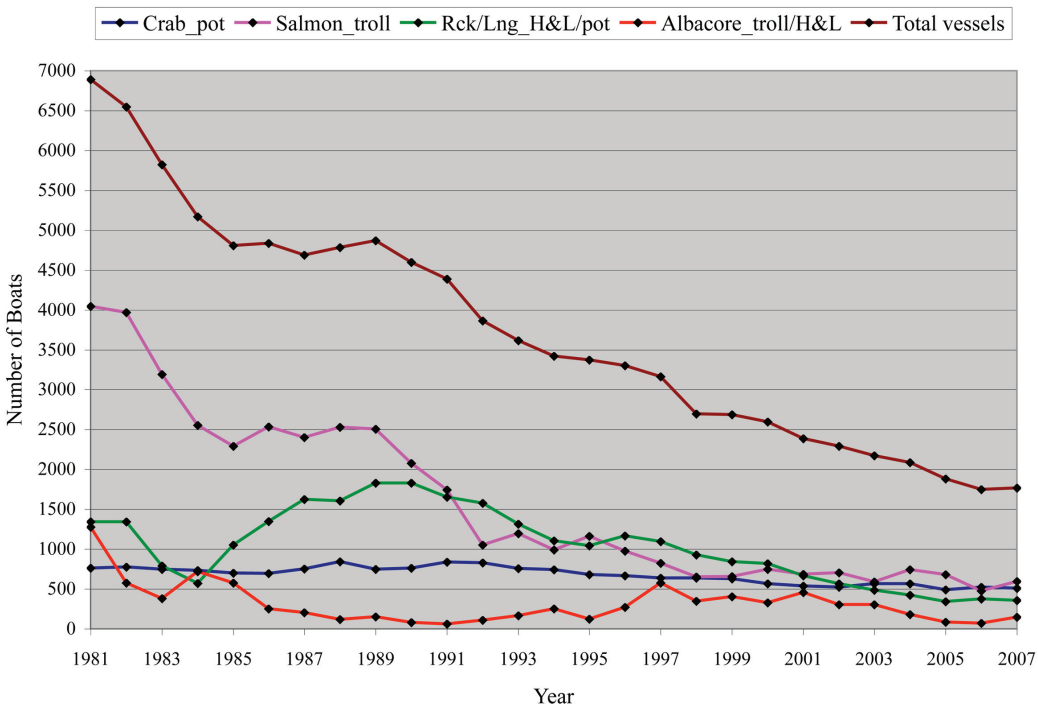

FIGURE 4.—Number of vessels that made at least one landing in California, total and for selected fisheries, 1981–2007. Number of vessels participating in individual fisheries are not additive, as some vessels participate in multiple fisheries.

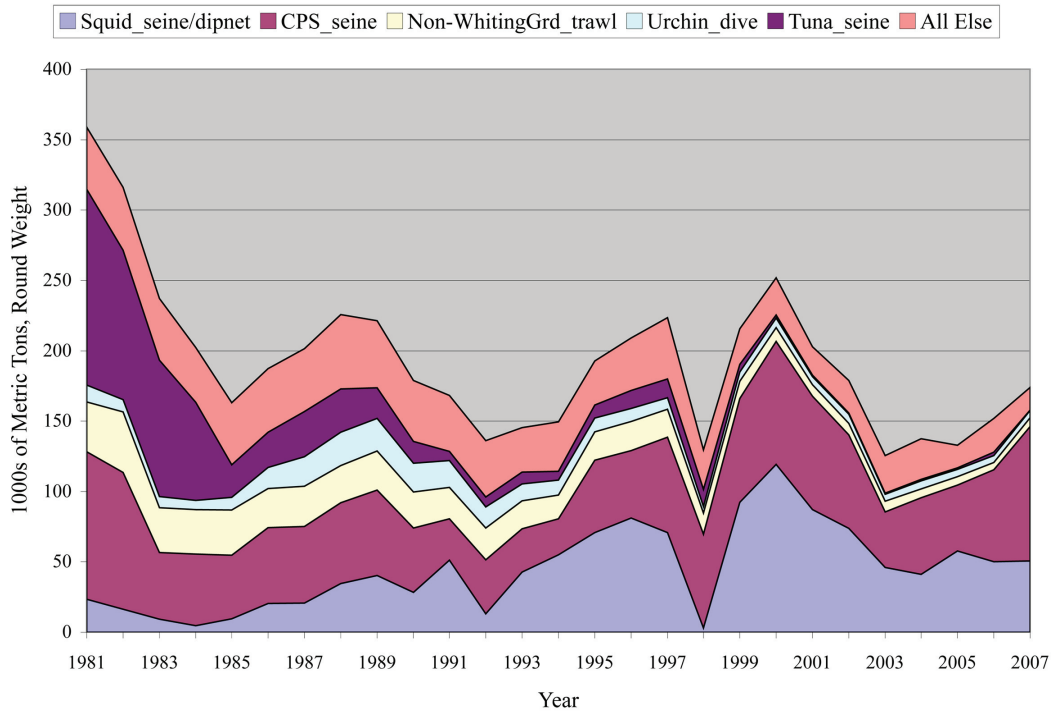

FIGURE 5.—California commercial landings (thousands of metric tons round weight), statewide and for selected fisheries, 1981–2007.

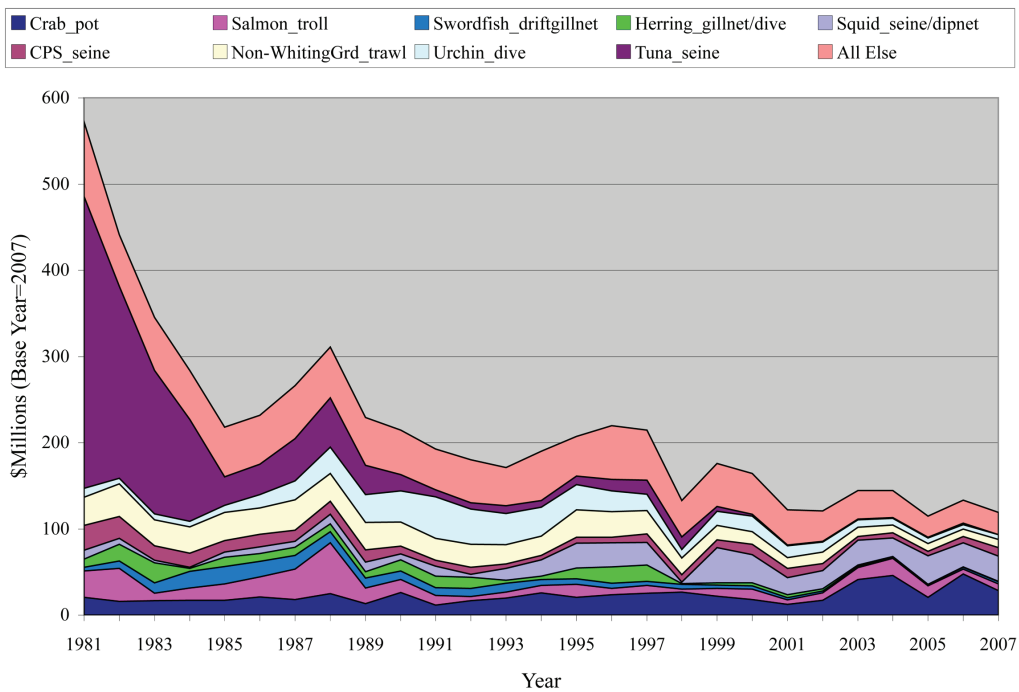

FIGURE 6.—Exvessel value of California commercial landings ($millions, base year=2007), statewide and for selected fisheries, 1981–2007.

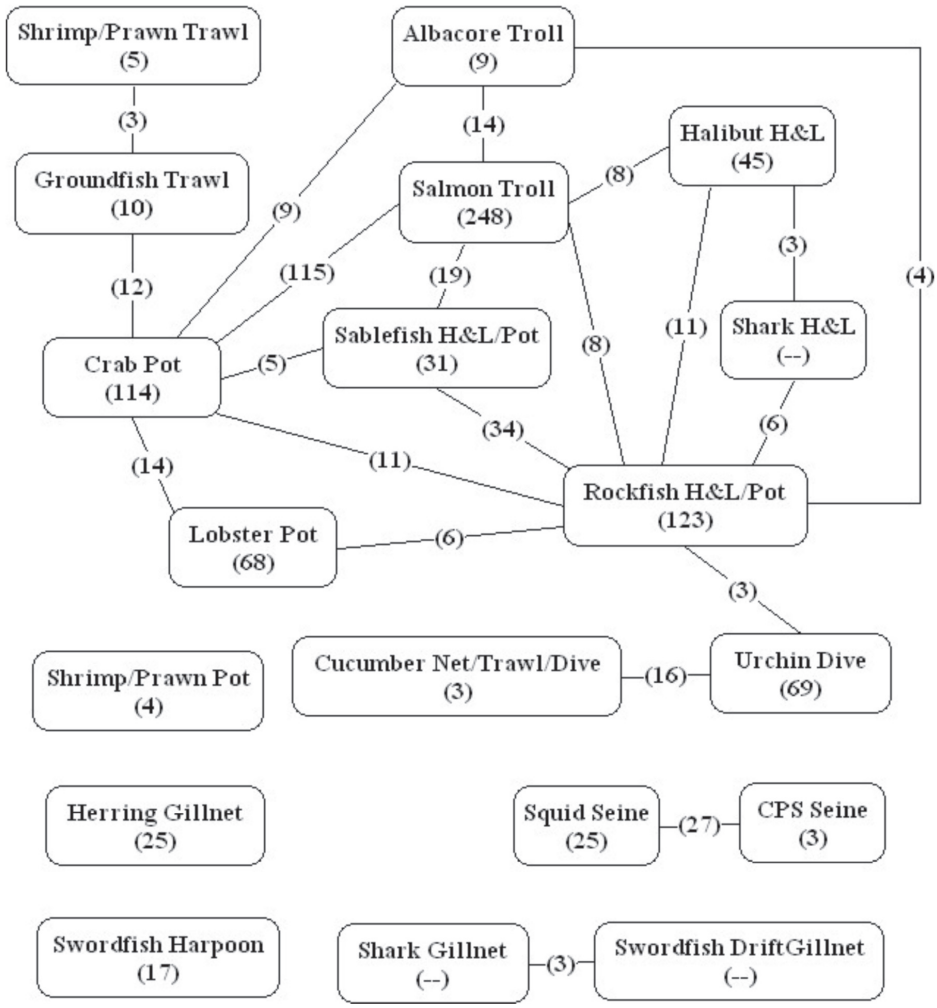

FIGURE 7.—Number of vessels engaged in one- and two-way fishery combinations in 2007 (only combinations involving at least three vessels are depicted).

- Landings receipts can be used to characterize trends in vessel participation by fishery. For instance, Figure 4 depicts the total number of vessels that made at least one fishing trip in California. The precipitous downward trend in participation (from 6,892 boats in 1981 to 1,753 boats in 2007) largely reflects trends in the more vessel-intensive fisheries — most notably salmon troll and to a lesser extent crab pot, rockfish hook-and-line/pot and albacore troll/H&L.[10]

- Landings receipts allow depiction of aggregate landings and revenue trends by fishery. As indicated in Figure 5, five high-volume fisheries have accounted for the vast majority of California landings since 1981. The squid and coastal pelagic species fisheries have been major contributors to landings in most years (a notable exception being El Niño years, when squid availability declines precipitously), while the other fisheries (nonwhiting groundfish trawl, urchin dive and tuna seine) have experienced major declines. These five fisheries (plus crab pot, salmon troll, swordfish drift gillnet and herring gillnet/dive) have also made notable contributions to statewide revenue in various years during 1981–2007 (Figure 6). The precipitous revenue decline in the early 1980s was largely driven by the decline of the tuna seine fishery associated with the relocation

[10]The numbers of vessels participating in each individual fishery are not additive, as some vessels participate in multiple fisheries. The statewide decline in vessel participation is strongly affected by changes in salmon troll fishery. Low capital requirements and high exvessel prices encouraged large-scale entry into the salmon troll fishery in the 1970s, a pattern which as been dramatically reversed by factors such as competition from farmed salmon, highly restrictive regulations and adverse habitat and water conditions.

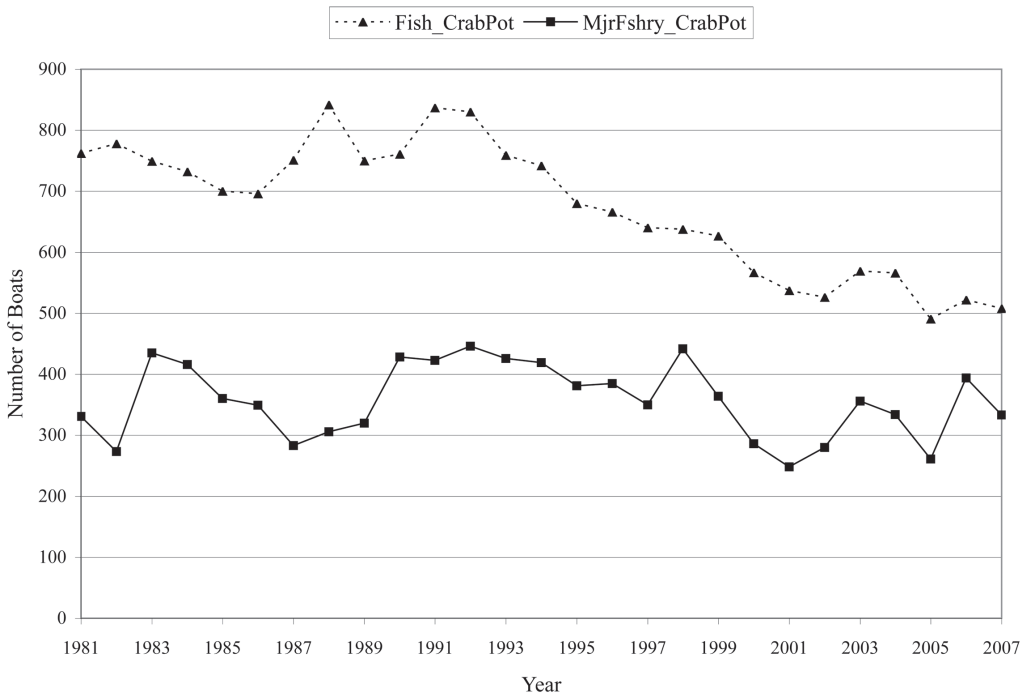

FIGURE 8.—Number of vessels that made at least one crab pot landing in California and number of these same vessels that derived the plurality of their annual revenue from the crab pot fishery, 1981–2007.

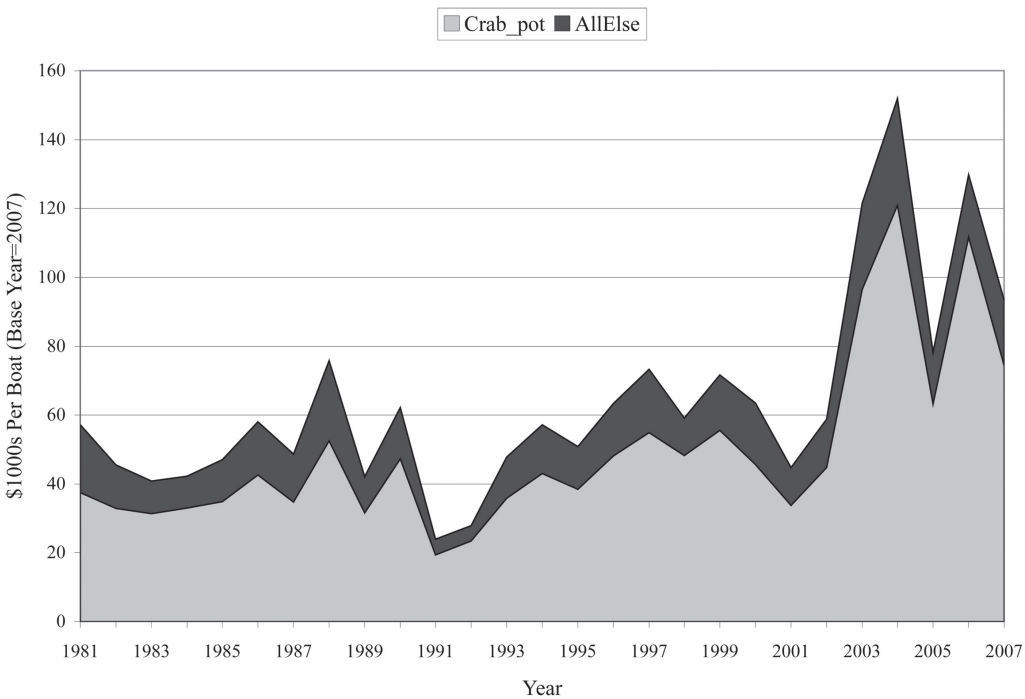

FIGURE 9.—Mean annual crab and noncrab revenue per vessel for vessels that derived the plurality of their annual revenue from the crab pot fishery, 1981–2007.

TABLE 1.—Major three- and four-way fishery combinations pursued by vessels that earned the plurality of their revenue from California fisheries in 2007.

Three- and Four-Way Fishery Combinations				No. Vessels
Fishery 1	Fishery 2	Fishery 3	Fishery 4	
Albacore Troll	Salmon Troll	Crab Pot	—	33
Sablefish H&L/Pot	Salmon Troll	Crab Pot	—	16
Rockfish H&L/Pot	Sablefish H&L/Pot	Salmon Troll	—	8
Rockfish H&L/Pot	Salmon Troll	Crab Pot	—	8
Rockfish H&L/Pot	Sablefish H&L/Pot	Crab Pot	—	6
Groundfish Trawl	Shrimp Trawl	Crab Pot	—	5
Rockfish H&L/Pot	Cucumber Net/Trawl/Dive	Urchin Dive	—	4
Rockfish H&L/Pot	Lobster Pot	Crab Pot	—	4
Squid Seine	CPS Seine	Tuna Seine	—	3
Rockfish H&L/Pot	Albacore Troll	Crab Pot	—	3
Rockfish H&L/Pot	Shark H&L	Halibut H&L	—	3
Groundfish Trawl	Salmon Troll	Crab Pot	—	3
Sablefish H&L/Pot	Albacore Troll	Salmon Troll	—	3
Rockfish H&L/Pot	Sablefish H&L/Pot	Salmon Troll	Crab Pot	5
Sablefish H&L/Pot	Albacore Troll	Salmon Troll	Crab Pot	5
Rockfish H&L/Pot	Albacore Troll	Salmon Troll	Crab Pot	3

of Southern California tuna canneries to Puerto Rico and American Samoa.

- An issue that often arises in the context of regulatory analysis is whether and to what extent effort displaced by regulations in one fishery is likely to be diverted to other fisheries. Landings receipts can help in this regard by identifying typical fishery combinations pursued by individual vessels. To illustrate, Figure 7 depicts major one- and two-way fishery combinations and Table 1 depicts major three- and four-way fishery combinations pursued by vessels that earned the plurality of their annual revenue from California fisheries during 2007. The parenthesized number in each text box in Figure 7 is the number of vessels that participated exclusively in that fishery during 2007, and the number on each line is the number that participated exclusively in the two fisheries connected by the line. Only fishery combinations pursued by at least three vessels are included in Figure 7 and Table 1. The fishery combinations thus depicted reflect the behavior of 1,242 vessels — 74 percent of the 1,683 vessels that earned the plurality of their annual revenue from California fisheries in 2007.
- In addition to identifying numbers of vessels engaged in single- and multi-fishery activity, landings receipts can also be used to estimate the extent of each vessel's dependence on a selected fishery in the context of its overall fishery participation. For instance, Figure 8 contrasts the annual number of vessels that made at least one crab pot trip in California with the number that derived the plurality of their annual revenue from that fishery, while Figure 9 depicts annual average crab and noncrab revenue per vessel for the latter vessels.

While "Vessel ID" is standardized across states on the PacFIN landings receipts, it is not possible to standardize "Dealer ID." However, each dealer ID is accompanied by a dealer name and these names are sometimes used as a basis for identifying dealers that operate in multiple states. This approach to tracking dealers is cumbersome and complicated by variations in dealer names on landings receipts, which can make it difficult to determine whether such differences represent different dealers or variations in nomenclature for the same dealer.

Dealer IDs, however, are useful for characterizing dealer behavior within each state. California's dealer IDs consist of seven-digit codes, the first five digits denoting the identity of the dealer and the last two digits denoting the plant number. The following discussion of dealer behavior is based on the first five digits of the dealer ID.

- The number of California dealers ranged from 488 to 541 during 1981–1986, increased to 757 in 1987, and has generally declined since then, reaching a low of 464 in 2007 (Figure 10). The vast majority of California landings are taken by a small number of dealers (typically large processors), with the remainder more widely dispersed among numerous small/medium dealers (including fishermen who market their own catch).

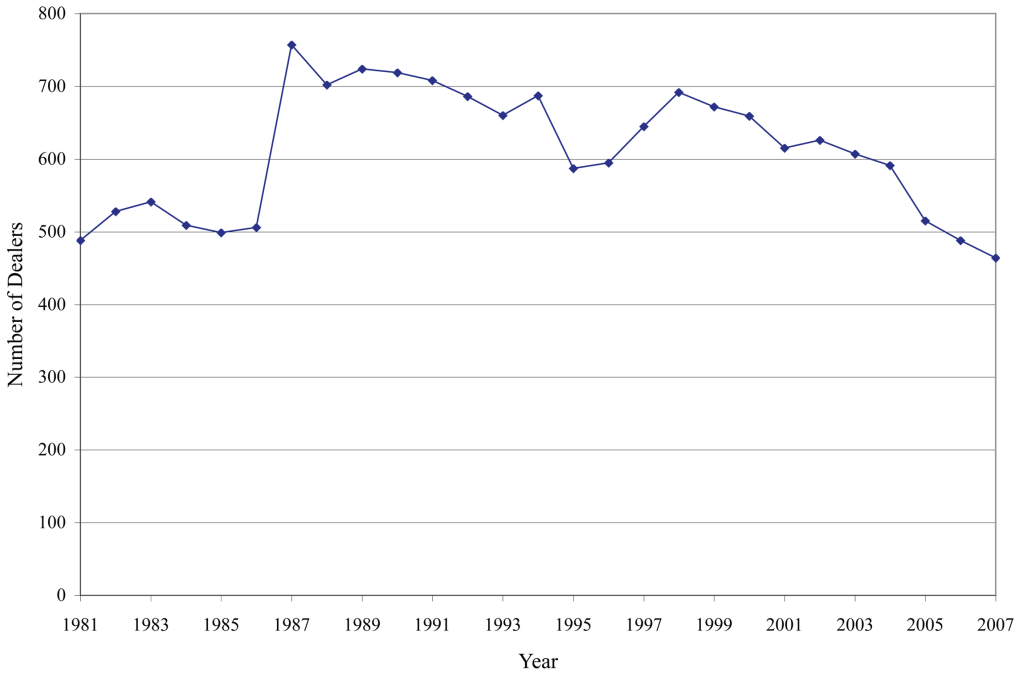

FIGURE 10.—Number of California dealers, 1981–2007.

- Landings receipts can be used to characterize the extent of dealer concentration using the Herfindahl Index (HI), which is calculated as

$$HI = \sum_{i=1}^{N} s_i^2$$

where s_i is the proportion of statewide landings accounted for by dealer i, and N is the total number of dealers.

Landings concentration (as reflected in the HI) generally decreased during 1981–1992, reaching a low of 0.037 in 1992, then steadily increased to a high of 0.100 in 2007 (Figure 11). Since 2001, changes in the HI have been disproportionate relative to changes in landings experienced in previous years.

Inclusion of the attribute "Port ID" in the Landing_Header table allows the same types of statewide analyses depicted in Figures 4–10 to be replicated for individual ports. For example:

- Figures 12–14 illustrate how landings receipts can be used to characterize port-specific vessel participation, landings and revenues by fishery — using San Francisco as an example. Differences between statewide and San Francisco trends in vessel participation (Figures 4 and 12), landings (Figures 5 and 13) and revenues (Figures 6 and 14) illustrate the importance of not generalizing statewide trends to individual ports.
- Figure 15 provides a cross-sectional comparison of 22 California ports in terms of their 2007 landings and the concentration of those landings among dealers (this time using port-level data to estimate the Herfindahl Index). For the 16 ports where landings were less than 5000 mt in 2007, the HI ranged from 0.112 to 0.880 — with the range being much tighter (0.112 to 0.331) for 14 of the 16 ports. For the six ports where landings exceeded 5000 mt, the HI ranged from 0.284 to 0.589.[11] Port-level HI values all exceeded the statewide HI of 0.100 in 2007 (Figure 11).

[11]Ports depicted in Figure 15 for which 2007 landings were less than 5000 metric tons (mt) include: San Diego, Dana Point, Newport Beach, Oxnard, Santa Barbara, Avila, Morro Bay, Monterey, Santa Cruz, Princeton, San Francisco, Bodega Bay, Point Arena, Fort Bragg, Trinidad and Crescent City. Ports for which 2007 landings exceeded 5000 mt were: Eureka (7.2K mt), Ventura (18.9K mt), Port Hueneme (22.7K mt), San Pedro (31.3K mt), Terminal Island (32.5K mt) and Moss Landing (43.7K mt).

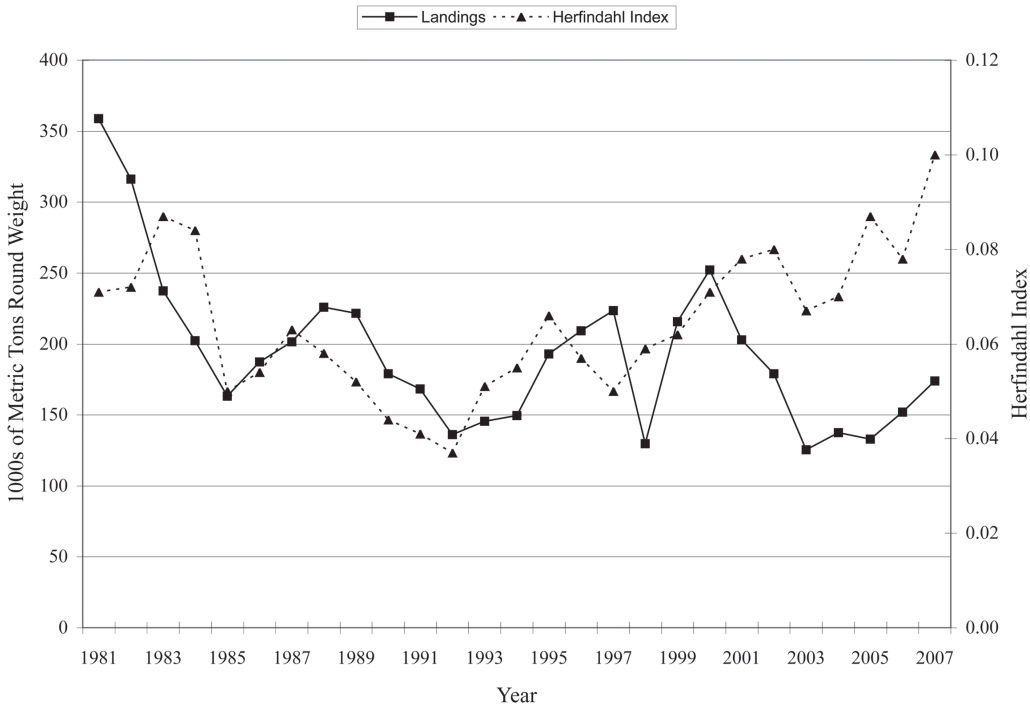

FIGURE 11.—California commercial landings (thousands of metric tons round weight) and landings concentration among dealers (as measured by Herfindahl Index), 1981–2007.

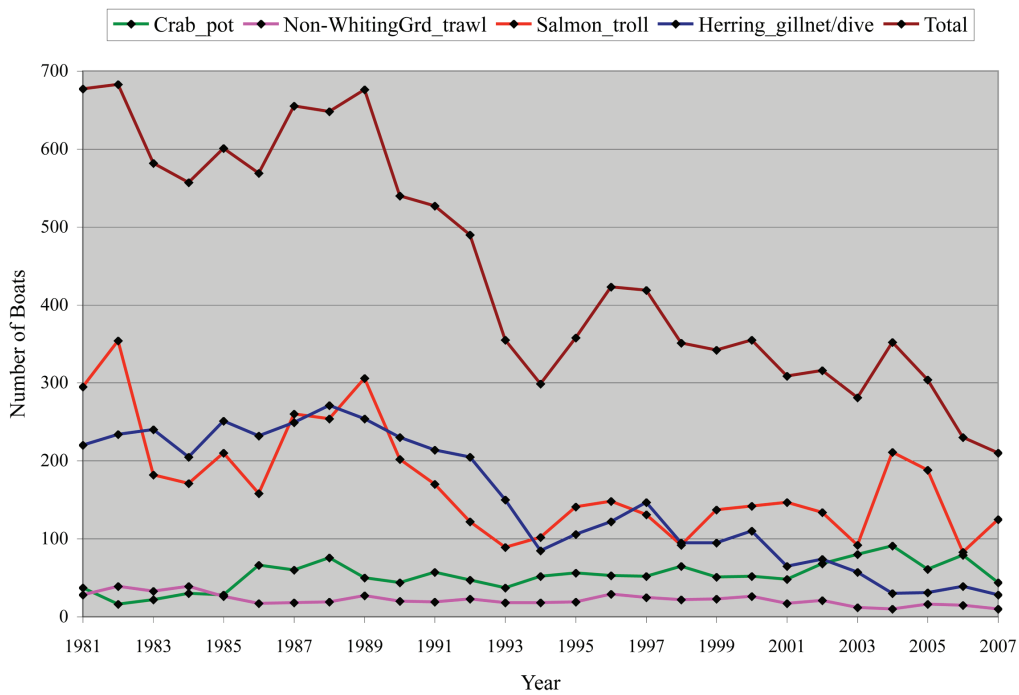

FIGURE 12.—Number of vessels that made at least one landing in San Francisco and numbers of these same vessels that participated in the crab pot, nonwhiting groundfish trawl, salmon troll, and herring gillnet/dive fisheries, 1981–2007. Number of vessels participating in individual fisheries are not additive, as some vessels participate in multiple fisheries.

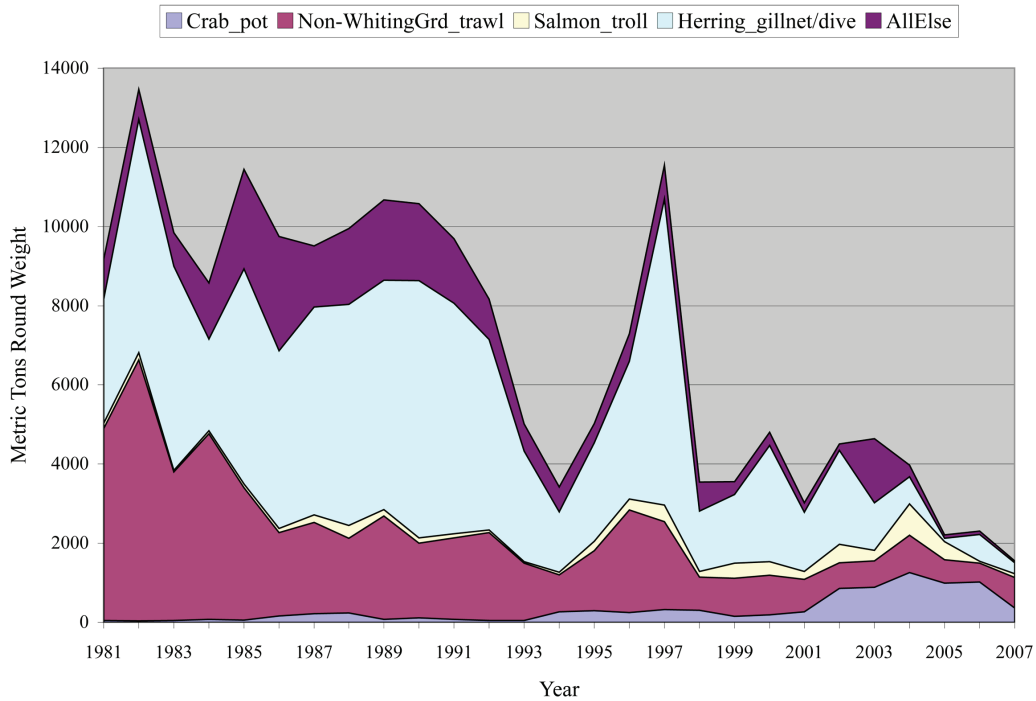

FIGURE 13.—Commercial landings in San Francisco (thousands of metric tons round weight), total and for selected fisheries, 1981–2007.

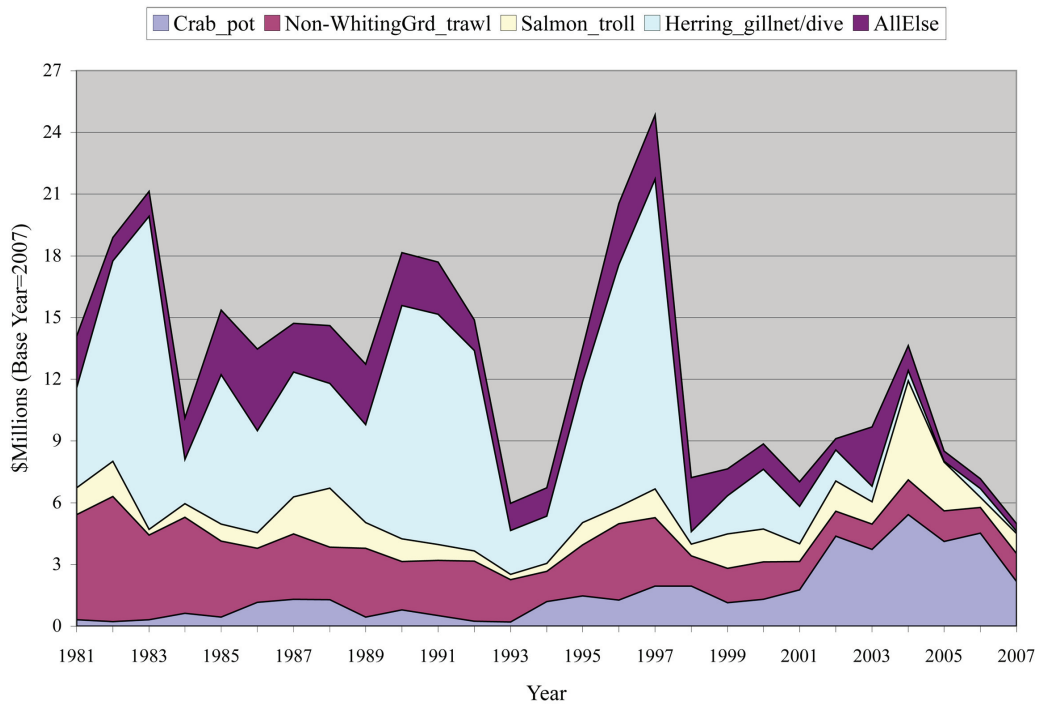

FIGURE 14.—Exvessel value of commercial landings in San Francisco ($millions, base year=2007), total and for selected fisheries, 1981–2007.

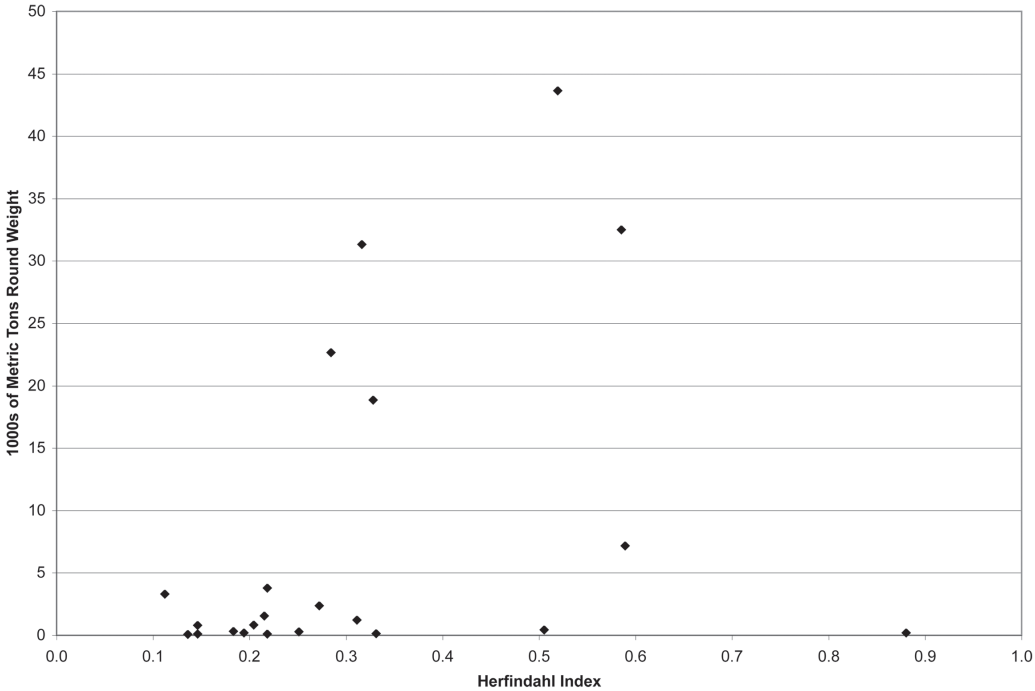

FIGURE 15.—Total landings and landings concentration among dealers (as measured by Herfindahl Index) in selected California ports in 2007.

The high degree of landings concentration among dealers can complicate regulatory analysis, as data confidentiality requirements only allow publication of data summaries that represent at least three vessels and three dealers. Confidentiality becomes particularly constraining when considering fine scaler regulatory effects (e.g., by year, port and fishery). Furthermore, the need to protect dealer confidentiality is not limited to minor or small-scale fisheries. As suggested by Figure 15, the ports with higher HI values tend to be ports that depend on high-volume fisheries that are subject to economies of scale in processing. While data confidentiality requirements do not preclude regulatory analysis, they may on occasion constrain the analysis to more aggregated or qualitative forms of evaluation.

Section V: Enhancing Opportunities for Economic Data Collection

While existing fishery data can be used in many and varied ways for regulatory analysis, ability to estimate economic impacts, conduct cost-benefit analysis and evaluate distributional effects is often constrained by lack of data. As indicated in Figure 1, many of the data elements needed to rigorously evaluate economic effects are of limited availability (italicized font). The placement of these data elements in particular tables in Figure 1 is intended to suggest more likely venues for eliciting economic data. Revenue per trip is readily derived from "Exvessel price" and "Landed weight" in the Landing_Spp table, as these data are routinely collected on landings receipts. However, as indicated in Section II, cost data are also important for estimating economic impacts and economic value. One viable alternative for collecting cost and other economic data are stand-alone surveys that target specific types of fishery participants (thus the inclusion of economic data elements typically collected in stand-alone surveys in the last row of the Dealer, Fisherman and Vessel tables). While such surveys can be highly informative, planning and implementation of stand-alone surveys tend to be costly and time-consuming, limiting the frequency of their occurrence.

Another option is to collect economic data as part of ongoing routine fishery data collections. To reduce respondent burden, such economic add-ons could focus on a few major components of trip expenses that would be more fully covered in periodic stand-alone surveys (as part of "operating costs" in the Vessel table). The inclusion of economic add-on data in the last row of the Obs/Log Header table ("skipper/crew/boat shares, fuel consumption/cost, crew size") reflects the fact that such add-ons are probably better accommodated in logbook/observer programs than landings receipts.

Opportunities to use landings receipts as a vehicle for collecting sensitive economic information such as "skipper/crew/boat shares" are likely limited, given that such information would thereby become available to fish dealers, who are responsible for submitting these receipts to the state. "Crew size," however, is a more innocuous data element that could perhaps be collected on landings receipts — though it would not be as useful as "Fisherman ID."

Comprehensive reporting of "Fisherman ID" on landings receipts would allow effects of management actions on skippers and crew members (e.g., distributional effects, effort displacement) to be considered in regulatory analysis. Such data would be useful for addressing issues such as capacity reduction by allowing consideration of a "skipper effect" in assessing vessel harvest capacity. Inclusion of "Fisherman ID" on landings receipts also could facilitate establishing permit programs that allow fishermen (not just vessels) to qualify based on historical participation.

Establishment of economic add-ons to logbook or observer programs would serve to supplement and update the more comprehensive stand-alone economic surveys that occur on a more occasional basis. Over time, routinely collected data on trip costs would provide opportunities to investigate how trip behavior varies under a range of regulatory, economic, biological and environmental conditions. The linkage with logbook/observer programs (which provide data on spatial patterns of fishing activity) would also facilitate economic analysis of spatial management measures.

Port sampling programs conducted in California provide information regarding the species composition of mixed landings that cannot be fully speciated using landings receipts. Given this focus on the biological aspects of landings, port sampling programs are a much less plausible venue for collecting trip-level socioeconomic data than logbook/observer programs. However, port samplers — given their field experience — may be good informal source of information regarding port operations and businesses that could be tapped to facilitate documentation of "Infrastructure/fishery-related businesses" in the Port* table of Figure 1.

Section VI: Discussion

The comprehensive, disaggregated and detailed nature of California landings receipt data make them well suited to address a wide range of management issues. The utility of state landings receipts is further enhanced by the PacFIN Program, which standardizes species, gear and vessel IDs as reported on California, Oregon and Washington landings receipts. Such standardization allows fisheries to be defined in comparable ways among the three states and also allows individual vessel activity to be tracked across states. PacFIN landings receipts are particularly useful for analyses involving federally managed fisheries (which typically cross state boundaries) and for state-managed fisheries involving vessels that engage in interstate fishing activity.

Landings receipts can serve as the basis for numerous and varied characterizations of fishery participation — provided that the identities of participants are consistently reported on the receipts. Such reporting is done for vessels, dealers and ports but not fishermen. A complete accounting of all fishermen (skipper and crew) on landings receipts would remedy the current deficit of information on fishing activity by these individuals and facilitate inclusion of fisherman effects in regulatory analysis. Another useful enhancement to landings receipts would be the addition of data on trip duration (which could be derived by adding date/time of departure and time as well as date of landing). Trip duration is an important measure of fishing effort that could be used to estimate catch-per-unit effort and also improve the explanatory power of economic analyses (trip duration being a major determinant of trip costs).

While Dealer IDs are consistently reported on landings receipts, these IDs are not coded in a compatible manner across states, making it difficult to determine the extent of interstate activity by individual dealers. Data on "Dealer type" that are not currently collected would also be useful for distinguishing stationary receivers and processing plants from mobile operations (e.g., buying stations, fishermen marketing their own catch), identifying linkages between buying stations and off-site processors, and evaluating port dependence on various types of dealer operations and how each type of operation adds value to landings at the port of landing.

The utility of landings receipts can be greatly enhanced by linkages with logbook/observer data, which provide highly useful information on at-sea fishing behavior (e.g., fishing locations, discarded catch). While some integration of landings receipts and logbook/observer data does occur, the required reconciliation of individual data elements is arduous and time-consuming, and often difficult to accomplish within the time frame of most regulatory analyses. Development of management support tools that facilitate this integration would encourage more routine use of logbook/observer data in regulatory analysis.

The inclusion of exvessel prices on landings receipts allows detailed characterization of vessel behavior in terms of revenue as well as landings. Other relevant types of economic data (most notably fishing costs) are much less available and collected largely in stand-alone economic surveys that target participants in

particular fisheries. Economic add-ons to logbook or observer programs are one way to ensure more routine collection of economic data that would improve understanding of how trip behavior varies under a range of regulatory, economic, biological and environmental conditions. Opportunities for economic add-ons would of course be limited to those fisheries covered by logbook/observer programs. Nevertheless, they are opportunities worth exploring, given the insights they could provide (e.g., regarding economic effects of spatial management measures) to fishery managers. Also, while port samplers are mainly concerned with collecting biological data on landings, their field experience may make them a good informal source of information regarding port-specific infrastructure and fishery-related businesses that could be supplemented by other methods of validation.

An issue that often requires attention in regulatory analysis is displacement of effort to other fisheries or areas induced by the regulatory change. Landings receipts, because of their comprehensive fishery coverage, are useful for evaluating movement of displaced effort to alternative fisheries. Logbook/observer programs are potentially useful for evaluating spatial displacement — at least for the fisheries covered by these programs. Expansion of logbook programs to include all trips made by logbook participants would provide spatial information for the entire range of fisheries targeted by these individuals and thus more fully capture the spatial effects of management measures. The need for spatial data is heightened by growing interest in spatial management measures to achieve fishery, ecosystem and social objectives.

Finally, fishery management and regulatory analysis are best served by integrated collection of biological, environmental (including habitat) and socioeconomic data. Relationships among fish stocks, regulatory actions, environmental conditions and fishery behavior are complex and dynamic. The potential to understand these relationships is only as good as the available data.

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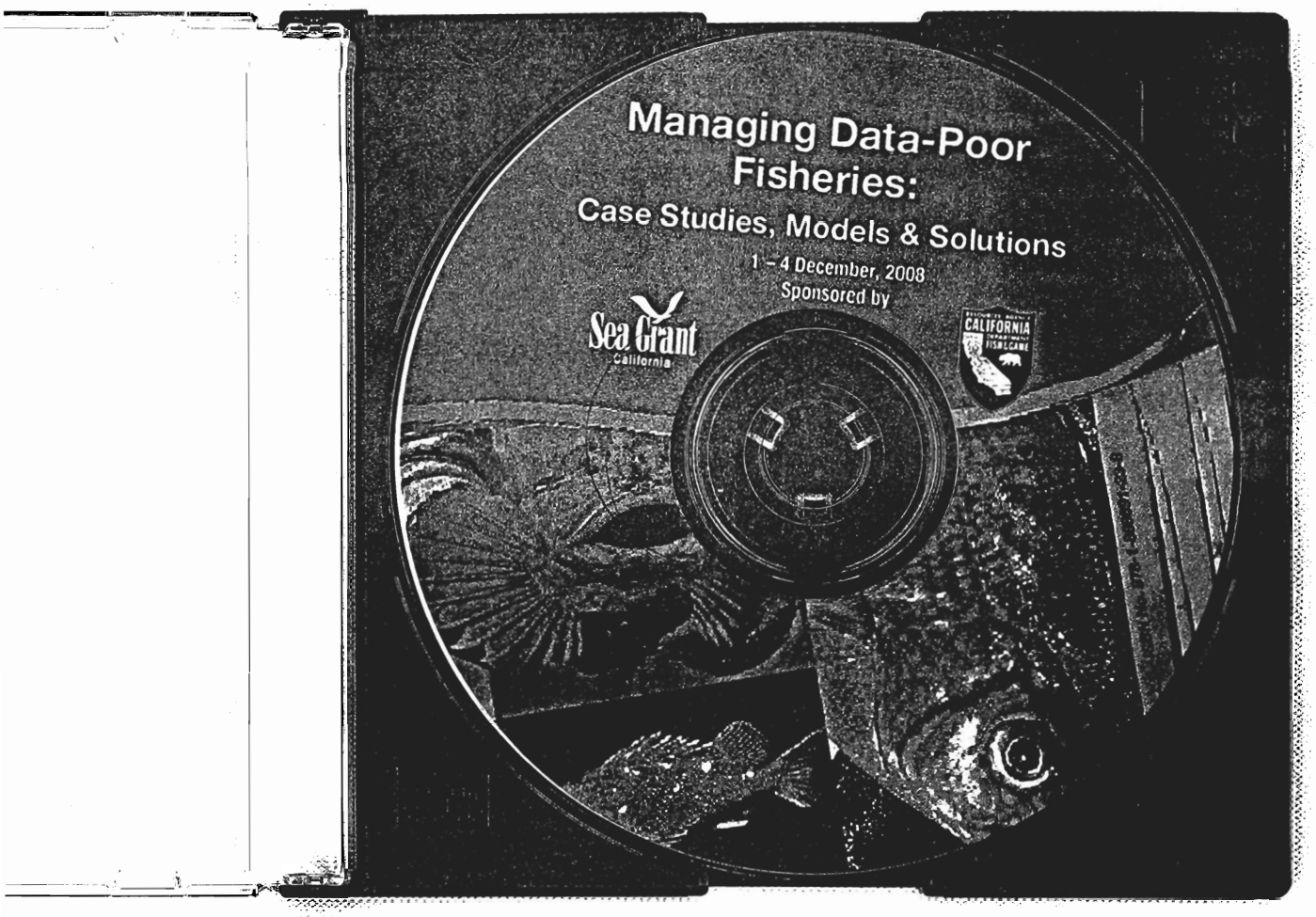
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