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Commercial Fisheries Data Collection Procedures for U.S. Pacific Coast Groundfish

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Commercial Fisheries Data Collection Procedures for U.S. Pacific Coast Groundfish

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PREFACE

The Pacific Groundfish Statistics Working Group convened for the first time in June 1992 in Seattle, with the primary objective of reviewing the data collection and processing procedures used to monitor commercial groundfish landings in Washington, Oregon, and California. At this meeting, the Group unanimously agreed that complete documentation of these procedures was long overdue and decided to embrace the daunting task of assembling the material that appears in this Technical Memorandum.

Earlier attempts at documenting data collection systems for U.S. Pacific coast groundfish fisheries resulted in rather general and superficial descriptions of the monitoring programs. This was primarily due to the very complex nature of the systems, in which the scope and intricacies of the data collection programs used in the three states had evolved largely independently. At the outset, the Group recognized that considerable attention, planning, and logistical and financial support would be needed to complete this Technical Memorandum. We thank all of the members of the Group for preparing their respective chapters in a timely fashion and for addressing the recommendations made by the editors.

We thank Stan Allen of the Pacific States Marine Fisheries Commission and Rick Methot of the National Marine Fisheries Service (Northwest Fisheries Science Center, Fishery Analysis and Monitoring Division) for financial support, without which this document would never have been completed. We thank Julianne Pagel of the Publications Unit of the National Marine Fisheries Service (Northwest Fisheries Science Center) and Tonya Builder of the National Marine Fisheries Service (Northwest Fisheries Science Center, Fishery Analysis and Monitoring Division) for reviewing drafts of this report and for editorial suggestions that greatly improved the final version. Finally, we thank Alec MacCall of the National Marine Fisheries Service (Southwest Fisheries Science Center, Tiburon Laboratory) for encouraging us to undertake this task and to publish this Technical Memorandum.

To all who were involved, thanks for your perseverance and patience.

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CHAPTER 1

INTRODUCTION

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1.1 Motivation for This Document

An important function of any government is monitoring the activities of its industries to gauge their productivity and health and to collect taxes. With the marine fishing industry, which exploits a publicly owned resource, government has the added responsibility of managing the industry to ensure that the natural productivity of the fish resources is not squandered and the overall integrity of the marine ecosystems is not compromised. At the least, the agencies that are responsible for monitoring and managing the fisheries need to know the magnitude of the fish landings and fishing effort. In addition, when a fish resource becomes heavily exploited, the management agencies generally require further, detailed information regarding the biological characteristics of the fish populations so that fishery scientists can assess what levels of harvest the resource can support. Many of the existing government institutions that routinely collect fishery-related data were created initially to provide basic landing statistics and then, as the fisheries expanded and fishery science matured, the institutions accepted additional responsibility for collecting the types of detailed information that now form the basis of the stock assessment and management processes.

The data collection programs for groundfish stocks commercially harvested from marine waters off Washington, Oregon, and California have been primarily designed to address two general management objectives: 1) provide estimates of the species compositions of the landings (in weight of fish), which are needed to monitor individual species that are managed by quotas or harvest guidelines, and 2) provide estimates of age compositions of the landings (in numbers of fish) and other biological characteristics, such as sex ratios, maturity stages, and length frequency distributions, which are needed to conduct stock assessments on regulated species. The data collection programs used by the individual states produce sample information that allows statistical inferences to be made about fish populations of interest. The accuracy and precision of the estimates depend on the sampling design and estimation methods that are used to derive the landing statistics.

Many of the monitoring programs used in commercial fisheries are based on the general theory and principles of sampling (e.g., Raj 1968, Sukhatme and Sukhatme 1970, Cochran 1977). Random sampling methods that have been appropriately implemented can provide valid estimates of population parameters, such as species and age compositions of the commercial landings, as well as measures of the estimates' precision, such as variances, standard errors, and coefficients of variation.

The sampling of commercial landings is a routine task and appropriate designs, field protocols, and estimation procedures have been discussed by various authors (e.g., Gulland 1955, 1966; Tomlinson 1971; Bazigos 1974; Quinn et al. 1983; Sen 1986; Pope 1988). In most cases, fishery monitoring programs are circumscribed by financial and logistical constraints, which ultimately result in estimates that reflect some level of compromise between statistical quality and practical considerations of sampling. Thus, it is imperative that commercial fishery sampling programs be well documented to ensure researchers can assess the accuracy and precision of the sample data that are to be analyzed and used to develop stock assessments and management strategies. Although most people accept that "bad" fishery data will generally not produce "good" stock assessment estimates, there have been few studies that have examined the relationship between data quality and stock assessment quality. As a consequence, there are no established standards by which to judge whether fishery statistics are adequate.

Given that fishery data collection programs in general evolve incrementally (Doubleday 1983, Pope 1988) and that fisheries management in the United States has until recently been primarily the responsibility of the individual states rather than the federal government (Knight 1977, PFMC 1990), it is understandable that many states have developed their own unique systems for collecting fishery data and deriving fishery statistics. However, when neighboring states attempt to assess and manage shared fish resources, difficulties necessarily arise if the states have not carefully coordinated their data collection activities. Currently, the Pacific Fishery Management Council (PFMC) advises the National Marine Fisheries Service (NMFS), which is responsible for the management of the groundfish fisheries off Washington, Oregon, and California. The PFMC relies on the individual states to develop and conduct independent sampling programs for groundfish landed at their respective ports. The states provide estimates of species compositions of the groundfish catch to the Pacific Fisheries Information Network (PacFIN).

The PacFIN system serves as a central database that is primarily utilized by researchers affiliated with state and federal fishery agencies that are responsible for the management of the groundfish fisheries off the U.S. Pacific coast (see section 1.2 and chapter 6 for detailed discussions that address this historical database). These data serve to monitor in-season progress towards quota attainment and as a historical record of landings for use in stock assessments and other fishery analyses.

In June 1992, the Pacific Groundfish Statistics Working Group was established, under the auspices of the Pacific States Marine Fisheries Commission, to conduct a comprehensive review of the data collection programs and data processing systems used by the individual states to monitor the commercial groundfish fisheries off the U.S. Pacific coast. Our primary objective was to produce a single document that addressed the current and past methods employed by each of the states for collecting, summarizing, and expanding the commercial groundfish landing information. We built upon a Pacific Coast Fisheries Data Committee report that outlined in general terms the data requirements and data collection activities associated with the U.S. Pacific coast groundfish fisheries (PCFDC 1990). We have endeavored to provide fishery researchers and managers with the supporting knowledge to evaluate the information associated with the groundfish fisheries of the U.S. Pacific coast, and to identify areas in which the current sampling programs and estimation methods are inadequate and can be improved. Researchers working with other fisheries, particularly those managed by multiple agencies, will undoubtedly find in this document information that is relevant and applicable to their own unique data collection programs.

We agree with Pope (1988) that "Every important data set should have someone to love and cherish it." We hope that this document will focus attention on the important, but demanding and often drab task of collecting fishery data, and that it will ultimately serve as a source of information for developing improved fishery management policies.

1.2 Historical Perspective

Since the late 1800s, commercial fishers, fish processors, and public consumers of fish products have utilized the groundfish stocks off the U.S. Pacific coast as sources of income and food (Miles et al. 1982). Three periods of growth characterize the history of the Pacific coast groundfish fishery: from the late 1800s to the early 1900s, little or no management was conducted on a disorganized and relatively small commercial fishery; from the early 1900s to the early 1980s, management on a rapidly expanding fishery was the responsibility of the individual coastal states; and currently, management on a diverse fishery and heavily exploited fish populations is coordinated by the federal government in conjunction with recommendations and support from the coastal states.

In 1976 the United States enacted the Magnuson Fishery Conservation and Management Act, which established an exclusive coastal fishing zone from three to 200 miles offshore known as the Exclusive Economic Zone (EEZ). This landmark legislation created regional fishery management councils, including the PFMC, that were responsible for developing fishery management plans. Since 1982, the domestic and foreign groundfish fisheries that operate within the EEZ off the U.S. Pacific coast have been managed in accordance with the Pacific Coast Groundfish Fishery Management Plan (FMP) and the Environmental Impact Statement for the California, Oregon, and Washington Groundfish Fishery (PFMC 1990) and subsequent amendments. Prior to the implementation of the FMP, the management of domestic groundfish fisheries was largely the responsibility of the individual states. However, many fisheries extended beyond state-imposed boundaries, which created management issues that required effective information exchange between the three state fishery agencies. To coordinate the activities of the individual states, the Pacific States Marine Fisheries Commission (PSMFC) was established in 1947. The PSMFC was not empowered with regulatory responsibilities, but was formed as a coordinating agency that would function as a data library for fishery-related information collected by the individual states.

The PSMFC recognized from its inception the necessity for coordinated collection and compilation of coastal groundfish statistics (PMFC 1948). Recognizing a need and effecting a result are two distinctly different events; not surprisingly, it was not until 1956 that the PSMFC began in earnest to develop the framework for what would become the PSMFC Data Series, a compilation of Pacific coast groundfish catch and effort data. The first published tables from the Data Series appeared in PSMFC's 14th Annual Report in 1961. The PSMFC Data Series were compiled for limited distribution, effectively to the management agencies responsible for regulation of the groundfish fishery. It begins in 1956 and ends in 1981, at which time the Data Series were replaced by PacFIN. The Data Series are contained in two volumes, one for groundfish and the other for shrimp and crab. Coincident with the development of the Data Series, the PSMFC created the PSMFC statistical reporting areas which have undergone some revisions over time.

The format and content of the Data Series were originally developed by the Research Committee of the PSMFC, an appointed group of biologists acting as technical advisors to the Commission. The Commission has also received advice from another group of technical advisors. The "Trawl Fishery Committee" (later named the International Trawl Fisheries Committee, the International Groundfish Committee, and currently the Canada/United States Groundfish Committee) was formed in 1958 to exchange information on groundfish regulations, groundfish research, and catch statistics between the United States and Canada. It has two members, one Canadian and one U.S., and a Technical Subcommittee (TSC). The U.S. member on the parent committee is the executive director of the PSMFC. The catch and effort data exchanged by the parent committee were compiled by the members of the TSC and, in fact, were the data prepared for the PSMFC Data Series.

The Data Series originally reported annual groundfish trawl landings by species and area, but this format was subsequently changed to monthly reporting at the request of the TSC. In 1970, a number of catch areas were added to the Data Series and in 1971 the Series began to report landings by gears other than groundfish otter trawl. Also in 1971, the Data Series began to be compiled under a computerized data system known as NORFISH. Early computer tapes of the compiled groundfish database have been lost; computerized data are only available since 1975 (Lynde 1986).

By the late 1970s, the data reporting system leading to the groundfish Data Series began to unravel. California stopped contributing in 1978. The United States and Canada were negotiating to exclude each other from fishing in their respective exclusive economic zones, and U.S. groundfish management was changing from exclusively state jurisdiction to state and federal jurisdiction. There was a recognized need for a revised catch data system, one which could be responsive to in-season management needs of the new federal management system. To facilitate the in-season management requirements of the FMP, the PacFIN data system was initiated in 1981, replacing the groundfish Data Series.

The PacFIN data system required several compromises when compared to the groundfish Data Series. The Data Series reported catch and effort by month and area of catch. These data were provided annually, 4-6 months after the end of the calendar year, and were effectively the contributing agency's record of final catch data. With PacFIN, the management agencies were trying to develop a catch data system with more timely reporting, something which could be used for in-season management. To achieve timeliness they compromised by using data from landing receipts that were unadjusted for area of catch, and they abandoned the reporting of trawl effort altogether. In effect, PacFIN was an approximation of the contributing agency's final data. These compromises were expected to be short-lived, with contributing states working toward in-season delivery, as soon as possible, of area-adjusted data on catch and effort. Oregon revised its catch data reporting system and began reporting area-adjusted catch data to PacFIN in 1986, while California and Washington continued to provide unadjusted data. Eventually, the contributing agencies agreed on revised formats for data transfer to PacFIN that would provide the necessary in-season adjusted data. The revised PacFIN reporting system, adopted coastwide in 1990, has become known as "redefined PacFIN."

While PacFIN data proved absolutely essential to monitor catch quotas in-season, the assessment of abundance of groundfish stocks managed by the PFMC required a historical catch data series. Stock assessment scientists were forced to compile these historical records independently from a variety of sources including the PSMFC Data Series, TSC reports, agency reports and computer files, and PacFIN data. Understandably, depending on the sources of their information, different analysts could compile different catch data for the same species. Consequently, the National Marine Fisheries Service sponsored the development of a historical landings database. This project, called HAL (Historical Annotated Landings database), contained catch data from 1956 to 1980, including information from the NORFISH system (Lynde 1986). The data were made available on computer files for convenient retrieval. Unfortunately, the database suffered from recognized data errors, some of which were captured and remedied, while others remained unresolved. As a result, the database has never received widespread use.

1.3 Overview

This document describes in detail the major features of the data systems used by the states of Washington, Oregon, and California for monitoring their groundfish fisheries. We developed this report because of a concern that the Pacific Fishery Management Council needed better data with which to manage the groundfish stocks under its jurisdiction. However, we decided that it was necessary to review and compare the three states' data collection systems before we could begin to determine how to improve data quality, either by standardization or changes in sampling levels or protocols.

The data collection systems described in this report have undergone major changes over the years and are likely to continue changing. For expediency, we have deliberately concentrated our review on the status of the systems as of 1992, but since then there have been substantial changes to portions of the systems. We have noted some of the pertinent changes in subsequent chapters. Although this document is a snapshot that was out of date before we even finished preparing it, it nevertheless provides a relevant overview of the data collection programs.

For the groundfish fisheries off the U.S. Pacific coast, there are two major categories of information routinely collected by the states of Washington, Oregon, and California: 1) weight and value of landings by species, geographic region, and season, and 2) biological characteristics of the landings (e.g., species, length, weight, and age composition). The data in the first category are used by various state and federal agencies for monitoring commercial fishing activities, collecting taxes, and for tracking landing quotas. Data in the second category are used primarily by the state fishery agencies and by members of the PFMC Groundfish Management Team, which is responsible for preparing stock assessments and developing regulations for managing the fisheries.

The document is organized as three major chapters (2-4), in which the authors describe state-specific data systems, data collection methods, and computational algorithms for the following items: landing receipts (fish tickets), trawl logbooks, species composition, and biological data. The chapter for each state follows a similar outline to facilitate comparisons between the three systems. The focus is on biological rather than economic aspects of the groundfish fishery, and little attention is given to economic information such as landed value and ex-vessel prices, although these data are often routinely collected on the landing receipts. Chapter 5 describes some special sampling programs that have been operated jointly by state and federal agencies. Chapter 6 reviews the Pacific Fisheries Information Network (PacFIN), which the state and federal agencies and the fishing industry use to share coastwide fisheries information. The concluding chapter (7) contrasts the three state systems and discusses possible methods for improving the overall quality of groundfish data. The Appendices contain examples of landing receipts used by the state fishery agencies (Appendix A) and a list of the common and scientific names for species of fish presented in this document (Appendix B).

Although some of the sampling and data systems used for the U.S. Pacific coast groundfish fishery are also used for collecting information about the commercial fisheries for salmon, herring, sardine, crab, and shrimp, we limited our review to the systems for the commercial groundfish fishery. We did not examine the program of the International Pacific Halibut Commission for monitoring the halibut fishery (Quinn et al. 1983) because this fishery is relatively small off the U.S. Pacific coast. Nor did we study the systems used for monitoring recreational landings of groundfish because the recreational landings are generally much smaller than the commercial landings, and the data collection systems are documented in various reports prepared by the NMFS (e.g., USDOC 1992). Also, we did not examine programs run exclusively by federal agencies, such as the NMFS Observer Program that monitors the offshore fisheries. Finally, although research surveys provide auxiliary information that is vitally important for stock assessments, our review does not include any sampling programs that are independent of the commercial fishery, such as the NMFS triennial bottom trawl survey (e.g., Zimmermann et al. 1994).

1.4 Acknowledgments

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CHAPTER 2

GROUNDFISH DATA COLLECTION IN WASHINGTON

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2.1 Introduction

Of the three U.S. Pacific coast states, Washington is unusual in being the home to a large fleet of distant-water vessels, some of which land a portion of their Bering Sea and Gulf of Alaska groundfish catches at Washington ports. Also, Washington is unusual in that it produces significant catches of groundfish from internal waters (Puget Sound). In this chapter, however, the descriptions of the groundfish fishery and data collection systems focus on the coastal fishery that operates outside of Puget Sound in waters south of the United States/Canada border.

2.1.1 Geographical Overview

Major ports

Coastal groundfish are landed in Washington at more than 30 different ports. Major ports include Ilwaco (at the mouth of the Columbia River), Westport/Grays Harbor (in Grays Harbor), and Bellingham (in northern Puget Sound). In 1991 and 1992, these major ports accounted for 78% and 98% of the total groundfish landings in Washington (Tables 2.1-2.2). Seasonally, the ports of Neah Bay (on the northwest tip of Washington at Cape Flattery) and La Push (at the mouth of the Quillyute River on the north central Washington coast) are also important, particularly for fixed-gear fisheries.

Major fishing grounds and principal species landed

Principal fishing grounds for Washington-based trawlers extend from Tillamook Head located north of Tillamook Bay to Cape Flattery on the United States/Canada border (Fig. 2.1). Exceptions include the catcher-processor trawl fleet that fishes for Pacific hake (also commonly known as Pacific whiting) from northern California to Cape Flattery and occasional fishing by catcher-only trawl vessels as far south as Heceta Bank. Specific fishing grounds vary according to the size and fishing strategy of the vessel. For the trawl fleet, effort is concentrated around Cape Flattery Spit and the Juan de Fuca Canyon, Grays Canyon, and on the northern edge of Astoria Canyon (Figs. 2.2-2.3). Fishing occurs across depths from 10 to 500 fathoms but tends to be concentrated along the continental slope and lower portion of the continental shelf between 50 and 300 fathoms.

The Washington Department of Fish and Wildlife (WDFW) has no logbook program for non-trawl fishers and consequently, the distribution of non-trawl fishing effort cannot be described. However, it is well known to WDFW personnel that longline fishers, for example, work the continental slope off Cape Flattery Spit, including Nitinat Canyon, Juan de Fuca Canyon, and Astoria Canyon, while the jig fishery works the nearshore areas of the north Washington coast from Destruction Island to Cape Flattery.

Species landed vary by port and gear. In 1991 and 1992, principal species landed in the trawl fishery were rockfish, Pacific hake (also commonly known as Pacific whiting), arrowtooth flounder, and Dover sole (Tables 2.3-2.4). The primary species for fixed-gear fishers was sablefish.

Port samplers

The WDFW employs four full-time port samplers (scientific technicians) in three year-round positions and one half-year position. In addition, a senior scientific technician serves as immediate supervisor and coordinator of the regional samplers. The year-round staff are stationed at the Willapa Bay Field Station in Ocean Park (Ilwaco area), the Coastal Field Station in Montesano (Westport/Grays Harbor area), and the Field Office in Bellingham (Fig. 2.2). The seasonal port sampler works out of the North Coastal Field Station in Forks and monitors the ports of La Push and Neah Bay. The port sampling supervisor works out of the Coastal Field Station in Montesano.

All port samplers have a similar set of responsibilities, including collection and data entry of trawl logbook data (catch, effort, and area of catch), collection of biological data (length, weight, sex, age, etc.) for selected groundfish species, estimation of the species composition of rockfish landings, weekly collection and transmittal of preliminary groundfish landings, and communications and liaison with the commercial fishing fleet. The sampler stationed in Bellingham routinely samples landings in Bellingham, Blaine, and Anacortes. The sampler stationed in Montesano routinely samples Westport and Hoquiam, with additional sampling in Raymond, South Bend, and Bay Center. The Ocean Park sampler gathers data from vessels in the Columbia River ports of Ilwaco and Chinook. Seasonally, from April through September, the sampler stationed in Forks collects data from vessels in Neah Bay and La Push. Vessels operating in unsampled ports mail their trawl logbook data to Olympia or to one of the field offices. These data are then forwarded to a port sampler for data entry.

2.1.2 History of Data Collection Systems

Washington's port samplers are involved with three principal sampling tasks: 1) collecting logbook data from groundfish otter-trawl fishers, 2) collecting biological information from designated groundfish species, and 3) collecting rockfish species-composition data from multispecies landings. Special sampling requests are also accommodated as time allows.

The otter-trawl logbook system was initiated in 1953 to distribute the landed weight of groundfish reported on fish receiving tickets to the correct statistical catch reporting area and to estimate the effort expended to obtain the catch. The evolution of this trawl logbook system is reviewed in Kimura and Pattie (1982) and Clark (1986a, 1986b). The system has been identified by several acronyms over the years: in the 1960s it was RIRS (Randomized Information Retrieval System), in 1980 RIRS was replaced with TIS (Trawl Interview System), and in 1985 TIS became CTLS (Coastwide Trawl Logbook System).

Biological data have been collected using different sampling protocols through the years. As a rule, the sample has always been designated as a fixed number of fish as opposed to a fixed weight of fish. Sample size has varied from as many as 300 fish per sample to as few as 25 fish per sample. The sampling protocol has usually required drawing a simple random sample from the landed catch prior to sorting by the processor. In the past, some samples were obtained using a stratified sampling scheme for age structures (a fixed number of fish per cm interval) and simple random sampling for length data. Annually, the number of samples collected were reported in the minutes of the Technical Subcommittee of the Canada/United States Groundfish Committee. Current sampling strategies follow Kimura (1984): 25-100 specimens per sample and 10-25 samples per stratum (e.g., gear/area fished/time).

Rockfish species-composition sampling was initiated in the late 1960s. Prior to this time, reported landings from fish ticket receipts in the Pacific ocean perch market category, the principal rockfish species landed, were assumed to contain only Pacific ocean perch, i.e., they were thought to be uncontaminated by other species of rockfish, which were in limited demand and received little interest from fisheries managers. In the late 1960s, extensive foreign fishing dramatically reduced the Pacific ocean perch population, and domestic harvesters began to land increasing quantities of other deep-water "red" rockfish. Simultaneously, the market demand for other rockfish grew along with the interest of fisheries managers. Subsequently, the species-composition estimation program began. Since its inception, the program has employed a variety of estimation algorithms and sampling protocols. Tagart and Kimura (1982) report on estimation methods and sampling schemes used by the agency through 1984. In 1985, the estimation algorithms were changed, while the sampling methods remained largely the same. The estimation algorithm used through 1992 is reported in this document (see section 2.6). Updated algorithms for species-composition estimation from 1993 to date are under development.

2.1.3 Legal Authority to Collect Data

Obligations of fishers

Under the authority of the director of the Washington Department of Fish and Wildlife through published regulations in the Washington Administrative Code (WAC), fishers and processors are required to comply with the lawful requests of authorized employees. Under the provision of WAC 220-20-010(8): "*It shall be unlawful for any person taking or possessing food fish or shellfish taken from any of the waters or beaches of the Columbia River, the state of Washington or the Pacific Ocean for any purpose to fail to submit such food fish or shellfish for inspection by authorized representatives of the department of fisheries [and wildlife].*" Furthermore, under WAC 220-20-010(18), "*It is unlawful for any person or corporation licensed by the department of fisheries [and wildlife] to fail to comply with the directions of authorized department personnel related to the collection of sampling data or material from food fish or shellfish. ...*" Finally, WAC 220-44-080 makes it "*... unlawful for any operator of otter trawl gear to fail to possess and maintain a Washington-Oregon-California Trawl Logbook while fishing in Coastal Marine Fish and Shellfish Management areas ...*" Moreover, the vessel operator is required to keep the logbook aboard the vessel while fishing and to submit the completed logbook to department personnel immediately upon request.

Noncompliance

Port samplers experience few problems with respect to obtaining biological or species-composition samples. The rapport between fishers, processors, and samplers is good, requiring few reminders to assist or comply with the request of a sampler. There are more frequent problems obtaining trawl logbook data, but these problems are generally associated with tardy logbook delivery. The WDFW has campaigned to get vessel operators to comply with the mandatory logbook system, requiring legible and complete logs delivered to the state in a timely manner. When an operator fails to deliver a log, the sampler mails a letter advising the operator that the log is overdue and should be delivered to their office in 10 days. Depending on the patience of the sampler and the history of the operator, the sampler may send a second letter requiring delivery of the delinquent log. Any subsequent reminders are made through the WDFW Enforcement Division. Lack of compliance can result in the issuance of a ticket and a fine. Overall, this process is effective, with compliance rates typically exceeding 85% (Table 2.5).

2.2 Fish Ticket/Landing Receipt System

Washington's Marine Fish Receiving Ticket ("fish ticket") is an official document used to record the landed weight and value by species of designated marine food fish (Fig. A-1). Additionally, the fish ticket must identify the fisher, their address, vessel name, vessel registration number, the fishing gear, date of landing, area fished, the processor purchasing the fish, whether the fish were caught within three miles of the coast (state waters), within 200 miles (federal waters) or outside 200 miles (international waters), and the number and amount of fish retained by the crew for personal use. The Washington Department of Revenue levies a tax (2.14%) on the value of the landing.

2.2.1 Market Categories

Market categories recorded on the fish ticket are established by the director of the Department of Fish and Wildlife from the list of designated food fish (WAC 220-12-010) and with the assistance of fisheries managers in accordance with the selling practices of the fish processors. For example, sablefish are a designated food fish, but their landings are coded under multiple market categories depending on whether they are sold round or dressed and on their size and grade. Processors are provided a booklet by the WDFW called, "Catch Data Reporting Instructions to Dealers and Buyers," which contains the codes for various market categories. There are 18 preprinted codes and species descriptions on the fish ticket. Purchases of food fish in other market categories must be handwritten onto the fish ticket. By statute, the processor is required to list purchases of any species with an explicit trip limit in a separate market category, e.g., sablefish, Dover sole, and some species of rockfish. Rockfish purchases are currently recorded by the department in seven market categories: Pacific ocean perch, widow rockfish, yellowtail rockfish, canary rockfish, shortspine thornyhead, longspine thornyhead, and "other rockfish."

2.2.2 Processing System

The WDFW issues, at no cost, sequentially numbered fish tickets to licensed buyers. Buyers are responsible for every ticket they are issued and must return either a completed or voided ticket in the number sequence in which they are used. Buyers are required to mail a completed fish ticket to the Department of Fish and Wildlife in Olympia within six days of receiving a landing.

In Olympia, marine fish tickets are separated from other tickets and previewed by a research analyst. The ticket is checked for completeness, assuring that all relevant information has been entered. The research analyst reviews species descriptions and market codes entered on the ticket and may replace an entered code with the appropriate code as required. For example, sablefish landings may be recorded by the buyer in multiple market categories by weight and product form (round or dressed). These categories are subsequently coded by the research analyst to one of the preassigned market categories. Missing data are retrieved by the research analyst by contacting the buyer and/or port sampler. The research analyst also reviews the catch reporting area, assuring that only one area is coded. When a buyer has noted catches from multiple catch reporting areas, the research analyst determines, through contact with the buyer or port sampler, where the bulk of the catch was taken and codes the ticket to that area.

After fish tickets have been previewed and precoded by the research analyst, they are keypunched and entered into the master database file. Keypunching typically occurs within a week of receipt of the fish ticket. After keypunching, the ticket data may still contain errors. Changes to the master database file are designated as new entries or updates. All new entries and updates are screened through an edit program that checks for missing data and erroneous codes, e.g., date, catch area, number of fish, pounds of fish, value, species codes, and days fished. Errors are reported in an error file that is reviewed by the research analyst. The errors are rectified by examining the original ticket and/or through further contact with the buyer or port sampler. Final corrections are again sent for keypunching and the master database file is updated. The error detection process is dynamic. Corrections to the master database file may occur at any time. Subtle errors undetected in the initial screening may be detected and corrected months later. At the end of a calendar year, the department prepares a preliminary "bound volume" of landed catch. The "bound volume" is a compilation of landed catch from commercial fisheries for all food fish and shellfish. This preliminary report is reviewed by research analysts and program managers for accuracy. Corrections are referred to data processing and a final "bound volume" is published two years after the landings were originally reported. At that time, the "bound volume" becomes the department's official record of landed catch and the fish ticket database for that year is closed.

2.3 Logbook System

For the coastal otter-trawl fishery, the department uses the standardized Washington-Oregon-California Trawl Logbook jointly developed by the Pacific Fishery Management Council and the states. There are no logbook requirements for other groundfish gears.

2.3.1 Groundfish Trawl

Collection

Otter-trawl vessel operators are required by law to maintain a complete and legible logbook and to deliver that logbook to an authorized representative of the Department of Fish and Wildlife on demand. Typically, logbooks are collected by the port sampler each time a fisher completes a trip. When the completed trip is unobserved by the sampler, the vessel operator is required to submit the logbook within 10 days of the termination of fishing or within 10 days of the end of the month, whichever comes first. In practice, the sampler may miss a vessel on a given trip and recover the log at the termination of a subsequent trip. When the sampler recognizes that an operator has completed a trip without submitting their log and the sampler has not been able to meet with the vessel operator to collect the log personally, a letter is sent to the operator reminding them of their obligation to submit the log. Ultimately, vessel operators with delinquent logs receive a warning or citation from the department's Enforcement Division as the case merits, accompanied by a demand to produce the log.

Data entry

Logbook data are recorded to disk by the port sampler. Data are entered with the aid of a custom program that conducts cursory error checking. Coded logbook data are then sent to the Marine Resources Division in Olympia, where the data are copied and stored in separate files.

Error checking

Raw logbook data are transmitted to the computer information consultant (CIC), a data specialist, in Olympia. Individual files of raw logbook data are each filtered through a comprehensive error checking program (Pattie 1987), at which point they become "processed trawl logbook data." Processed data are then aggregated into a single file and further processed into "tow-expanded logbook data" to account for tows that were not keypunched (Clark 1988a, 1988b). Tow-expanded data are subsequently processed with fish ticket data to generate the "expanded trawl logbook data."

The error screening program checks raw logbook data for "data out of range" errors in Loran coordinates, depth, fishing block, species, port, and trip type. It also screens for errors such as tow information entered in the wrong column and missing data. Records with errors are flagged in the database and a separate file is generated that describes the type of error and records the data line in the raw trawl data file where the error occurred. The CIC then has to rectify the error by reviewing the raw data or returning the coded data to the port sampler for clarification. More than 95% of the logs are free of coding errors after two passes through the error screening program.

2.4 Species-Composition Sampling

Prior to 1993, WDFW obtained estimates of the species composition of rockfish landings almost exclusively by visual inspection of the landed catch. The procedure involved the observation of the top layer of one or more totes of landed fish. The frequency of occurrence of various species visible in the top layer was recorded by the sampler who subsequently converted the counts by number to weight based on average individual weights for various species. A standard set of mean species weights was maintained by the port sampling supervisor and used by each port sampler. The mean weights were derived from opportunistic basket samples of each species by dividing the cumulative basket weight by the number of fish in the sample. Samples from all ports were pooled and updated annually. The species composition was the proportion by weight of the species encountered. The visual method worked adequately provided the landing was dominated by no more than three species. When more than three species were present, samplers were encouraged to draw a weighed subsample of the landed catch, separate the species, and directly measure the weight of contributing species to the catch. There was no prescribed quantity for such a weighed sample. The method of determining the species composition was coded on the data entry form.

In 1993, sampling protocols were amended. Samplers were required to use a weighed subsample for any market category with more than three species in the landing. Furthermore, weighed subsamples were required for all landings in the "other rockfish" market category. Separate samples were taken for each of the five market categories (Pacific ocean perch, widow, yellowtail, thornyhead, and "other rockfish") used at that time.

Prior to 1994, samplers were encouraged to obtain as many species-composition samples as possible, but there was no prescribed number of samples. Landings could only be sampled when the rockfish catch was taken from a single Pacific States Marine Fisheries Commission (PSMFC) area. For example, when an "other rockfish" catch was taken from one PSMFC area and a widow or Pacific ocean perch catch from another, the landing could be sampled. However, if the catch of a single rockfish market category came from more than one PSMFC area, it could not be sampled.

In 1994, samplers were instructed to obtain 10-20 species-composition samples per 100 t of landed catch in each market category sampled. The PSMFC area continued to be the basis for qualifying whether a landing could be sampled.

The WDFW requires the processor to separate species regulated by trip limits from other species at the time they are unloaded. Samplers examine totes to verify that species have been separated appropriately. Their species-composition report will indicate the fish ticket reported weight of the landed catch and the observed species composition. Prior to 1993, all species-composition reports were coded to one of two market categories: nominal Pacific ocean perch or nominal "other rockfish." The term "nominal" implies that the market category, while ostensibly comprised of a single species, may actually be represented by additional species (e.g., Table 2.6). Since 1993, the number of market categories has increased to reflect the number of species regulated by trip limits.

Species-composition reports are coded onto forms by the port samplers and sent to a data specialist in Olympia. These data are keypunched and then screened for errors. A program checks for errors in area fished, port, and species codes; assures the correct year is coded and that the vessel code is valid; and verifies that the proportions by species sum to 100%.

The WDFW has collected rockfish species-composition reports for nominal Pacific ocean perch and "other rockfish" since the late 1960s (Tables 2.7-2.8). Since 1993, species-composition samples have been obtained for all market categories of species with designated trip limits. Species-composition sampling is conducted throughout the fishing year (Tables 2.9-2.10), but is routinely undertaken only in the major ports.

In 1995, WDFW's species-composition sampling underwent a substantial revision. Species-composition samples were stratified by port/quarter rather than by PSMFC area/month. Single species market categories, which were those categories that had been previously demonstrated to contain primarily one species (at least 98%), no longer were sampled for species composition. These included Pacific ocean perch, widow rockfish, and yellowtail rockfish. Visual and weighed subsample techniques continued to be used for species-composition sampling for the remaining market categories: shortspine thornyhead, longspine thornyhead, canary rockfish, and "other rockfish." Revised catch estimation algorithms were adopted to reflect the change in sampling design.

2.4.1 A Hypothetical Example

The following example illustrates some of the protocols and decisions involved in sampling commercial groundfish landings in Washington prior to 1995, when field techniques involved in the species-composition sampling program were modified (see section 2.4). A vessel makes a landing that includes 4,000 lb of nominal yellowtail rockfish, 3,500 lb of nominal widow rockfish, 800 lb of nominal Pacific ocean perch, and 7,000 lb of "other rockfish." The sampler observes the unloaded catch in 18 totes awaiting processing. To determine whether the catch can be sampled for rockfish species composition, the sampler reviews the vessel's logbook, which indicates that all the yellowtail rockfish and Pacific ocean perch were taken in PSMFC area 3CS, all the "other rockfish" were harvested in area 3B, and the widow rockfish were caught in both areas. The totes containing widow rockfish cannot be sampled for species composition because the catches were made in multiple PSMFC areas, but the remaining totes can be sampled.

Yellowtail rockfish and Pacific ocean perch are species regulated by trip limits. The processor purchasing the fish has segregated these species from the "other rockfish"; however, a small amount of "other rockfish" species remains with the Pacific ocean perch. The sampler finds only one tote with Pacific ocean perch and notices that it is contaminated with only redstripe rockfish. Using a visual estimation technique, the sampler counts and identifies all of the fish that can be observed on the top layer of the tote. There were 41 Pacific ocean perch and 3 redstripe rockfish. Using standard mean weights, 1.54 lb for Pacific ocean perch and 1.29 lb for redstripe rockfish, the sampler records a species composition of 94% Pacific ocean perch and 6% redstripe rockfish. The sampler observes that the yellowtail rockfish have been successfully separated from the other species, i.e., no contamination, and reports a species composition of 100% yellowtail rockfish.

The "other rockfish" are contained in eight totes. Visual inspection of the top layer of these totes indicates that there are more than three rockfish species present in the landing. The sampler determines that there is adequate time to obtain a weighed subsample of the catch. Selecting one of the eight totes, the sampler sorts the catch into baskets containing single species. Each basket is weighed on a platform scale with a composition as follows: 400 lb of bocaccio, 200 lb of redbanded rockfish, 100 lb of splitnose rockfish, 75 lb of sharpchin rockfish, 50 lb of Pacific ocean perch, 30 lb of rosethorn rockfish, and 20 lb of greenstriped rockfish. The species composition is then 46% bocaccio, 23% redbanded rockfish, 11% splitnose rockfish, 9% sharpchin rockfish, 6% Pacific ocean perch, 3% rosethorn rockfish, and 2% greenstriped rockfish.

2.5 Biological Sampling

The WDFW routinely collects biological samples from Dover sole, English sole, arrowtooth flounder, Pacific cod, lingcod, yellowtail rockfish, widow rockfish, canary rockfish, black rockfish, and sablefish. Other species are sometimes sampled in response to specific requests. Samples are stratified by species, gear, and area fished.

The sampling level is specified by a research scientist in consultation with other staff. Annually, the table of requested samples is given to the port sampler's supervising senior technician who subsequently distributes the list to all samplers and coordinates the data collection activities. The port sampling supervisor compiles semi-monthly summaries of samples collected at each port and shares this information with all samplers. Samplers are requested to collect a specified number of samples per species for combinations of gear/area fished/month. The supervisor assures that the samples are collected on schedule and reminds port samplers of missing samples when necessary.

Port samplers temporarily store biological samples (age structures) in their field office and periodically transfer them to Olympia for processing and permanent storage. In Olympia, the samples are delivered to the technician responsible for age determination. The technician logs the samples and stores the structures as required (spines and interopercles to a freezer, and otoliths to a storage chest). The accompanying data forms are sent to a CIC who enters the data into the WDFW's Biological Data System (BDS) (Kimura and Cross 1983). Once ages have been determined, the age reader enters the information into the BDS database.

New or recently hired samplers, as a part of their initial job orientation, receive training on how, where, and when to sample as well as how to complete the many data entry forms. All groundfish biological data are recorded in the same format. Paper records of sablefish samples are also coded and maintained in the format requested by the National Marine Fisheries Service.

Vessels arriving at a port are selected for sampling opportunistically, i.e., non-randomly. Moreover, only those vessels whose catch can be identified as coming from a prescribed gear/area fished stratum are eligible for sampling. Individual specimens are typically drawn at "random" by taking fish from one corner (top to bottom) of an unsorted tote of landed fish. Occasionally, the sampler will obtain specimens from the fillet line prior to processing and/or from discarded carcasses (frames) after processing. As mentioned earlier, WDFW's sampling protocol, with the exception of sablefish, requires drawing a fixed number of fish for each sample (see section 2.1.2).

During data entry, the CIC checks data manually for obvious omissions and gross errors. There is no formal error checking program to scan the biological data; consequently, some errors are undetected until the data are analyzed. Types of errors that may occur include transposed size or age data (trapped when data are scanned for outliers) and missing integers on individual specimen weight data, which occasionally occur because samplers neglect to enter the integer portion of the weight when recording data in the field.

The BDS is currently a 20-megabyte computer database containing more than 1 million records. Data records date back to 1954 for some species (Table 2.11).

2.6 Estimating Derived Quantities

The following sections describe estimation algorithms for the determination of groundfish catch and effort and rockfish catch by individual species. These algorithms form the basis of a catch reporting system that has undergone numerous changes over the years. The algorithms used to derive point estimates of catch and effort are applicable for all years of data collection by WDFW unless otherwise noted; however, the estimates of variance are applicable for specified periods only.

In Washington, fish ticket receipts report the actual weight of landed fish by date, port, management area (a unique WDFW defined area), and market category (species or species group). However, area information on these receipts is imprecise because it is limited to only one reporting area when in fact one or more areas may have been fished. For coastal fisheries, the greatest volume of landings are taken by the trawl fishery, and each trawler is required to maintain a logbook with tow-by-tow records of their fishing location, towing time, depth fished, and estimated (hailed) weight of species landed (retained catch only). The fisher's recorded tow-by-tow catches cannot be used directly to describe landed weight because the logged weights are estimated by the skipper with varying degrees of accuracy, minor catches of some species are never recorded by the skipper, and the tow sampling rate (see section 2.6.1, tow-expanded values) used by the department has been less than 100% in some years (Clark 1988b).

Logbook data do represent the best information available on the relative distribution of catch by statistical catch reporting area (10 minute latitude/longitude block, WDFW statistical area, PSMFC and/or International North Pacific Fisheries Commission (INPFC) area). In addition, logbook data are the only source of information on trawl effort (hours fished), depth fished, and net type used. In order to provide tow-by-tow data that correspond with fish ticket totals, ticket landings are "distributed" over the logbook data in proportion to the tow-expanded values (Fig. 2.4). Tow-expanded values are the hailed weights multiplied by the ratio of total to sampled tows for a trip. Fish ticket receipts for a given vessel trip are not matched with the vessel's logbook entries. Rather, the expanded tow-by-tow logbook weights are multiplied by the ratio of fish ticket to expanded logbook weight. The distribution is performed within each of many primary strata defined by year, trip type (e.g., coastal, Puget Sound), month, port cluster (a group of ports), and species (Clark 1988b).

2.6.1 Trawl Catch and Effort: Point Estimates

To the extent possible and practicable, the notation below utilizes unique variable and index values. The defined values are applicable for all subsequent equations unless specifically redefined. In addition, "dot" notation is sometimes used to represent summation over a specific index, e.g.,

$$x_{\cdot j} = \sum_i x_{ij} . \tag{2.1}$$

Because the algorithms described below reference catch data under several variable names, a few remarks about the nature of the catch data are appropriate. There are three generic types of weight or catch data used in the CTLS logbook system: 1) hail weights, which are estimates of retained catch recorded by a fishing vessel operator in the vessel's log, 2) fish ticket weights, which are scale-measured weights that are recorded on an official sales receipt, and 3) sampled landing weights, where the source of the weight may be a hail, fish ticket receipt, sampler's estimate, or scale-measured weight.

In addition to multiple catch variables, there are multiple species indices. Fish tickets and logbooks report catches in market categories. A market category may represent either single or multiple species, e.g., Pacific cod, "other flatfish," or "other rockfish." Rockfish species-composition reports record catches in single and multiple species groups as well, but the groups may be different than those represented by the market category. For example, a landing recorded on a fish ticket receipt in the "other rockfish" market category could have a species composition as follows: 95% silvergrey rockfish, 3% redbanded rockfish, and 2% "other rockfish." In this case, the "other rockfish" in the species-composition report is a different collection of species than the "other rockfish" market category reported on the fish ticket. Consequently, one index is needed to represent the market categories, and a second index to represent the species or species groups within the market categories.

Finally, a few remarks are needed on the relationship between trips, fish ticket receipts, and species-composition samples. Logbook data are used to count the number of trips within a primary strata. For any given trip, a fisher may sell his catch to one or more buyers, each of whom will complete a fish ticket sales receipt. Therefore, the number of fish tickets is greater than or equal to the number of trips. For each trip fished and each landing at a unique buyer, a sampler may obtain one or more rockfish species-composition samples. Prior to 1995, multiple species-composition samples could be taken to reflect catches from different statistical catch reporting areas or to report the species composition from multiple market categories. Since 1995, multiple species-composition samples are taken only when multiple market categories from the same landing are sampled.

The total weight recorded on a fish ticket is the landed weight sold to a specific buyer. Some fishers sell the retained catch from a single trip to multiple buyers; therefore, the landed weight reported on a single sales receipt may not be the trip weight of a species. Some samples may be obtained from a portion of the landed weight at a single buyer. This is sometimes the case when sampling rockfish landings for species composition. So, the total weight of the sampled rockfish catch may not be the total weight reported on the fish receiving ticket nor the total weight of the trip.

Tow-expanded values

The WDFW has recorded tow-by-tow logbook data since 1985. The logbook system was designed to accommodate subsamples of tows. Originally, approximately every fourth tow was keypunched from each logged trip; currently, all of the recorded tow-by-tow data are entered into the logbook database. When tow-by-tow data are subsampled, hailed weights of the subsampled tows have to be expanded to represent the weights of all tows in the trip. This process produces the "tow-expanded" values, which are simple random sampling estimates.

For a given trip,

let m be the number of tows recorded (i.e., sampled),
M be the total number of tows logged (i.e., fished),
x_{ij} be either the total hours fished, or the hailed catch of a single species (e.g., sablefish) or species group i (e.g., "other rockfish") from tow j, and
t_{ij} be the tow-expanded catch (or effort).

Then the tow-expanded catch is calculated as,

$$t_{ij} = \frac{M}{m} x_{ij} . \qquad (2.2)$$

The sum of catches across all tows within a trip is then,

$$t_{i\cdot} = \sum_j t_{ij} = \frac{M}{m} \sum_j x_{ij} = M \bar{x}_{i\cdot} . \qquad (2.3)$$

Note that within the database, a "dummy" species code (599) is used to uniquely identify an effort data record.

Distributed values

Fish ticket landings are "distributed" over the tow-by-tow logbook data in proportion to the tow-expanded values. In doing so, the ratio between logged effort and logged catch is preserved in the distributed catch and effort. The estimates of distributed catch and effort must accommodate several special cases. To preserve the absolute sum of landed catches recorded on the fish tickets, adjustments are necessary for catches of species that are reported on the fish ticket but not in the logbook data. In addition, effort is missing from some logbook tows. To preserve the catch-per-unit-effort (CPUE) ratio represented by the sampled logbook catch, missing effort is estimated from the ratio of distributed catch for each tow to CPUE for all tows.

The distributed fish ticket values (catch weight and effort) are estimated within each of many primary strata determined by trip type (g), year (y), month (z), and port cluster (p). Ports are clustered to minimize the number of cells with missing values (i.e., primary strata containing only logbook or only ticket data) (Table 2.12). There are five trip types: Alaska, Canada, outside, inside, and deep inside. Outside trips represent catches from the Washington, Oregon, and California coast beyond the Strait of Juan de Fuca. Inside trips represent catches from Puget Sound and the Strait of Juan de Fuca. Deep inside refers to the inner reaches of Puget Sound. The catches from inside and deep inside trips are pooled for the purposes of distributing catch to avoid too many empty cells. However, the trip type is retained with the distributed values in the final catch database.

For a given primary stratum (trip type, year, month, and port cluster),

let c_i be the fish ticket catch of species i, and
d_{ij} be the distributed ticket catch of species i on tow j.

Then the distributed catch corresponding to each record of tow-expanded catch is,

$$d_{ij} = \frac{t_{ij}}{t_{i\cdot}} c_i \, . \tag{2.4}$$

When there is a trawl-expanded catch for a species but no catch recorded on the fish ticket, the distributed value is zero, which follows from equation 2.4. However, when there is a fish ticket record of a species landing and no logbook data for that species, a record is added to the database with the distributed catch set equal to the fish ticket catch. For these records, tow-expanded catch and depth fished are blank. Adding these data records is necessary to preserve the absolute weight of landed catch recorded on the fish ticket. Added data lines are coded with a vessel identifier called "TICKETS." The trip type and catch area for these records are determined from the catch reporting area recorded on the fish ticket. Port of landing is recorded directly from fish ticket information.

There are three cases to be considered when computing distributed effort: 1) tow-expanded effort is unknown, (i.e., the duration of the tow was never recorded in the logbook or the catch of this species appeared on a fish ticket but was never recorded in the logbook, which makes this a "TICKETS" data line for which there is no corresponding effort information), 2) tow-expanded effort is known, but the distributed catch is less than the tow-expanded catch, and 3) tow-expanded effort is known, but the distributed catch is greater than the tow-expanded catch.

For clarity and convenience in the following exposition, a variable is defined to represent expanded trawl effort. However, from a data-processing perspective, effort is just another "species." Recall from equations 2.2-2.3 that t_{ij} represents the tow-expanded catch of species i and that effort is given a dummy species code (599).

Let e_j be the tow-expanded logbook effort on tow j,
e_j^* be the distributed effort, and
u_{gh} be the catch per unit effort for all reported species (total tow-expanded logbook pounds per hour fished) for trip type g and net type h (bottom trawl, roller trawl, mid-water trawl, any trawl) computed from all sampled tows where effort was recorded.

Within a given trip, tow-expanded effort is,

$$e_j = t_{599j} = \frac{M}{m} x_{599j} . \tag{2.5}$$

Prior to estimating distributed effort, CPUE must be computed. The CPUE is estimated from a simple ratio of tow-expanded catch to tow-expanded effort for all tows reporting any effort. While distributed catch and effort are estimated within a primary stratum, mean CPUE is computed from catch and effort data aggregated across all species, tows and trips within a trip type, and net type.

When the net type is known,

$$u_{gh} = \frac{\sum_{i,j,l} t_{ghijl}}{\sum_{j,l} e_{ghjl}} = \frac{t_{gh\cdots}}{e_{gh\cdot\cdot}} . \tag{2.6}$$

When the net type is unknown,

$$u_{gh} = \frac{\sum_{h,i,j,l} t_{ghijl}}{\sum_{h,j,l} e_{ghjl}} = \frac{t_{g\cdots\cdot}}{e_{g\cdots}} . \tag{2.7}$$

Now, the three distributed effort cases mentioned above can be addressed. For a given primary stratum, if e_j is unknown then,

$$e_j^* = \frac{\sum_i d_{ij}}{u_{gh}} . \tag{2.8}$$

If e_j is known and $d_{.j} \leq t_{.j}$, then we deflate the tow-expanded effort,

$$e_j^* = e_j \frac{\sum_i d_{ij}}{\sum_i t_{ij}} . \tag{2.9}$$

If e_j is known and $d_{.j} > t_{.j}$, then we inflate the tow-expanded effort,

$$e_j^* = e_j + \frac{\sum_i d_{ij} - \sum_i t_{ij}}{u_{gh}} . \tag{2.10}$$

Distributed effort is adjusted to avoid computing very large effort when the actual logged effort is low and the ratio of ticket to logbook catch is high (Clark 1988b). For the purposes of computing variances, the distributed effort is treated as a known quantity within a stratum, i.e., a parameter known without error.

Rockfish species catch through 1992

The proportion of each rockfish species in a stratum is determined from a simple ratio estimator following Cochran (1977). Estimated landed weight within a year (y), month (z), and PSMFC area (a) stratum is the sum over all market categories of the product of the estimated weighted proportion by species and the distributed fish ticket catch by rockfish market category.

For a given stratum,

let λ_{iko} be the proportion of rockfish species o in sample k and market category i (nominal Pacific ocean perch or nominal "other rockfish"),
w_{ik} be the total weight of market category i in sample k,
w^*_{iko} be the estimated weight of rockfish species o in sample k and market category i,
Φ_{io} be the estimated proportion of rockfish species o in market category i,
d_i be the distributed fish ticket catch of market category i, and
W^*_{io} be the estimated landed weight of rockfish species o in market category i.

Then the estimated weight of rockfish species o in sample k and market category i is calculated as,

$$w^*_{iko} = \lambda_{iko} w_{ik} , \tag{2.11}$$

and the estimated proportion of rockfish species o in market category i is calculated as,

$$\Phi_{io} = \frac{\sum_k w^*_{iko}}{\sum_k w_{ik}} . \tag{2.12}$$

The estimated landed weight of rockfish species o in market category i is then calculated as,

$$W_{io}^{*} = \Phi_{io}\, d_i \,. \tag{2.13}$$

Total catch of species o within the stratum is obtained by summing the estimated landed weights across market categories.

2.6.2 Trawl Catch and Effort: Variance Estimates

Prior to 1985, submission of trawl logbooks was voluntary. Tow-by-tow data reported in submitted logs were aggregated based on area of catch prior to coding. Since 1986, trawl logbooks have been mandatory, and although subsamples of logbook tow-by-tow data were originally keypunched, the WDFW has subsequently recorded all of the tow-by-tow data obtained from trawl logbooks. Consequently, components of variance due to subsampling tows have been eliminated. Moreover, because we are quite successful at recovering logbooks for nearly all trips (> 85%), the sampling system is, in effect, a complete census and all variance components go to zero, with the exception of variance due to rockfish species-composition sampling. The variance formulae presented below are applicable when tows are subsampled and/or when total trips are subsampled. They are provided as a record of the algorithms used in the CTLS and as an aide for those who may be considering a logbook system that relies on subsamples of tows and trips.

Tow-expanded values

Variance for the tow-expanded catch is derived from standard methods. The variance for $t_{i\cdot}$ is calculated as,

$$V(t_{i\cdot}) = V(M\ \bar{x}_{i\cdot}) = M^2\, V(\bar{x}_{i\cdot}) = M^2\, \frac{S_{i\cdot}^2}{m}\left[1 - \frac{m}{M}\right], \tag{2.14}$$

where

$$S_{i\cdot}^2 = \frac{\sum_j (x_{ij} - \bar{x}_{i\cdot})^2}{m-1}\,. \tag{2.15}$$

To assign a component of variance to each catch from an individual tow, the variance has to be expressed in terms of t_{ij},

$$V(t_{ij}) = \frac{m(M-m)}{M(m-1)} \sum_j (t_{ij} - \bar{t}_{i\cdot})^2\,. \tag{2.16}$$

When $m = 1$, the variance $V(t_{ij})$ is obtained from the approximate relationship,

$$CV(t_{ij}) = \frac{S_{i\cdot}}{\bar{t}_{i\cdot}} = \sqrt{2} \; ; \tag{2.17}$$

therefore,

$$V(t_{ij}) = 2\left(\sum_j t_{ij}\right)^2 \left[1 - \frac{m}{M}\right]. \tag{2.18}$$

When values are summed across trips the variances are additive, which allows the variance of the total catch to be conveniently obtained for any user-defined stratum of interest. Note that when the number of sampled tows (m) equals the number of tows in the trip (M), the variance due to subsampling tows goes to zero.

Distributed values

Complications in calculating variances of distributed quantities are discussed in detail by Clark (1988b). Complications arise as a consequence of summing a subset of distributed values from each of several primary strata into a new aggregate of interest. For example, suppose one wishes to estimate the annual catch and variance for English sole caught in PSMFC area 3B. Catches will have to aggregated across primary strata for each month and across strata representing different port clusters. The variance of the total catch of English sole is a composite of the variance due to sampling tows and trips and the variance of the estimated proportion of the fish ticket catch represented by the logged catch. The variances are computed within each of the contributing primary strata and then summed across strata to represent the quantity of interest.

Let x_q be the sum of all logbook values within a primary stratum that qualify for a subset of interest, and

$x_{\cdot}$ be the sum of all logbook values in the stratum.

Then the actual proportion of qualified pounds in the stratum of interest is calculated as,

$$p_q = \frac{x_q}{x_{\cdot}}. \tag{2.19}$$

The quantities x_q and $x_{\cdot}$ are the sums that would be obtained from the logbooks if all of the trips were logged and all of the tows were coded.

Let t_q be the sum of all qualifying tow-expanded logbook values (i.e., the sample catch or effort logbook data for the specified stratum of interest),

$t_.$ be the sum of all tow-expanded logbook values in the specified stratum of interest,

$n_.$ be the number of tows contributing to $t_.$,

$d_.$ be the sum of distributed fish ticket values in the primary stratum, and

f_c be the relative completeness of logbook coverage in the stratum.

The relative completeness of logbook coverage is calculated as,

$$f_c = \frac{t_.}{d_.}, \tag{2.20}$$

and the estimated proportion of qualifying tow-expanded logbook catch or effort is,

$$p'_q = \frac{t_q}{t_.}. \tag{2.21}$$

The variance of p'_q is,

$$V(p'_q) = \frac{1}{t_.^2}\left[p_q^2 V(t_.) + (1 - 2p_q)V(t_q)\right]. \tag{2.22}$$

Clark (1988b) notes that in most cases it will be approximately true that $V(t_q)$ will equal $p_q V(t_.)$. Consequently, $V(p'_q)$ will be zero when $V(t_.) = 0$, $p_q = 0$, or $p_q = 1$. In other words, this variance is zero whenever the number of recorded (sampled) tows equals the number of logged tows. This component of the variance only deals with variability due to sampling tows. As Clark points out, there is additional variability. If we let $(p_q|s)$ represent the true value of p_q for all sampled trips, then it is also a random variable dependent on the number of trips sampled and the completeness of the trip samples. So, the estimated variance of $(p_q|s)$ is,

$$V(p_q|s) = \left[p_q \frac{1-p_q}{n_.}\right](1 - f_c). \tag{2.23}$$

The above variance goes to zero when logbook coverage is complete or nearly complete, i.e., when the sum of the tow-expanded logbook values equals or is nearly equal to the sum of the distributed values (Clark 1988b). If $t_.$ plus twice its standard deviation is greater than or equal to the sum of the distributed pounds, the logbook coverage is regarded as nearly complete, and f_c is set equal to one and $V(p_q|s)$ goes to zero. Otherwise, f_c is estimated, and the variance of p'_q is computed as the sum of its two component parts, $E[V(p'_q|s)]$ and $V(E[p'_q|s])$,

$$V(p'_q) = \frac{1}{t_.^2}\left[p_q^2 V(t_.) + (1 - 2p_q)V(t_q)\right] + \left[p_q \frac{1-p_q}{n_.}(1 - f_c)\right]. \tag{2.24}$$

Finally, since $d_q' = p_q' (d.)$, the estimated variance of the distributed values within the primary strata is,

$$V(d'_q) = d_.^2 \, V(p'_q) \, . \tag{2.25}$$

The variance of d_q' is summed across primary strata to yield the overall variance.

Rockfish species catch through 1992

The variance for the rockfish proportion by species (the ratio estimate) is computed following Cochran (1977).

Let m be the number of species-composition sampled landings within a market category.

Then the variance of the estimated proportion of rockfish species o in market category i is,

$$V(\Phi_{io}) = \frac{m\left(\sum_k w_{iko}^{*\,2} - 2\Phi_{io}\sum_k w_{ik}\,w_{iko}^{*} + \Phi_{io}^2\sum_k w_{ik}^2\right)}{\left(\sum_k w_{ik}\right)^2 (m-1)} \, . \tag{2.26}$$

Equation 2.26 is actually an underestimate of the variance due to sampling species composition, because the species weight for each trip is itself an estimate. However, we have ignored the within-trip sample variability. We have done this because historically our data system only recorded the sampler's estimate of the proportion of each species in a landing, not the actual count or weight of species in the sampled portion of the landing. Although not measured, we suspect that the within-trip variance is small relative to the between-trip variance (Sen 1986).

The variance for the estimated landed catch by species is derived from a delta method approximation as follows,

$$V(W_{io}^{*}) = d_i^2 \, V(\Phi_{io}) + \Phi_{io}^2 \, V(d_i) \, . \tag{2.27}$$

The variance of d_i is the sum of the variances for the distributed catch in each of the primary strata that contribute to the distributed catch in the year, month, and PSMFC area stratum. When the estimate of distributed catch is treated as a census, the variance component in the second term in equation 2.27 goes to zero, so that the variance of the estimated species weight is basically a function of the variance due to species-composition sampling among trips.

2.6.3 Non-Trawl Catch and Effort

Reported landings of groundfish by non-trawl gears are taken directly from fish ticket receipts. Area of catch is converted to a PSMFC area based on the reported WDFW management area. Effort is not estimated for non-trawl gears.

2.6.4 Catch-at-Age

Catch-at-age algorithms are variations on a theme. One has to compute the proportion of the total catch weight attributable to each age class, and divide that weight by the mean weight-at-age to compute the number caught-at-age. Estimates of catch-at-age can be derived through weighted or unweighted methods. Unweighted methods pool data from all samples within a stratum, giving each sample equal weight. Since individual fish are only weighed periodically, the weight of each specimen is estimated from an allometric length-weight relationship. For the pooled samples, the frequency of occurrence at each age is determined, along with the total weight-at-age. The proportion-at-age, based on weight, is then calculated. These proportions are multiplied by the total catch weight and then divided by the mean weight-at-age to generate catch-at-age in numbers of fish. Weighted methods for estimating catch-at-age weight each sample prior to aggregating the observations within a stratum. The sample is typically weighted by the weight of the total catch from which the sample was drawn. Other weighting methods convert the fixed number of fish sampled into a sample of fixed weight (Tagart 1991). Variance measures for the estimates of catch-at-age have not been developed.

2.6.5 Relation to PacFIN

Under the "redefined PacFIN" protocols (see chapter 6), the WDFW submits the complete, detailed, line-by-line fish ticket data to PacFIN. Also submitted is a matrix of proportions that assign the fish ticket data to PSMFC area according to adjustments based on trawl logbook data as described above. Finally, the WDFW provides an additional matrix of proportions that assign the rockfish species composition to the area-adjusted catches of each rockfish market category reported in the fish ticket data. Variances in the form of coefficients of variation are also presented for the area-adjusted catch and species-composition data.

The point estimates of trawl catch will be reported in PacFIN by PSMFC area and port and should be precise replicas of WDFW final data. The variances only apply to the area stratification and would not be applicable for catch estimates by port or any other aggregate.

Under the original PacFIN protocols, the WDFW submitted aggregated fish ticket data rather than individual ticket data. Based on the statistical catch reporting area coded on the fish ticket, catch data were distributed by INPFC area rather than PSMFC area. There was no incorporation of catch area adjustments from logbook data. Rockfish market categories on fish tickets were aggregated into two groups: nominal Pacific ocean perch and nominal "other rockfish." The nominal rockfish catch data were distributed to species based on a matrix of proportions from our rockfish species-composition data; however, the species-composition data were stratified by INPFC area rather than PSMFC area. So, the original PacFIN rockfish catch data accurately represented the total statewide catch by port and market category, but were often a poor representation of the catch by area and species. It should be noted that the original PacFIN data were expected to be replaced by logbook adjusted data as soon as the appropriate data became available; unfortunately, that turned out to be nearly 14 years later.

2.7 Acknowledgments

This chapter was prepared with the assistance of Martha Rickey, Farron Wallace, Sandra Rosenfield, Han Lin Lai, Brad Pattie, Cathy Evans, and Mel Stanley. Their contributions are gratefully acknowledged.

2.8 Citations

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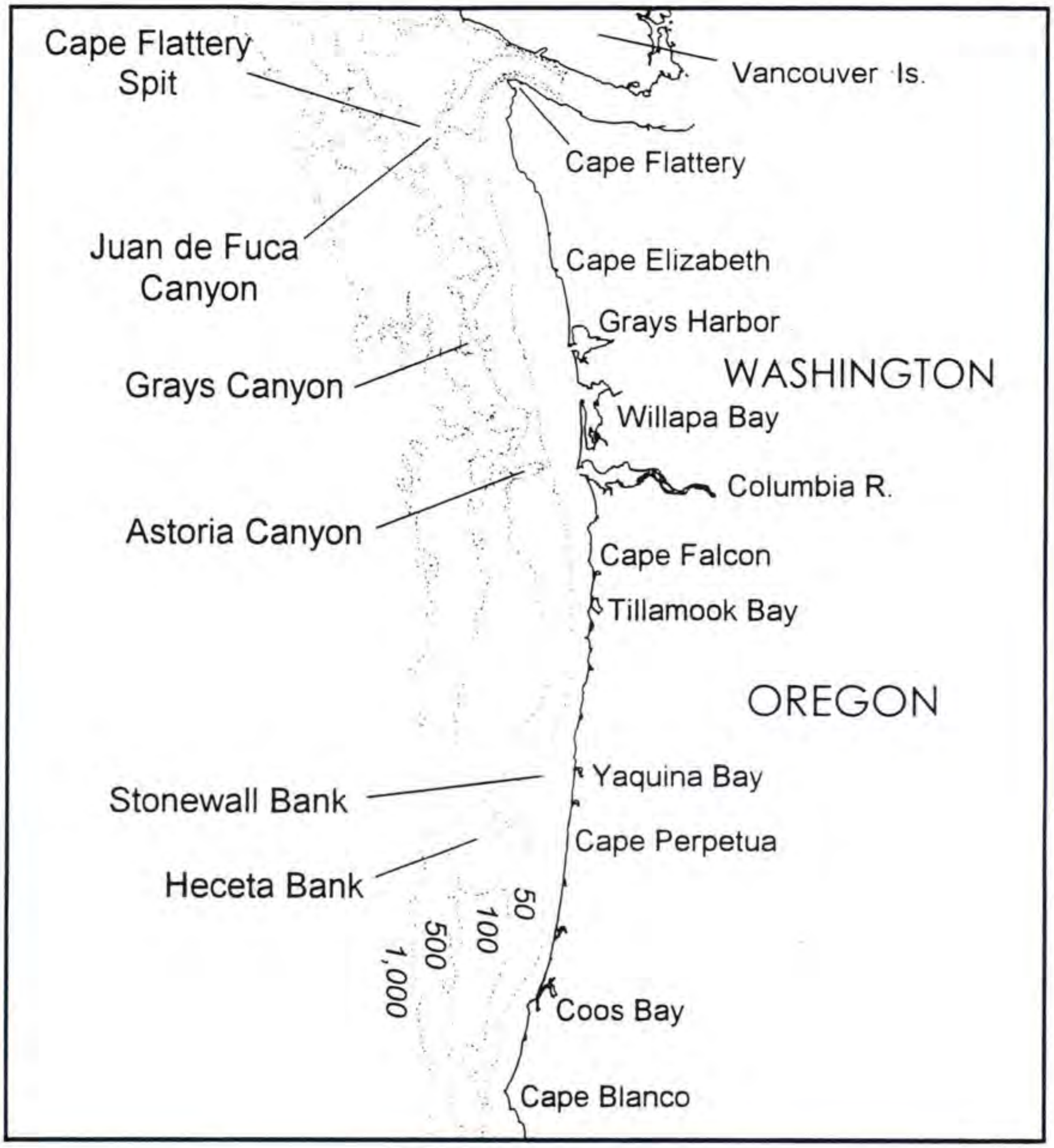

Figure 2.1. Landmarks of the Washington and Oregon coasts. Depth contours are presented in fathoms.

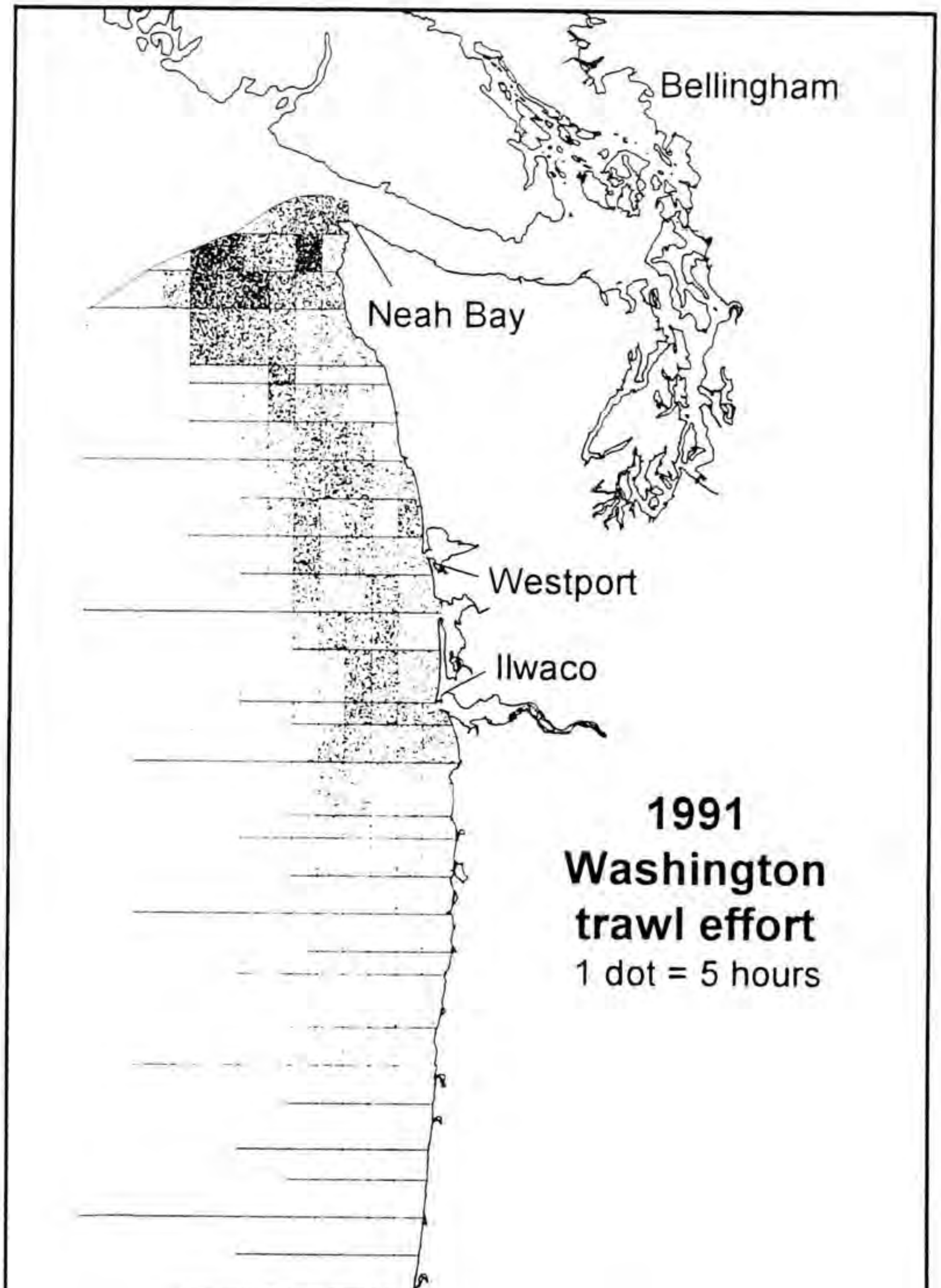

Figure 2.2. Estimated coastal groundfish trawl effort in Washington, 1991. Dots are randomly placed within each block, where greater density represents higher effort.

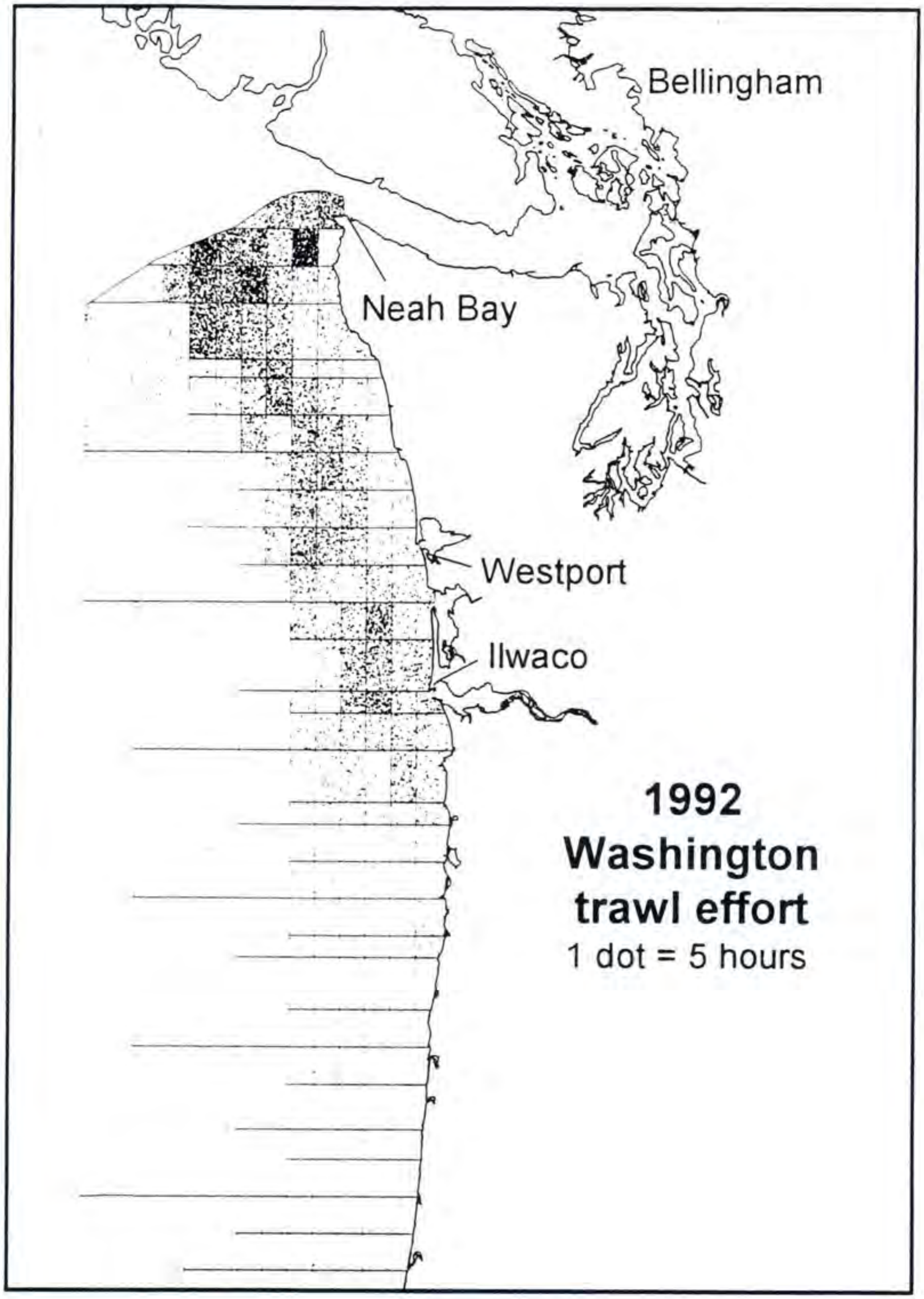

Figure 2.3. Estimated coastal groundfish trawl effort in Washington, 1992. Dots are randomly placed within each block, where greater density represents higher effort.

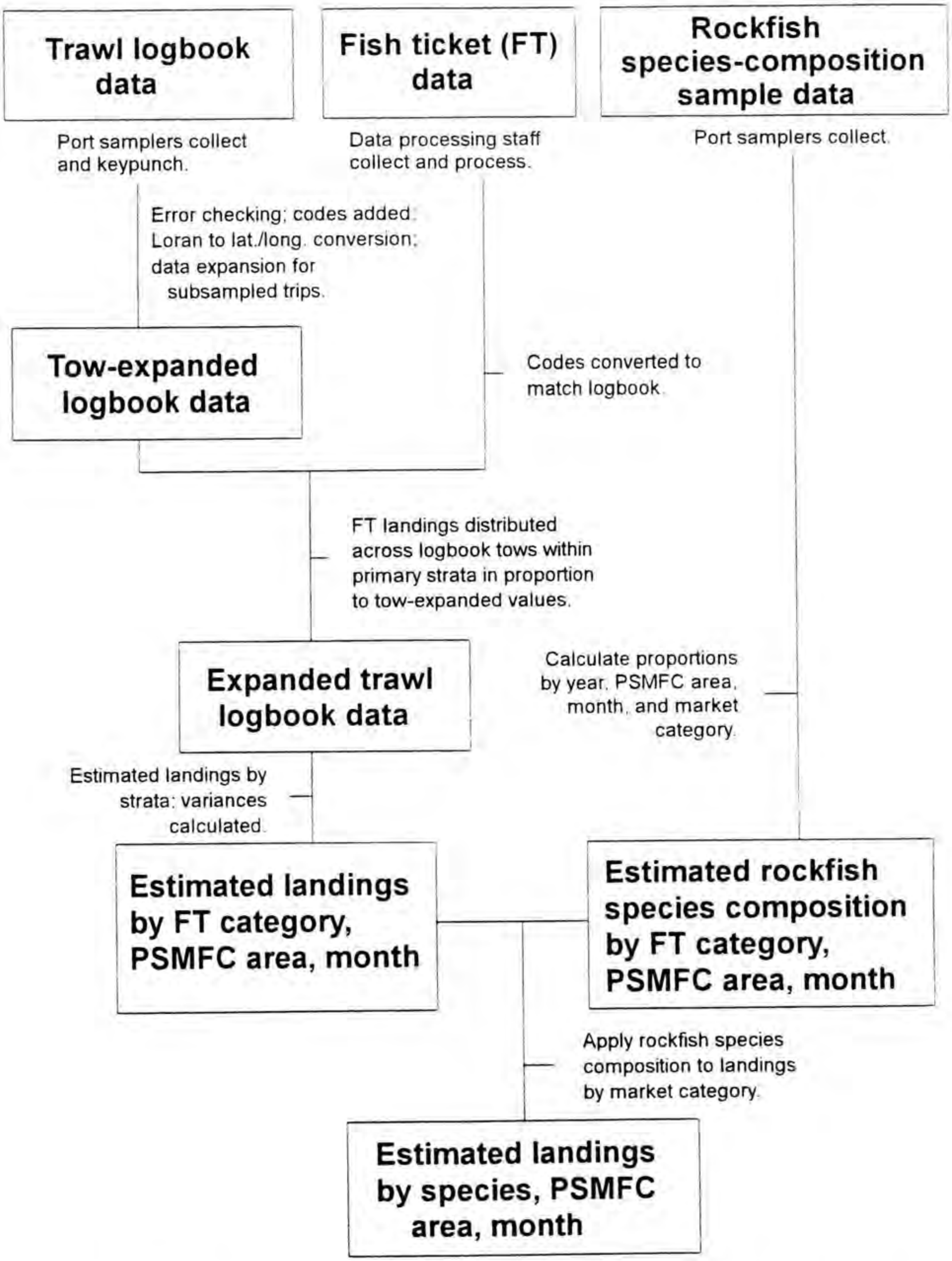

Figure 2.4. System used in Washington for collecting and processing information from Marine Fish Receiving Tickets and Coastwide Trawl Logbooks.

Table 2.1. Washington groundfish landings (in number of fish tickets and pounds) by gear (trawl and non-trawl) and port, 1991-92. Catches from Alaska and Canada are not included.

		Fish tickets		Pounds	
Year	Port*	Trawl	Non-trawl	Trawl	Non-trawl
1991	Bellingham	403	79	13,876,693	1,243,413
	Ilwaco	336	252	7,351,377	214,982
	Miscellaneous	0	6	0	1,666
	Miscellaneous Coastal	24	655	13,854	729,779
	North Puget Sound	2	13	4,546,616	127,188
	Neah Bay/Straits	143	1,488	992,377	2,210,865
	South Puget Sound	2	321	2,953,925	1,355,471
	Westport/Grays Harbor	445	944	8,754,141	719,981
	Willapa Bay	1	103	8,934	105,414
1992	Bellingham	420	51	11,844,076	505,096
	Ilwaco	324	330	8,996,628	310,499
	Miscellaneous	0	4	0	2,030
	Miscellaneous Coastal	25	1,120	18,110	1,070,864
	North Puget Sound	0	12	0	8,706
	Neah Bay/Straits	182	2,302	695,209	2,309,032
	South Puget Sound	1	193	405	206,460
	Westport/Grays Harbor	449	1,454	7,760,344	1,332,964
	Willapa Bay	1	94	1,600	109,758

*Major ports include the following minor ports:
Bellingham: Anacortes, Bellingham Bay, and Blaine
Ilwaco: Ilwaco and Chinook
Miscellaneous: Centralia-Chehalis and East Washington
Miscellaneous Coastal: Hoh, La Push, Taholah, Long Beach, and Copalis Beach
North Puget Sound: Coupeville, Everett, Friday Harbor, and La Conner
Neah Bay/Straits: Neah Bay, Port Angeles, Port Townsend, and Sequim
South Puget Sound: Bremerton, Olympia, Poulsbo, Seattle, Shelton, and Tacoma
Westport/Grays Harbor: Westport, Aberdeen, and Hoquiam
Willapa Bay: Bay Center, Nahcotta, Raymond, South Bend, and Tokeland

Table 2.2. Washington groundfish trawl landings, excluding Pacific hake, by major port and quarter, 1991-92. Catches from Puget Sound, Alaska, and Canada are not included.

Year / quarter	Port	Number of boats	Number of landings	Number of tickets	Landings (pounds)
1991					
Jan.-Mar.	Bellingham	18	85	93	2,747,934
	Ilwaco	15	92	93	1,928,627
	Neah Bay	11	29	30	187,369
	Other	2	3	3	15,115
	Westport	26	126	126	2,661,809
Apr.-Jun.	Bellingham	20	117	121	4,062,813
	Ilwaco	17	96	96	2,362,777
	Neah Bay	10	48	48	226,858
	Other	2	2	2	9,987
	Westport	18	115	118	2,265,545
Jul.-Sep.	Bellingham	17	98	103	5,140,869
	Ilwaco	11	113	113	2,035,115
	Neah Bay	9	46	46	503,766
	Other	0	0	0	0
	Westport	17	128	132	2,597,445
Oct.-Dec.	Bellingham	18	80	86	1,926,349
	Ilwaco	11	58	58	1,038,712
	Neah Bay	8	15	15	126,737
	Other	2	2	2	4,062
	Westport	20	69	69	1,235,675
1992					
Jan.-Mar.	Bellingham	13	96	115	2,909,280
	Ilwaco	12	77	77	1,219,889
	Neah Bay	10	50	53	183,566
	Other	3	3	3	3,143
	Westport	31	121	131	2,592,234
Apr.-Jun.	Bellingham	21	95	100	3,024,371
	Ilwaco	13	106	110	2,003,591
	Neah Bay	10	51	52	263,732
	Other	3	3	3	22,972
	Westport	21	105	124	2,277,963
Jul.-Sep.	Bellingham	17	101	106	4,150,174
	Ilwaco	18	117	117	3,951,347
	Neah Bay	6	48	50	122,753
	Other	2	15	15	57,754
	Westport	15	107	135	1,987,182
Oct.-Dec.	Bellingham	22	86	97	1,725,821
	Ilwaco	10	44	44	1,837,694
	Neah Bay	9	39	39	103,403
	Other	2	5	5	23,905
	Westport	16	61	61	903,511

Table 2.3. Washington groundfish landings (in pounds) by species and gear, 1991. Catches from Alaska and Canada are not included.

Species*	Trawl	Shrimp trawl	Longline	Other hook and line	Other gear
Pacific halibut	0	0	231,116	19,609	0
Flathead sole	26,705	26	0	0	0
Dover sole	3,712,308	9,326	2,986	0	18
English sole	1,161,686	50	0	0	98
Petrale sole	574,960	79	96	0	0
Rex sole	261,777	374	0	0	0
Rock sole	14,382	14	13	120	339
Sand sole	123,120	0	5	0	349
Butter sole	40	0	0	0	0
Sanddab	20,818	0	0	0	0
Starry flounder	718,755	0	0	8	709
Arrowtooth flounder	5,882,461	42,811	27,076	107	13
Groundfish, miscellaneous	1,418	0	9	0	0
Sablefish	716,519	10,320	4,202,781	53	8
Lingcod	1,718,524	9,323	43,735	197,322	32,578
Pacific cod	2,812,967	1,959	6,946	2,467	110
Walleye pollock	15,012	68	0	0	0
Pacific hake	8,539,128	0	0	0	0
General rockfish	9,622,672	808,186	300,395	181,254	76,842
Nominal Pacific ocean perch	1,101,411	1,499	2	0	0
Surfperch, unidentified	0	0	0	0	2,271
Sculpins, unidentified	125	0	0	320	0
Sharks, unidentified	866	0	581	0	0
Blue shark	0	0	42	0	0
Dogfish	1,382,243	0	456,885	870	241
Mud shark	0	0	459	0	0
Soupfin shark	950	87	0	0	95
Thresher shark	246	0	0	0	0
Skate, unidentified	88,824	60	25,049	465	404
Pacific hagfish	0	0	0	0	9,731

*Species presented in table are those listed on the Washington Department of Fish and Wildlife Marine Fish Receiving Ticket.

Table 2.4. Washington groundfish landings (in pounds) by species and gear, 1992. Catches from Alaska and Canada are not included.

Species*	Trawl	Shrimp trawl	Longline	Other hook and line	Other gear
Pacific halibut	0	0	293,018	28,707	7,772
Flathead sole	52,539	21	0	0	0
Dover sole	2,883,055	17,850	1,816	0	0
English sole	933,532	63	1	1	0
Petrale sole	552,727	134	119	4	0
Rex sole	226,246	593	1	0	0
Rock sole	12,755	96	10	4	19
Sand sole	121,217	0	0	3	36
Sanddab	64,068	68	0	0	0
Starry flounder	104,751	0	0	31	45
Arrowtooth flounder	3,112,710	900	1,995	0	6
Groundfish, miscellaneous	515	16	0	0	0
Sablefish	797,679	72,692	3,058,540	620	16,595
Lingcod	1,035,724	7,045	34,841	159,488	31,248
Pacific cod	2,982,147	5,217	13,573	2,038	275
Walleye pollock	22,585	0	0	0	0
Pacific hake	4,931,653	0	0	0	0
General rockfish	8,627,107	732,730	448,379	340,253	124,808
Nominal Pacific ocean perch	896,033	0	980	0	0
Surfperch, unidentified	0	0	0	0	257
Sculpins, unidentified	234	0	16	499	0
Sharks, unidentified	5,531	0	17	0	55
Blue shark	0	26	42	0	0
Dogfish	1,911,309	0	389,066	0	188
Soupfin shark	608	24	26	0	0
Thresher shark	1,139	0	0	0	0
Skate, unidentified	40,508	0	20,292	69	0
Pacific hagfish	0	0	0	0	42,181

*Species presented in table are those listed on the Washington Department of Fish and Wildlife Marine Fish Receiving Ticket.

Table 2.5. Estimated percentage of number of groundfish trawl landings represented in Washington trawl logbook records, 1991-92.*

Year	Quarter	Number of fish tickets	Number of landings	Number of logbooks	Percent represented
1991	Jan.-Mar.	345	335	287	86%
	Apr.-Jun.	385	378	323	85%
	Jul.-Sep.	394	385	318	83%
	Oct.-Dec.	232	224	150	67%
1992	Jan.-Mar.	369	347	285	82%
	Apr.-Jun.	379	360	304	84%
	Jul.-Sep.	413	388	338	87%
	Oct.-Dec.	241	235	170	72%

*Determining the actual number of landings in any given period is problematic. The number of fish tickets is an overestimate of the actual number of landings, since there may be several different fish tickets for a given trip. Numbers of landings given above represent an attempt to reconcile fish tickets against logbook records. The number of trips recorded in trawl logbooks should provide a minimum estimate of the number of landings, since logbook records for some trips are never reported and some fishers log more than one trip on a logbook page, causing the multiple trips to appear as a single trip. The number of logbook trips reported above were determined by counting the number of unique boat/landing date records in the Washington Department of Fish and Wildlife trawl logbook data files after excluding trips from Puget Sound.

Table 2.6. Species of rockfish that were sampled in the "other rockfish" and Pacific ocean perch market categories in 1992.

	"Other rockfish" samples		Pacific ocean perch samples[b]	
Species	Weight (lb)[a]	Number of boat trips	Weight (lb)[a]	Number of boat trips
Rougheye rockfish	22,290	28		
Silvergrey rockfish	162,974	82		
Darkblotched rockfish	82,396	64	3,754	6
Widow rockfish	921,856	144		
Yellowtail rockfish	986,707	280	3,385	1
Black rockfish	63,546	19	3,682	1
Redbanded rockfish	45,074	31		
Pacific ocean perch	84,282	32	266,242	143
Splitnose rockfish	17,979	17	59	2
Bocaccio	200,351	79	1,128	1
Yelloweye rockfish	157,458	59	16	1
Greenstriped rockfish	54,375	54	59	2
Rosethorn rockfish	12,816	13		
Tiger rockfish	1,936	1		
Aurora rockfish	78	1		
Canary rockfish	734,263	203	6,884	2
Redstripe rockfish	238,853	79	1,595	7
Yellowmouth rockfish	24,601	5		
Shortraker rockfish	24,418	26		
Sharpchin rockfish	70,198	62	6,701	8
Thornyhead[c]	121,838	71	284	2
Unidentified	33,451	2		

[a]Weight denotes the estimated weight of the species in the sampled boat trips.

[b]Missing cells denote that the species did not occur within the sample.

[c]Thornyhead includes both longspine and shortspine thornyhead.

Table 2.7. Number of nominal Pacific ocean perch[a] species-composition samples collected in Washington, 1968-92.

	PSMFC area[b]								
Year	2B	2C	3A	3B	3S	3N	3D	5A	5B
1968	0	0	0	0	0	0	0	1	3
1969	0	0	0	2	0	0	0	8	7
1970	0	0	0	4	0	4	1	13	17
1971	0	0	0	5	9	0	2	16	25
1972	0	0	3	1	7	1	3	18	34
1973	0	0	0	4	8	1	0	12	35
1974	0	0	0	1	13	1	0	14	34
1975	0	0	3	13	7	1	1	10	16
1976	0	0	0	8	10	3	1	9	2
1977	0	0	0	3	9	0	1	21	7
1978	0	2	8	2	16	0	0	1	1
1979	0	0	2	7	32	0	2	12	0
1980	1	7	38	10	19	0	4	9	7
1981	0	5	41	20	21	0	0	0	0
1982	0	7	20	25	33	0	0	0	0
1983	0	5	25	17	25	0	0	0	0
1984	0	3	35	31	30	0	0	0	0
1985	0	2	27	11	21	0	0	0	0
1986	0	0	42	38	48	0	0	0	0
1987	0	0	19	37	54	0	0	0	0
1989	0	1	55	24	64	0	0	0	0
1990	0	1	26	21	62	0	0	0	0
1991	0	1	56	36	90	0	0	0	0
1992	0	0	28	31	88	0	0	0	0

[a]Nominal Pacific ocean perch is a multispecies market category used to report rockfish landings on Marine Fish Receiving Tickets.

[b]The PSMFC area denotes the Pacific States Marine Fisheries Commission area. The coastal regions of the Pacific Ocean are partitioned into the PSMFC areas (geographical units) for monitoring and management purposes.

Table 2.8. Number of "other rockfish"[a] species-composition samples collected in Washington, 1966-92.

	PSMFC area[b]								
Year	2B	2C	3A	3B	3S	3N	3D	5A	5B
1966	0	0	0	2	1	0	4	6	2
1967	0	0	0	3	4	0	8	10	7
1968	0	0	0	17	8	2	8	12	11
1969	0	0	0	42	17	4	23	35	17
1970	0	0	0	12	17	2	20	20	13
1971	0	0	0	18	13	0	16	17	17
1972	0	0	0	13	10	2	14	13	13
1973	0	0	0	3	4	0	11	20	15
1974	0	0	0	4	1	0	16	12	11
1975	0	0	1	11	2	0	8	4	7
1976	0	0	22	6	12	3	10	13	5
1977	0	0	7	11	20	1	8	5	8
1978	0	0	16	9	11	0	4	0	1
1979	1	2	20	10	11	1	32	22	19
1980	6	4	310	43	32	0	31	13	6
1981	0	6	486	73	74	2	6	0	0
1982	0	26	365	114	117	0	0	0	0
1983	0	6	283	100	54	0	0	0	0
1984	0	7	221	78	81	0	0	0	0
1985	0	3	195	58	63	0	0	0	0
1986	0	2	233	83	70	0	0	0	0
1987	0	0	204	123	86	0	0	0	0
1989	0	1	299	124	104	0	0	0	0
1990	0	8	267	97	132	0	0	0	0
1991	0	4	258	150	147	0	0	0	0
1992	0	0	190	171	157	0	0	0	0

[a]"Other rockfish" is a multispecies market category used to report rockfish landings on Marine Fish Receiving Tickets.

[b]The PSMFC area denotes the Pacific States Marine Fisheries Commission area. The coastal regions of the Pacific Ocean are partitioned into the PSMFC areas (geographical units) for monitoring and management purposes.

Table 2.9. Number of nominal Pacific ocean perch[a] species-composition samples collected in Washington by port, PSMFC area, and month, 1991-92.

Year	Port[b]	PSMFC area[c]	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1991	Bellingham	3B	2	0	1	0	1	2	1	0	1	1	1	0
		3S	2	1	3	2	4	3	2	3	1	3	1	4
	Ilwaco	2C	0	0	1	0	0	0	0	0	0	0	0	0
		3A	1	1	4	1	1	8	1	3	4	2	3	0
		3B	2	0	1	0	0	4	1	0	1	1	7	1
		3S	1	0	0	0	1	0	0	0	1	1	2	1
	Westport	3A	1	1	1	1	0	0	1	3	3	5	1	0
		3B	1	0	1	0	0	0	1	2	1	1	0	0
		3S	0	1	1	0	0	0	3	1	2	4	1	2
1992	Bellingham	3B	0	0	0	0	1	1	0	0	0	0	0	0
		3S	1	2	2	5	6	6	1	1	6	6	2	2
	Ilwaco	3A	1	0	3	1	1	1	1	1	2	0	0	0
		3B	0	2	1	1	2	2	4	3	1	2	0	0
		3S	1	0	1	1	0	0	2	1	0	0	0	0
	Westport	3A	1	1	0	1	2	2	2	1	2	1	0	1
		3B	1	1	0	1	4	0	1	1	0	1	0	1
		3S	1	2	8	1	2	0	1	2	0	0	0	0

[a]Nominal Pacific ocean perch is a multispecies market category used to report rockfish landings on Marine Fish Receiving Tickets.

[b]Major ports include the following minor ports: Bellingham includes Anacortes and Blaine, and Ilwaco includes Chinook.

[c]The PSMFC area denotes the Pacific States Marine Fisheries Commission area. The coastal regions of the Pacific Ocean are partitioned into the PSMFC areas (geographical units) for monitoring and management purposes.

Table 2.10. Number of "other rockfish"[a] species-composition samples collected in Washington by port, PSMFC area, and month, 1991-92.

Year	Port[b]	PSMFC area[c]	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1991	Bellingham	3B	6	4	2	2	1	1	1	1	1	1	1	1
		3S	3	6	1	3	6	4	3	8	4	2	1	5
	Ilwaco	2C	0	0	4	0	0	0	0	0	0	0	0	0
		3A	8	4	12	8	11	18	18	13	12	7	2	2
		3B	4	2	6	5	4	2	3	2	5	0	5	0
		3S	2	3	0	2	2	1	4	0	3	3	4	0
	Westport	3A	13	2	13	5	2	7	1	11	9	10	1	3
		3B	2	0	2	8	2	6	3	11	12	8	1	2
		3S	0	0	2	0	0	0	3	5	4	4	2	3
1992	Bellingham	3B	5	6	1	5	2	4	5	1	10	1	6	1
		3S	1	6	11	1	6	1	1	2	2	7	1	2
	Ilwaco	3A	4	14	8	12	15	6	4	2	4	4	0	2
		3B	1	7	6	1	5	2	6	5	4	2	0	0
		3S	2	2	10	4	0	0	3	3	2	3	0	0
	Neah Bay	3B	0	0	0	1	1	0	1	1	0	0	0	0
		3S	0	0	0	2	1	0	1	0	0	0	0	0
	Westport	3A	0	8	6	5	6	9	5	4	5	5	0	4
		3B	3	5	3	3	11	5	3	4	2	1	0	1
		3S	2	4	8	1	2	2	2	1	1	2	1	0

[a]"Other rockfish" is a multispecies market category used to report rockfish landings on Marine Fish Receiving Tickets.

[b]Major ports include the following minor ports: Bellingham includes Anacortes and Blaine, and Ilwaco includes Chinook.

[c]The PSMFC area denotes the Pacific States Marine Fisheries Commission area. The coastal regions of the Pacific Ocean are partitioned into the PSMFC areas (geographical units) for monitoring and management purposes.

Table 2.11. Number of fish sampled for biological information from sport and commercial fisheries in Washington by species and PSMFC area from January 1954 to September 1993.

Data type[a]	Species[b]	Age method[c]	Time period[d]	PSMFC area[e] 2A	2B	2C	3A	3B	3C	3D	5A	5B	5C	5D	6A	SPC areas[f]
S	Spiny dogfish	N	1977-85	0	0	0	0	0	0	0	0	0	0	0	0	2
C	Pacific cod	N	1954-93	0	0	0	2,604	30,977	32,434	451	12,620	15,270	1425	5725	0	0
C	Pacific cod	O	1974-75	0	0	0	0	0	3,190	0	0	0	0	0	0	0
C	Pacific cod	S	1980	0	0	0	0	0	91	0	0	0	0	0	0	0
C	Walleye pollock	N	1969-80	0	0	0	0	0	0	0	226	0	0	0	0	0
C	Pacific ocean perch	N	1967-83	0	0	0	621	3,638	1,143	306	3,116	13,924	0	0	0	0
C	Pacific ocean perch	O	1966-88	0	0	676	9,906	24,685	42,752	1,588	16,676	64,215	0	0	0	0
S	Brown rockfish	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	2
C	Redbanded rockfish	N	1968-73	0	0	0	0	0	0	112	103	0	0	0	0	0
C	Silvergrey rockfish	N	1968-80	0	0	0	53	0	388	1,490	620	0	0	0	0	0
C	Silvergrey rockfish	O	1977-82	0	100	100	400	100	1,300	0	0	0	0	0	0	0
S	Silvergrey rockfish	N	1979-87	0	0	0	0	0	0	0	0	0	0	0	0	2
S	Copper rockfish	N	1975-92	0	0	0	0	0	0	0	0	0	0	0	0	20
S	Grs. rockfish	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	1
C	Widow rockfish	N	1971-88	0	0	0	250	90	753	0	0	0	0	0	0	0
C	Widow rockfish	O	1980-93	0	0	200	16,450	5,142	6,049	0	0	0	0	0	0	0
S	Widow rockfish	N	1977-83	0	0	0	0	0	0	0	0	0	0	0	0	2
C	Yellowtail rockfish	N	1968-91	0	100	0	587	3,584	4,330	303	6,344	5,016	0	0	0	0
C	Yellowtail rockfish	O	1973-93	65	0	492	18,502	9,604	9,490	138	767	576	0	0	0	0
S	Yellowtail rockfish	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	48
S	Quillback rockfish	N	1975-92	0	0	0	0	0	0	0	0	0	0	0	0	14
C	Black rockfish	N	1976-83	0	0	0	488	175	0	0	0	0	0	0	0	0
C	Black rockfish	O	1976-93	0	0	0	4,689	2,800	0	0	0	0	0	0	0	0
S	Black rockfish		1991	0	0	0	0	0	0	0	0	0	0	0	0	25
S	Black rockfish	N	1975-92	0	0	0	0	0	0	0	0	0	0	0	0	2,513
S	Black rockfish	O	1980-93	0	0	0	0	0	0	0	0	0	0	0	0	4,666
S	Vermilion rockfish	N	1977-83	0	0	0	0	0	0	0	0	0	0	0	0	1
S	Blue rockfish	N	1977-85	0	0	0	0	0	0	0	0	0	0	0	0	63
S	China rockfish	N	1976-87	0	0	0	0	0	0	0	0	0	0	0	0	68
S	Tiger rockfish	N	1977-87	0	0	0	0	0	0	0	0	0	0	0	0	1
C	Bocaccio	N	1973-80	0	0	0	6	0	0	0	801	241	0	0	0	0
C	Canary rockfish	N	1968-83	0	0	0	865	1,759	3,177	5,078	1,412	1,175	0	0	0	0
C	Canary rockfish	O	1975-93	0	0	0	6,284	4,601	4,700	599	0	551	0	0	0	0
S	Canary rockfish	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	110
C	Redstripe rockfish	N	1972-83	0	0	0	0	0	2,046	282	0	0	0	0	0	0
C	Ywm. rockfish	N	1970-73	0	0	0	0	0	45	0	1,504	0	0	0	0	0
S	Yelloweye rockfish	N	1975-92	0	0	0	0	0	0	0	0	0	0	0	0	14

Table 2.11. Continued.

Data type[a]	Species[b]	Age method[c]	Time period[d]	PSMFC area[e]												SPC areas[f]
				2A	2B	2C	3A	3B	3C	3D	5A	5B	5C	5D	6A	
C	Sharpchin rockfish	N	1970	0	0	0	0	0	0	0	152	0	0	0	0	0
S	Kelp greenling	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	77
S	Rock greenling	N	1981-81	0	0	0	0	0	0	0	0	0	0	0	0	9
S	Whs. greenling	N	1976-87	0	0	0	0	0	0	0	0	0	0	0	0	30
C	Lingcod	F	1978-93	0	0	0	4,225	5,061	4,298	1	0	0	0	0	0	0
C	Lingcod	N	1965-92	0	0	0	3,059	3,050	12,236	2,530	4,328	9,896	118	0	0	0
S	Lingcod	F	1978-93	0	0	0	0	0	0	0	0	0	0	0	0	2,957
S	Lingcod	N	1975-92	0	0	0	0	0	0	0	0	0	0	0	0	393
C	Sablefish	N	1967-91	0	0	200	2,555	956	2,267	0	0	115	0	0	0	0
C	Sablefish	O	1986-86	0	0	0	0	0	24	0	0	0	0	0	0	0
S	Red Irish lord	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	7
S	Cabezon	N	1976-87	0	0	0	0	0	0	0	0	0	0	0	0	25
S	Surfperch, unident.	N	1978-83	0	0	0	0	0	0	0	0	0	0	0	0	7
S	Striped seaperch	N	1975-85	0	0	0	0	0	0	0	0	0	0	0	0	45
S	Pile perch	N	1975-85	0	0	0	0	0	0	0	0	0	0	0	0	65
S	Redtail surfperch	N	1978-82	0	0	0	0	0	0	0	0	0	0	0	0	818
C	Arrowtooth flounder	N	1986-91	0	0	0	50	0	95	0	0	0	0	0	0	0
C	Arrowtooth flounder	O	1986-93	0	0	0	2,000	1,050	2,800	0	0	0	0	0	0	0
C	Petrale sole	N	1955-81	0	0	0	694	4,303	10,673	13,047	2,342	435	0	505	0	0
C	Petrale sole	O	1960-81	0	0	407	3,912	9,609	22,034	8,349	4,248	1,583	0	0	0	0
S	Petrale sole	N	1978-91	0	0	0	0	0	0	0	0	0	0	0	0	91
C	Rock sole	N	1966-89	0	0	0	0	0	1,186	0	689	10,782	371	0	0	0
S	Rock sole	N	1975-87	0	0	0	0	0	0	0	0	0	0	0	0	4
C	Dover sole	N	1965-87	0	0	0	0	6,223	4,213	2,195	958	3,985	0	0	0	0
C	Dover sole	O	1985-93	0	0	0	100	2,300	5,198	0	0	0	0	0	0	0
S	Dover sole	N	1980-81	0	0	0	0	0	0	0	0	0	0	0	0	2
C	English sole	I	1969-93	0	100	0	5,636	7,502	1,845	0	0	0	0	0	0	0
C	English sole	N	1961-92	0	0	0	1,622	14,738	438	252	198	528	0	319	0	0
C	English sole	O	1961-91	0	0	0	0	50	100	0	0	0	0	101	0	0

Table 2.11. Continued.

Data type[a]	Species[b]	Age method[c]	Time period[d]	PSMFC area[e]												SPC areas[f]
				2A	2B	2C	3A	3B	3C	3D	5A	5B	5C	5D	6A	
C	Starry flounder	N	1966-86	0	0	0	0	1,970	0	0	0	0	0	0	400	0
S	Pacific halibut		1991	0	0	0	0	0	0	0	0	0	0	0	0	94
S	Pacific halibut	N	1976-92	0	0	0	0	0	0	0	0	0	0	0	0	9,404

[a]Data type denotes the type of fishery that samples were collected from: C is commercial fishery, and S is sport (recreational) fishery.

[b]Species abbreviations are as follows: "Grs. rockfish" is greenstriped rockfish; "ywm. rockfish" is yellowmouth rockfish; "whs. greenling" is whitespotted greenling; and "surfperch, unident." is unidentified surfperch.

[c]Age method denotes the structure that was used to determine the age of the specimen: N is not aged, O is otolith, I is interopercle, F is fin ray, and S is scale.

[d]Time period represents the beginning and ending year of the dataset, although data may not be available from each year in the period.

[e]The PSMFC area denotes the Pacific States Marine Fisheries Commission area. The coastal regions of the Pacific Ocean are partitioned into the PSMFC areas (geographical units) for monitoring and management purposes.

[f]SPC areas denote sport punch card areas, which are statistical catch reporting areas for recreational fisheries.

Table 2.12. Port code classification used with the Washington Department of Fish and Wildlife Marine Fish Receiving Ticket (FT) and Coastwide Trawl Logbook System (CTLS).

CTLS port code	FT port code	CTLS port cluster	PacFIN port code*	Port name
ALA	501	ALA	AAL	Alaska (all ports)
ANA	105	ANA	ANA	Anacortes
LAC	140	ANA	LAC	La Conner
L.C.	140	ANA	LAC	La Conner
BEL	110	BEL	BLL	Bellingham
F.H.	135	BEL	FRI	Friday Harbor
BLA	115	BLA	BLN	Blaine
P.R.	156	BLA	ONP	Point Roberts
CAL	502	CAL	ACA	California (all ports)
CHI	409	COL	LWC	Chinook
ILW	421	COL	LWC	Ilwaco
KEL	423	COL	OCR	Kelso
VAN	438	COL	OCR	Vancouver (Wash.)
ABE	210	GRH	GRH	Aberdeen
C.B.	230	GRH	CPL	Copalis Beach
HOQ	240	GRH	GRH	Hoquiam
L.P.	260	GRH	LAP	La Push
TAH	290	GRH	OWC	Taholah
WES	295	GRH	WPT	Westport
N.B.	150	N.B	NEA	Neah Bay
ORE	503	ORE	AOR	Oregon (all ports)
P.A.	160	PEN	PAG	Port Angeles
P.T.	165	PEN	TNS	Port Townsend
SEQ	175	PEN	SEQ	Sequim
BRE	120	PSD	OSP	Bremerton
BRI	181	PSD	OWA	Brinnon
COU	125	PSD	ONP	Coupeville
EVE	130	PSD	EVR	Everett
OLY	155	PSD	OLY	Olympia
POU	169	PSD	OSP	Poulsbo
SEA	170	PSD	SEA	Seattle
SHE	180	PSD	SHL	Shelton
TAC	190	PSD	TAC	Tacoma
B.C.	310	WLB	WLB	Bay Center
L.B	320	WLB	WLB	Long Beach
NAS	340	WLB	WLB	Naselle
RAY	345	WLB	WLB	Raymond
S.B.	350	WLB	WLB	South Bend
TOK	360	WLB	WLB	Tokeland

*PacFIN is the Pacific Fisheries Information Network.

CHAPTER 3

GROUNDFISH DATA COLLECTION IN OREGON

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3.1 Introduction

The groundfish fishery is an important component of the commercial fisheries in Oregon. During the 1980s, the groundfish fishery surpassed the fisheries for salmon and shellfish in landed weight and was comparable to them in landed value (Fig. 3.1). During this decade, the rockfish species composed the largest segment of the groundfish landings, both in landed weight and landed value, followed by the flatfish species, and then the other groundfish species (Fig. 3.2). In 1991, the groundfish fleet in Oregon consisted of approximately 136 trawlers and a smaller number of longline, hook and line, and pot vessels (Silverthorne 1992).

Compared to the fisheries for salmon and halibut, the fishery for groundfish along the Pacific coast is a relatively recent development. According to Harry (1956) the Oregon fishery for groundfish was sporadic until the end of the 1930s, when a permanent otter-trawl fishery became established in response to increased demand for fish during World War II. During the period from 1940 to 1953 the fishery reached a peak in 1945, when 73 vessels harvested about 26 million lb of groundfish. Markets for groundfish declined after the war, and by 1953 the groundfish landings, delivered by 44 vessels, were only about 15 million lb, one third of which was used for animal food on commercial mink ranches.

Prior to 1979, groundfish landings in Oregon consisted primarily of flatfish species, particularly Dover, English, and petrale sole. The large landings of rockfish, which are typical of today's fishery, did not develop until the late 1970s. During the 1950s the flatfish species accounted for 58% by weight of the groundfish landings and the rockfish species accounted for 35%. During this decade the landings averaged 22.5 million lb annually. Similarly, during the 1960s the annual groundfish landings were 51% flatfish and 41% rockfish, and averaged 27.8 million lb per year. Even during the 1970s the landings were 52% flatfish and 30% rockfish, and averaged 28.5 million lb annually. Rockfish landings did not surpass flatfish landings until 1979, when the midwater trawl fishery developed for widow rockfish.

3.1.1 Geographical Overview

Major ports

The major ports for groundfish landings in Oregon are Astoria on the north coast, Newport on the central coast, and Coos Bay on the south coast (Fig. 3.3). These three ports accounted for 95% by weight and 91% by value of the reported groundfish landings in Oregon during 1991 through 1992 (Table 3.1). The ports of Garibaldi on the north coast and Brookings on the far south coast together accounted for an additional 4% of the weight and 7% of the value of the 1991 and 1992 total landings of groundfish.

Major fishing grounds

The groundfish vessels that land their catches in Oregon generally operate in the waters directly off Oregon or to the north off Washington, with some vessels from ports on the far south coast occasionally fishing off northern California. Although areas differ in productivity and in the species assemblages, and therefore attract differing amounts of fishing pressure, essentially all areas off the coast are fished to some degree (Fig. 3.4). Depending on the size of the fishing vessel and the species of interest, the vessels operate in the shallows near shore on out to depths of greater than 650 fathoms at a distance of 30 to 40 miles offshore. During the development of the fishery there has been a general tendency for the fleet to operate at greater and greater depths, fishing on stocks that were previously unexploited.

Principal species landed

In terms of the total weight of the harvest, the top five groundfish species landed in Oregon during 1991 through 1992 (in descending order) were Pacific hake, Dover sole, widow rockfish, sablefish, and thornyhead (Table 3.2); in terms of the total landed value, the five most important species were sablefish, Dover sole, thornyhead, Pacific hake, and widow rockfish. The relative importance of the different species was not uniform across all Oregon ports, however. In Astoria during 1991 through 1992, the top five species (in descending order by weight) were Pacific hake, Dover sole, arrowtooth flounder, yellowtail rockfish, and widow rockfish; in Newport, the top five species were Pacific hake, widow rockfish, Dover sole, thornyhead, and yellowtail rockfish; and in Coos Bay, the top five species were Dover sole, thornyhead, sablefish, widow rockfish, and canary rockfish.

The vast majority of the groundfish landed in Oregon are caught with trawl gear. During 1991 through 1992 midwater trawls accounted for 50% of the total landed weight of groundfish at Oregon ports, and bottom trawls accounted for an additional 46% (Table 3.3). The remaining landings were taken by line gear (2.5%), fish pots (0.8%), shrimp trawls (0.7%), and troll gear (0.1%). The large increase in the relative amount caught by midwater trawls, from 31% in 1991 to 62% in 1992, was due to the rapid development of the shore-based fishery for Pacific hake.

Port biologists and field staff

Maintaining communications with the fishers and the dealers is vitally important for the successful management of any commercial fishery. The field staff are the most visible and accessible components of the Oregon Department of Fish and Wildlife's (ODFW) Marine Finfish Program, and they are the primary instruments for collecting data and disseminating information to the fishing industry. The ODFW has local offices at the three major ports on the Oregon coast. These facilities are used by the four permanent groundfish port biologists: one stationed at Astoria, two at Newport, and one at Coos Bay (Charleston). Most of these port biologists have served in their present positions for more than 10 years. During the 1992 fishing season, ODFW employed four seasonal aides to assist the permanent port biologists. These temporary staff, who worked 5- or 7-month appointments, were based at the ports of Astoria, Newport, Coos Bay, and Brookings. Some of these seasonal aides functioned in the same capacity in previous years.

Port biologists involved in groundfish sampling in Oregon are responsible for collecting the following information: 1) Oregon Fish Receiving Tickets completed by the dealers, 2) trawl logbooks completed by the fishers, 3) species-composition samples from landings of rockfish, and 4) biological samples from selected groundfish species. The specific tasks associated with each of these responsibilities are further discussed later in this chapter.

In 1992 ODFW also instituted a special program for sampling the developing shore-based fishery for Pacific hake. Its primary function was to document the bycatch of regulated species. One of the port biologists in Newport was assigned to act as the overall program coordinator, and a seasonal aide was hired to serve as the crew chief for the six to eight samplers employed by the Pacific States Marine Fisheries Commission (PSMFC) to sample the Pacific hake fishery in Oregon. In addition to the field staff involved in the on-site sampling of groundfish landings, numerous other personnel serve in various roles in the data collection and processing systems used by ODFW to monitor the commercial groundfish fishery (Table 3.4).

3.1.2 History of Data Collection Systems

There have been few formal descriptions of the data systems used for collecting and processing information about Oregon's groundfish fishery. According to Harry (1956) there was little research on Oregon's otter-trawl fishery prior to World War II, but beginning in June 1941 fish processing companies were required for taxation purposes to record landing statistics in terms of pounds landed per delivery. These data were gathered and tabulated by staff of the Oregon Fish

Commission. Beginning in 1943, as a check on the accuracy of company records, commercial fishers were required to record their landings in a "pass book" that was sent to the Fish Commission at the end of each fiscal year, as a condition of license renewal. Initially, the landing statistics were recorded and processed using hand-punch cards, but starting in April 1947, IBM punch-card machines were used to organize and tabulate the data. A program of scientific research that addressed the Oregon groundfish fishery began during the summer of 1947 and the first "market samples" from the landings were taken in January 1948.

Although Harry (1956) does not refer to any form of logbook system for collecting information from the groundfish fishery, in 1949 the Oregon Fish Commission was using logbooks for monitoring the soupfin shark fishery (Westrheim 1950), and trawl logbooks had become an integral part of the groundfish monitoring program at least by the late 1970s. During 1975 and 1976, staff of the Oregon Department of Fish and Wildlife, with assistance from Oregon State University (OSU), designed and implemented a groundfish and shrimp data processing system. The system utilized a mainframe computer at OSU to match trip-by-trip landing information (from fish tickets) with tow-by-tow trawl logbook data, thereby developing estimates of catch by geographic area (Johnson and Lukas 1976). This system was the forerunner of the system described below.

3.1.3 Legal Authority to Collect Data

Obligations of fishers

Authority to collect fisheries information is granted in general terms specified by the Oregon Fish and Wildlife Code, which contains rules established by the Oregon Legislature. However, most of these rules are only indirectly associated with data collection activities in the marine environment. Rules directly related to marine fisheries are found in the Oregon Administrative Rules (OAR), which are established by the Oregon Fish and Wildlife Commission. The Director of the Oregon Department of Fish and Wildlife, acting on behalf of the Commission, has authority to establish emergency rules, when doing so is deemed to be in the best interests of the resource.

Division 4 of the OAR (Commercial Fisheries Other Than Salmon or Shellfish) contains several rules that facilitate data collection activities for "Ocean Food Fish Fisheries." OAR 635-04-018 defines the general intent of the rules regarding these data collection activities. OAR 635-04-029 requires fishers to sort their catch according to identified "management categories," which are defined as those species or groups of species that have a trip limit, quota, or harvest guideline. OAR 635-06-210 requires that landings reported on Oregon Fish Receiving Tickets be sorted by individual species; however, in practice, sorting is only enforced at the management category level rather than at the species level. Because of recent changes in the tax structure, this rule now requires that the species or groups of species also must be recorded according to the ex-vessel prices paid to the fisher.

Three rules facilitate the collection of data and are used to ascertain where at-sea commercial catches were made. OAR 635-04-050 establishes that logbooks must be maintained aboard each vessel that harvests ocean food fish, which includes fish caught with groundfish trawls, pots, and longlines, as well as shrimp trawls. Currently, small vessels that use miscellaneous gears (e.g., jigs, vertical longlines, and trolls) are not required to keep logbooks. A set of rules regarding offshore fisheries (OAR 635-04-125, 130, 135, 140, and 145) establishes, via a mandatory declaration procedure, the identification of vessels that fish outside the U.S. Exclusive Economic Zone and land their catches at Oregon ports.

Noncompliance

There have been few problems associated with the collection of mandatory data, with the exception of the late 1970s and early 1980s, when many fishers refused to maintain logbooks. An informal education program regarding the legal requirements of maintaining logbooks and visits from Oregon State Police officers eliminated most of these problems. Although citations may be issued for noncompliance, the need for this has been rare. In general, problems have occurred due to inadequate communication regarding the need for the information, or when individual buyers or fishers have been upset by recent management actions.

3.2 Fish Ticket/Landing Receipt System

Any fish dealer who purchases groundfish from a commercial fisher is required by law to complete an Oregon Fish Receiving Ticket indicating the weight and value of the fish purchased. An example of the fish tickets used in 1992 is given in Figure A-2. The fish tickets provide important information about harvest levels, species composition, and economic value of the fishery. Also, Oregon uses the fish tickets to levy a tax on the value of the reported landings.

3.2.1 Market Categories

In consultation with other ODFW staff, the fisheries information supervisor and the groundfish technical supervisor determine the physical format of the ticket and the official market categories under which the fish must be landed. The existence of different market categories is controlled in part by the marketplace, e.g., different species or sizes of fish may command different prices. However, in some cases the Pacific Fishery Management Council (PFMC) imposes the market categories on the fishery because of the need to maintain control over the landings of regulated species. For example, in the 1970s all of the rockfish species landed in Oregon were recorded in a single market category. However, special market categories have since been established for certain species (e.g., Pacific ocean perch, widow rockfish, yellowtail rockfish, and thornyhead) because the PFMC established landing quotas and required that the fishers sort these species from other rockfish species prior to landing their catches.

In 1992 there were a total of 89 official market categories used by ODFW. Each market category is designated as an individual species or group of species. As of 1992 in Oregon, only landings of rockfish market categories were sampled for determining species compositions (see section 3.4). Some of the market categories were sampled as part of the biological sampling program (see section 3.5).

Dealers are allowed to write in additional, unrecognized market categories on the fish tickets. For example, some dealers might itemize the landings of yelloweye rockfish separately from the "large rockfish" market category because they pay the fishers a higher price for this species than for the other species landed within the large rockfish category. When this occurs, the local port biologist corrects the tickets so that they conform with the officially recognized market categories.

Because of their ability to obtain higher prices for certain species, fishers now sort their landings of rockfish to a much greater extent than in earlier years. This is particularly true for fish caught by hook and line that are sold as whole fish. The occurrence of mixed-species landings that are sometimes sorted, but not always, greatly complicates the sampling program. A system in which there are only a few categories has the advantage of compactness and simplicity, but with such a system important information may be lost regarding the composition of the landings.

A groundfish market category has never been deleted from the Oregon system. The decision to delete a category would be made by the fisheries information supervisor and the groundfish technical supervisor.

3.2.2 Processing System

The system for collecting, entering, and verifying the landing information on a fish ticket is fairly complicated, involving several steps and numerous people (Fig. 3.5). The process begins with the purchase of fish by a dealer and the completion of a fish ticket. The dealer sends one copy of each completed multi-part ticket to the ODFW office in Portland. Dealers are legally obligated to send their completed tickets to the Portland office within five working days of the purchase of any fish. Another copy of the ticket is collected by the local port biologist during one of his regular visits to the fish dealers. In some cases, dealers who are remote from a port biologist send copies of their tickets to the local ODFW office. The ODFW routinely provides the dealers with pre-addressed business reply envelopes for mailing in the completed tickets. The two copies of the ticket are processed and keypunched independently, one copy in Newport and one in Portland. The two resulting data files are compared and discrepancies are resolved. Through 1992 an additional check on the consistency of the ticket data was provided by an ODFW auditor in Portland, who identified discrepancies between the total landings reported by each dealer each month and the total landings from the corresponding individual tickets sent to the Portland office. However, starting in 1993, the commercial fish auditor was assigned other duties.

Although it is generally true that a fish ticket represents landings from only one fishing trip, it is important to recognize that a fishing trip can result in more than one ticket. This can occur for several reasons: 1) dealers are legally required to create separate tickets for trips with multiple gear types (e.g., for the bottom trawl and midwater trawl portions of trips that used both types of fishing gear), 2) dealers create separate tickets for landings that are over trip limits if instructed to do so by the Oregon State Police, and 3) a fishing vessel may deliver to more than one dealer. Because of the Oregon ad-valorem tax on groundfish purchases, each delivery must have a separate ticket.

Data entry and error checking

Every fish ticket that involves the sale of groundfish is examined by the local port biologist for missing or inconsistent information. The port biologists check for errors, such as inappropriate gear codes (e.g., 30,000 lb of widow rockfish caught with a bottom trawl rather than a midwater trawl) or an incorrect market category (e.g., rockfish that were reported as "large rockfish," but which the port biologist knows were "small rockfish"). The port biologist revises the ticket as required.

When a port biologist finds an error, he fills out an error correction form, which indicates the required change and the reasons for it. Copies of the error correction form are given both to the data entry staff in the Newport office and to the fisheries information supervisor in Portland.

The port biologist is responsible for filling in the fishing area code (PSMFC area) on the ticket, using either logbook information, if available, or the default fishing area code for that port. The fishing area data from the tickets are used to apportion the landings to fishing areas for preliminary reports to PacFIN. A more complete accounting of catches by area is provided in an end-of-the-year report that makes full use of all available logbook data to designate which fishing areas the landings came from.

Entry of the fish ticket data in Newport is done directly onto the mainframe computer in Portland and occurs after the same ticket information has been entered by staff at the Portland office. As the data technician enters the data in Newport, the data are checked immediately against the corresponding information in Portland and the operator in Newport is alerted to any discrepancies. If the data technician in Newport determines that data have been incorrectly entered, the discrepancy is resolved later by the fisheries information supervisor after consultation with the port biologist and possibly with the fish dealer.

Data processing in Portland

Books of fish ticket forms are issued to fish dealers by clerical staff in the Portland office. Every fish ticket is preprinted with a unique serial number, and the clerical staff in the Portland office maintains a complete list of all outstanding serial numbers. When tickets are received in the Portland office, the ticket numbers are cross-checked against the complete list. Dealers are warned when they return tickets out of sequence and are required to account for all of the tickets they have been issued.

Each completed fish ticket is examined by clerical staff members in Portland, who are responsible for filling in appropriate codes for any unofficial market categories that the dealer may have written on the form. They leave blank the "area fished" field, which is completed by the data technician in Newport. The coded tickets are then keypunched by the data entry staff during the evening, usually on the same day they were received in the mail.

During data entry the following data elements from each ticket are cross-checked against preexisting information: the commercial license number, the boat number, the dealer number, the date, and the port, gear, and species codes. Also, the values entered by market category for the pounds and prices are checked against valid ranges. Error reports are generated for each evening's entries and are investigated and corrected the following day by the fisheries information supervisor and his clerical staff.

Typically, one week elapses between the date of a landing and the initial data entry in Portland of the ticket that accounts for that landing. About 95% of the tickets are entered within two weeks of the actual date of the landings. The main objective for the initial data entry in Portland is to get the information onto the database as quickly as possible. Although some routine error checking occurs during this initial stage, the more complete validation of the data does not occur until the data technician in Newport enters the information a second time. This stage of the process does not occur until the month following the landing, after the port biologists have examined and coded the tickets. Rectifying an error after it is discovered may take one month or until the final end-of-the-year reporting, in May of the following year. However, most errors are corrected shortly after the second entry in Newport.

3.2.3 Groundfish Landings Not Covered by the Fish Ticket System

In Oregon, the vast majority of the groundfish catches are taken by the commercial fishery and are reported on fish tickets. However, there are active fleets of charter and private boats that catch groundfish for recreation and personal consumption. These recreational catches are not included in the Fish Ticket System, but the recreational landings are minor relative to the commercial landings (Table 3.5). Using interview data and boat information that are maintained separately from the commercial fishery database, staff from the Marine Recreational Fishery Program routinely estimate the catches of groundfish by the recreational fishery in Oregon. The recreational fishery in Oregon tends to target nearshore groundfish species that are not commercially important, the main exceptions being halibut, yellowtail rockfish, canary rockfish, and lingcod.

Other potential sources of landings that may go unreported include fish sold directly to consumers and fish taken home by the crews of commercial vessels ("home pack"). However, in Oregon it is illegal for fishers to sell fish directly to restaurants or consumers unless they possess a "limited fish seller's license," and unreported direct sales of groundfish are believed to occur infrequently. Also, fishers in Oregon are legally required to report any home pack on the fish tickets, and the amount of unreported home pack is believed to be small.

3.3 Logbook System

The ODFW issues logbooks to groundfish vessels to obtain detailed information about fishing locations and fishing effort (hours of fishing). Because most of the groundfish landed in Oregon are caught in the trawl fishery, this section addresses the collection protocols and data processing associated with the standardized Washington-Oregon-California Trawl Logbook. During 1991 through 1992, only 4% of the reported groundfish landings in Oregon were caught by fishing gears other than bottom or midwater groundfish trawls (Table 3.3).

The ODFW has two trawl logbook database systems. One is maintained by the Marine Finfish Program and is used to assist in the routine management of the fishery. The other is maintained by the Marine Habitat Program for use with its Geographic Information System (GIS). The GIS and associated database are described in detail in Starr and Saelens (1987), Starr and Saelens (1989), and Fox et al. (1992). Both databases are derived from the same standard trawl logbook data.

3.3.1 Groundfish Trawl

Collection

Logbooks for trawlers from a given port are collected routinely by local port biologists, whenever they are working on the docks and in contact with vessel captains. Sometimes, however, captains mail their logbooks directly to the local ODFW office; the port biologists provide pre-addressed and stamped envelopes for this purpose. Data entry for all Oregon trawl logbooks occurs at the ODFW office in Newport. The entry is done directly onto the mainframe computer in Portland.

Data entry and error checking

The local port biologist examines every logbook for completeness and consistency. The process includes checking the logbook for incorrect temporal sequencing of the tows or inappropriate dates or times, and filling in the following items: 1) the ticket number(s) corresponding to each trip, 2) missing depths based on the tow locations and the depths indicated on the nautical charts, and 3) missing target species based on the most prevalent species hailed.

The port biologist assigns each logbook a code of 1, 2, or 3 depending on its degree of completeness. The criteria used to make this determination are fully described in Wood (1992a). If a logbook has only partial information on the tow locations or hailed weights (the captain's estimates of the weights of the retained catches), the port biologist will attempt to get the missing information from an interview with the captain. If the missing information cannot be obtained, the logbook will be assigned a code 2 if only hailed weights are missing, or a code 3 if tow locations are missing. Logbooks that are assigned a code 3 are excluded from further processing.

The data entry program in Newport is not a "double-entry system"; the data are entered only once. However, invalid dates, ticket numbers, boat numbers, port codes, fishing block codes, and species codes are "trapped" during entry. Also, if tow locations are reported as Loran coordinates, the microsecond values must fall within valid ranges; if tow locations are reported as latitude and longitude, they must fall within generally valid ranges. Tow-specific information is not directly verified, but a program is run routinely that adjusts the hailed weights in the logbooks on the basis of the landings reported on the fish tickets on a trip-specific basis. Hailed weights of market categories that appear on the logbook but not on the ticket are identified. Discrepancies that are 500 lb or greater are investigated and resolved by the port biologist; smaller catches are ignored. For landings of species that appear on the ticket but not on the logbook, the program apportions the landings to all tows (see section 3.6.1).

Typically, the processing of a logbook by the port biologist and the subsequent data entry occur within two months of the corresponding landing date. Final processing of the logbook data does not take place until the end-of-the-year reporting in May. In 1991 and 1992, there were valid trawl logbooks for roughly 83% of the deliveries of groundfish by trawlers (Table 3.6).

3.3.2 Other Gears

In addition to the standardized trawl logbook used coastwide by the states of Washington, Oregon, and California, special logbooks in Oregon are used 1) in the shrimp fishery, 2) by vessels that fish with fixed gear (e.g., longlines and pots), and 3) by vessels that fish with miscellaneous gears (e.g., hook-and-line and vertical longline). Fishers are legally required to complete and turn in a trawl logbook, a shrimp logbook, or a fixed-gear logbook for every fishing trip in which they participate in any of these fisheries, but this regulation is not strictly enforced. As of 1992, completion of the miscellaneous gear logbook was done on a voluntary basis.

3.4 Species-Composition Sampling

Often when fish are landed in Oregon, particularly rockfish, they are not sorted by species, but instead are sold as a mixture. To estimate the species compositions of these landings and in particular, to ascertain accurately the landings of those species that are regulated with annual quotas and trip limits, the port biologists routinely take samples from the rockfish market categories that appear on the fish tickets, namely widow rockfish, yellowtail rockfish, Pacific ocean perch, thornyhead, and the miscellaneous categories "small rockfish" and "large rockfish." All other market categories that appear on the fish tickets are assumed to represent single species, although there are no sampling programs to confirm their purity.

As of 1992, large and small thornyhead were often presorted by the fishers and were sampled separately. In this case, the sample data from these subcategories were combined to provide a single category to match the fish ticket market category.

Beginning in 1991, the ODFW has conducted a small-scale sampling program for groundfish landed by the shrimp fishery in addition to the routine monitoring of rockfish landings made by the groundfish fishery. Typically, the shrimp dealers report the groundfish bycatch simply as "rockfish," with no further specification concerning the appropriate market categories. In 1992 the port biologists were instructed to take approximately four samples per month in each major port. In the early 1980s, there was a similar but more intensive sampling program that addressed the groundfish landings made by the shrimp fishery.

The sampling supervisor and the groundfish technical supervisor coordinate the rockfish species-composition sampling in Oregon. In the late autumn of each year, these supervisors determine the sampling priorities for the upcoming year. The staff associated with the groundfish sampling program in Oregon has monthly or bimonthly meetings to discuss "quality control" issues related to sampling and data processing. Prior to 1992, the groundfish sampling program personnel in Newport also held weekly quality control meetings to discuss sampling and data processing problems.

The port biologists, with assistance from seasonal aides, are responsible for the sampling programs within their individual ports. They prepare monthly summaries of their sampling activities, which the groundfish technical supervisor reviews to identify deficiencies in the level of sampling. The sampling itinerary of a port biologist is largely self-supervised. Since 1989, for each rockfish market category, port biologists have been instructed to obtain 5 boat trip samples per 100 t of the category landed, with the exception of the widow rockfish market category (2 samples per 100 t landed). From 1989 to 1992, port biologists usually achieved and surpassed these recommended sampling rates. The number of species-composition samples collected annually since 1981 is given in Table 3.7.

Since 1989, Oregon has employed a stratified, two-stage random sampling plan. Combinations of port and quarter (a year partitioned into four, 3-month blocks) are treated as strata, and boat trips (primary sampling units) within a stratum are selected at the first stage of the design. Landings are poststratified into market categories, and for each category a number of boat trips are selected based on the recommended sampling rates presented above. Not all of the market categories landed by a boat are necessarily sampled. At least two baskets with fixed weights of fish are subsampled within each market category; the baskets (secondary sampling units) are selected at the second stage of the design. As of 1992, samples were taken on the basis of a fixed weight, rather than a fixed number of fish. However, in years prior to 1989, fixed-number samples were taken.

3.4.1 Sampling Protocol

To assess the species composition of a rockfish market category, a port biologist selects fish from the landed market category and determines the percent composition by weight of the different species contained in the sample. Port biologists arbitrarily select boat trips at the first stage of the design; there are no strictly random procedures involved. They follow the sampling rates presented above, making adjustments based on their own judgement and advice from the sampling supervisor and groundfish technical supervisor.

The sampling rates required at the second stage of the design are as follows: 1) two to four 25-lb baskets are taken for the widow rockfish and thornyhead market categories, 2) two to four 50-lb baskets are selected for the yellowtail rockfish and Pacific ocean perch market categories, (3) four to six 25-lb baskets are chosen for the "small rockfish" market category, and (4) four to six 50-lb baskets are selected for the "large rockfish" market category. Currently, a typical basket of fish contains from 10 to 50 fish, depending on the market category of interest.

At the fish processing facilities, the fish are removed from the hulls of the vessels and placed in "totes," which are bins made of plastic, wire, or wood, containing from 800 to 1700 lb of fish when full. The totes are then either immediately transported to processing rooms (via forklifts, conveyor belts, or vacuums) or placed in a temporary cold storage room within the facility. The port biologists sample the totes while they are en route to the processing rooms, usually as the vessel is being unloaded, or while the totes are in cold storage. Because most ports have several fish processing facilities, each with different methods for handling fish, there is no single dockside sampling technique that can be applied to all of the facilities. The port biologists are instructed to select baskets of fish from totes separated over the entire unloading time of a vessel, e.g., a basket of fish from one of the first totes unloaded and a basket from later in the unloading operation. The individual fish selected for each basket are taken from one corner of a tote, starting at the top and working to the bottom. The port biologists try not to account consciously for sizes or species of fish selected. They record the aggregate weights for each species contained in a basket.

Ultimately, each sample consists of two to six baskets of fish (secondary sampling units) selected from a market category (poststratification unit) within a boat trip (primary sampling unit). Detailed instructions for taking and processing a species-composition sample are given in Wood (1992b).

In commercial fishery sampling programs it is often very difficult to obtain random samples (Tomlinson 1971). Because it is not possible to predict accurately when a boat that has completed a fishing trip will arrive at a particular fish processing facility, there is no way of constructing a sampling frame and thus, no efficient method for randomly choosing a trip. The issue of nonrandom sampling in commercial fisheries, including those in Oregon, is most often dealt with by assuming that boats arrive at a fish processing facility in a random manner and any selection thereof will produce samples that can be treated as random units.

With the exception of the Pacific hake samplers, the ODFW port biologists usually sample during weekdays and daylight hours. Generally they do not sample at night or on weekend days. Except for Pacific hake, deliveries of groundfish that are made at night or on weekends may be available for sampling during standard hours, because the totes sometimes remain at the plants for a day or two before they are processed.

In general, the ports in Oregon are sampled in proportion to the total amount of fish landed there. In 1991 and 1992, the three major ports, where samples are routinely collected, accounted for more than 90% of the total commercial landings of rockfish (Table 3.2). Because of the unpredictable and infrequent nature of the groundfish landings at the smaller ports (e.g., Depoe Bay), very few samples are taken there.

3.4.2 A Hypothetical Example

The following example illustrates the sampling process and some of the choices that the port biologist must make. A boat trip arrives at a fish processing facility with the following catches: 1) 10,000 lb of fish in the widow rockfish market category, which are unloaded into approximately 10 totes, 2) 4,000 lb of fish in the yellowtail rockfish market category, which are unloaded into approximately 4 totes, and 3) 2,000 lb of fish in the "large rockfish" market category, which are unloaded into approximately 2 totes.

A port biologist might select this boat trip if additional samples were needed to meet the recommended sampling rates for any of the market categories being landed (widow rockfish, yellowtail rockfish, and "large rockfish"). That is, any combination of the three categories could be sampled, depending primarily on whether the port biologist was ahead of, or behind schedule in terms of the target sampling rates. Regardless of which market categories were sampled, the port biologists would use the same process for subsampling fish within the categories.

Suppose, for example, a port biologist needed more samples for two of the three market categories, namely the widow rockfish and "large rockfish" market categories. He would obtain two 25-lb baskets of fish (subsamples) from the widow rockfish market category, using the procedures discussed previously (see section 3.4.1). He would attempt to obtain a subsample from different locations of the vessel's hold, e.g., by collecting one sample early during the unloading operation and another towards the end of the operation. If the boat had unloaded its catches before he arrived at the processing facility, then he would select each basket from a different tote; however, because the unloading sequence was unknown, he would arbitrarily choose which totes to sample. He would use a similar protocol to sample the "large rockfish" market category; however, now four to six 50-lb baskets of fish would be selected from two available totes, with two to three baskets being subsampled per tote. If samples are needed and time permits, port biologists in Oregon often sample more than one market category of a boat trip.

3.4.3 Processing System

Data entry and error checking

Entry of all species-composition data occurs at the ODFW office in Newport. The entry is done directly onto the mainframe computer in Portland. Data entry is done using a "double-entry system" in which the operator enters the data once and later re-enters the same data.

Discrepancies between the two sets of data are identified and resolved during the second entry. For example, invalid dates and unrecognized port, gear, market category, and species codes are trapped, and entries for ticket numbers must fall within a valid range. The program does not check the landed weights on the species-composition form against the landed weights reported on the corresponding ticket.

Sampling coverage of the fishery

The ODFW port biologists usually meet or exceed their target sampling rates for rockfish species compositions. Based on the sampling rate criterion in 1991 there should have been a total of 635 samples taken, but port biologists actually collected a total of 1,012 samples (Table 3.8A); in 1992 there should have been a total of 703 samples taken, but a total of 1,924 were collected (Table 3.8B). Nevertheless, even these levels of sampling were insufficient to provide certain details about the species compositions of the rockfish landings. For example, in 1992 there were potentially 120 aggregate combinations for which sampling might be required (six market categories within 20 port/quarter strata). However, rockfish were landed in only 114 of these aggregate combinations. Eleven of the combinations received no sampling (e.g., the yellowtail rockfish market category within the Garibaldi/4th quarter port/quarter stratum) and 20 had only one sample collected (e.g., the thornyhead market category within the Newport/3rd quarter port/quarter stratum) (Table 3.8B). However, according to the target sampling rates, 16 (80%) of the aggregate combinations where just one sample was collected actually required one sample or less to be taken. There was a similar pattern to the sampling coverage for 1991 (Table 3.8A). General issues relevant to sampling coverage and intensity are further discussed in chapter 7.

3.5 Biological Sampling

In addition to providing information on the total quantity and species composition of the commercial groundfish landings, the ODFW port biologists routinely collect detailed information on the biological characteristics of some of the main species, particularly those that are regulated or heavily exploited. In Oregon the samples that are collected to provide biological information are referred to as "market samples." Estimates of the age, size, maturity, and sex compositions of the landings are used in the stock assessments prepared by the Groundfish Management Team (GMT) of the PFMC. The age-composition data in particular are vital to catch-at-age assessment methods such as Virtual Population Analysis (Gulland 1965), Cohort Analysis (Pope 1972), and Stock Synthesis (Methot 1990).

The mix of species that is sampled for biological information varies from year to year. For 1992 the ODFW port biologists were instructed to sample the following species: English sole, petrale sole, Dover sole, arrowtooth flounder, canary rockfish, yellowtail rockfish, widow rockfish, darkblotched rockfish, shortspine and longspine thornyhead, lingcod, and Pacific grenadier. Also, in 1992 ODFW staff from the Marine Recreational Fishery Program collected biological sample data for black and blue rockfish landed by the recreational charter boat fishery. The numbers of biological samples taken annually by ODFW staff since 1981 are given in Table 3.9.

One of the major tasks of the biological sampling program is to collect the physical structures that are used for determining the ages of the fish. For many of the commercial groundfish species, age can be measured by counting annual marks (rings) on the otoliths. After the structures are read, they usually are retained in storage. A list of the age structures stored at the ODFW facility in Newport is given in Table 3.10. Some additional otoliths are available from odd specimens collected during groundfish cruises. Also, several hundred Pacific grenadier otoliths collected by the ODFW port biologist in Coos Bay are stored at the Department of Oceanography, Oregon State University, in Corvallis.

Because it requires considerable training and skill to read the age structures from some species, staff from different institutions specialize in particular species. As a consequence, processing of the structures collected by the ODFW port biologists occurs at various sites along the U.S. Pacific coast. For example, structures from widow rockfish and lingcod are sent to the NMFS laboratory in Tiburon, California for processing. Staff at the ODFW facility in Newport specialize in English sole, petrale sole, Dover sole, sablefish, canary rockfish, and black rockfish.

The biological sampling program in Oregon is based on the same general framework as the species-composition sampling program for landings of rockfish (see section 3.4). The sampling supervisor and groundfish technical supervisor coordinate the statewide sampling activities, and each year in the late autumn they decide the sampling priorities for the following year. Any sampling or data processing problems that arise during the season are discussed amongst the staff at monthly quality control meetings.

Because data from the biological samples are used primarily for stock assessments, the decisions regarding which species to sample and appropriate target levels for sampling are based largely on suggestions by the GMT. However, the port biologists, with assistance from the seasonal port samplers, are responsible for the sampling programs within their individual ports. They prepare monthly summaries of their sampling activities, which the groundfish technical supervisor reviews to identify any deficiencies in the level of sampling. Target sampling rates for 1992 are presented in Table 3.11.

3.5.1 Sampling Protocol

Biological sampling consists of selecting a quantity of a particular species from the market category in which the species is most often landed. If a market category is assigned to a single species, then all biological samples for that species are selected from its market category. This sampling design is generally effective in Oregon because the species for which biological samples are required are primarily landed within their own market categories. For example, in 1991, over 95% of the total poundage of yellowtail rockfish was landed within the yellowtail rockfish market category. In 1992, 10 of the 12 species included in the biological sampling program were sampled from their own market categories (Table 3.11). Those species that have not been assigned their own market categories are sampled from the categories in which they are most often landed. For example, in 1992 canary rockfish and darkblotched rockfish, which were not assigned their own market category, were sampled from the "large rockfish" market category and the "small rockfish" market category, respectively.

In general, for each fish in the sample, the port biologists are instructed to measure and record its length, sex, and to collect physical structures for age determination. For some species, the state of maturity (reproductive stage) is also routinely recorded. Port biologists attempt to perform all of these sampling duties whenever possible, but logistical and time constraints occasionally preclude a sampler from conducting all of these tasks on a given sample. The port biologists choose species (market categories) and boat trips to sample based on their own judgment and advice from the sampling supervisor and groundfish technical supervisor.

All biological samples collected from landings of rockfish are obtained while the port biologists conduct species-composition sampling. For example, if port biologists are conducting species-composition sampling from landings designated as widow rockfish and they need more biological information on this species, they may decide to measure the lengths, remove the otoliths, and record the maturity information from the individual fish that compose the two 25-lb basket subsamples. When the port biologists sample those species other than rockfish, they follow the same basic procedures.

The protocol used to select subsamples (baskets of fish) is similar to that used in species-composition sampling, described earlier in section 3.4.1. Depending on the species of interest, two or four, 25-lb or 50-lb baskets of fish are selected from totes from each boat trip sampled. At the fish processing facility the port biologist chooses a tote to sample and then selects individual fish for a basket from one corner of the tote, starting at the top and working down to the bottom, trying not to account consciously for sizes of fish selected. Baskets for most species are based on weight. Because some species do not occur in "pure" market categories (e.g., darkblotched rockfish), the port biologist may have to re-sample the tote and select more of the target species to get a complete basket sample. To maintain the statistical integrity of the two data sets, any additional fish selected to secure a complete biological sample are not incorporated in the species-composition sample. Details regarding sample sizes and port-by-port sampling priorities for 1992 are given in Table 3.11.

Prior to 1991, biological samples for all species except widow rockfish were composed of fixed numbers of fish rather than fixed weights of fish. Biological sampling that incorporated subsamples of a fixed weight began in 1989 for widow rockfish.

For each basket subsample, the fork length of every fish is measured to the nearest centimeter. For most groundfish species, the sex and reproductive stage of each fish are determined by external examination or by internal investigation of the gonads. Males are separated from females, and the total numbers and weights by sex are recorded. During certain years, individual fish are also weighed to establish a length-weight relationship. Age structures (otoliths for most species, fin rays for lingcod, and interopercles for English sole) are removed from the individual fish and placed in distinct containers. Depending on the species of interest, either the left, right, or both otoliths are collected. When sampling is completed at the processing facilities, the collected data and age structures are returned to the laboratory for further processing. The completed data forms and age structures are sent to the Newport office approximately one month after the sample date. Detailed instructions for collecting and processing biological samples are given in Wood (1992b).

Biological samples in Oregon are collected mostly from trawl landings, but in previous years sablefish samples have also been collected from landings by pot and longline fishers. The GMT recommended that the landings of lingcod be sampled in place of sablefish in 1992.

If a dealer refuses to allow a port biologist to remove otoliths or otherwise mutilate a fish to determine its sex or state of maturity, the port biologist will discuss the situation with the dealer and try to arrange some acceptable method for obtaining the information. In any case, the port biologist will collect the length information.

3.5.2 Age Determination Methods

Age determinations for selected species of groundfish have been conducted by ODFW age specialists ("age readers") since the early 1970s. The ODFW has appointed a representative to the Committee of Age Reading Experts (CARE) since 1983, when CARE was first established by the Technical Subcommittee of the Canada/United States Groundfish Committee. Prior to 1992, when ODFW formally established a Fish Ageing Unit at the Newport office and hired a full-time age specialist, routine age readings were primarily performed by staff biologists who were involved in preparing stock assessments for regulated species of groundfish.

Over the years, ODFW personnel have performed age determinations for various species of groundfish including Dover sole, English sole, petrale sole, sablefish, Pacific ocean perch, canary rockfish, black rockfish, yelloweye rockfish, blue rockfish, and shortspine thornyhead. For some of these species, such as Dover sole, scales were the first structures used to determine the age of a fish specimen. However, by 1980, otoliths largely replaced scales as the preferred structures for age reading, with the exception of interopercles, which are currently the structures used to determine the age of English sole specimens. Prior to 1980, ages were determined predominantly using the "thin section method" (by counting annual marks (rings) on otolith sections mounted on microscope slides) and the "surface method" (by counting rings on whole otoliths immersed in an alcohol solution). In 1980, a break and burn technique (Christensen 1964) replaced other methods of age determination for virtually all species analyzed by ODFW personnel. The break and burn procedure has been demonstrated as an effective technique for processing large numbers of otolith specimens for various species of groundfish (Chilton and Beamish 1982) and is currently the most widely employed age reading method used by management agencies responsible for groundfish fisheries off the Pacific coast of the United States and Canada.

No formal validation studies have been conducted to assess the accuracy of age determination techniques for groundfish species analyzed at the Fish Ageing Unit in Newport. However, workshops conducted by the ODFW, WDFW, and Canada DFO have generated several unpublished reports that generally support the break and burn method as a valid technique that can be used to identify annual rings on otoliths of groundfish species.

3.5.3 Processing System

Data entry and error checking

Data entry for all biological sample data occurs at the ODFW office in Newport. The entry is done on a personal computer using a "single-entry" system, with visual inspection of a verification screen. The data entry program does only cursory error checking, such as trapping invalid characters, and doing simple range-checks on the length and age data. The data are not cross-checked against the corresponding fish tickets or logbooks.

Sampling coverage of the fishery

The ODFW port biologists often meet or exceed their target sampling rates, but the level of coverage is more sporadic than the coverage for species-composition sampling. From 1991 through 1992, for example, widow rockfish was the only rockfish species for which the target sampling rates were met consistently (Table 3.12). The targets for yellowtail rockfish were achieved in only 4 of the 12 port and quarter strata during 1991, and in 5 of the strata during 1992. The targets for canary rockfish were achieved in only 3 of the 12 port and quarter strata in 1991, and in 7 of the strata during 1992.

3.6 Estimating Derived Quantities

The fishery data collected by the various ODFW programs are used to estimate quantities that are relevant to the assessment and management of the fish stocks. The quality of the estimates depends both on how the sample data are collected and processed, and on how they are then combined into final estimates. This section documents some of the manipulations and calculations that are involved in producing the final estimates of the groundfish landings and the characteristics of those landings.

3.6.1 Landings by Area

Often fish tickets do not contain complete and accurate information concerning the locations of the catches. This occurs because the port biologists are not always cognizant of where the fleet is operating, and because the boats sometimes fish on several grounds. Although fishing boats in Oregon tend to operate near the port in which they land their catch, the landings by port give only a rough representation of the spatial distribution of the catches. However, detailed information is available from the logbooks.

For those fish tickets for which corresponding logbooks are available, the reported landings are apportioned to the PSMFC area where the tows were made (commonly referred to as the area fished variable). Then, total landings by area fished are estimated using the partial statistics on landings by area fished (from the fish tickets that had corresponding logbooks) along with the reported landings for which no corresponding logbooks are available (Fig. 3.5). All calculations are performed on the central computer system at the Portland office.

The following algorithm illustrates the general procedures used to estimate landings by PSMFC area.

1. Fish tickets are matched with logbooks.

2. For those tickets with logbooks, the tow-by-tow hails are adjusted so that for each trip the total hails by market category conform to the landings by market category reported on the corresponding fish tickets.

   a. When a market category is reported on a fish ticket but is missing from the corresponding logbook, adjusted hails are generated using the total hails by tow of all market categories to prorate the missing landing to individual tows, provided the tow-by-tow hails are reported on the logbook. If the hails are not reported but the tow durations are, then the adjusted hails are based on the tow durations.

   b. When a market category is reported on a logbook but does not appear on the corresponding fish ticket, an error report is generated and the ODFW staff contact the owner or captain of the vessel to reconcile the discrepancy.

3. The adjusted hails from all of the logbooks are tabulated to create a proration table of catch by market category, month, port, gear, and area fished. The proration table consists of percentages that individual PSMFC areas contributed to the total landings of each market category by month, port, and gear.

   a. The following hypothetical example illustrates the general form of an entry in a proration table for a particular market category. The percentage of the thornyhead market category caught using bottom trawl gear and landed in Newport during March 1992 was 60% from PSMFC area 2B, 35% from PSMFC area 2C, and 5% from PSMFC area 3A.

   b. This proration table is submitted to PacFIN, where the actual proration of fish tickets to area fished is performed.

c. Logbooks collected in a given year may not be processed until as long as six months into the following year and thus, the monthly proration table is often constructed from the available fish ticket information, rather than from the logbook data. As the logbook information becomes available, the monthly proration tables are reconstructed and submitted to PacFIN. The monthly proration tables for a given year generally receive final updates by June of the following year.

4. Individual fish ticket records, rather than data summaries, are submitted to PacFIN, where they are tabulated to estimate landings by market category, month, port, and gear.

5. At PacFIN, the proration table from (3) is applied to the results from (4) to estimate the total landings by market category, month, port, gear, and area fished.

In the trawl logbooks the fishers can report their tow locations either as Loran coordinates, as latitude and longitude, or as a "block" number. If tow locations are reported as Loran coordinates, the coordinates are converted to latitude and longitude values by the systems analyst at the Portland office. Tows are assigned to particular geographic regions of interest, such as PSMFC area, on the basis of the starting positions.

3.6.2 Rockfish Landings by Species

Species-composition sample data are merged with the fish ticket information to estimate rockfish landings by individual species, rather than by reported market categories. The computations are performed on a mainframe computer at the Portland office. Also, ODFW provides monthly estimates to PacFIN of the species compositions (in percent) for the rockfish market categories by port, gear, and PSMFC area fished. The estimated percentages are based on the weight that a species contributed to the total landings of a given market category for a specified port, month, gear, and area fished. For example, the percentage breakdown by species for the yellowtail rockfish market category might be 83% yellowtail rockfish, 10% widow rockfish, 5% redstripe rockfish, and 2% sharpchin rockfish for the landings in Astoria during March 1992 that were caught using bottom trawl gear from PSMFC area 3A.

Species-composition estimates are generated for the following types of gear: 1) bottom trawl gear, which includes roller and sole gears, 2) midwater trawl gear, 3) longline gear, and 4) hook-and-line gear. Because there are rarely enough samples collected in a given month to determine estimates of species composition for individual market categories by port, gear, and area fished, the monthly estimates are based on sample data collected over a series of months (quarters). For example, the estimates of species compositions for March are based on sample data collected from January through March.

Because port biologists sample in an opportunistic fashion, obtaining boat trip samples when and where possible during their daily work schedule, in some instances there may be no sample data available for a particular port or quarter. When this occurs, sample data from adjacent ports or quarters are substituted for the missing values according to the following scheme.

1. If there are no sample data for landings of a particular market category made at a minor port, then comparable samples (with similar quarter, gear, and area fished characteristics) from the nearest major port are used. To perform these reassignment tasks, Astoria, Newport, Coos Bay, and Brookings are defined as the major ports in Oregon.

2. If after step (1) there are no suitable sample data, then comparable samples are used from the next closest major port to the south.

3. If after step (2) there are no applicable sample data, then samples are used from the preceding quarter for the nearest major port.

4. Finally, if after step (3) there are no applicable sample data, then samples are used from the succeeding quarter for the nearest major port.

The following formulae are used to estimate the weight, and subsequent percent contribution, of a given species in the landings. As stated above, estimates of species composition are calculated separately for market category, gear, and area fished combinations, but for simplicity the subscripts for these variables have been dropped. The estimated mean weight of species y per pound of a market category of interest of boat trip k within a port i and quarter j stratum is calculated as,

$$\bar{y}_{ijk\cdot} = \frac{\sum_{l}^{m_{ijk}} y_{ijkl}}{\sum_{l}^{m_{ijk}} w_{ijkl}}, \tag{3.1}$$

where y_{ijkl} is the weight of species y in basket l, w_{ijkl} is the weight of basket l, and m_{ijk} is the number of baskets selected from the sampled market category of boat trip k. Note that $\bar{y}_{ijk\cdot}$ is equivalent to the proportion by weight that species y contributed to the landings of this market category for this boat trip.

The ratio estimate for the mean weight of species y per pound of a market category of interest across all boat trips within a port i and quarter j stratum is calculated as,

$$\bar{y}_{ij\cdot\cdot} = \frac{\sum_{k}^{n_{ij}} \left(W_{ijk}\, \bar{y}_{ijk\cdot}\right)}{\sum_{k}^{n_{ij}} W_{ijk}}, \tag{3.2}$$

where W_{ijk} is the total weight of all species in the sampled market category of boat trip k and n_{ij} is the number of boat trips sampled. Equation 3.2 is a weighted estimator, where samples from boat trips with market category landings that are large are given more weight in estimating $\bar{y}_{ij\cdot\cdot}$ than boat trips with relatively small landings. Values for W_{ijk} are determined from the fish ticket information.

The percent of the landings (in weight) that species y constitutes for a market category of interest within a port complex i and quarter j stratum is simply,

$$\hat{y}_{ij}\% = \bar{y}_{ij\cdot\cdot}\,(100). \tag{3.3}$$

The ODFW does not routinely generate variance estimates associated with the estimates above, but the redefined PacFIN system is capable of accepting coefficient of variation estimates, along with the estimates of species composition. Further details of the calculations, including appropriate variance estimators, are given in Sen (1986) and Crone (1992a, 1992b, 1995).

The estimates of species composition for each market category by port, quarter, gear, and area fished are submitted monthly to PacFIN in Seattle. At PacFIN, the estimated percents derived above are applied to aggregated fish ticket information to partition the landings (in pounds) by reported market categories into landings (in pounds) by individual species. Landing estimates generated by PacFIN are routinely revised throughout a year as fish ticket information is updated and species-composition sample data accumulate.

3.6.3 Catch-at-Age

Although age-composition data (catch-at-age) play a central role in almost all current stock assessments, ODFW staff do not routinely publish estimated age or length frequency distributions for the landings of groundfish in Oregon. Instead they respond to specific requests for information by different researchers. Because there is no standard, universally acceptable procedure for estimating catch-at-age or catch-at-length, several methods have been developed for expanding the sample data and for combining different samples. It is left to the researchers using the data to determine which method best suits their requirements.

The age-composition estimates are based on the data collected in the biological sampling program (see section 3.5). The methods used to calculate age compositions of individual species are fundamentally similar to the methods used to derive species compositions (see section 3.6.2). The primary differences are: 1) age-composition estimates require the landings to be partitioned into age groups for a particular *species* of interest, whereas species-composition sampling requires the landings to be partitioned into the species observed within a *market category* of interest, and 2) age-composition estimates are based on the *number* of fish landed, whereas species-composition estimates are based on the *weight* of fish landed.

Because the market category is still maintained as the poststratification unit in the biological sampling program and because the species incorporated in the program are only sampled from their own respective market categories, estimates of age composition for a particular species reflect the characteristics of the total landings of the corresponding market categories. However, for those species involved in the biological sampling program, the vast majority of the landings occur within their own market categories (i.e., the market categories are "pure") and thus, the final estimates generally reflect the total landings of the species of interest. For the major species of rockfish, a species-composition sample exists for every biological sample; consequently, it is possible to estimate the total landings of the rockfish species of interest within the sampled market category and then use this estimate as a weighting variable in the procedures presented below.

Additionally, although the biological sampling program is based on a two-stage design, the current procedures for estimating age composition ignore the second stage of sampling (baskets of fish), primarily to simplify analysis, and in effect, are based on single samples of fish from each boat trip. Also, because of the relatively small number of boat trips that are sampled, it is generally not practical to calculate age-composition estimates by port, quarter, gear, and area fished. Instead, most researchers combine biological samples across all ports and generate statistics for annual landings.

The formulae used to estimate the age (or length) composition of the landings for individual species are based on one of the following general methods (1-4). The calculations are performed using Pascal programs at the Newport office.

1. For the species of interest, the number of fish of age group y is estimated as,

$$
\begin{aligned}
\hat{Y} &= \frac{W}{\sum_{k}^{n} W_k} \sum_{k}^{n} \left[\left(\frac{W_k}{w_k} \right) y_k \right], \textit{ where} \\
W &= \sum_{k}^{N} W_k, \\
w_k &= \sum_{l}^{m_k} w_{kl}, \textit{ and} \\
y_k &= \sum_{l}^{m_k} y_{kl}.
\end{aligned}
\tag{3.4}
$$

Equation 3.4 generates an estimate of the total number of fish of age y in the total landings of the corresponding market category, W_k is the total weight of the market category within boat trip k, w_{kl} is the weight of basket l subsampled from the market category within boat trip k, y_{kl} is the number of fish of age y in basket l subsampled from the market category within boat trip k, n is the number of boat trips sampled, N is the total number of boat trips, and m_k is the number of baskets sampled from the market category within boat trip k. The ratio W_k / w_k is a weighting variable that expands the subsample values (y_k) to total values for each sampled boat trip, and the ratio $W / \sum W_k$ expands the values for the individual boat trips to total values across all trips.

2. The second method for estimating age (or length) composition is identical to the first (eq. 3.4) except that the w_k values are not the observed basket weights, but instead are estimated from the observed lengths of the fish in the basket subsamples using appropriate weight-length relationships. The current estimation program has standard weight-length coefficients for widow rockfish, canary rockfish, and Dover sole. The values for the total weight of the baskets subsampled from each sampled boat trip are estimated as,

$$
w_k = \sum_{l}^{m_k} \sum_{f}^{F} \alpha \left(L_{klf} \right)^{\beta}, \tag{3.5}
$$

where L_{klf} is the length of fish f ($f = 1, \ldots, F$) in basket l subsampled from the corresponding market category of boat trip k, and α and β are coefficients determined empirically using regression techniques.

3. The third method is essentially the same as the first (eq. 3.4), however, the numbers of fish at age (y_k) are not weighted by the size of the market category landings (W_k / w_k). Thus, the estimator is simply,

$$\hat{Y} = \frac{W}{\sum_k^n w_k} \sum_k^n y_k \, . \tag{3.6}$$

4. The fourth method is identical to the third (eq. 3.6) except that values for w_k are estimated using equation (3.5).

If there are large differences between boat trips, both in terms of age (or length) compositions and total landings of the market categories sampled, then there can be considerable differences between the results from (1) versus (3), and from (2) versus (4). Also, if there are changes in the weight-length relationship associated with a particular species, then there can be large differences between the results from (1) versus (2), and from (3) versus (4).

Variance estimates associated with the estimators above are not routinely calculated by ODFW. However, formulae for calculating estimates of age composition and their variances that fully accommodate the two stages of the sampling design are given in Sen (1986) and Crone (1993, 1995).

3.6.4 Other Estimates

In addition to the fish ticket data, the proration tables for estimating landings by area (section 3.6.1), and the proration tables for estimating rockfish landings by species (section 3.6.2), the ODFW data processing staff periodically provide the PacFIN office with lists of licensed commercial fishing vessels, with tables for translating various codes (e.g., market categories, gear types, ports, etc.), and with estimates of the number of hours of trawling (the amount of time that trawl nets were dragged through the water). The estimates of trawl hours by month, port, gear type, and PSMFC area are derived by 1) summing the trawl hours reported in the logbooks, and then 2) multiplying the total logbook hours by the ratio of the total pounds landed from the fish tickets divided by the total adjusted hailed pounds from the logbooks (see section 3.6.1). The expansions are needed to account for landings for which logbook data are unavailable.

3.7 Acknowledgments

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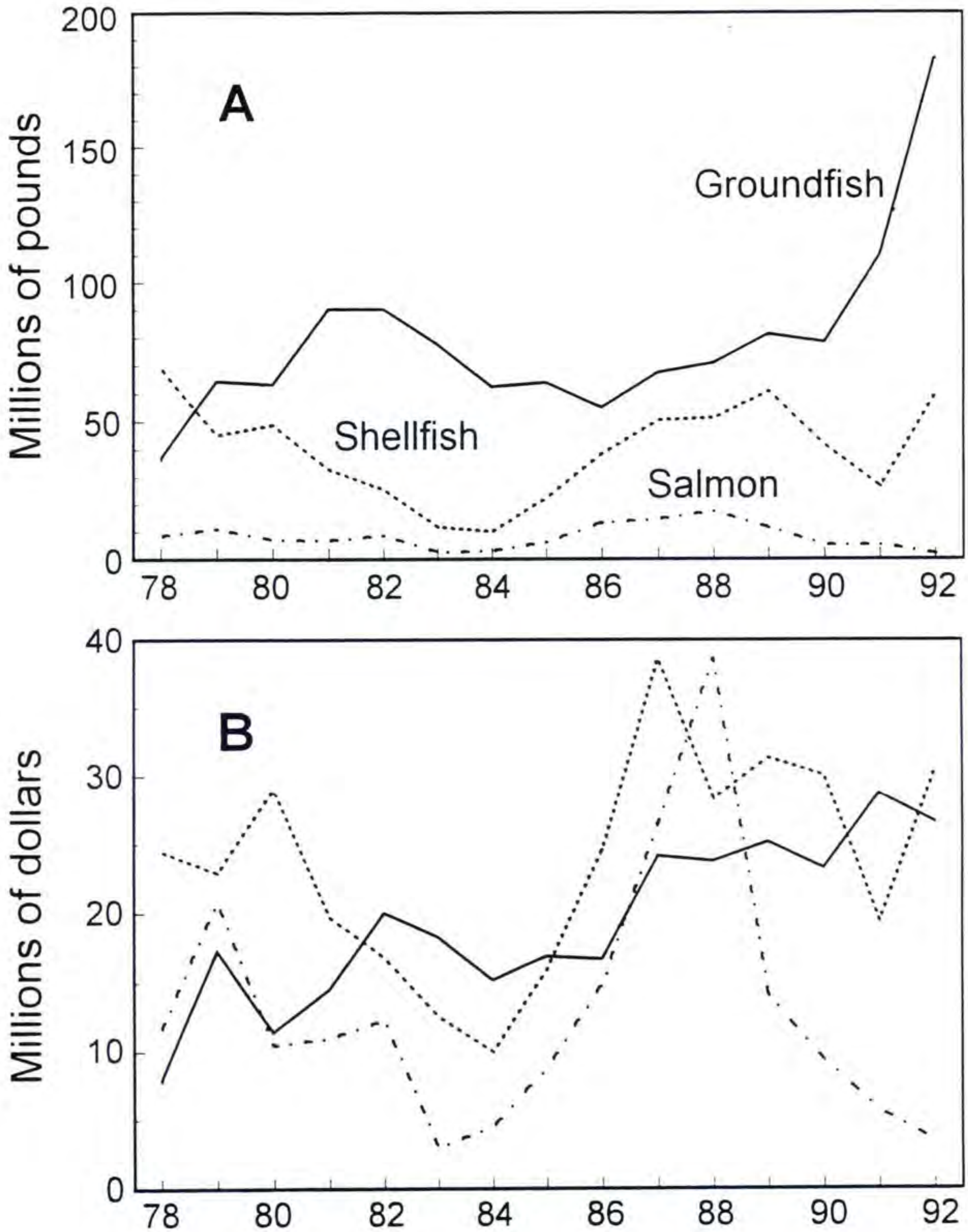

Figure 3.1. Recent annual estimates of (**A**) landings (in pounds) and (**B**) economic values (in ex-vessel dollars) for the groundfish, shellfish, and salmon commercial fisheries in Oregon. The groundfish landings exclude halibut and pelagic finfish, such as anchovy, herring, mackerel, and tuna. The shellfish landings include only crabs and pink shrimp. The figures are based on estimates reported in Lukas and Carter (1987, 1992).

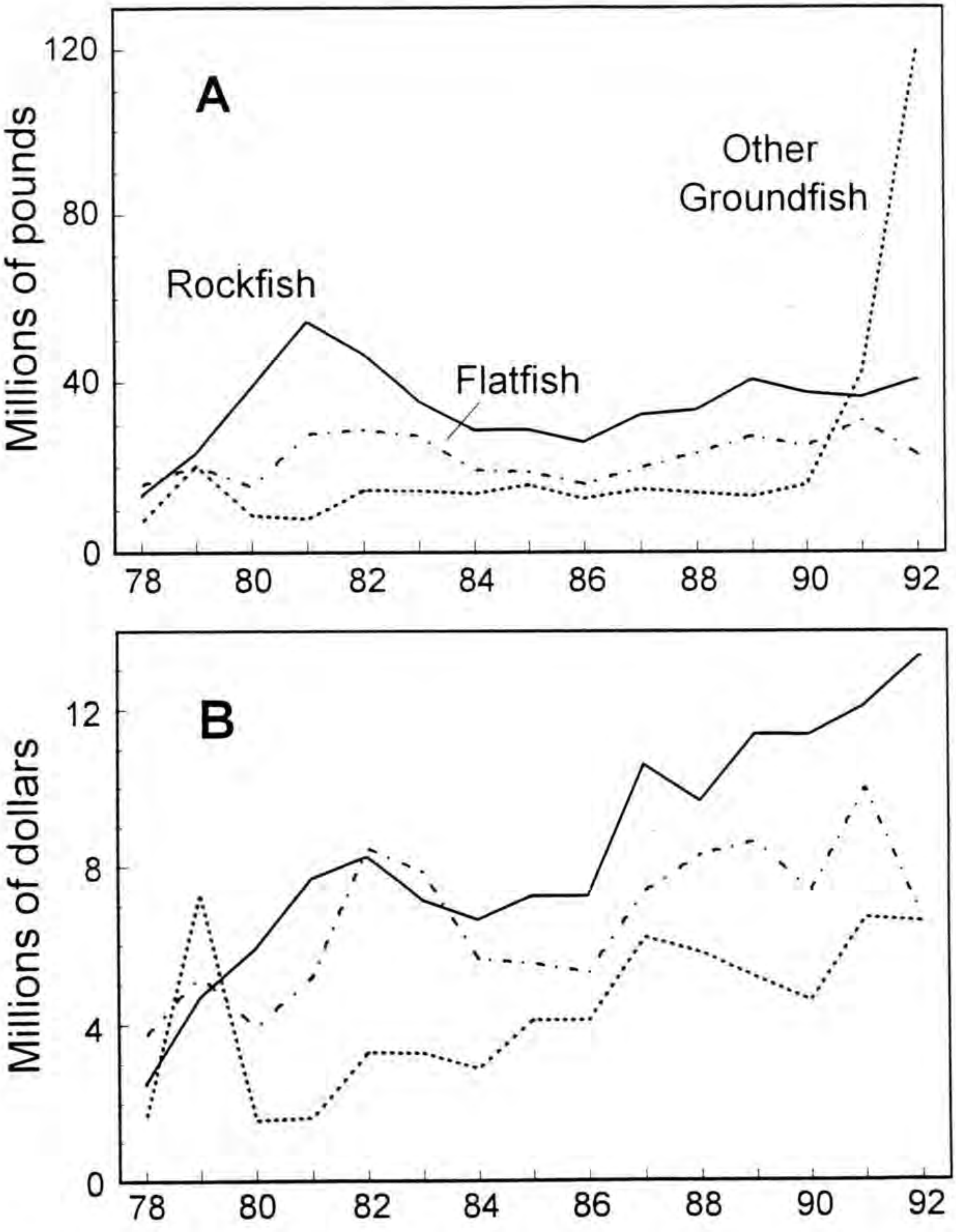

Figure 3.2. Recent annual estimates of (**A**) landings (in pounds) and (**B**) economic values (in ex-vessel dollars) for the groundfish (rockfish, flatfish, and "other groundfish") commercial fisheries in Oregon. The flatfish landings exclude halibut. The "other groundfish" landings include Pacific cod, Pacific hake, lingcod, sablefish, spiny dogfish, skates and rays, walleye pollock, and wolf-eels. The figures are based on estimates reported in Lukas and Carter (1987, 1992).

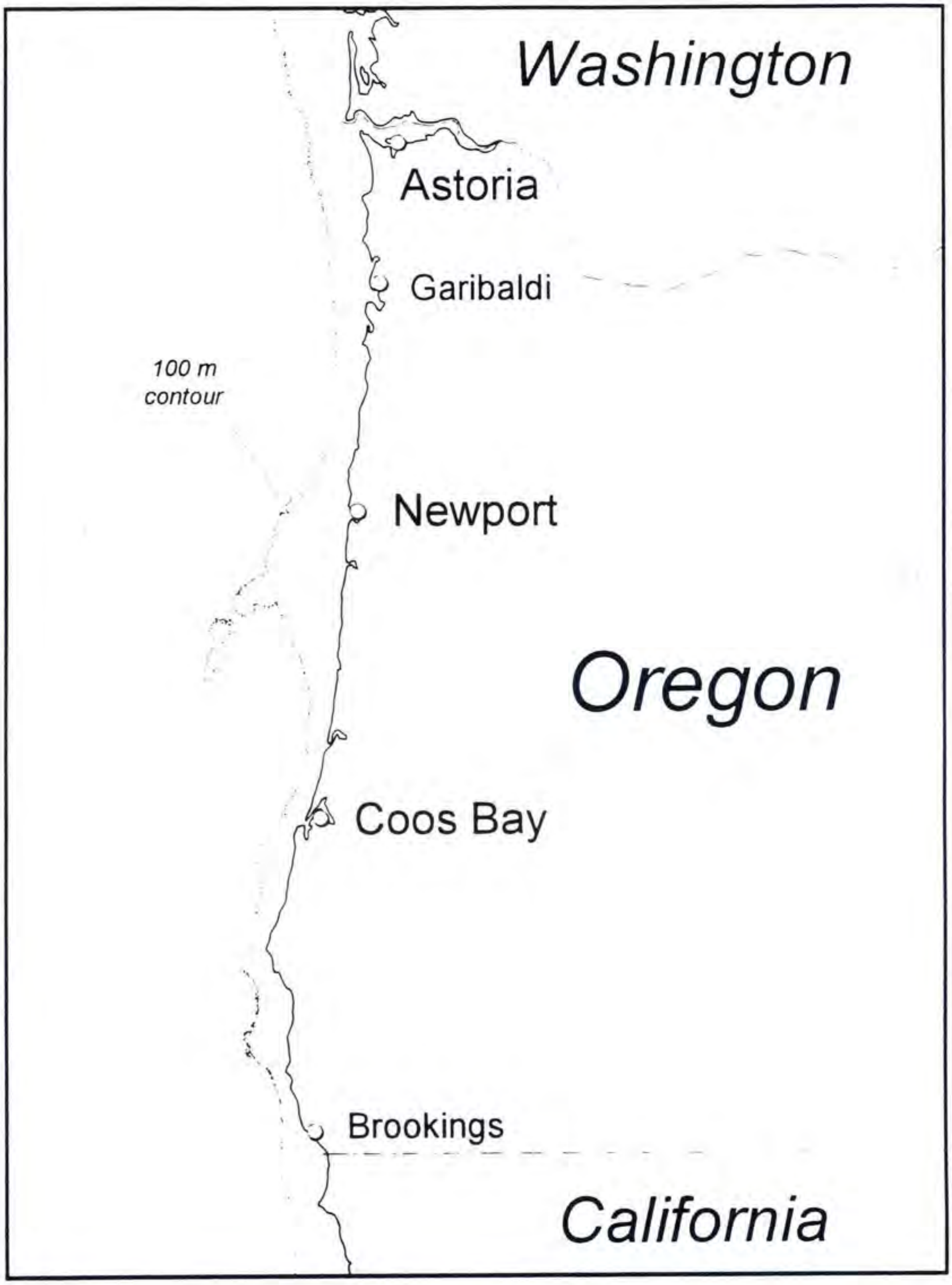

Figure 3.3. The major groundfish ports in Oregon are Astoria, Newport, and Coos Bay.

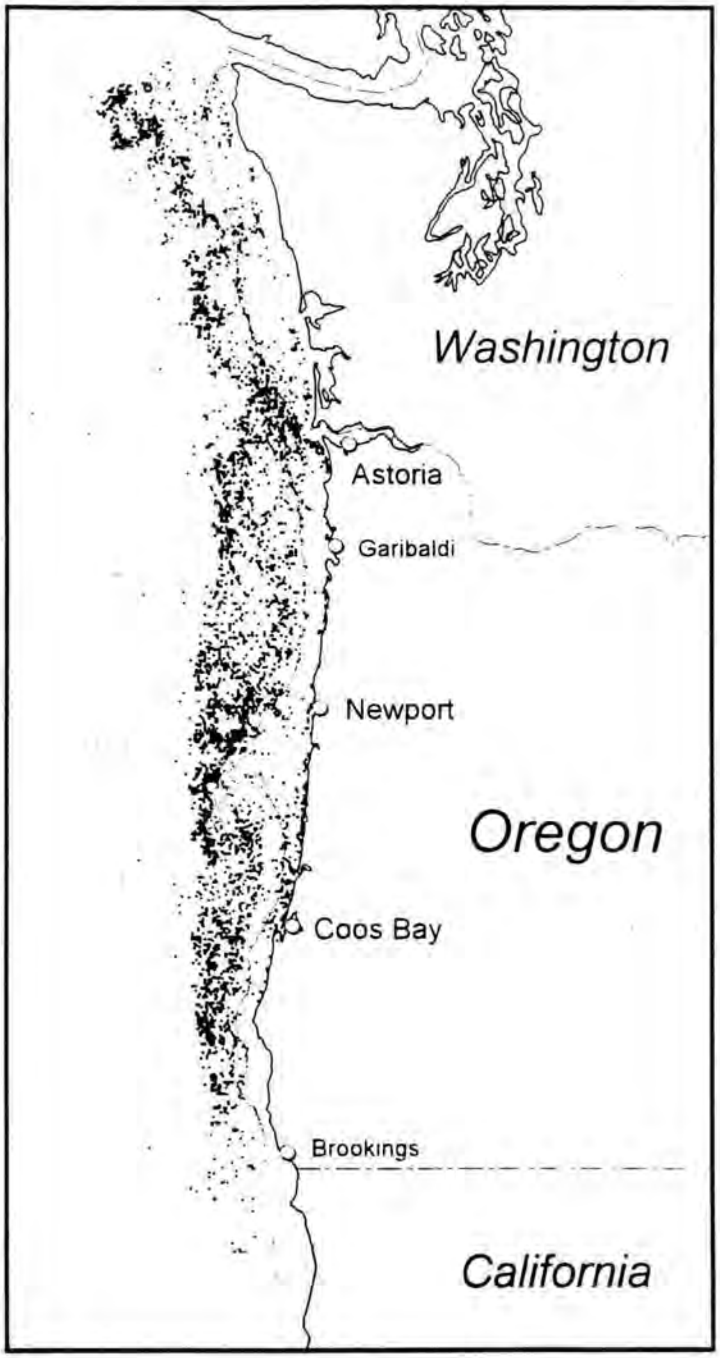

Figure 3.4. Tow locations from a 10% sample of logbooks collected in Oregon during 1991 and 1992.

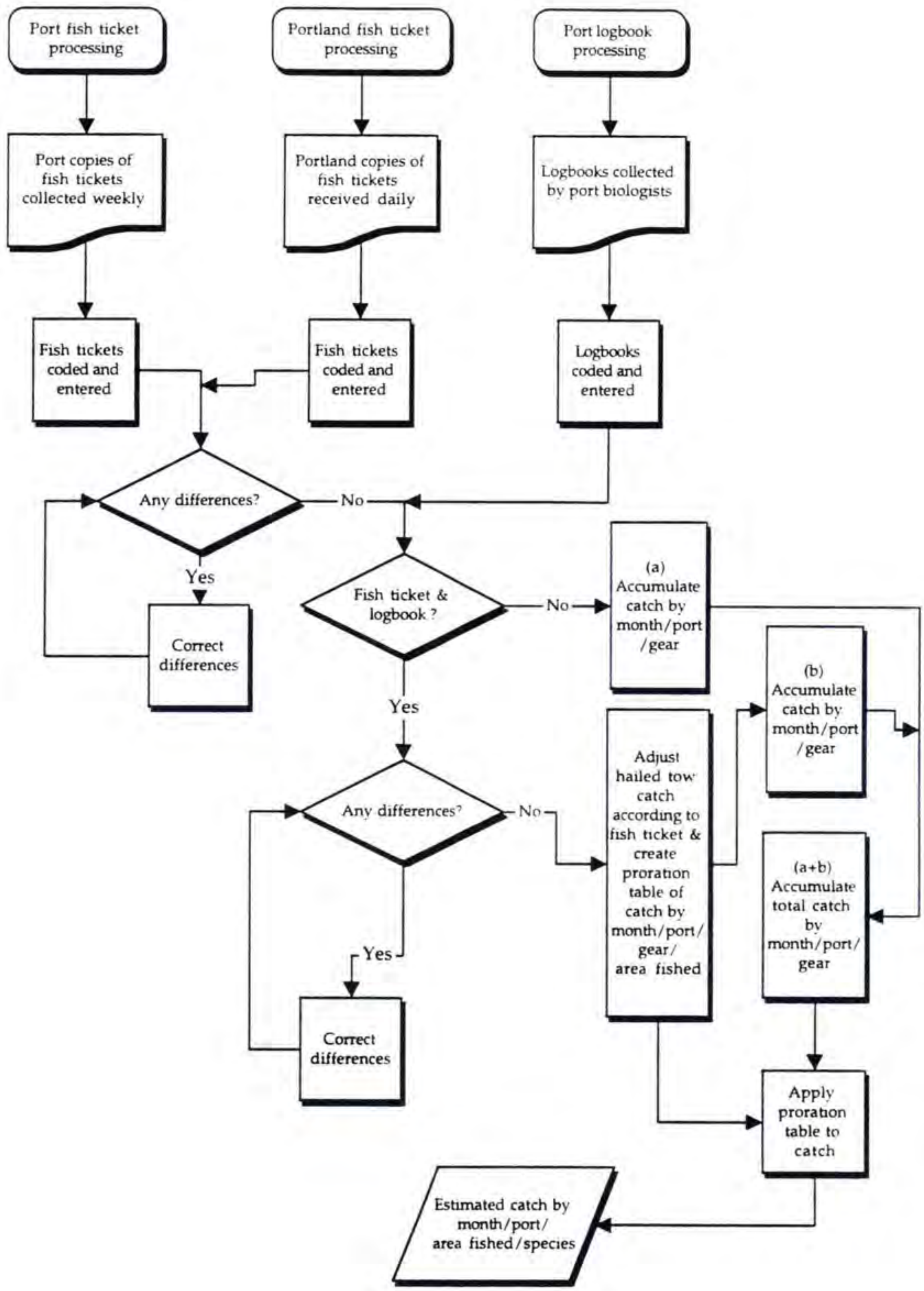

Figure 3.5. System used in Oregon for collecting and processing information from fish tickets and logbooks.

Table 3.1. Oregon groundfish landings (in number of deliveries, metric tons, and dollars) by port, (**A**) 1991 and (**B**) 1992.[a]

A 1991

Port[b]	Landings[c] Number of deliveries[d]	Metric tons	$1,000s
Astoria	1,588	15,877.9	10,697.3
Garibaldi	330	1,479.6	1,047.5
Pacific City	299	28.3	29.1
Depoe Bay	73	9.4	12.5
Newport	2,026	19,628.5	7,480.3
Florence	40	117.3	198.7
Winchester Bay	88	40.9	62.6
Coos Bay	1,906	10,447.5	8,348.8
Bandon	5	2.8	3.8
Port Orford	1,102	437.4	564.9
Gold Beach	145	27.0	45.5
Brookings	616	1,123.7	1,116.6
Total	8,218	49,220.3	29,607.6

B 1992

Port[b]	Landings[c] Number of deliveries[d]	Metric tons	$1,000s
Astoria	1,865	23,068.6	10,375.8
Garibaldi	327	889.0	672.8
Pacific City	540	62.7	64.4
Depoe Bay	131	10.9	18.7
Newport	2,846	47,253.4	11,669.4
Florence	78	133.0	137.1
Winchester Bay	53	70.9	117.7
Coos Bay	1,821	9,063.2	7,641.5
Bandon	54	10.0	10.2
Port Orford	1,094	400.7	485.0
Gold Beach	99	26.7	30.6
Brookings	770	1,248.8	1,204.2
Total	9,678	82,237.9	32,427.4

[a]Table does not include small amounts of groundfish that are occassionally landed at Gearhart, Cannon Beach, and at ports along the Columbia River.

[b]Ports are listed from north to south.

[c]Figures represent landings of all commercial groundfish excluding halibut.

[d]Number of deliveries represents the number of fish tickets. See section 3.2.2 for a further discussion regarding the system used in Oregon for processing fish tickets.

Table 3.2. Oregon groundfish landings (in metric tons) by species and port, (**A**) 1991 and (**B**) 1992.

A 1991

Species[a]	Astoria	Garibaldi	Newport	Coos Bay	Brookings	All ports[b]
Arrowtooth flounder	1,759.2	104.8	98.8	110.5	28.9	2,102.3
Dover sole	3,480.8	482.6	1,232.4	3,244.2	347.4	8,787.6
Other flatfish	1,668.3	99.9	460.4	778.0	86.0	3,093.6
All flatfish	6,908.3	687.3	1,791.6	4,132.7	462.3	13,983.5
Canary rockfish	444.2	28.3	583.5	807.0	23.3	1,898.6
Yellowtail rockfish	1,171.1	136.3	418.7	265.7	28.5	2,036.9
Widow rockfish	1,229.3	200.9	1,645.1	755.3	29.9	3,862.4
Pacific ocean perch	603.3	41.0	170.4	36.9	0.7	852.3
Thornyhead	613.8	33.9	1,003.7	1,618.1	215.1	3,484.6
Other rockfish	1,210.7	159.7	1,261.4	807.8	74.4	3,762.6
All rockfish	5,272.4	600.1	5,082.8	4,290.8	371.9	15,897.4
Lingcod	941.7	75.8	197.8	214.8	21.3	1,485.4
Pacific hake	1,230.5	0	11,557.5	415.5	0	13,203.5
Sablefish	1,022.9	85.8	923.2	1,285.2	258.2	3,921.6
Other roundfish	439.8	29.8	61.0	2.8	0.1	534.4
All roundfish	3,634.9	191.4	12,739.5	1,918.3	279.6	19,144.9
Other groundfish	62.4	0.8	14.5	105.6	9.5	195.9
All groundfish	15,878.0	1,479.6	19,628.4	10,447.4	1,123.3	49,221.7

Table 3.2. Continued.

B 1992	Port					
Species[a]	Astoria	Garibaldi	Newport	Coos Bay	Brookings	All ports[b]
Arrowtooth flounder	1,791.4	45.9	105.4	106.0	11.5	2,060.8
Dover sole	2,247.7	212.2	954.3	2,407.4	247.8	6,077.8
Other flatfish	1,065.7	74.6	380.2	621.6	66.8	2,280.1
All flatfish	5,104.8	332.7	1,439.9	3,135.0	326.1	10,418.7
Canary rockfish	583.1	21.2	697.4	471.4	23.9	1,839.5
Yellowtail rockfish	1,402.1	137.1	1,612.0	757.2	22.7	3,980.9
Widow rockfish	1,035.8	117.8	1,675.9	883.4	201.3	3,916.9
Pacific ocean perch	454.3	8.1	116.4	27.4	8.4	614.7
Thornyhead	1,128.9	46.4	1,069.1	1,822.0	208.0	4,277.2
Other rockfish	755.2	133.5	979.6	474.5	136.3	2,695.6
All rockfish	5,359.4	464.1	6,150.4	4,435.9	600.6	17,324.8
Lingcod	351.4	22.6	137.7	163.8	31.1	740.2
Pacific hake	10,661.8	1.3	38,287.6	9.8	0	48,960.6
Sablefish	1,059.6	62.8	979.0	1,178.9	288.2	3,851.2
Other roundfish	505.5	5.5	220.4	1.2	0	732.6
All roundfish	12,578.3	92.2	39,624.7	1,353.7	319.3	54,284.6
Other groundfish	25.9	0	37.9	138.5	3.0	210.0
All groundfish	23,068.4	889.0	47,252.9	9,063.1	1,249.0	82,238.1

[a]Species are presented in three groups: flatfish, rockfish, and roundfish. "Other flatfish" includes miscellaneous species of flatfish, such as English sole, petrale sole, rex sole, etc. "Other rockfish" includes miscellaneous species of rockfish, such as bocaccio, darkblotched rockfish, yellowmouth rockfish, etc. "Other roundfish" includes miscellaneous species of roundfish, such as jack mackerel, Pacific cod, walleye pollock, etc. "Other groundfish" includes miscellaneous groundfish species, such as spiny dogfish, green sturgeon, longnose skate, etc. "All groundfish" includes all groundfish landings excluding halibut.

[b]"All ports" includes landings made at major ports (presented in the table) and minor ports (not presented in the table).

Table 3.3. Oregon groundfish landings (in metric tons) by species and gear, (**A**) 1991 and (**B**) 1992.

A 1991	Gear[b]						
Species[a]	Bottom trawl	Midwater trawl	Shrimp trawl	Line	Pot	Troll	All gears
Arrowtooth flounder	2,096.6	0	4.6	0.2	1.0	tr	2,102.4
Dover sole	8,760.2	8.4	18.9	0.1	tr	0	8,787.6
Other flatfish	3,090.5	0.5	1.8	0.1	0.1	tr	3,093.0
All flatfish	13,947.3	8.9	25.3	0.4	1.1	tr	13,983.0
Canary rockfish	1,840.2	0.2	23.1	35.1	0	0	1,898.6
Yellowtail rockfish	1,615.5	78.7	292.6	49.7	0	0.4	2,036.9
Widow rockfish	1,967.7	1,864.3	25.2	5.2	0	0	3,862.4
Pacific ocean perch	848.2	1.6	2.3	0.1	0	0	852.2
Thornyhead	3,463.3	15.2	2.3	3.7	0	0	3,484.5
Other rockfish	3,118.1	12.0	47.9	562.2	0.6	20.8	3,761.6
All rockfish	12,853.0	1,972.0	393.4	656.0	0.6	21.2	15,896.2
Lingcod	1,408.0	0.3	16.3	57.4	0.4	2.9	1,485.3
Pacific hake	68.1	13,135.4	0	0	0	0	13,203.5
Sablefish	2,429.8	5.4	12.0	761.5	712.7	tr	3,921.4
Other roundfish	512.4	19.3	1.7	0.2	0	0	533.6
All roundfish	4,418.3	13,160.4	30.0	819.1	713.1	2.9	19,143.8
Other groundfish	185.7	0	0.2	9.2	0.4	0.4	195.9
All groundfish	31,404.3	15,141.3	448.9	1,484.7	715.2	24.5	49,218.9

Table 3.3. Continued.

B 1992	Gear[b]						
Species[a]	Bottom trawl	Midwater trawl	Shrimp trawl	Line	Pot	Troll	All gears
Arrowtooth flounder	2,057.0	tr	3.3	0.3	tr	0	2,060.6
Dover sole	6,057.3	0.1	20.2	0.1	0.1	0	6,077.8
Other flatfish	2,270.4	3.9	5.2	0.6	tr	tr	2,280.1
All flatfish	10,384.7	4.0	28.7	1.0	0.1	tr	10,418.5
Canary rockfish	1,654.4	0	24.4	160.6	0	0	1,839.4
Yellowtail rockfish	3,526.4	61.4	275.5	116.9	0	0.6	3,980.8
Widow rockfish	2,762.3	1,139.7	7.1	7.6	0	0.2	3,916.9
Pacific ocean perch	613.3	1.2	0.2	tr	0	0	614.7
Thornyhead	4,271.6	0.1	0.1	5.3	0.2	0	4,277.3
Other rockfish	1,994.0	65.9	85.9	511.6	1.0	37.1	2,695.5
All rockfish	14,822.0	1,268.3	393.2	802.0	1.2	37.9	17,324.6
Lingcod	643.1	0.3	14.2	76.4	0.1	6.1	740.2
Pacific hake	18.9	48,939.9	1.7	0	0	0	48,960.5
Sablefish	2,452.0	12.4	89.0	899.8	397.2	0.8	3,851.2
Other roundfish	414.2	316.1	2.1	tr	0	tr	732.4
All roundfish	3,528.2	49,268.7	107.0	976.2	397.3	6.9	54,284.3
Other groundfish	156.9	43.4	0.2	9.2	0.3	0.1	210.1
All groundfish	28,891.8	50,584.4	529.1	1,788.4	398.9	44.9	82,237.5

tr = landings less than 0.05 metric tons.

[a]Species are presented in three groups: flatfish, rockfish, and roundfish. "Other flatfish" includes miscellaneous species of flatfish, such as English sole, petrale sole, rex sole, etc. "Other rockfish" includes miscellaneous species of rockfish, such as bocaccio, darkblotched rockfish, yellowmouth rockfish, etc. "Other roundfish" includes miscellaneous species of roundfish, such as jack mackerel, Pacific cod, walleye pollock, etc. "Other groundfish" includes miscellaneous groundfish species, such as spiny dogfish, green sturgeon, longnose skate, etc. "All groundfish" includes all groundfish landings excluding halibut.

[b]Gear is defined as follows: Shrimp trawl includes double-shrimp trawl and single-shrimp trawl; line includes longline and hook-and-line; and pot includes crab pot and fish pot.

Table 3.4. Staff involved in the groundfish sampling programs conducted in Oregon in 1992.

Position	Location
Sampling Supervisor[a]	Astoria
Groundfish Technical Supervisor	Newport
Port Biologist	Astoria
Port Biologist Aide[b]	Astoria
Port Biologists (2 positions)	Newport
Port Biologist Aide[b]	Newport
Port Biologist	Coos Bay
Port Biologist Aide[b]	Coos Bay
Port Biologist Aide[b]	Brookings
Data Coordinator	Newport
Data Technician	Newport
Assessment and Ageing Supervisor[c]	Newport
Assessment and Ageing Assistant	Newport
Ageing Specialist	Newport
Pacific Hake Data Technician[d]	Newport
Fisheries Information Supervisor	Portland
Commercial Fish Auditor[e]	Portland
Systems Analyst	Portland
Clerical Staff	Portland
Data Entry Staff	Portland

[a]Retired in June 1993.

[b]Seasonal positions that were five or seven month appointments.

[c]Retired in June 1992.

[d]Temporary position funded by PSMFC.

[e]Position was discontinued in 1993.

Table 3.5. Oregon groundfish landings (in number of fish and metric tons) for the recreational ocean boat fishery, (**A**) 1991 and (**B**) 1992.[a]

A 1991

Species	Number of fish	Metric tons
Black rockfish	135,888	172.4
Yellowtail rockfish	42,080	78.2
Canary rockfish	15,712	23.2
Yelloweye rockfish	8,310	18.3
Blue rockfish	18,506	14.5
China rockfish	3,055	1.5
Other rockfish	14,205	11.4
Lingcod	18,773	77.1
Pacific halibut	3,169	35.9
Cabezon	4,798	8.5
Kelp greenling	2,920	3.2
Other fish	6,637	5.7
Total	274,053	450.0

B 1992

Species	Number of fish	Metric tons[b]
Black rockfish	243,704	309.3
Yellowtail rockfish	26,330	67.5
Canary rockfish	28,851	42.7
Yelloweye rockfish	12,984	28.6
Blue rockfish	32,245	25.2
China rockfish	4,227	2.1
Other rockfish	16,968	13.6
Lingcod	30,907	126.9
Pacific halibut	4,042	45.8
Cabezon	5,229	9.3
Kelp greenling	4,512	5.0
Other fish	11,241	9.6
Total	431,240	685.5

[a]Figures represent only partial landings made by the recreational fishery in Oregon. Figures are estimates, based on interviews and samples, of the landings made by the recreational charter vessels and private boats operating out of the ports of Astoria, Garibaldi, Pacific City, Depoe Bay, Newport, Florence, Winchester Bay, Coos Bay, and Brookings during the months from May through September.

[b]Landed weights (metric tons) for 1992 are based on the average weights observed in 1991 samples, because the appropriate estimates were not available for 1992 sample information.

Table 3.6. Logbook coverage of the trawl fishery in Oregon, (**A**) 1991 and (**B**) 1992.

A 1991

Quarter / Port	Number of deliveries[a]	Number of deliveries with logbooks	Coverage[b]
1st Quarter /			
Astoria	296	280	94.6%
Garibaldi	47	41	87.2%
Newport	298	232	77.9%
Coos Bay	296	213	72.0%
Brookings	51	28	54.9%
2nd Quarter /			
Astoria	463	428	92.4%
Garibaldi	51	41	80.4%
Newport	346	290	83.8%
Coos Bay	286	236	82.5%
Brookings	9	7	77.8%
3rd Quarter /			
Astoria	499	452	90.6%
Garibaldi	43	23	53.5%
Newport	432	345	79.9%
Coos Bay	346	263	76.0%
Brookings	16	11	68.8%
4th Quarter /			
Astoria	246	206	83.7%
Garibaldi	30	17	56.7%
Newport	309	239	77.3%
Coos Bay	279	205	73.5%
Brookings	38	34	89.5%
Total	4,381	3,591	82.0%

Table 3.6. Continued.

B 1992

Quarter / Port	Number of deliveries[a]	Number of deliveries with logbooks	Coverage[b]
1st Quarter /			
Astoria	318	265	83.3%
Garibaldi	41	25	61.0%
Newport	288	224	77.8%
Coos Bay	287	215	74.9%
Brookings	30	28	93.3%
2nd Quarter /			
Astoria	394	353	89.6%
Garibaldi	33	30	90.9%
Newport	527	485	92.0%
Coos Bay	223	166	74.4%
Brookings	19	15	78.9%
3rd Quarter /			
Astoria	653	575	88.1%
Garibaldi	28	23	82.1%
Newport	754	652	86.5%
Coos Bay	232	183	78.9%
Brookings	23	16	69.6%
4th Quarter /			
Astoria	289	242	83.7%
Garibaldi	27	20	74.1%
Newport	295	210	71.2%
Coos Bay	183	149	81.4%
Brookings	17	17	100.0%
Total	4,661	3,893	83.5%

[a]In this table a delivery represents a landing made at a specific dealer (processing facility) by a vessel and a particular fishing gear. For example, a boat that landed two market categories at a dealer, each of which was harvested using different gears, would result in two deliveries. There are cases when a vessel unloads some of its landings at one dealer and some at another dealer, where in this table, the multiple landings are together defined as a single delivery. Thus, the number of deliveries presented here does not correspond to the number of deliveries (fish tickets) given in Table 3.1. See section (3.2.2) for a further discussion regarding the system used in Oregon for processing fish tickets.

[b]Coverage estimates are calculated as:
[(Number of deliveries with logbooks / Number of deliveries) • 100]

Table 3.7. Number of species-composition samples collected in Oregon, 1981-1992.

Year	Number of samples[a]
1981	234
1982	458
1983	683
1984	662
1985	829
1986	762
1987	698
1988	613
1989	547
1990	671
1991	1,012
1992	1,096

[a]Number of samples denotes the total number of boat trip samples selected over all market categories. Prior to 1989, a subsample (basket of fish) selected from a market category of a boat trip sample was composed of a fixed number of fish. From 1989 through the present, subsamples have been taken as fixed weights of fish.

Table 3.8. Market category landings (in pounds)[a] and species-composition samples (in target number and number taken)[b] collected in Oregon by port and quarter, (**A**) 1991 and (**B**) 1992.

A 1991

Port / Market category[c]	1st Quarter Landings (lb)	No. samples Target	No. samples Taken	2nd Quarter Landings (lb)	No. samples Target	No. samples Taken	3rd Quarter Landings (lb)	No. samples Target	No. samples Taken	4th Quarter Landings (lb)	No. samples Target	No. samples Taken
Astoria /												
LRC	599,573	14	21	1,175,229	27	37	1,120,806	26	26	572,374	13	9
POP	284,295	7	14	341,807	8	21	397,759	9	17	241,085	6	3
SRC	30,742	1	1	64,497	2	2	47,648	1	1	58,587	1	0
TYH	259,537	16	24	319,536	7	30	286,708	7	16	485,430	11	7
WDW	867,567	8	15	652,279	6	20	1,430,768	13	15	951,716	9	3
YWT	674,617	15	16	617,303	14	23	523,851	12	12	362,289	8	5
Garibaldi /												
LRC	68,496	2	5	46,884	1	10	35,835	1	5	16,158	<1	1
POP	29,466	1	1	20,028	1	4	23,721	1	1	14,528	<1	2
SRC	60,530	1	1	82,959	2	6	42,136	1	4	18,812	<1	2
TYH	25,837	1	0	8,289	<1	0	8,303	<1	0	31,791	1	1
WDW	224,455	2	1	21,302	<1	0	169,092	2	1	25,044	<1	1
YWT	93,602	2	2	61,832	1	4	46,993	1	2	20,965	1	1
Newport /												
LRC	110,658	3	4	531,725	12	17	669,269	15	19	363,027	8	3
POP	91,061	2	12	51,071	1	4	68,203	2	11	63,503	1	12
SRC	782,873	18	14	478,738	11	9	385,968	9	11	414,352	9	9
TYH	476,263	11	19	548,448	13	7	555,923	13	9	638,352	15	9
WDW	1,612,329	15	39	678,146	6	19	1,188,125	11	20	120,047	1	9
YWT	270,151	6	12	148,240	3	10	192,399	4	16	113,821	3	5
Coos Bay /												
LRC	461,022	10	13	915,600	21	31	753,884	17	21	495,033	11	13
POP	9,455	<1	0	4,975	<1	1	8,729	<1	1	3,648	<1	0
SRC	216,155	5	14	266,952	6	28	193,021	4	22	173,155	4	19
TYH	820,508	19	10	569,010	13	16	914,978	21	11	1,278,041	29	17
WDW	773,146	7	19	210,532	2	14	560,930	5	18	88,354	1	5
YWT	183,178	4	9	137,456	3	13	61,422	1	5	105,208	2	5
Brookings /												
LRC	38,688	1	1	5,341	<1	0	13,422	<1	3	10,384	<1	1
SRC	14,520	<1	2	3,201	<1	1	6,798	<1	3	7,302	<1	1
TYH	183,563	4	1	21,167	1	0	24,038	1	2	244,573	2	1
WDW	27,473	<1	0	26,360	<1	1	2,087	<1	1	5,641	<1	0
YWT	10,229	<1	0	5,231	<1	0	4,642	<1	1	0	0	0

Table 3.8. Continued.

B 1992	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter		
Port / Market category[c]	Landings (lb)	No. samples Target	No. samples Taken	Landings (lb)	No. samples Target	No. samples Taken	Landings (lb)	No. samples Target	No. samples Taken	Landings (lb)	No. samples Target	No. samples Taken
Astoria /												
LRC	511,397	12	18	1,071,205	24	32	815,693	19	15	370,374	8	25
POP	182,145	4	7	295,325	7	9	347,696	8	11	133,190	3	13
SRC	25,948	1	2	29,926	1	3	23,605	1	3	17,993	<1	1
TYH	427,379	10	11	656,603	15	29	1,012,661	23	26	388,039	9	23
WDW	1,149,662	10	7	683,446	6	9	1,602,107	15	15	821,691	7	8
YWT	789,779	18	4	914,714	21	13	789,167	18	9	331,722	8	13
Garibaldi /												
LRC	30,321	1	3	23,570	1	1	37,799	1	2	17,090	<1	0
POP	7,136	<1	0	3,369	<1	1	797	<1	1	0	<1	0
SRC	40,505	1	5	54,123	1	3	29,788	1	1	16,750	<1	0
TYH	53,924	1	2	17,318	<1	0	19,058	<1	1	11,456	<1	0
WDW	143,868	1	2	66,069	1	3	38,517	<1	2	13,039	<1	0
YWT	123,110	3	4	37,570	1	2	47,035	1	2	46,577	1	0
Newport /												
LRC	586,941	13	14	618,622	14	17	521,412	12	9	310,089	7	4
POP	61,189	1	5	43,548	1	8	67,063	2	8	37,426	1	7
SRC	287,517	7	13	161,251	4	6	311,730	7	10	297,464	7	15
TYH	700,026	16	5	554,072	13	5	787,317	18	1	312,369	7	1
WDW	1,671,123	15	39	874,828	8	20	785,923	7	23	595,683	5	24
YWT	1,733,169	39	30	803,949	18	23	463,248	11	17	176,579	4	12
Coos Bay /												
LRC	296,615	7	13	403,625	9	11	460,885	10	12	195,125	4	8
POP	3,525	<1	1	3,060	<1	2	89	<1	0	0	<1	0
SRC	166,668	4	14	154,511	4	16	153,174	3	20	158,706	4	7
TYH	1,578,867	36	24	1,114,146	25	13	810,193	18	17	523,815	12	13
WDW	837,107	8	10	513,090	5	8	523,506	5	12	174,041	2	6
YWT	554,028	13	10	397,767	9	4	441,960	10	6	122,464	3	1
Brookings /												
LRC	31,879	1	0	41,513	1	1	67,618	2	3	47,395	1	1
SRC	8,665	<1	1	4,091	<1	1	6,014	<1	2	2,560	<1	1
TYH	236,168	5	4	42,972	1	5	106,089	2	7	71,100	2	1
WDW	134,767	1	1	232,269	2	4	88,180	1	4	36,028	<1	0
YWT	500	<1	0	415	<1	1	8,410	<1	1	33,447	1	1

[a]Landings were determined from Oregon Department of Fish and Wildlife fish ticket records.

[b]The number of samples (No. samples) denotes the number of boat trip samples for each market category.

[c]Acronyms for the six market categories are as follows: LRC is "large rockfish," POP is Pacific ocean perch, SRC is "small rockfish," TYH is thornyhead, WDW is widow rockfish, and YWT is yellowtail rockfish.

Table 3.9. Number of biological samples collected in Oregon, 1981-1992.[a]

	Year[b]											
Species	1981	82	83	84	85	86	87	88	89	90	91	92
Rockfish												
Pacific ocean perch	20	20	29	22	12	24	23	19	5	16	8	
Widow	49	36	44	62	84	83	103	72	118	121	141	139
Yellowtail	10	16	3	12	26	17	37	28	42	36	39	70
Canary	9	20	17	19	28	14	35	23	23	22	22	38
Boccaccio			1									
Silvergrey			1									
Darkblotched		2		1	2							
Shortbelly	1											
Black					4							8
Blue												2
Yellowmouth	7	2										
Redstripe		15										
Shortspine thornyhead	6	7								25	55	55
Longspine thornyhead										38	44	47
Arrowtooth flounder										7	11	13
Dover sole	36	35	35	38	47	30	39	50	64	64	91	87
English sole	39	38	18	14	22	18	18	14	18	21	14	11
Petrale sole	41	21	4			14	18	17	16	13	17	19
Sablefish	6	9	3		29	77	77	26	100	66	110	
Grenadier											2	10
Hagfish										8		
Lingcod												40

[a]Figures presented in the table denote the total number of boat trip samples selected for each species. Prior to 1991, a subsample (basket of fish) selected from a market category of a boat trip sample was composed of a fixed number of fish. From 1991 through the present, a subsample has consisted of a fixed weight of fish, with the exception of widow rockfish, for which fixed-weight subsamples have been selected since 1989.

[b]A year with a missing value denotes no biological samples were collected for the given species.

Table 3.10. Number of age structure samples retained at Oregon Department of Fish and Wildlife (ODFW, Newport office) for (**A**) regulated species, pre-1980 to 1992 and other (**B**) miscellaneous species, various years from pre-1980 to 1985.[a]

A

		Year[d]														
Species[b]	Agency[c]	Pre-80	80	81	82	83	84	85	86	87	88	89	90	91	92	Unk[e]
Pac. oc. perch	ODFW	4,300	600	900	1,600	1,000	800	1,100	1,700	1,150	200	550	400	225		100
Widow	ODFW		400	550	500	1,100	1,410	1,850	2,090	2,870	1,850	50			3,400	
Yellowtail[f]	ODFW	3,240	360	440	1,040	360	700	1,940	440							
Canary	ODFW	1,150	525	125	900	1,485	3,125	2,500	1,750	1,436	330	50	1,110	1,719	1,339	15
	WDFW		700	1,200	750	1,050	900	900		1,400	1,250	3,180	650	50	850	
	NMFS														280	
S. thornyhead	ODFW	105	31	30	29			1						8	1,529	
L. thornyhead	ODFW	75												32	2,147	2,000
Arrowtooth[f]	ODFW	77														
Dover	ODFW					430		400			2,300				4,026	2,380
	WDFW							3,600	1,100	900	500	900	850	800		
English	ODFW	2,400	540	690	950	605	350	405	575	125				2,002	803	
Petrale	ODFW	750	200	1,000	2,175	150		300	915	855	790	600	450	700	741	
Sablefish	ODFW				6	300		100	8							10

Table 3.10. Continued.

B Species	Year	Number of age structure samples
Rougheye rockfish	1985	53
Shortraker rockfish	1975	1
	1982	2
	1983	15
	1984	6
	1985	63
Darkblotched rockfish	1979	63
	1982	95
	Unk	600
Redstripe rockfish	1982	850
Yellowmouth rockfish	1979	34
	Unk	1200
Black rockfish	1992	1,800
Blue rockfish	1992	400
Yelloweye rockfish	1992	13
Rosy rockfish	1992	36
Bocaccio	1992	1
Pacific grenadier	1992	1,300

[a]Figures presented in the table represent the number of age structure samples (specimens) retained at ODFW (Newport office); however, not all samples have been, or are even currently planned to be, examined for age determination. The figures for the number of samples are approximate only. In some cases, the number of samples for a year actually represents a series of years. For example, the 2,300 otolith samples of Dover sole in 1988 includes fish collected in 1986 and 1987. Age structures represent interopercles for English sole and otoliths for all other species.

[b]Species are as follows: Pac. oc. perch is Pacific ocean perch, widow is widow rockfish, yellowtail is yellowtail rockfish, canary is canary rockfish, S. thornyhead is shortspine thornyhead, L. thornyhead is longspine thornyhead, Arrowtooth is arrowtooth flounder, Dover is Dover sole, English is English sole, and Petrale is petrale sole.

[c]Agency denotes the fishery agency that collected and analyzed the age structure samples: WDFW is the Washington Department of Fish and Wildlife and NMFS is the National Marine Fisheries Service (Tiburon Laboratory).

[d]A year with a missing value denotes no age structure samples were collected for the given species.

[e]The acronym Unk denotes the number of age structure samples for which the year of collection was unknown.

[f]Age structure samples from the most recent years are retained at WDFW (Olympia office).

Table 3.11. Biological sampling program in Oregon, 1992.[a]

Species	Sampling rate[b]	Subsample[c]	Priority level[d] Astoria	Newport	Coos Bay
Widow rockfish	2 per 100 mt	2 25-lb baskets	1	1	1
Thornyhead[e]	2 per 100 mt	2 25-lb baskets	1	1	1
Lingcod	2 per month	4 50-1b baskets	1	1	1
Dover sole	1 per 100 mt	2 25-lb baskets	1		1
Yellowtail rockfish	2 per 100 mt	2 50-1b baskets	1	1	2
Canary rockfish	2 per 100 mt	4 50-1b baskets	2	2	2
Pacific grenadier	1 per month	4 50-1b baskets			2
Petrale sole	2 per 100 mt	2 25-lb baskets	3		3
English sole	2 per 100 mt	2 25-lb baskets	3		
Arrowtooth flounder	1 per month	100 fish		3	
Darkblotched rockfish[e]	2 per 100 mt	100 fish		3	
Pacific hake[f]					

[a]In general, for each fish in the sample, the port biologists are instructed to measure and record its length and sex (sometimes the reproductive stage), and to collect physical structures for age determination (fin rays from lingcod, interopercles from English sole, and otloliths from all other species).

[b]Sampling rates denote the number of boat trip samples to select per metric tons of the landed market category or month, depending on the species. Each species was sampled from its own market category, with the exeption of canary rockfish, which were sampled from the "large rockfish" market category, and darkblotched rockfish, which were sampled from the "small rockfish" market category.

[c]Subsamples are denoted as the number of baskets (25 or 50 lb in size) selected from the market category contained within the boat trip sample.

[d]Levels 1 to 3 denote highest to lowest priority. A missing value denotes no sampling is conducted.

[e]Only length information was collected for these species.

[f]The sampling program for Pacific hake is administered by the National Marine Fisheries Service (Alaska Fisheries Science Center). The target sampling rate was to collect at least 750 otolith samples, 250 fish to be sampled from Astoria and 500 fish from Newport. Subsamples consisted of 20 fish (otolith samples) selected from roughly one boat trip sample per week (of the fishing season) at these ports. Additionally, length frequency data (3 50-lb baskets of fish) were collected from approximately one boat trip sample per week at the two ports.

Table 3.12. Species landings (in metric tons) and biological samples (in number and rate) collected in Oregon by port and quarter, (**A**) 1991 and (**B**) 1992.[a]

A 1991

Port / Species[b]	1st Quarter Landings (t)	Samples No.	Samples Rate	2nd Quarter Landings (t)	Samples No.	Samples Rate	3rd Quarter Landings (t)	Samples No.	Samples Rate	4th Quarter Landings (t)	Samples No.	Samples Rate	Total Landings (t)	Samples No.	Samples Rate
Astoria-Garibaldi /															
Widow rockfish	495	14	2.8	306	16	5.2	558	18	3.2	72	3	4.2	1,430	51	3.6
Yellowtail rockfish	351	6	1.7	447	5	1.1	334	3	0.9	176	2	1.1	1,308	16	1.2
Canary rockfish	50	1	2.0	184	5	2.7	142	2	1.4	96	2	1.0	473	9	1.9
L. thornyhead[c]	130	3	5.4	149	0	1.3	137	1	1.5	232	1	0.9	648	5	2.0
S. thornyhead		4			2			1			1			8	
Pac. ocean perch	149	2	1.3	170	2	1.2	205	4	2.0	121	0	0	644	8	1.2
Dover sole	1,254	14	1.1	1,170	13	1.1	842	14	1.7	698	7	1.0	3,963	48	1.2
English sole	66	1	1.5	126	5	4.0	204	5	2.4	99	3	3.0	495	14	2.8
Petrale sole	207	5	2.4	45	1	2.2	45	3	6.7	90	0	0	387	9	2.3
Arrowtooth	208	2	1.0	763	5	0.7	693	3	0.4	200	1	0.5	1,864	11	0.6
Sablefish	195	5	2.6	510	3	0.6	199	2	1.0	204	1	0.5	1,109	11	1.0
Newport /															
Widow rockfish	733	29	4.0	306	17	5.6	552	13	2.4	54	2	3.7	1,645	61	3.7
Yellowtail rockfish	128	1	0.8	125	2	1.6	104	3	2.9	62	0	0	419	6	1.4
Canary rockfish	31	0	0	194	4	2.1	225	1	0.4	134	1	0.7	583	6	1.0
L. thornyhead[c]	217	0	0	250	0	2.0	252	0	2.4	285	0	0	1,004	0	1.1
S. thornyhead		0			5			6			0			11	
Sablefish	118	0	0	495	21	4.2	165	0	0	145	0	0	923	21	2.3
Coos Bay-Brookings /															
Widow rockfish	365	15	4.1	114	8	7.0	263	9	3.4	44	1	2.3	787	33	4.2
Yellowtail rockfish	98	6	6.2	88	7	7.9	70	4	5.7	52	0	0	308	17	5.5
Canary rockfish	88	1	1.1	322	1	0.3	254	1	0.4	179	3	1.7	843	6	0.7
L. thornyhead[c]	456	2	1.3	268	9	7.1	426	6	2.8	683	3	0.9	1,833	20	2.3
S. thornyhead		4			10			6			3			23	
Dover sole	1,216	12	1.0	879	14	1.6	673	10	1.5	824	4	0.5	3,592	40	1.1
Petrale sole	216	5	2.3	29	2	6.9	18	0	0	135	1	0.7	399	8	2.0
Sablefish	315	8	2.5	873	13	1.5	258	6	2.3	336	4	1.2	1,781	31	1.7

Table 3.12. Continued.

B 1992

Port / Species[b]	1st Quarter Landings (t)	Samples No.	Rate	2nd Quarter Landings (t)	Samples No.	Rate	3rd Quarter Landings (t)	Samples No.	Rate	4th Quarter Landings (t)	Samples No.	Rate	Total Landings (t)	Samples No.	Rate
Astoria-Garibaldi /															
Widow rockfish	586.7	10	1.7	340.3	12	3.5	744.7	14	1.9	378.6	5	1.3	2,050.3	41	2.0
Yellowtail rockfish	414.1	6	1.4	488.6	6	1.2	414.2	4	1.0	204.6	8	3.9	1,521.5	24	1.6
Canary rockfish	74.1	1	1.3	342.4	8	2.3	139.4	0	0	48.4	2	4.1	604.3	11	1.8
L. thornyhead[c]	218.7	2	1.8	308.9	2	1.6	468.9	2	0.9	181.3	2	2.2	1,177.8	8	1.4
S. thornyhead		2			3			2			2			9	
Dover sole	837.5	14	1.7	834.6	12	1.4	370.8	14	3.8	417.1	11	2.6	2,460.0	51	2.1
English sole	76.2	3	3.9	72.5	4	5.5	139.4	3	2.2	44.0	1	2.3	332.1	11	3.3
Petrale sole	149.5	3	2.0	27.3	1	3.7	40.5	3	7.4	86.6	2	2.3	303.9	9	3.0
Arrowtooth	216.2	3	1.4	797.6	3	0.4	727.8	4	0.5	95.8	3	3.1	1,837.4	13	0.7
Lingcod	40.5	2	4.9	115.2	2	1.7	162.7	3	1.8	26.5	3	11.3	344.9	10	2.9
Newport /															
Widow rockfish	759.1	26	3.4	396.9	12	3.0	357.2	11	3.1	271.4	6	2.2	1,784.6	55	3.1
Yellowtail rockfish	797.0	11	1.4	380.8	12	3.2	225.2	7	3.1	95.1	0	0	1,498.1	30	2.0
Canary rockfish	191.2	2	1.0	170.2	4	2.4	231.6	2	0.9	104.4	1	1.0	697.4	9	1.3
L. thornyhead[c]	317.9	1	0.6	252.1	3	2.4	357.1	1	0.6	141.7	0	0	1,068.8	5	0.9
S. thornyhead		1			3			1			0			5	
Dover sole	186.2	1	0.5	234.4	0	0	348.8	0	0	184.9	0	0	954.3	1	0.1
Lingcod	29.6	3	10.1	45.3	8	17.7	36.5	2	5.5	21.3	4	18.8	132.7	17	12.8
Coos Bay-Brookings /															
Widow rockfish	440.9	8	1.8	341.3	8	2.3	279.4	7	2.5	95.6	5	5.2	1,157.2	28	2.4
Yellowtail rockfish	254.6	6	2.4	189.8	4	2.1	211.2	4	1.9	74.1	1	1.3	729.7	15	2.1
Canary rockfish	80.2	2	2.5	169.0	4	2.4	202.6	6	3.0	43.3	1	2.3	495.1	13	2.6
L. thornyhead[c]	823.5	10	2.4	525.0	11	4.2	415.7	10	5.5	269.9	3	4.1	2,034.1	34	3.7
S. thornyhead		10			11			13			8			42	
Dover sole	905.2	11	1.2	555.1	9	1.6	566.8	9	1.6	628.5	6	1.0	2,655.6	35	1.3
Petrale sole	121.4	4	3.3	18.0	2	11.1	22.8	1	4.4	175.5	3	1.7	337.7	10	3.0
Lingcod	39.5	2	5.1	55.9	2	3.6	68.7	7	10.1	31.0	1	3.2	195.1	12	6.2

[a]Each species was sampled from its own market category, with the exeption of canary rockfish, which were sampled from the "large rockfish" market category, and darkblotched rockfish, which were sampled from the "small rockfish" market category. The number of samples (No.) denotes the number of boat trip samples for each market category. The rate denotes the number of boat trip samples collected per 100 metric tons of the species landings.

[b]Species abbreviations are as follows: L. thornyhead is longspine thornyhead, S. thornyhead is shortspine thornyhead, Arrowtooth is arrowtooth flounder, and Pac. ocean perch is Pacific ocean perch.

[c]The landings (t) include both longspine and shortspine thornyhead.

CHAPTER 4

GROUNDFISH DATA COLLECTION IN CALIFORNIA

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4.1 Introduction

California has a long history of commercial fishing, dating back to at least the 1860s. Groundfish became an important component of the commercial fishery soon after the first dragnet was towed along the bottom of San Francisco Bay by two lateen sail boats (paranzella trawl) in 1876. From that time to the present, groundfish have provided an abundant and consistent supply of fish to the California fishing industry. Groundfish landings in California averaged around 10 million lb annually from the mid-1920s through the 1940s. From 1980 to 1992, annual landings averaged nearly 90 million lb.

4.1.1 Geographical Overview

Major ports

From 1991 to 1992, 11 California ports (Fig. 4.1) received annual landings of groundfish that exceeded 1 million lb (Fig. 4.2, A and B). The percentage of the total groundfish catch for each of the major ports in 1992 was as follows: Crescent City (22%), Eureka (21%), Fort Bragg (9%), Morro Bay (9%), Bodega Bay (9%), San Francisco (8%), Princeton (5%), Moss Landing (5%), Avila (4%), Santa Barbara (2%), and Monterey (2%) (Fig. 4.2B). Twenty-six minor ports accounted for a total of 4% of the groundfish landings in 1992.

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Major fishing grounds

Fishing for groundfish occurs almost continuously along the California coast from the Oregon border to the Mexico border; however, most groundfish are landed from Morro Bay northward. Trawl-caught groundfish accounted for roughly 77% of the total landings annually from 1991 to 1992 (Fig. 4.3, A and B). Line gear produced the next largest component (about 14%) during this time period, while set-net and trap landings were 5% and 1%, respectively.

In general, trawl gear is not used south of Point Conception; instead, groundfish are predominantly caught using line gear. North of Point Conception, trawl vessels fish at depths of 20-500 fathoms. The use of set nets is prohibited north of Point Reyes, and due to concerns for marine mammals and birds, these vessels are restricted from fishing in many nearshore areas south of Point Reyes. Traps and hook-and-line gear are used from the Oregon border to the Mexico border to catch rockfish and sablefish.

Principal species landed

In the Eureka INPFC (International North Pacific Fisheries Commission) area, the three major groundfish species landed in 1992 were Pacific hake (34%), Dover sole (22%), and thornyhead (15%) (Table 4.1). In the Monterey INPFC area, the three major species landed in 1992 were Dover sole (26%), sablefish (11%), and chilipepper (11%). In the Conception INPFC area, the three major species landed in 1992 were Dover sole (28%), unspecified rockfish (22%), and thornyhead (16%).

Port biologist locations

The marine management functions of the California Department of Fish and Game (CDFG) are accomplished at the local level through Marine Resources Division management units, with personnel stationed at various locations (Fig. 4.4). Each unit encompasses one or two counties and is staffed by one unit manager (associate biologist) and one or two assistant unit managers (biologists). Marine management units are located in Eureka, Fort Bragg, Bodega Bay, Menlo Park, Monterey, Morro Bay, Santa Barbara, Long Beach, and San Diego. The Groundfish Coordination Unit (GCU), located in Menlo Park, serves as a clearing house and repository for groundfish data.

In 1992 the Pacific States Marine Fisheries Commission (PSMFC) administered Pacific Fisheries Information Network (PacFIN) funds to support seven full-time and one part-time fisheries technicians to assist with port sampling duties, and a data technician and an associate programmer analyst to assist with data processing. Currently, the majority of California groundfish sampling activity is performed by PSMFC fisheries technicians. Supplemental sampling is performed by CDFG biologists and scientific aides.

Fisheries technicians ("port samplers") are assigned to major ports or port complexes (Table 4.2); however, some ports are never sampled, including several in the San Francisco Bay area. In 1992 there were no groundfish samples taken in southern California. Almost all samples are collected at processing plants adjacent to the docks where fish are unloaded.

4.1.2 History of Data Collection Systems

In California, systematic groundfish sampling began during the early 1960s. The focus during those years was primarily species of flatfish (Dover, English, and petrale sole), which together represented the major component of the groundfish landings. Additionally, a short-term study was conducted at several ports from 1962 to 1963 to determine the species compositions of the rockfish landings (Nitsos 1965).

Comprehensive sampling of rockfish landings did not begin until 1977, when the Cooperative Rockfish Survey was established. The survey is a fisheries monitoring program operated jointly by the CDFG and the National Marine Fisheries Service (NMFS). This cooperative sampling arrangement has remained virtually unchanged since its inception nearly two decades ago. However, major restructuring of the program occurred in 1992 in an effort to strengthen the collaborative role of the two agencies and to improve sampling statistics and program documentation.

The CDFG Landing Receipt System, which was the mandated system for recording commercial landings (see section 4.2), was started in 1917 and by 1930, "punch cards" and IBM tabulating machines were used to summarize the data. The current system uses a DEC/Alpha server located in Sacramento, with data entry performed by the Marine Fisheries Statistical Unit (MFSU) in Long Beach.

The trawl logbook, which is the mandated system for recording the catch locations, date, and amount of commercial catches, is the oldest CDFG logbook system. Trawl logbooks were introduced in 1933, as part of the official statistical system of the CDFG. At that time, the trawl logbook and landing receipt were combined on one form. This worked satisfactorily because wholesale houses owned the boats and gear and operated the fleet with paid crews. During the 1930s the dominant fishing method was sail-powered pair-trawlers towing paranzella nets. By 1944 the dominant fishing method was otter-board trawls towed by a single diesel-powered vessel, not necessarily owned by the company receiving the fish. This prompted the CDFG to design a new logbook, independent of the Landing Receipt System, to meet the needs of the developing fishery.

Through 1975 the logbook data were verified and edited by biologists, collated with corresponding landing receipts, and then forwarded monthly to the MFSU. The data were keypunched and summary reports were generated annually by April or May of the following year. With the need for greater resolution of catch by area data, the use of a computer system became necessary. A program developed in cooperation with NORFISH, a University of Washington

Sea Grant program, was used to process the 1976-77 logbook data. In 1976, the enactment of the Magnuson Fishery Conservation and Management Act resulted in the formation of the Pacific Fishery Management Council (PFMC), and the formulation of the Pacific Coast Groundfish Fishery Management Plan (FMP). A provision of the FMP was to develop a uniform, coastwide trawl logbook. The PFMC provided a contract to the CDFG to develop a computer system that addressed the new logbook format (Goodrich 1988). This system has been used to process logbook data from 1978 to the present.

Documentation

This chapter represents an overview of the California groundfish sample collection and data processing systems. Other documents provide important additional information on subsets of the system and a historical perspective. The California Department of Fish and Game Operations Manual, sections 4370 through 4372, contains information on the authority for development of groundfish management, establishes and defines the position of the groundfish coordinator (Menlo Park), and reviews data collection procedures.

Documentation of sampling protocols are given in the California Cooperative Commercial Groundfish Survey Sampling Manual (GCU 1995) for the collection of rockfish and other biological samples. Sen (1984, 1986) provided an overview and statistical evaluation of the Cooperative Rockfish Survey as it existed in the early 1980s. Nitsos (1965) provided information on a sampling method that was used during the early 1960s.

The existing Landing Receipt System and a proposed, but unimplemented revision are detailed by Ernst and Young (1989) as part of their feasibility study report for improving the Marine Fisheries Statistical System. This report contains detailed information of the actual programs used in processing the data. The methods used to collect and compile the fishery-related data associated with the Marine Fisheries Statistical System for the years from 1936 to 1952 are presented in Conner et al. (1952).

4.1.3 Legal Authority to Collect Data

Obligations of fishers

California Fish and Game Code statute sections 8010, 8016, 8043, 8046, and 8047 grant authority to CDFG personnel to collect commercial fish landing information and requires fish receivers to maintain copies of landing receipts for four years. California Fish and Game Commission Division 1 (Title 14), and California Code of Regulations sections 176 (trawl fishing activity records), 174f (permit to use gill nets or trammel nets for commercial purposes), 180f (traps), and 120 (prawn and shrimp trawling) grant authority to CDFG staff to collect logbooks. Information collected by the CDFG is generally governed by the California Fish and Game Code section 8043 and the Information Practices Act as stated in the California Civil Code section 1798 et seq.

Noncompliance

Failure to comply with the above listed statutes results in the following penalties as listed in section 12002 (Punishment) of the California Fish and Game Code. "Unless otherwise provided, the punishment for a violation of this code, which is a misdemeanor, is a fine of not more than one thousand dollars ($1,000), imprisonment in the county jail for not more than six months, or both the fine and imprisonment."

4.2 Fish Ticket/Landing Receipt System

In California, official landing receipts (fish tickets) must be completed for all fish or shellfish purchased or received by commercial fish dealers (persons licensed as a fish receiver or multi-function fish business). Landing receipts are required for the following transactions: 1) upon receipt or purchase of fish from a commercial fisher not licensed as a fish receiver, and 2) upon receipt or purchase of fish from a commercial fisher licensed as a fish receiver, when the commercial fisher has not previously made out a landing receipt or if an original receipt has been voided. The principal purpose for requiring the landing information is to "gather and prepare data of the commercial fisheries, showing particularly the extent of the fisheries and the extent to which the various species abound" (California Fish and Game Code statute section 8010).

There are currently 14 types of landing receipts, of which 12 include categories for groundfish transactions. Examples of landing receipts with groundfish categories are presented in Figures A-3 and A-4. The fish dealer determines which landing receipt is used based on the fishing gear used and the market categories that compose the landing. The fish dealer is legally obligated to include the date, market category, landing weight, price, port, gear, area fished, vessel registration number and name, dealer number and name, and fisher license number and name on each landing receipt.

Reports that include information regarding catch by area fished from landing receipt data are usually based on the port where the fish were landed. There is a field on the landing receipt that specifies area caught (e.g., PSMFC area); however, in the past the accuracy of this information has been questioned. In recent years, editing at the MFSU has resulted in more accurate recording of area fished information.

California levies a tax on the value of fish landings, but the Landing Receipt System is not used directly for assessing the tax. Instead, taxation is based on monthly processor reports that are the responsibility of the Compliance and External Audits Branch (CEAB), which ensures that commercial fish businesses are remitting appropriate taxes to CDFG. Tax reports and landing receipt data are compared only during audits.

4.2.1 Market Categories

The market categories listed on the landing receipts (e.g., Figs. A-3 and A-4) represent individual species or groups of species. Market categories are defined by different sizes of fish, price, or mandated by federal/state regulations. There are currently 94 groundfish market categories officially recognized by CDFG, including 47 nominally single species rockfish market categories and 10 multi-species rockfish market categories.

The CDFG Technical Services Branch (TSB) in Sacramento is responsible for the assignment of three-digit market category codes. If a unit biologist, a marine supervisor, or the groundfish coordinator determines that a market category needs to be added or deleted, they must send a formal written request to TSB.

4.2.2 Processing System

Landing receipts are issued to the fish dealers by CDFG. Dealers are legally obligated to mail completed landing receipts to CDFG on or before the first and the 16th of each month, depending on the date of the landing transaction. The Department provides stamped and addressed envelopes for mailing landing receipts. All landing receipts were modified in 1993 to accommodate Optical Character Reader (OCR) technology that allows automated entry of landing receipt information. A flowchart that describes the overall processing system for landing receipts is presented in Figure 4.5.

Currently, all CDFG marine units edit landing receipts and then forward them to the MFSU in Long Beach. About 75% of the landing receipts have errors, with missing vessel registration numbers and invalid market category names being the most common. Other errors include missing or incorrect block (catch area), prices, gear codes, and dealer numbers. Because the unit biologists are generally familiar with vessels and their landings, they are able to identify and correct many of these errors.

At the MFSU, the landing receipts are processed using the OCR scanning technology. Considerable editing occurs at the OCR edit stations, including validation for missing fields, reference checks against lists of dealers, fishers, and vessel registration numbers and names. Additionally, a program checks to ensure catch weights and prices are within a specified range of values. Files created in the OCR process are stored and transmitted nightly via telephone links to the Alpha server in Sacramento. An extensive data validation process on the Alpha server is used to detect missing or invalid fields, including those not checked in the OCR process. A transaction report is created for updates and corrections. Corrections are processed manually using personal computer work stations.

A preliminary report of the catch by month and port for a calendar year is issued about six months after the end of the year. A final report (referred to as the Bulletin Tables) is printed and bound as a public document for release in October or November. The value of the catch is also included in the final report. If there are less than three dealers who buy fish in a given port, then the landings are reported within a larger port group to ensure confidentiality. The 1992 Bulletin Tables were the 52nd in a series that was first published in 1929 (CDFG 1992).

4.2.3 Groundfish Landings Not Covered by the Landing Receipt System

Some landings of groundfish in California are not accounted for in the current Landing Receipt System. Groundfish caught by the recreational fishery are not included in any CDFG data system at this time. Estimates of recreational catches are given in Marine Recreational Fishery Statistics Surveys prepared by the NMFS (e.g., USDOC 1992). The sampling procedures and estimation methods used to generate landing statistics for the marine recreational fishery in California are currently under re-evaluation. Estimates of recreational groundfish landings in 1989 were approximately 6,045 t, which was roughly 17% of the commercial groundfish catch for that year.

Numbers of groundfish caught by Commercial Passenger Fishing Vessels (CPFV) are recorded on logbooks and entered into a separate CPFV system. The CPFV system is maintained independently and is not cross-referenced with the commercial fishery Landing Receipt System.

Transportation receipts are used by fishers when the catch is landed and moved to another site before being sold to a fish dealer. Transportation receipts are not currently entered into the data system, but are maintained in a permanent file system by the MFSU. Sometimes dealers fail to fill out a landing receipt when a transportation receipt has been filled out. These unrecorded landings are most likely minor relative to the total commercial landings represented by landing receipts; however, in some ports they can be significant. For example, in the San Francisco area unreported hook-and-line landings could be as high as 30% of the total reported commercial landings.

4.3 Logbook System

For the trawl fishery, CDFG uses the standardized Washington-Oregon-California Trawl Logbook. Trawl and CPFV logbooks are the only logbooks that are keypunched by the MFSU and included in the marine fisheries system on the Alpha server in Sacramento.

4.3.1 Groundfish Trawl

Collection

Typically, trawl logs are collected by the port samplers once a month or the vessel operators mail the logs to the nearest CDFG marine management unit. Vessel operators are required by law to file their logs for the preceding month by the 10th of every month.

Data entry and error checking

A flowchart that describes the overall processing system for logbooks is presented in Figure 4.5. Trawl vessel operators are legally required to complete a log for each trip. Logs are first edited by port samplers or unit biologists to assign each tow to a single 10 square-mile geographic "block" as defined by the CDFG block system that was established in 1933. The charting of the coastal waters of the state into fishing area blocks was completed concurrently with the designing of the first trawl logbook (Clark 1935). Assignment to a block is based on the Loran coordinates and depth at which a tow was made. Only the block data are keypunched; Loran coordinates and latitude and longitude are not currently captured.

After editing is complete, logbooks are accumulated by the GCU in Menlo Park, then mailed to the MFSU in Long Beach for data entry. Logbook data are keypunched twice in Long Beach and compared for verification. As of June 1995, annual processing of logbook data has been completed for 1978-92.

After all logbooks for one year have been keypunched and compared, final error checking is conducted using a program within the trawl logbook system. This program identifies fatal errors, such as invalid or missing trip return dates, block numbers, or vessel registration numbers, then generates an error report that is subsequently sent to the GCU for review. A manual search through the trawl logs is made to locate the source of the errors and to correct them. These corrections are sent back to the TSB, where they are keypunched into the existing database.

After the logbook database has received its final corrections, the TSB in Sacramento submits the data to an annual processing routine that matches logs with landing receipts. The market categories that have been matched successfully are then converted to one of 27 trawl market categories in the logbook database.

The logs and trawl landing receipts are matched by vessel registration number and trip return date. Because landing receipts are sometimes completed after the date of the landing, unmatched logs and unmatched tickets are reprocessed by subtracting one day from the landing receipt date and rerunning the matching process. After five processing cycles, all unmatched logs are deleted from the system and unmatched landing receipts are converted to "dummy" logs for compliance tracking and effort estimations. In addition, fishing trip summary records are created to be used primarily in a hail adjustment program.

For a given fishing trip, discrepancies between the logbook data and the associated landing receipt are addressed using a hail adjustment program that prorates the poundage from the receipt among the individual tows from the log. If the market category pounds listed on the landing receipt are greater than those on the corresponding trip summary record, the surplus pounds are distributed among trawl tows where that market category occurs. If market category pounds on the landing receipt are less than those on the trip summary record, the missing pounds are subtracted from trawl tows where that market category occurs. Market category landings found on a receipt but not in a logbook are distributed equally among trawl tows for that fishing trip. Species found in the logbooks but not present on the landing receipt are deleted.

The final logbook data file consists of adjusted logbook records (record "type 1") and dummy logbook records (record "type 2"). Reports are created by month, INPFC area, and block number. The logbook data file is downloaded to a Bernoulli cartridge and sent to the GCU for distribution. The block data from the trawl logbook database have never been merged with the landing receipt database to determine specific areas where catches were made. At this time, California does not analyze fishing effort based on the trawl logbook data.

Logbook coverage of the groundfish trawl fishery by port and quarter in 1992 is presented in Table 4.3. In general, the major ports, which are associated with relatively large amounts of landed groundfish (e.g., Crescent City and Eureka), were characterized by high logbook return rates, where at least 80% of the landing receipts had a corresponding log. The minor ports (e.g., San Pedro and Long Beach) were characterized by considerably lower logbook return rates than the major ports, where usually less than 10% of the landing receipts had a corresponding log. Approximately 70% of all trawl landing receipts processed in California in 1992 also had corresponding trawl logs.

4.3.2 Other Gears

Other CDFG groundfish logbooks include gill net, daily trap, daily sablefish trap, and Commercial Passenger Fishing Vessels (CPFV). In most cases, only limited information from these logbooks is entered into computers and can be retrieved electronically. Sablefish logbooks are forwarded to and edited by the GCU. The CPFV logbooks are mailed to Long Beach and are entered as CPFV landings. Although the need for a hook-and-line logbook has been recognized in recent years, current financial constraints have prevented its implementation.

Two other logbooks contain groundfish information. There is a shrimp logbook that includes a field for the amount of groundfish caught by the vessel; however, no formal analyses have been conducted to determine the extent to which this field is used. Regardless, data from these logbooks are not entered into the mainframe computer system, and thus, cannot be merged with either the trawl logbook information or the landing receipts. There is also a salmon logbook that includes a field for the vessel's rockfish bycatch; completion of this logbook is currently voluntary.

Future plans for processing commercial fishery data include an automated method for tracking logbook information and the use of OCR equipment for scanning logbooks. Data captured from each type of logbook may vary to some extent; however, common data can be standardized and criteria for matching these data with the landing receipts can be more clearly defined than the current evaluation methods. Plans to modify the processing system for logbooks have been developed to provide CDFG biologists with more detailed information than is currently available to assess the impact of commercial fishing on various fisheries.

4.4 Species-Composition Sampling

California's commercial groundfish sampling program, which includes species-composition sampling as well as biological sampling, is coordinated at the state level by the groundfish coordinator in Menlo Park and at the local level by marine unit biologists. Port samplers, stationed at various ports (Fig. 4.4), sample only rockfish market categories to determine the species compositions of the landed catch. Historically, most rockfish landings were caught using trawl gear in northern California (Morro Bay and north). Thus, the sampling program was largely designed to cover that gear and area. Only limited sampling has been conducted for the line (hook-and-line and longline) and set-net (set gill and trammel nets) fisheries throughout the state.

When the current sampling program began in 1977, the goal was to obtain samples from every market category contained within a sampled boat trip (Tomlinson 1977). However, this sample selection procedure proved to be impractical, given the logistical and time constraints associated with collecting information at the fish processing locales (sample sites). Sen (1984, 1986) demonstrated that species and age compositions could be estimated by treating the market categories separately and then summing the estimates over the market categories. The current sampling program does not require all of the market categories within a given boat trip to be sampled, and thus, there are generally no estimates produced that address the statistical properties of the individual boat trips.

The species-composition sampling program used in Oregon is also largely based on the design proposed by Sen (1984, 1986) and the following discussion is generally similar to the analogous section presented in the Oregon chapter (section 3.4). However, differences do exist between the two sampling approaches, dictated primarily by the unique fishery operations in each state; therefore, the sections are presented independently of one another.

California's species-composition sampling is based on a stratified, two-stage random sampling design. Port complex and quarter combinations are treated as strata, and boat trips within a stratum represent the first-stage sampling units. The boat trip landings are poststratified into market categories. Typically, two "clusters" (baskets of fish) of a fixed weight are subsampled within each market category at the second stage of sampling.

The current species-composition sampling program for rockfish is designed around the market category as the "domain of study" (Cochran 1977). Thus, the primary goal of the sampling design is to obtain reasonable estimates of the species compositions of the important market categories for a given port complex and quarter stratum. A port complex is a grouping of ports sampled by a CDFG unit, where each CDFG marine unit is responsible for sampling the major port for the area and other nearby minor ports.

There are 57 rockfish market categories that are currently defined, and each of these categories could potentially be landed by each gear type (trawl, line, set net, etc.). There are 47 nominal rockfish species market categories and 10 combined species market categories. Not all of the possible combinations of market category and gear type are routinely sampled; a number have never been sampled, and some have never been used.

Landings in 1992 for southern and northern California by gear type and market category show that relatively few market categories contributed to the total landings for each of the major types of gear (Table 4.4). For example, for northern California ports, approximately 73% (in weight) of the rockfish caught with trawl gears was landed within the thornyhead and unspecified rockfish market categories. Another roughly 18% of the rockfish catch taken by trawl gears and landed at northern California ports was associated with three other categories, namely the widow rockfish, chilipepper, and bocaccio market categories. The line fishery was also sampled fairly intensively in 1992. The line fishery of northern California used the most (28) market categories for landing rockfish catches. In 1992, no sampling for purposes of species-composition evaluations was conducted at southern California ports or for fisheries in northern California that employed gears other than trawls, set nets, or lines.

In annual analyses and reports, the minor market categories (i.e., categories that receive relatively few rockfish landings and usually no sampling) are typically combined with major market categories that have been sampled. Through 1992, the target sampling rates were set at four samples per major market category per month, but this goal was rarely met. Sampling effort is currently determined by a priority scheme that distributes the total time allocated to sampling among the major rockfish market categories for the trawl, set-net, and line fisheries (see section 4.4.2 for an example of a priority list). This sample allocation scheme is applied to each of the port complexes. The Pacific hake, Dover sole, lingcod, and sablefish fisheries are also subjected to a sampling schedule that is based on a priority list.

Among the rockfish, no market category is assumed to be completely "pure" (composed entirely of a single species). However, several market categories are assumed to consist largely of a single or small number of species, and for this reason they are analyzed somewhat differently than the other, "less pure" categories. For example, the widow rockfish market category is generally thought to be nearly pure. The thornyhead market category is thought to consist almost solely of the two species of thornyhead, longspine and shortspine thornyhead. The longspine and shortspine thornyhead market categories were added to the CDFG market category list in 1994. In January 1995, these two market categories were required to be landed as pure categories. In January 1991, bocaccio were required to be landed as a pure market category. When samples are available for individual market categories, including the pure categories, final landing estimates are based on the estimates of species composition determined from the samples and not on an assumption that the landings are pure.

4.4.1 Sampling Protocol

To estimate the species compositions of the landings, a number of boat trip samples are selected for each market category (domain of study). Port samplers choose particular trips to sample based on their own judgement, including the vessel's arrival time, information received from a dealer, or scheduling conflicts. Difficulties associated with obtaining strictly "random" samples from commercial fisheries are addressed in section 3.4.1.

Except in special circumstances described below, samples consist of clusters taken from a given market category contained within a boat trip. Clusters are subsamples (baskets of fish) that are a fixed weight, rather than a fixed number of fish. Generally two clusters are taken per sample, although occasionally samples consist of one or, more rarely, three clusters. Clusters are usually 50 ± 5 lb in size, but 25 ± 2 lb clusters are selected for some market categories that contain small fish, such as the thornyhead market category. In most cases, all of the clusters selected from a given market category have the same target size. However, samples from the nearshore hook-and-line fishery often consist of relatively small clusters (less than 25 lb in size), because total landing weights are frequently less than twice the target cluster size.

Clusters can be taken from the fillet tables, bins, or directly from boxes as they are unloaded from the vessel. The actual sampling site depends largely on where the fish are located in the landing or processing stage when the sample is taken. In general, two clusters are taken from different portions of the market category catch, in order to obtain a more representative description of the species composition. For example, if some of the landings were in a bin, and another portion was on a fillet table, one cluster would be selected from each area. If the entire catch was unloaded into a single bin, generally one cluster would be taken from the center of the bin and another selected from a corner. If more than one bin were available, then the two clusters generally would be taken from different bins.

In some cases, certain fish are selected from a landed market category and placed into groups differing in composition ("subsorts") before a sample can be obtained. Generally subsorts are based on a single species or a certain size range of a single species. In these cases, the sampler is expected to collect a sample from each subsort of the market category. When a market category consists of subsorts, time constraints often preclude a sampler from obtaining more than a single cluster per subsort.

All fish in each cluster are counted and identified to the species level. A combined weight is obtained for each species (all individuals pooled) within a cluster. When possible, the sex and length are recorded for every fish in each cluster.

A port sampling manual is available that describes in detail the selection procedures used by samplers to obtain species-composition samples from rockfish landings in California (GCU 1995). Newly employed samplers receive on-the-job training from experienced port samplers and unit biologists. Currently, all port samplers record information on standardized data sheets; however, historically, this was not the case. In prior years, the sampling data sheets were not uniform coastwide and some samplers used otolith storage (coin) envelopes to record information, while others used data sheets that were unique to their individual ports. Sampling is usually conducted during daylight hours on weekdays (Monday through Friday); however, sampling occasionally takes place at night and on weekend days.

4.4.2 A Hypothetical Example

In 1993, a new sample allocation plan was implemented that redefined the sampling tasks of the port samplers. The plan encompassed the species-composition sampling program for rockfish, as well as the sablefish, Dover sole, and lingcod sampling programs. Prior to 1993, these four programs had sampling goals that were independently established, and, in effect, competed with one another for a sampler's time. This proved to be a generally unsuccessful sampling approach because one or more of the programs usually received inadequate sampling attention. The goals of the new plan were to: 1) effectively apportion sampling effort among the sablefish, Dover sole, and lingcod programs, and among market categories for rockfish, and 2) ensure that the sampling effort within each of the programs was distributed over an extended period of time so that sample information would be available throughout the fishing season.

The new plan established sampling itineraries based on a "priority list." That is, a port sampler is required to first collect samples at the top of the list (high priority), completing each sampling task before proceeding to other tasks at the bottom of the list (low priority). At the beginning of a new quarter, the port sampler starts from the beginning of the priority list again. Currently, the priority lists reflect the specific characteristics of the individual port complexes. The priority lists are constructed once a year at the Annual Cooperative Survey Meeting. The sampling goals are determined by analyzing the landings and sampling effort of the previous year, and evaluating how well the sampler met the goals outlined in the priority list of the previous year. The priority lists also reflect any current directives established by the Groundfish Management Team (GMT) to meet the needs of future stock assessments, NMFS statisticians and biologists, the groundfish coordinator, and other GCU staff. The GCU has the final decision and responsibility for informing the port samplers of the new priority list.

The variability in fishery operations between ports plays a significant role in what samples are taken and how the priority list is used. The following priority list illustrates the approach used in California to select commercial fishery samples. This list, in descending order of importance, is applicable to a port complex and quarter (samples denote individual boat trips). Age structures (fin rays from lingcod and otoliths from other species) are generally collected from selected species for up to three cycles through the list during a quarter.

1. Trawl: unspecified rockfish market category - 3 samples.
2. Trawl: widow rockfish market category - 1 sample.
3. Trawl: bocaccio market category - 1 sample.
4. Trawl: red rockfish (group) market category - 1 sample.
5. Trawl: sablefish market category - 1 sample.
6. Trawl: Dover sole market category - 1 sample.
7. Trawl: lingcod market category - 1 sample.

8. Trawl: chilipepper market category - 1 sample.
9. Trawl: thornyhead market category - 1 sample.
10. Line: unspecified rockfish market category - 2 samples.
11. Set net: unspecified rockfish market category - 2 samples.
12. Line: gopher rockfish (group) market category - 1 sample.
13. Set net: small rockfish (group) market category - 1 sample.

The following example demonstrates how a port sampler might use the priority list to decide which market categories to sample.

A trawl boat arrives at a dealer and unloads the following market categories: unspecified rockfish, bocaccio, lingcod, and chilipepper. Following the priority list presented above, the sampler first obtains a sample from the unspecified rockfish market category. The sampler selects a 50 ± 5 lb cluster from one of the bins that the unspecified rockfish catch has been unloaded into using protocols discussed in section 4.4.1. The sampler then sorts the cluster into individual species and records their aggregate weights. Length, sex, and stage of maturity are recorded for each fish in the subsample (cluster). Otoliths are removed from those species that are included in a biological sampling program for rockfish (see section 4.5). A second cluster is collected from a different bin of unspecified rockfish, if possible, and processed in the same manner as the first cluster. Sample information collected in the field is written on standardized data sheets, or in the case where length frequency boards are used, the data are transcribed to the data sheets from the boards after the sampler has returned to the office.

If time permits, the sampler will next sample the bocaccio market category (number 3 on the priority list). That is, two similar-sized clusters are selected from the bocaccio market category using the same sampling protocols that are discussed above for the unspecified rockfish market category. Because bocaccio is currently included in the biological sampling program, the otoliths from each sampled specimen are collected in addition to the length, sex, and maturity information that is routinely recorded.

Given that the sampler still has adequate time to collect samples, a third market category from this boat trip would be sampled. Lingcod (number 7 on the priority list) are currently included in a federally coordinated sampling program that involves the cooperation of all three Pacific coast states (Washington, Oregon, and California). The federal sampling program for lingcod is discussed further in section 5.2. The sampling program for lingcod is generally similar to the stratified, two-stage designs used in California and Oregon to obtain information regarding the species compositions of rockfish landings. Given that at least 200 lb of lingcod were landed, the sampler selects four 50 ± 5 lb clusters. The sampler is instructed to obtain the four total clusters from as many different bins as possible. The length and sex of each fish in the sampled clusters are recorded and dorsal fin rays from the specimens are collected.

Again, if time permits, the chilipepper market category (number 8 on the priority list) will be sampled; however, fish operations currently used by dealers in some areas do not typically provide a port sampler enough time to sample more than three market categories per boat trip. The chilipepper market category is sampled in the same manner as the unspecified rockfish and bocaccio market categories.

4.4.3 Processing System

Because age-composition data (see section 4.5) and species-composition data are routinely processed together, the discussion presented in this section describes the processing system for both types of information. Species-composition data, including fish length information, are entered directly into personal computers by port samplers at marine units. Prior to 1992, data entry was done using a FORTRAN program that directly stored data in a binary form. From 1992 to 1993, the data entry component of this program was replaced by customized database software that was more "user friendly" than the original program. Beginning in 1994, the entire FORTRAN program was rewritten in QuickBASIC. The format used in the final end-of-year data file has remained constant since 1977 to maintain a consistent file structure for the species-composition data that are collected annually. Every month port samplers send the data files for the current quarter to the GCU. Data sheets are collected by the GCU for permanent storage.

When age data become available, they are appended to these data files. Personnel at the NMFS (Southwest Fisheries Science Center, Tiburon Laboratory) enter all data associated with ageing studies conducted at their laboratory. Age data generated from other studies are entered by personnel from the GCU. Data entry of all length and age information for Dover sole is done by the Dover sole age reader located in Menlo Park.

The analysis procedures for summarizing species- and age-composition information and for generating landing statistics require a master data set. Because age data are entered at two locations, there are often two different data files, one containing ages entered by the NMFS staff and another that was prepared by the GCU personnel. Annually, a routine in the data entry program is used to merge the two data files of age information together. The merged file is referred to as the "master" data set of age information and is stored at Menlo Park and the Tiburon Laboratory. The current processing system for species and age-composition data reflects a design that provides information in a format(s) that can be utilized by a diverse group of fishery researchers and managers.

Error checking of data occurs at many levels. Port samplers are responsible for checking their data entries for accuracy. The current version of the data entry program checks for a number of common errors during the entry process, such as species codes that are not within a valid range, invalid species lengths, invalid market categories, and characters that are entered in fields where numbers are required. Any errors that are identified by the program must be corrected before data entry can continue. In addition, the sample data are extensively checked for missing values and other errors by the GCU. For the species-composition sample data that are sent to PacFIN, there is a BASIC program on the Alpha server that checks for errors, such as blank fields, duplicate records, and invalid species codes.

4.5 Biological Sampling

In general, the biological information collected from California groundfish landings consists of sex, size (length), age, and maturity data. The sampling design used to collect biological data from landings of rockfish and Dover sole is an extension of that used to collect rockfish species-composition samples (see section 4.4). Biological sampling for sablefish, lingcod, and Pacific hake is coordinated through a federal program and is described in chapter 5.

It is important to note that biological sampling requires considerably more time to administer in the field than species-composition sampling, and can result in samples with incomplete information. For example, time- and dealer-imposed constraints often preclude samplers from performing the following tasks for each biological sample: 1) determining the sex and stage of maturity of each fish in the sample; 2) measuring the length of each fish in the sample, and 3) collecting the age structures from each fish in the sample.

4.5.1 Sampling Protocol

Rockfish

Rockfish species-composition sampling includes collecting sex and size (length) information for all species when possible. Maturity and age data are currently collected for bank rockfish, bocaccio, chilipepper, darkblotched rockfish, widow rockfish, and yellowtail rockfish. Only species composition and size data can be collected when fish are to be sold whole and a dealer will not allow them to be mutilated for purposes of extracting otoliths and determining sex and stage of maturity.

Currently, biological sampling rates for rockfish are determined for each market category (i.e., for those species presented above) within individual port complex and quarter combinations. Examples of biological sampling rates are included in the priority list presented in section 4.4.2. The number of age structures that have been collected from targeted species of rockfish in California since 1955 are presented in Table 4.5. Prior to 1993, otoliths were collected whenever a sampler had adequate time to remove the structures while conducting a species-composition sample. However, beginning in 1993, the number of samples in which otoliths were removed from the sampled fish was reduced so that the number of species-composition samples could be increased.

Port samplers clean the otoliths and store them in coin envelopes. Once a month, the otoliths are shipped to the GCU in Menlo Park. A technician sorts the otoliths and sends the yellowtail and widow rockfish samples to the NMFS (Tiburon Laboratory) for age analysis. Otoliths from chilipepper and bocaccio are analyzed by the GCU. After age data have been recorded for the otoliths, the structures are permanently stored at the facility where they were analyzed. No age analysis has been conducted for otolith specimens from bank and darkblotched rockfish, and these age structures are stored at the Tiburon Laboratory. Over the years, the commercial and recreational fishery sampling programs conducted in California have generated a large number of otoliths of various species, many of which have not yet been examined; these otoliths are stored at Menlo Park and at the Tiburon Laboratory.

Prior to 1984, surface ages were recorded from whole otoliths of widow rockfish; however, this method proved to be unreliable for older fish and it was replaced by a break and burn technique that is currently used to prepare otoliths from widow rockfish for ageing. Analysis procedures involve the enumeration of annual marks. Starting in 1992, only partial samples (one cluster per sample) of widow rockfish were processed for purposes of age determination. All otolith samples from widow rockfish have been analyzed through 1994 (Table 4.5).

Otoliths from yellowtail rockfish are also prepared and examined using the break and burn technique. Prior to 1983, surface ages were recorded from whole otoliths of yellowtail rockfish. Ages have been determined for all otolith specimens from yellowtail rockfish through 1994 (Table 4.5).

There is a backlog of otolith specimens from bocaccio and chilipepper to be analyzed due to staffing limitations in recent years. However, an age reader was hired in 1993 to work specifically on these reserves of unexamined otoliths. Ages have been determined for all chilipepper otolith samples through 1990; samples taken since 1985 have been aged using every other fish in a sample. Otoliths from chilipepper sampled after 1982 have been prepared and analyzed using the break and burn method. Prior to 1982, only surface ages were recorded from whole otoliths of chilipepper. Ages have not been determined for bocaccio otolith specimens collected after 1985. All otoliths from bocaccio have been examined whole; however, the validity of the results from some of these analyses has been questioned by fishery researchers, in particular the analysis conducted in 1985 (Bence and Hightower 1990).

Dover sole

Beginning in 1990, the only species of flatfish to be routinely sampled for purposes of age determination was Dover sole. However, since 1955, relatively small numbers of English, petrale, and rex sole have been sampled as part of the biological sampling program in California (Table 4.5). The Dover sole market category is assumed to be pure (composed only of Dover sole) and thus, it is not sampled for purposes of species-composition determination.

Historically, landings of Dover sole were primarily sampled at the ports of Morro Bay, Fort Bragg, and Eureka. These samples of Dover sole provided sufficient biological data for each INPFC area. From 1960 to 1990, biological samples collected from landings of flatfish consisted of 50 randomly selected fish per boat trip sample. Length and sex data were recorded for all 50 fish that were sampled; however, otoliths were removed from only the first 25 fish.

In 1991, CDFG adopted the two-stage sampling design that is based on selecting clusters (subsamples) of a fixed weight, rather than a fixed number of fish. Current samples of Dover sole consist of two 25 ± 2 lb clusters, where length and sex data are recorded and otoliths are collected for all of the fish in each cluster.

Otoliths from Dover sole are analyzed by different age readers based on the INPFC area (i.e., port) where the samples were collected. The break and burn technique is currently used to prepare and analyze otolith specimens from Dover sole. In the past, surface ages were determined from whole otoliths of Dover sole; however, most of these samples have been re-analyzed using the break and burn method. All otolith samples from Dover sole collected within the Eureka INPFC area have been analyzed through 1990 and also for 1994. In the Monterey INPFC area for the years 1984-89 and 1994, the only otolith samples from Dover sole that have been examined are those that were collected at ports within the Fort Bragg complex. Ages have been determined for only those Dover sole collected in 1985 for the Conception INPFC area. Starting in 1993, otolith samples collected from both the Monterey and Conception INPFC areas were assigned to a single age reader in Menlo Park.

4.5.2 Processing System

Procedures used to enter and process biological sample data are presented in section 4.4.3.

4.6 Estimating Derived Quantities

The procedures described below are currently under review and could be changed in upcoming years, and not all of these potential changes in the analytical methods will necessarily be made retroactively. Users of landing estimates should check with their data source for details of the procedures used to generate the specific estimates they have requested.

4.6.1 Landings by Area

Landing estimates are calculated for each port complex and not on an area-fished basis, such as PSMFC areas. Consequently, it is not necessary to use logbook data to apportion landings to fishing areas. It appears reasonable to determine estimates by port complex in California because the vessels are relatively small and tend to range only a short distance from their home ports. In any case, until recently, there was a considerable backlog of keypunching of logbook data, so it was not feasible to use the data to derive current landing estimates.

4.6.2 Annual Estimates

Rockfish

Annual estimates of trawl-gear landings, and age and length compositions, have been routinely generated on a species-by-species basis for northern California (Morro Bay and north). Similar estimates are now generated for set-net and line gear landings, including southern California, in cases when sampling was adequate.

The calculation of the estimates requires the sample-composition data and landing receipt information for each market category landed within each port complex and quarter stratum. In practice, there are often market categories and port complex and quarter strata for which no samples were taken. Thus, the first step in the processing of the data is to reassign landings to other quarters or port complexes, and/or to combine market categories. Ultimately, these procedures generate a reduced set of port complex and quarter strata and possibly market categories, with the necessary data for each.

The method used to combine and reassign the landings depends on the type of market category. Market categories considered to be relatively pure (e.g., widow rockfish, bocaccio, and thornyhead) are generally not combined with other market categories. When possible, the landings for a quarter that were not sampled are assigned to an adjacent quarter that had applicable samples. If no samples were obtained from a port complex during a year, then the landings for the market category are assigned to the nearest port complex for which samples were taken, with the caveat that landings are not reassigned across INPFC area boundaries except when absolutely necessary. When there are two candidate quarters or port complexes for reassignment, the landings are reassigned to the candidate with the most samples.

Some efforts are also made to not combine minor single species market categories with other market categories, under the assumption that these categories would not be recorded unless they were somewhat distinct. For example, if there were samples for these market categories (minor single species market categories, such as vermilion rockfish) in a given port complex but not for every quarter of the year, then the landings from the unsampled quarters would be reassigned to quarters that had been sampled, instead of categories with other rockfish market categories that had been sampled. If reassigning the landings for these market categories to nearby quarters is not possible, then the sample information is sometimes combined with the unspecified rockfish market category for that port complex.

The method currently used to reassign the landings of the mixed species categories of rockfish is also unique. If samples were taken for a given mixed species market category within a port complex and quarter stratum, then the landings for that category and stratum are treated separately; otherwise, the landings are combined with the unspecified rockfish market category for that stratum. In the case that the unspecified rockfish category is not sampled within a given stratum, then these combined landings are reassigned to a quarter that was sampled, and if no quarter was sampled, to the nearest port complex that was sampled. In some prior years, mixed species market categories were combined based on the judgements of the individual port biologists regarding the similarity of the categories at their port.

Annual reports are generated using a list of the sample data files, specific sort groups (market categories that are combined and evaluated as though they were a single category), and the landings that apply to the specified sort groups within each port complex and quarter stratum. For each port complex and quarter analyzed, landing estimates (in number) are determined for individual species by length class and sex, and by age class when age data are available. Total landings (in number and weight) are also estimated for the individual species for each port complex and quarter stratum. In these analyses, lengths are rounded to the nearest centimeter, and unknown information (i.e., missing values) for sex, length, and age is a recognized classification, with estimates being calculated for the number of fish landed in each of these classes. No attempt is made to reassign the unknown sex, length, or age information to other classes, although users of the data frequently need to do this.

The software first calculates estimates for each of the specified sort groups, and then adds these values together and reports the total quantity for all of the sort groups combined; however, the totals are based on only those market categories that were included in a sort group. Reports for individual sort groups are not generated.

For a given port complex i and quarter j, let the estimated quantity be designated as V_{ij}. Calculations of V_{ij} are done separately for specified sort groups and gear combinations, but these subscripts have been dropped for simplicity. The V_{ij} could be estimates of the total number of fish landed of a particular species, the weight landed for that species, the number of 8-year-old females of that species, or any other sex/length or sex/age combination. The quantity V_{ij} is found by first calculating an average quantity per pound of landings and then multiplying this value by the total pounds landed.

The average quantity per pound, $\bar{v}_{ij}$, is calculated as a ratio estimate. Let the quantity observed for a single cluster l on trip k be v_{ijkl} (say the number of yellowtail rockfish observed in an individual cluster). The average quantity per pound on trip k can be estimated as,

$$v_{ijk\cdot} = \frac{\sum_{l} v_{ijkl}}{\sum_{l} w_{ijkl}}, \tag{4.1}$$

where w_{ijkl} is the weight of cluster l selected on trip k in port complex i and quarter j.

The average quantity per pound on trip k ($v_{ijk\cdot}$) multiplied by the total pounds of the sort group on trip k (L_{ijk}) provides an estimate of the total quantity for the trip. Values for L_{ijk} are determined from landing receipt information. The ratio estimator of the average quantity per pound over all trips is then,

$$\bar{v}_{ij} = \frac{\sum_{k} \left(L_{ijk}\, v_{ijk\cdot}\right)}{\sum_{k} L_{ijk}}, \tag{4.2}$$

which is simply the ratio of the sum of the sampled quantities to the sum of the landing weights of the sort group for all of the trips sampled within the port complex and quarter stratum.

The estimate of the total quantity of the species for the specified sort group within port complex i and quarter j can now be calculated as the average quantity per pound over all trips ($\bar{v}_{ij}$) multiplied by the total reported landing weight of the specified sort group within the port complex and quarter stratum (W_{ij}),

$$V_{ij} = \bar{v}_{ij} \, W_{ij} . \tag{4.3}$$

Values for W_{ij} are determined from landing receipt information. Note that the values for W_{ij} are almost always greater than the sum of L_{ijk}, because W_{ij} is the sum of the landing weights of the specified sort group for both sampled and unsampled trips.

No standard reports on variances are generated. Estimates of variances have been occasionally generated following procedures outlined by Sen (1986).

The information on age, size, and sex compositions of the catch comes from the same samples used to estimate species composition. Thus, numbers-at-age or size, by sex, are calculated using essentially the same algorithms that are used to estimate total number or weight landed.

Dover sole

Species-composition analysis is not done on Dover sole because these landings are assumed to be pure. Annual estimates of age and length compositions for Dover sole are determined separately from the estimates for the rockfish species, but the two sets of analyses use basically the same programs. However, the problems associated with rockfish analyses that are due to lack of sample data do not occur for Dover sole analyses, because estimates for Dover sole are generated by INPFC areas and not by port complexes. That is, landings of Dover sole are never reassigned across INPFC area boundaries and sufficient levels of sampling are obtained from each INPFC area. Estimates are generated on a request-only basis and for the trawl gear only.

Annual reports are generated using a list of the sample data files, the Dover sole sort group, and the landings that apply to the Dover sole sort group within each INPFC area and quarter combination. For each INPFC area and quarter analyzed, landing estimates (in number) are determined for Dover sole by length class and sex, and by age class when age data are available. In these analyses, lengths are rounded to the nearest centimeter. Since sex and age information is determined for all samples of Dover sole prior to processing the annual reports, estimates for missing values are not needed.

4.6.3 Monthly Estimates to PacFIN

In a separate process from the annual estimates, estimated landings (in weight) for individual species are generated monthly. First, monthly estimates of the species composition of the landings are generated by the GCU based on the sample data. These estimates are forwarded to Sacramento, where they are processed together with data on landings for each market category.

The species-composition reports generated in Menlo Park consist of separate records for each market category, port complex, gear type, and month. Species compositions are reported separately for: bottom trawl (beam trawl, otter trawl, balloon trawl, roller gear trawl, and Danish seine); midwater trawl gear; longline gear; and hook-and-line gear (vertical hook-and-line, troll, and rod-and-reel). All gill- and set-net landings are combined and reported to PacFIN as a single category. Other gear types are generally unsampled and are not expected to contribute significantly to the total landings of rockfish.

Species compositions are generated for a gear group, not individual gear; therefore, the species compositions for midwater and bottom trawls are identical, and similarly, longline and hook-and-line species compositions are identical. Monthly estimates are based on sample data collected over a series of months. For months other than January and December, three months of data are used. For example, the species composition for July would be based on samples from June, July, and August. January estimates are based on January and February data, and December estimates on November and December data. Multiple months of data are used because sampling intensity is generally too low within a given month to provide reliable estimates of the landings.

Species compositions are calculated separately for each port complex. Port complexes are not combined as is done in the calculation of the annual estimates. Species compositions are also calculated separately for each market category, which are not combined together into sort groups as is done in the calculation of the annual estimates. However, in past years the chilipepper/bocaccio market category was combined with the unspecified rockfish market category, but because bocaccio are now generally reported in their own category, this combination of market categories is no longer applicable. Species-composition reports are not prepared for all landing categories (see below), because not all market categories are sampled for each gear type.

Species compositions are reported as the percent of the landings (in weight) that each species constituted. These percentages are based on the estimators described above for deriving the annual estimates. First, for a given market category sampled on trip k within port complex i and time period j (a 2- or 3-month time block), the average weight per pound of a species is calculated using equation 4.1. The weight of the species per pound of the market category over all trips is then calculated in the same manner as the annual estimate using equation 4.2.

The estimated percent of the landings (in weight) that a species constitutes for the specified market category within the port complex and time period combination is simply,

$$V_{ij}\% = \bar{v}_{ij}(100). \tag{4.4}$$

In the reports, the percentages are rounded to the nearest integer, and species with percentages less than 0.5 (i.e., those that would be rounded to zero) are not reported. The percentages for these unreported species are summed together, rounded to the nearest integer, and are reported as "unknown" fish if the rounded sum is 1% or greater.

The estimated species compositions are applied to the reported landings (for a corresponding year, month, port complex, gear, and rockfish market category) by the PacFIN Coordinator in Sacramento. Generally, when a species composition is not generated, landings are categorized as unknown rockfish. If the unsampled category is the unspecified rockfish market category, landings are left in this category. If unsampled landings are in the widow rockfish, thornyhead, bocaccio, or Pacific ocean perch market categories, they are treated as pure landings that contain only their respective species. The PacFIN data are updated as landing reports become more complete and are replaced with the results from the annual estimates when these become available.

4.7 Acknowledgments

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4.8 Citations

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Figure 4.1. The major groundfish ports in California, 1992.

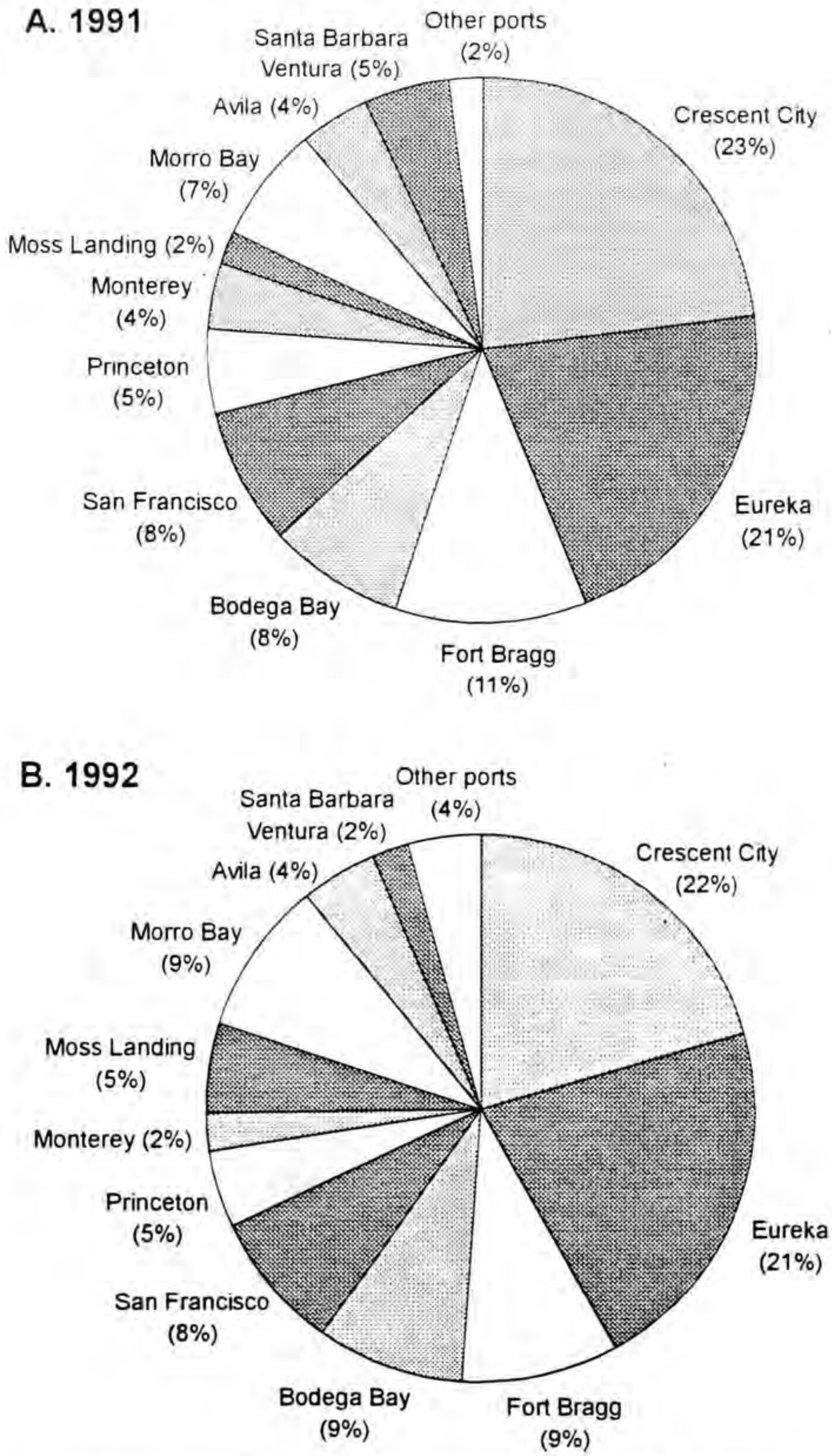

Figure 4.2. California groundfish landings by port, (**A**) 1991 and (**B**) 1992.

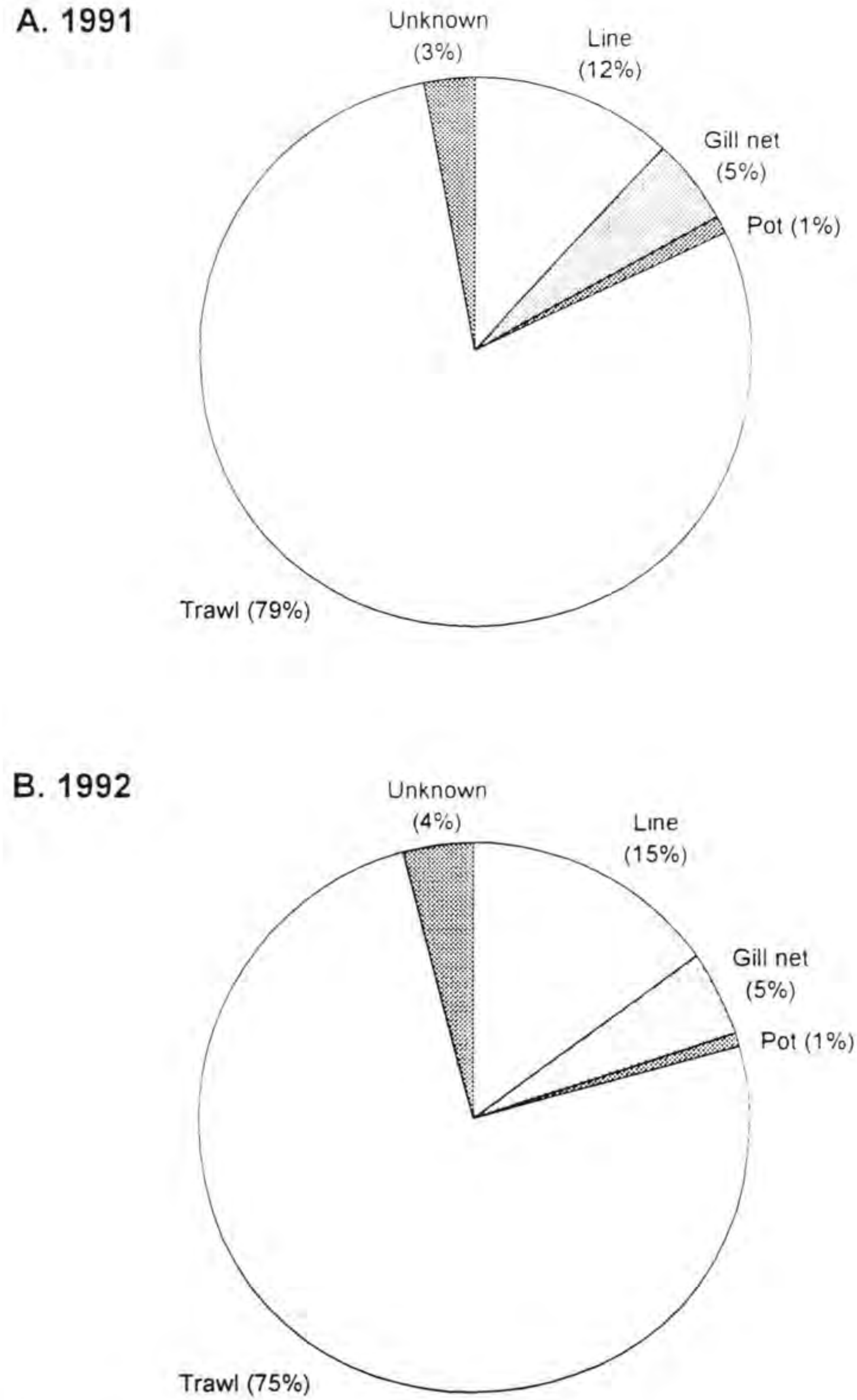

Figure 4.3. California groundfish landings by gear, (**A**) 1991 and (**B**) 1992.

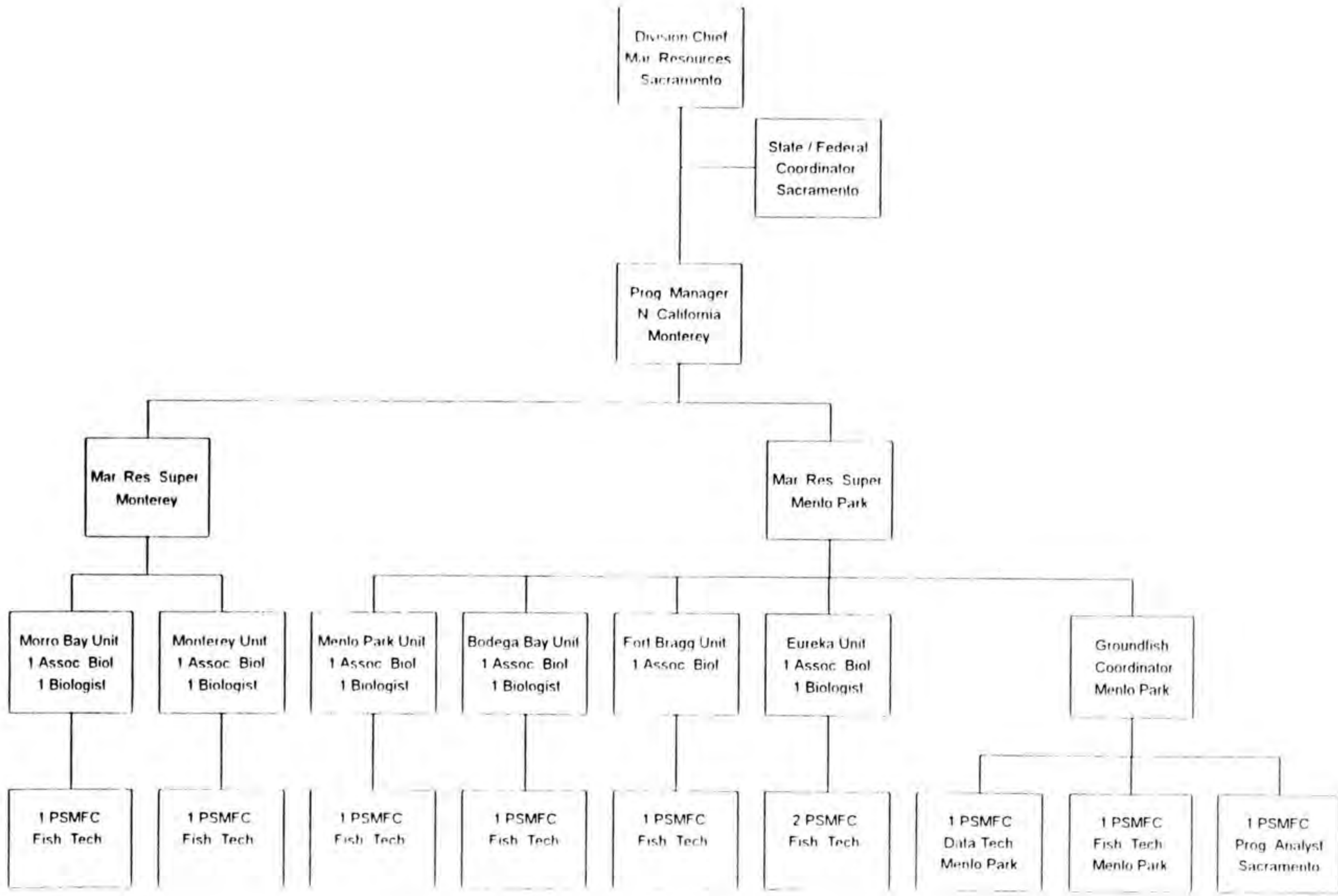

Figure 4.4. Organization chart of California Department of Fish and Game, Marine Resources Division (northern California) personnel, 1992.

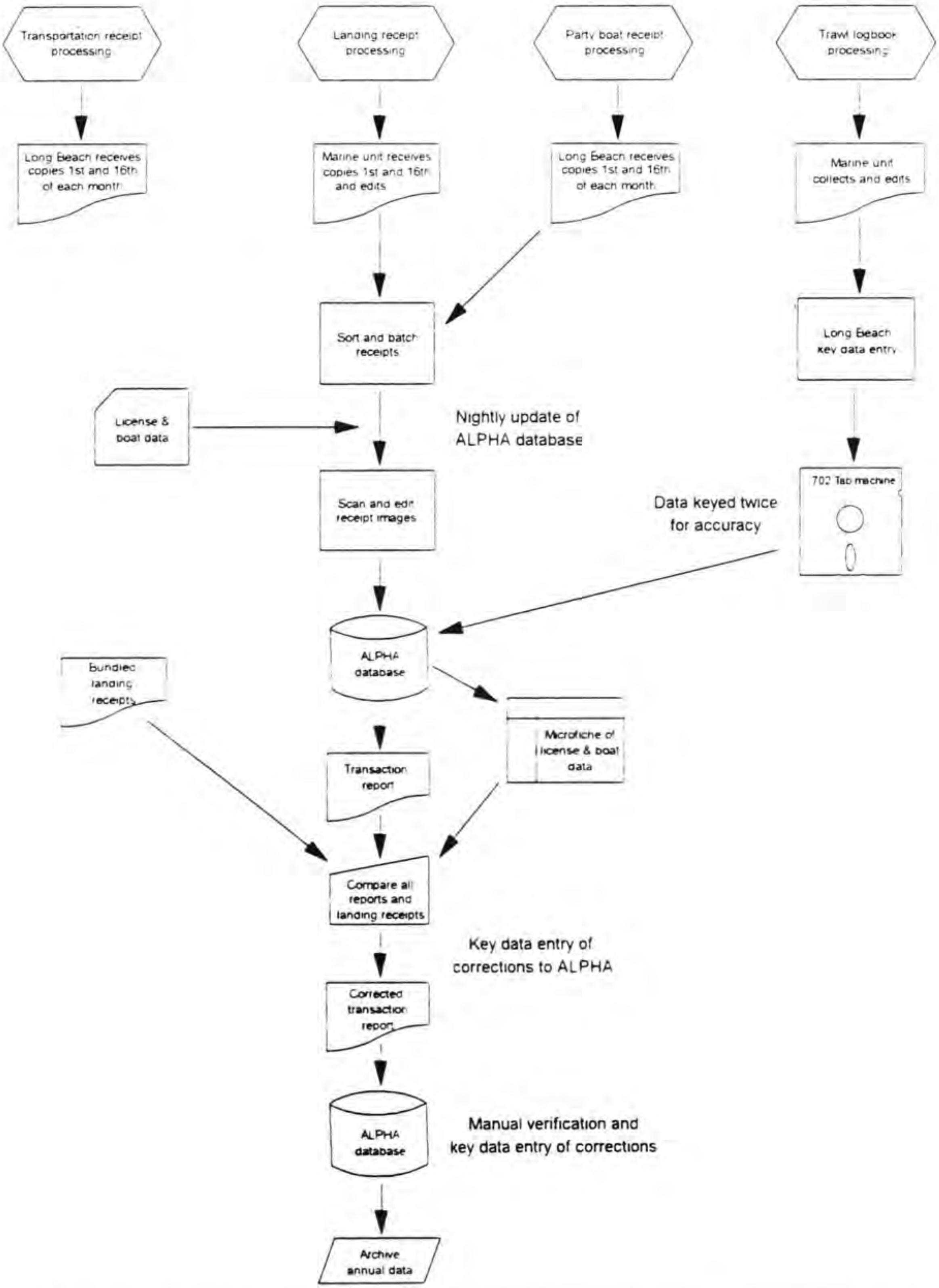

Figure 4.5. System used in California for collecting and processing information from landing receipts and logbooks.

Table 4.1. California groundfish landings (in metric tons) by species and INPFC area, 1992.

Species*	INPFC area		
	Eureka	Monterey	Conception
Dover sole	3,207.9	3,598.9	1,834.1
English sole	87.3	466.9	20.7
Petrale sole	157.5	336.6	37.9
Rex sole	113.9	275.6	50.8
California halibut	0.3	180.5	220.6
Other flatfish	159.6	313.8	13.1
Unspecified flatfish	2.0	20.9	19.2
Subtotal	3,728.5	5,193.2	2,196.4
Black rockfish	174.3	12.6	<0.05
Bocaccio	49.6	813.8	652.8
Canary rockfish	217.6	85.0	6.3
Chilipepper	20.5	1,517.3	161.6
Darkblotched rockfish	77.9	103.6	0.9
Splitnose rockfish	28.0	172.5	0.9
Yellowtail rockfish	212.0	412.6	10.3
Thornyhead	2,211.2	1,076.6	1,086.6
Widow rockfish	583.6	531.8	4.1
Other rockfish	212.6	639.9	420.3
Unspecified rockfish	252.8	1,367.0	1,428.3
Subtotal	4,040.1	6,732.7	3,772.1
Lingcod	107.3	440.9	64.1
Pacific cod	0.2	0.6	0
Pacific hake	4,929.1	0	0.6
Sablefish	1,590.2	1,536.0	536.4
Subtotal	6,626.8	1,977.5	601.1
Other groundfish	4.7	20.8	57.7
Unspecified groundfish	116.9	62.1	10.4
Subtotal	121.6	82.9	68.1
Total	14,517.0	13,986.3	6,637.7

*Other flatfish, rockfish, and groundfish reflect the sums of landing values for miscellaneous species that were landed in relatively small amounts (coastwide landings that were less than 100 metric tons). Unspecified flatfish, rockfish, and groundfish reflect the sums of landing values for miscellaneous species that were unable to be identified to the species level.

Table 4.2. California groundfish sampling personnel in 1992.

Funding agency[a]	Number of Fisheries Technicians/ Scientific Aides	Home port	INPFC area[b]
CDFG	1	Eureka	Eureka
PSMFC	1		
PSMFC	1	Crescent City	Eureka
CDFG	1	Fort Bragg	Monterey
PSMFC	1		
CDFG	1	Monterey Bay	Monterey
PSMFC	1		
PSMFC	1	San Francisco	Monterey
CDFG	1	Morro Bay	Conception
PSMFC	1		

[a]Acronyms for funding agency are as follows: CDFG is the California Department of Fish and Game and PSMFC is the Pacific States Marine Fisheries Commission.

[b]INPFC area denotes the International North Pacific Fisheries Commission catch reporting area.

Table 4.3. Logbook coverage of the groundfish trawl fishery in California by port and quarter, 1992.

Quarter[a]	Landing receipt[b]	Port[c]																	
		CC	FL	EU	FB	SF	PR	BB	MN	ML	SC	AV	MB	OX	SB	LB	SP	OTH	*Total*
1	T	334	176	156	154	122	264	255	46	117	7	191	101	54	58	45	11	25	
	M	325	173	136	136	111	222	223	22	36	2	152	79	0	0	9	0	18	
2	T	378	124	167	126	197	175	128	89	138	87	210	105	75	67	55	8	0	
	M	318	118	155	109	131	147	86	35	44	1	161	70	1	2	0	2	0	
3	T	359	117	179	174	222	239	157	60	155	73	215	144	77	31	28	0	5	
	M	299	112	167	153	149	214	128	14	19	0	128	87	1	0	1	0	4	
4	T	133	87	105	117	109	216	176	32	121	65	182	135	45	24	22	10	55	
	M	117	71	94	99	106	183	151	28	93	6	157	93	1	1	0	2	4	
Total	T	1,204	504	607	571	650	894	716	227	529	232	798	485	251	180	150	29	85	8,115
	M	1,059	474	567	497	497	766	588	99	192	9	588	329	3	3	10	4	26	5,685
Percent		88%	94%	93%	87%	77%	86%	82%	44%	36%	4%	74%	68%	1%	2%	7%	14%	31%	70%

[a]Quarter is denoted as follows: 1 is January-March, 2 is April-June, 3 is July-September, and 4 is October-December.

[b]Landing receipt is denoted as follows: T is the total number of trawl landing receipts, and M is the number of trawl landing receipts that had a corresponding logbook.

[c]Port is denoted as follows: CC is Crescent City, FL is Fields Landing, EU is Eureka, FB is Fort Bragg, SF is San Francisco, PR is Princeton, BB is Bodega Bay, MN is Monterey, ML is Moss Landing, SC is Santa Cruz, AV is Avila, HN is Port Hueneme, MB is Morro Bay, OX is Oxnard, SB is Santa Barbara, LB is Long Beach, SP is San Pedro, and OTH is other.

Table 4.4. Southern and northern California rockfish landings (in metric tons) by market category and gear type, 1992. Numbers of samples collected in northern California are also presented. No samples were collected in southern California (ports south of Morro Bay). Market categories are listed in ascending order according to contribution of landings to subtotal values for each gear type for northern California.[a]

		Southern California	Northern California	
Market category	Gear type[b]	Landings	Landings	Number of samples
Blackgill rockfish	Trawl	0	36.0	1
Small rockfish (group)		0	141.9	8
Red rockfish (group)		1.4	157.6	8
Rosefish rockfish (group)		0	292.4	15
Bocaccio		1.8	343.8	53
Chilipepper		0.6	470.0	24
Widow rockfish		0	598.6	41
Unspecified rockfish		5.4	1,588.0	30
Thornyheads		0	4,116.3	43
Other rockfish (9)[c]		0	36.8	3
Subtotal		9.2	7,781.4	226
Red rockfish (group)	Set net	27.7	21.8	2
Rosefish rockfish (group)		0	29.5	0
Widow		1.4	46.3	5
Chilipepper		17.6	241.1	14
Unspecified rockfish		197.4	305.3	24
Bocaccio		166.2	259.1	41
Other rockfish (11)[c]		2.7	36.1	1
Subtotal		413.0	939.2	87
Blackgill rockfish	Line	234.5	19.1	11
Yelloweye rockfish		0	27.1	2
Small rockfish (group)		0	59.2	51
Bolina rockfish (group)		1.3	62.0	34
Gopher rockfish (group)		0.4	72.6	24
Black rockfish		0.6	78.7	6
Widow rockfish		0.4	111.1	16
Bocaccio		199.3	161.5	29
Yellowtail rockfish		0	166.4	19
Red rockfish (group)		135.7	372.3	46
Chilipepper		6.5	702.7	45
Unspecified rockfish		354.1	1,184.2	3
Other rockfish (16)[c]		10.9	24.3	48
Subtotal		943.7	3,041.2	334

Table 4.4. Continued.

Market category	Gear type[b]	Southern California	Northern California	
		Landings	Landings	Number of samples
Other rockfish (16)[c]	Other	3.6	22.1	0
Subtotal		3.6	22.1	0
Total		1,369.5	11,783.9	647

[a]Market category and gear type combinations that had landings in excess of 1 metric ton were incorporated into the calculations used to present figures in this table. Individual market category and gear type combinations for northern California that had landings that were greater than or equal to 19 metric tons are presented. Market categories denoted as (group) reflect categories that are designated by groups of species, rather than individual species.

[b]Gear types are as follows: "Trawl" includes midwater, bottom, and roller gears and Danish seine; "set net" includes gill and trammel nets; and "line" includes hook-and-line, longline, rod-and-reel, and troll.

[c]Other rockfish is not a market category, but rather a term used to denote the sums (landings and number of samples) of individual market category and gear type combinations that had landings that were less than 19 mt (i.e., combinations that did not meet the criterion stated in footnote 'a' above). The number in parentheses denotes the number of individual market categories that were included in the summations.

Table 4.5. Number of age structures that have been collected for rockfish and flatfish species as part of the biological sampling program in California, 1955-93.[a]

Year	Rockfish[b]				Flatfish			
	Widow	Yellowtail	Chilipepper	Bocaccio	Dover sole	English sole	Petrale sole	Rex sole
1955-79	1,221	753	5,406	4,478	4,242	545	431	3
1980	727	133	1,632	1790	1,546	122	110	8
1981	1,677	174	955	1,356	1,048	90	114	3
1982	4,069	348	2,217	2,687	1,048	90	83	0
1983	2,110	372	1,463	1,685	1,578	79	64	0
1984	3,076	865	3,898	2,721	580	54	48	0
1985	3,115	639	6,769	1,992	1,270	78	47	0
1986	2,852	699	1,987	4,300	433	64	44	0
1987	3,014	250	3,055	3,400	1,201	51	35	0
1988	2,309	322	2,630	2,590	993	10	18	0
1989	2,783	701	2,500	2,230	1,154	9	18	0
1990	3,388	435	5,490	2,900	963	1	6	0
1991	5,232	618	8,000	3,150	1,722	0	0	0
1992	4,756	686	5,000	3,302	1,218	0	0	0
1993	3,850	259	4,796	1,620	1,150	0	0	0
1994	1,091	356	2,243	628	2,794	0	0	0
Total	45,270	7,610	58,041	40,829	22,940	1,193	1,018	14

[a]Figures presented in the table represent the number of age structures (one structure represents one fish specimen) that have been collected for rockfish and flatfish species; however, not all samples have been, or are even currently planned to be, examined for age determination. The figures for the number of samples are approximate only.

[b]Age structure samples for bank and darkblotched rockfish have also been collected by the California Department of Fish and Game; however, the number of specimens for each of these species is not available at this time.

CHAPTER 5

STATE/FEDERAL GROUNDFISH SAMPLING PROGRAMS

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5.1 Introduction

This chapter describes federally coordinated sampling programs for lingcod, sablefish, and Pacific hake (also referred to as Pacific whiting). Sampling programs addressed here target shoreside landings of commercial fisheries, and involve coordination with two or more of the U.S. Pacific coast states. These federally coordinated programs are designed to follow the same protocols in each of the participating states and to help allocate effort to the programs in a manner consistent with coastwide needs. The sampling personnel used in each state are supervised by the states and are usually involved in other state programs.

5.2 Sablefish

Washington, Oregon, and California participate in a joint port sampling program for sablefish. As of 1995, the NMFS (Tiburon Laboratory) has the primary responsibility for coordinating this program. For example, appropriate design methods (including target sampling rates) and data summaries (including realized sampling rates) are provided by the Tiburon Laboratory.

The sablefish sampling program, which was established in 1986, is designed after the California species-composition sampling program for rockfish (see section 4.4). The coastwide sampling program continued without interruption through 1991. In 1992, sampling was discontinued in California and Oregon to allow effort to be directed towards lingcod; however, samples continued to be collected throughout the year at Washington ports. Sampling resumed in California and Oregon in 1993 and has continued in all three states through 1996. The specifics of the design were developed taking into account analyses by Hightower (1986). Sampling is done at each of the major port complexes along the U.S. Pacific coast from Morro Bay north.

The price paid for a landing depends on the distribution of the catch among "sort groups" (based on fish size), but these sort groups do not have the same status as market categories. All sort groups are not always recorded in the fish receipt databases; sometimes the original sort groups

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sampled are aggregated into broader categories. In California and Oregon, the sablefish sampling program differs from the California species-composition sampling program for rockfish in that the samplers are instructed to take clusters (i.e., subsamples) from each sort group on a sampled trip. In Washington, individual trips are often sorted into more groups than can be sampled in the time available. Consequently, only "ocean run" trips, which are not divided into sort groups, are sampled in Washington. These samples consist of three clusters.

Sampling personnel are requested to obtain samples from landings of both whole and dressed fish in each state. Sampling effort is distributed among gear types (fixed gear or trawl gear) and ports or port complexes. The fixed-gear season is generally quite short (several weeks), and during this period samplers are instructed to direct their sampling toward this fishery. For the trawl fishery, the current sampling goal is to obtain one complete sample (i.e., data collected from every sort group of a landing from a single boat trip) each month within each major port complex. Samplers distribute their sampling effort among different vessels when possible. Actual numbers of samples varied from 163 (9 in Washington, 50 in Oregon, and 104 in California) to 256 (44 in Washington, 99 in Oregon, and 113 in California) during the 1986-91 period.

Sablefish samples consist of two 50-lb clusters from a sort group (or three in Washington). When possible, clusters are taken from different parts of the landing (e.g., from different strap boxes, totes, or baskets). For fish landed whole, fork length and sex are recorded, and otoliths are removed. For fish landed dressed, dorsal length (from the insertion of the dorsal fin to the fork of the caudal fin) is recorded. The data are recorded on standard sablefish data sheets provided by the sablefish sampling coordinator at the Tiburon Laboratory.

Over time, sampling procedures have been modified in response to changes in the sort groups used by the fishery. In earlier years, landings tended to consist of a few general sort groups, such as ocean run (unsorted), small, medium, large, and so on. More recently there has been a tendency for the landings to be classified into more groups based on the weight of the individual fish. Beginning in 1993, the data sheet was modified so that samplers could record condition (dressed or whole) and whether the fish were landed as ocean run or sorted into weight groups. When the fish are sorted into weight groups, the sampler records the actual weight interval for the sort group sampled. The goal is still to obtain two clusters from a sort group and to sample each sort group from a trip.

Collected otoliths are cleaned, placed in plastic trays, and numbered so that later the otoliths can be matched to the measurements for that fish on the data sheet. Otoliths and data sheets are sent to the sablefish sampling coordinator at the Tiburon Laboratory approximately once a quarter.

As soon as the otoliths and data sheets are received at the Tiburon Laboratory, they are briefly examined to make sure that the otoliths can be matched to their corresponding data sheets. At the time of data entry, each sample is examined to ensure that the data sheet was correctly filled out by the sampler. The data are entered using an MS-DOS BASIC program, and the resulting data are stored in ASCII (text) form. After the data are entered, approximately 10% of the samples are randomly selected and checked against the computer files manually. If any errors are detected, then all of the samples are checked and errors are corrected. Updates to the samples from fish receipts and trawl logs are entered as they are received. These updates can include landing weight, INPFC area, minimum and maximum depth fished, and boat number. No standard reports containing derived quantities are produced. Data are made available to stock assessment scientists and others on request.

As of 1995, no ageing of sablefish is done because of a staff cutback and because low between-reader agreement in recorded ages may be contributing to biased estimates of age. Approaches are currently being explored to improve age-reading methods, which could lead to a resumption of routine age reading. Otoliths are currently stored at the Tiburon Laboratory in plastic trays and soaked in a 30% glycerin solution with a small amount of thymol added as a preservative.

5.3 Lingcod

California and Oregon participate in a federally coordinated sampling program for lingcod that began as a pilot program in 1992, while Washington continued a preexisting sampling program for this species. The federal lingcod program is coordinated from the Tiburon Laboratory by the lingcod sampling coordinator. The lingcod sampling program was modeled after the sablefish sampling program. The program was continued after 1992 originally because too few samples were collected in the first year to allow the sample data to be evaluated critically, and then because the information produced by the sampling program was viewed as a necessary component of ongoing management efforts for lingcod.

Sampling is directed towards the trawl fishery and is distributed among ports. The three major ports in Oregon and the seven major port complexes from Morro Bay north in California are covered by the sampling program. A sample consists of four 50-lb clusters, if landings are large enough. Landings of less than 50 lb are not sampled. Four clusters are selected so that roughly the same number of fish would be sampled as is collected in the Washington sampling program, where samples consist of 25 individual fish. Currently, landings of lingcod usually are not subsorted into different sort groups or market categories. The sampling design and software, however, can be adapted to accommodate multiple sort groups in the same manner as for the sablefish sampling program.

For each lingcod in the sample, the sex is determined and fork length is measured. The soft dorsal fin rays (numbers 1 through 8) are removed, placed in a labeled manila envelope, air dried, and then stored in a freezer until they are mailed quarterly to the lingcod sampling coordinator at the Tiburon Laboratory.

The target sampling goal is to collect two samples per major port or port complex every month. During the first two years of the sampling program, there was difficulty obtaining a sufficient number of samples, especially from California. Sampling effort was redistributed from other sampling programs in California to improve the quality of the estimates from the lingcod sampling program. Actual numbers of samples in 1992 were 39 in Oregon and 15 in California. Although the 39 samples in Oregon constitute less than the nominal target of 72 (two samples each month at each major port), sampling was adequate in Oregon during the months when lingcod were landed in substantial numbers. This is now also true for sampling in California. The lingcod sampling coordinator is currently considering reducing the target sampling levels to near the realized level.

Following receipt of the data sheets and fin rays at the Tiburon Laboratory, they are examined for completeness. Information from the data sheets is entered into a database program. The data entry program generates a printed copy of the information entered for each sample, which is then compared with the original data sheet. The database is updated after the fin rays have been examined to determine ages. The fin rays are embedded in plastic resin and sectioned prior to counting annual rings.

5.4 Pacific Hake

There is a federally coordinated sampling program for the shore-based Pacific hake fishery, with primary responsibility assigned to the Pacific hake port sampling coordinator at the Status of the Stocks Task, Alaska Fisheries Science Center (AFSC). Data files and archives of data sheets are maintained by the coordinator. Samples have been collected in California and Oregon since 1990. The 1990 program began as a pilot program located only in Eureka, California. In 1991, the program was expanded to include Crescent City and Newport, Oregon. Deliveries to Astoria, Oregon were also sampled in 1992. The sampling was initiated to characterize the landings of the shore-based fishery, as a supplement to data collected by onboard observers on the larger at-sea processed portion of the fishery.

Because of regulations on the catch and the migratory nature of the species, the open season for the shore-based fishery varies geographically and annually. This requires that the sampling design be modified in response to the fishery. There are two basic types of samples: "otolith" samples and "length-frequency" samples. Clusters are selected for both sample types, and both sample types are based on a fixed number of fish. For otolith samples, length, weight, and sex of individual fish are recorded and otoliths are removed for later examination. For length-frequency samples, only length and sex are determined and no otoliths are removed. Otolith samples are intended for use in constructing an age-length key, which can then be used together with the length-frequency samples to estimate catch-at-age and growth parameters. Compilations of the sample data are given in Dorn and Methot (1992) and Dorn et al. (1993). The total number of otolith samples to obtain is based on a specified total number of age determinations that can be made. This number of age determinations is contingent on the availability of personnel to read the otoliths. Within a year, the apportionment of samples among ports is roughly in proportion to expected landings, with the provision that the minimum number of samples at a port should be expected to produce 200 otoliths. This apportionment of samples among ports is made in an effort to reduce the variance of the combined (across ports) age composition, in comparison with what would be obtained with equal numbers of samples at each port. However, no formal analysis of optimal sampling allocation has been done. Starting in 1992, the recommended number of fish to collect per sample was 20, rather than the 50 fish per sample collected in 1990 and 1991. Age determinations are made from the otoliths by personnel assigned to the Age and Growth Unit at the AFSC. The number of age determinations for 1990-92 was 683, 941, and 1,070, which was based on fish collected from 15, 26, and 47 samples, respectively. The target number of otoliths for 1993 was 1,750.

A length-frequency sample consists of 100-200 fish. In 1991 and 1992, the sampling program produced 2,672 and 4,472 recorded lengths. For 1993, the initial target sampling rate was one sample every two weeks at each port, with this sampling rate subject to alteration based on changes in the expected duration of the fishery. The samplers are instructed to sample landings randomly within a port, and to distribute their sampling effort over the duration of the fishery.

After delivery of the data sheets to the Pacific hake port sampling coordinator, the data are keypunched and checked for errors by an outside contractor. Data are kept in an ASCII format at the AFSC.

5.5 Acknowledgments

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CHAPTER 6

PACIFIC FISHERIES INFORMATION NETWORK

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6.1 Introduction

Since 1974, the Pacific States Marine Fisheries Commission (PSMFC) has worked actively with its member states and federal agencies to improve the quality and timeliness of data collection, processing, and analysis of fishery information and to produce data summaries required for regional conservation and management purposes. This effort was recommended initially by leaders from the albacore fishing industry, who urged management agencies to organize coastwide databases for fish landings, fishing effort, and characteristics of fishing vessels for all fisheries of the U.S. Pacific coast. These leaders recognized that simple summation of the results generated independently by each state could lead to serious misconceptions regarding the status of a fishery, because of the different sampling and analytical methods used by the individual states. In particular, highly mobile fisheries that span state boundaries would greatly benefit from a coastwide database that was accurately maintained. The landings data that existed prior to 1974 (see section 1.2) was insufficient for coastwide in-season quota monitoring.

This coastwide data coordination and consolidation effort received major impetus from enactment of the Magnuson Fisheries Conservation and Management Act of 1976, which established Regional Fishery Management Councils charged with managing fishery resources as geographical units throughout the range of the species on the basis of the best available scientific information. It was clear that regionally comprehensive and coherent fisheries data were needed on a timely basis to provide the information required by the Regional Fishery Management Councils.

Regional fisheries data coordination requires effective cooperation and mutually supportive interactions among state fisheries agencies, which on the Pacific coast collect all commercial catch statistics from domestic fishers who land their catch at shoreside ports in the United States, and among Pacific-area National Marine Fisheries Service (NMFS) Regions and Centers, which are responsible for collection of all data for fisheries that operate in the U.S. Exclusive Economic Zone. To assure effective communication and cooperation among those state and federal entities, the Pacific area has been served since 1974 by a sequence of regional coordinating committees comprised of representatives from the participating fishery agencies.

First, there was the Albacore Coordination Committee and its Data System Task Group, which was superceded by a NMFS-sponsored committee known as the Coastwide Data Task Force. The Committee on Goals and Guidelines for Regional Fisheries Data Collection was then established and restructured in 1980 as the Pacific Coast Fisheries Data Committee, which remains the name of the regional coordinating committee today.

The Data Committee consists of 13 members appointed by the directors of the following participating agencies: Alaska Department of Fish and Game (ADFG), California Department of Fish and Game (CDFG), Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Pacific Fishery Management Council (PFMC), North Pacific Fishery Management Council (NPFMC), six Centers and Regions of the NMFS, and PSMFC. The member appointed by the Alaska Fisheries Science Center (AFSC) also represents the Northwest Fisheries Science Center (NWFSC).

The Data Committee was chartered in 1980 with four stated goals.

1. Implement and manage a Pacific Fisheries Information Network (PacFIN), which is responsible for aggregating detailed and summarized state and federal fisheries data that are used by resource managers and associated fishery-related agencies.

2. Provide data-management consultation and technical advice to the Council's Management Teams and participating agencies upon request.

3. Establish priorities and coordinate plans to improve the efficiency and timeliness of data acquisition and delivery with a minimum of unnecessary duplication.

4. Promote the development and implementation of coastwide data-collection standards to facilitate aggregation of fisheries data within the PacFIN system.

The overall PacFIN system is expansive, and many of the intricacies involved in accessing, retrieving, and interpreting the data that reside in the system are beyond the scope of this document. This chapter focuses on the procedures and components of the PacFIN system that are relevant to the groundfish fishery data collected and submitted by the three state fishery agencies of the U.S. Pacific coast: WDFW, ODFW, and CDFG. Brief descriptions of related information are also presented to complement primary areas of discussion. Information presented in this chapter summarizes an extensive description of the PacFIN system that is available through the PacFIN office in Seattle (Daspit 1996).

6.2 PacFIN System, 1981-87

6.2.1 Groundfish Data Collected by State Fishery Departments

In February 1981, the Data Committee hired the system designer/manager to design and implement the PacFIN system. Prior to this, the Data Committee had met on eight occasions over a two-year span and produced an initial requirements document that became the starting point for system development. One requirement was that the system would be operational within six months. Others were that input data would be provided to the central database on the 15th of each month, that data for the month ending 15 days earlier would be 90% complete, and that all earlier months would be more complete than the most recent month. Issues regarding the confidentiality of fishery-related data were discussed at the February 1981 meeting of the Data Committee. Discussions focused on developing protocols for data acquisition that met all legal requirements and that allowed researchers and managers to obtain needed information easily. The consensus of the Committee was to avoid the confidentiality issue by specifying a system that required only data that were aggregated to some reasonable and useful higher level. Individual fish tickets and vessel registration records were specifically ruled out of consideration as possible information to be included in the central database. The Groundfish Management Team (GMT) of the PFMC produced specifications for two initial reports that addressed primary retrieval requirements. One report presented monthly catch estimates by species and International North Pacific Fisheries Commission (INPFC) area, and another report provided monthly catch estimates by species and data source (i.e., agency providing fishery-related data), including foreign countries and joint-venture (JV) operations. A system specification was produced in May 1981 and the initial implementation of the PacFIN system was operational in October 1981. The system was developed on a Burroughs B7800 computer that was owned, operated, and maintained by the Office of Fishery Information Systems of the Northwest and Alaska Fisheries Center (NWAFC), now the NWFSC and AFSC.

A database management system (DMSII) and the ALGOL programming language were the primary tools used to build the 1981 system. When the system went on-line in October 1981, it included a single type of input transaction that contained data elements, such as date, species, area, gear, port/country/JV, weight-of-catch, number-of-landings, number-of-fish, and dollar-value. The transactions provided by the WDFW, ODFW, and CDFG were data aggregated on a daily basis, while the transactions provided by the NWAFC were data aggregated weekly.

One very important development during this initial process was the establishment of a set of coastwide PacFIN codes for species, area, gear type, and port/country/JV. Since each data source had its own coding system, it was deemed critical that the PacFIN system be based on a set of codes that would apply throughout the entire geographic range that PacFIN intended to address, as well as across all time periods.

The stipulation that reports present catch estimates for each groundfish species by INPFC area and data source was soon expanded to include the data elements of gear type, port, and month. To meet these additional reporting requirements, it became apparent that the data would need to be summarized as they were received from the data sources and the summaries stored in an on-line "summary" table. This summary-catch table included data for the following: year, time period, species, area, gear type, port/country/JV, pounds, and estimated dollar value. The summary-catch table was essentially a five-dimensional array that allowed for the storage and retrieval of catch and landed value by any combination of time period, species area, gear type, and port/country/JV.

In this summary structure, a time period could represent any month or an entire year. A species code could represent a single species, a species complex, or management group. An area code could represent a single PSMFC area, a single INPFC area, or all areas managed by the PFMC. A gear code could be a single gear type, a group of gear types, or all gear types combined. A port/country/JV code could represent a single port, a group of ports, all ports in a state, or various other combinations of port, country, and JV. The first reports generated from summary-catch tables (PFMC Groundfish by INPFC areas and PFMC Groundfish by Source) were both produced and distributed in October 1981.

Three additional standard reports were developed: Groundfish by Gear Group, Groundfish by Port Group, and Groundfish by Month. All of these initial reports contained coastwide fishery statistics. Because the database contained summaries for nearly every combination of period, species, area, gear type, and port/country/JV, it was decided to enhance the reporting system to produce similar reports specific to each data source. Agency-specific reports were originally intended as feedback to PacFIN agency coordinators so that they would be able to compare PacFIN-compiled summaries with their own agency-generated statistics. However, the state-specific reports quickly became the primary source of landing data for some agency managers, biologists, and economists.

The set of five programs that generated the initial 1981 reports became the primary PacFIN reporting system. The capabilities of this retrieval system continued to be enhanced as new functions and features were suggested by PacFIN clients or were deduced as a result of day-to-day interactions with the various users. Many of the extensions and enhancements that were made in the first few years were a direct result of suggestions and requests made by ODFW personnel.

In January 1982, the GMT requested that the central database include the number of fish tickets classified as groundfish, pink shrimp, etc., so that "indices" of fishing effort could be determined on a coastwide basis. The number of fish tickets, described as deliveries on the PacFIN reports, could be aggregated by each data source, for combinations of management group, area, gear type, and port. Some of the data sources were able to develop the requisite software, but coastwide reporting of delivery information did not commence until March 1987, when all of the PFMC data sources were able to provide data on groundfish deliveries to the central processing system. Nevertheless, delivery statistics by management group became an integral part of the PacFIN system starting in 1982, even though reporting of this information was relegated to agency-specific reports for the first 5 years.

In December 1983, the PFMC began preliminary discussion regarding ways to improve the monitoring component of the PacFIN system, in particular, the timeliness with which landing information was updated and made available to management. The Quota Species Monitoring (QSM) subsystem was largely initiated at the request of the fishing industry, which needed timely information regarding the cumulative catch of the groundfish species regulated by annual quotas (e.g., widow rockfish and sablefish). The industry requested that the cumulative catch estimate be updated monthly, or possibly weekly, to allow them to develop production and marketing plans. At the time, the PacFIN system was providing routine reports on a monthly basis; however, the reports did not contain up-to-date estimates of catch. For example, the most current data provided by an agency were received 15 to 45 days following a fishing trip, and in some cases data were not received for as long as 4 to 5 months following the actual catch dates.

Initially, the QSM program was administered by one member of the GMT, who was responsible for compiling weekly catch reports following phone conversations with state agency personnel regarding recent catch information for species regulated by quotas. The weekly catch reports for a species were multiplied by a correction factor based on the assumption that the catch data were incomplete. At first, correction factors were determined subjectively, but as more and more catch reports were prepared, improved correction factors became available. Eventually, correction factors were computed by comparing annual summations of weekly reported catches to comparable data in the PacFIN central database. The QSM program was applied using these manual procedures through October 1985. An automated version of the QSM subsystem was finalized in November 1985, which resulted in a more efficient process and more accurate reports than were possible using the original manual operation.

6.2.2 Other Data

The PacFIN system also includes various databases that are not directly associated with groundfish data collected from shoreside landings in Washington, Oregon, and California. In November 1982, the PacFIN system was expanded to include foreign country and JV data for the

Alaskan fisheries managed by the North Pacific Fishery Management Council. These data, which were collected and processed by the NWAFC, represented weekly estimates of landed catch by species, area, gear type, and foreign country or JV. Foreign country and JV data are included within the PacFIN system starting in 1981. In April 1984, groundfish data from the ADFG were included in the PacFIN central database. With the addition of the ADFG data, the PacFIN database included catch statistics for all fish harvested from U.S.-controlled waters (0-200 miles) from California to Alaska and landed at U.S. ports.

In July 1986, the Alaska Regional Office (AKR) of the NMFS became a PacFIN data source. The inclusion of AKR data was an important expansion for PacFIN, because these data included catches from domestic at-sea processors that were not being landed at U.S. ports, but were being shipped directly to foreign markets. In recent years, the AKR has primarily submitted data on retained catch for species, or species assemblages, by area, gear type, and week.

In 1987, the PacFIN system also began to receive catch, effort, and economic statistics for the Pacific salmon commercial fisheries of Washington, Oregon, and California. The salmon database, which includes the years 1981 to the present, is a repository for commercial catch statistics associated with the salmon fisheries off the U.S. Pacific coast (Washington, Oregon, and California). The salmon database includes landings (in pounds, rather than in numbers of fish) and landed value by species, state, port, gear type, and month.

In February 1983, an investigation was conducted to determine if the PSMFC Data Series and the PacFIN system were both necessary. The Data Series consisted of a set of tables (hard copies) dating back to the mid-1950s that included catch statistics for species of groundfish and shrimp. These data were provided by the Department of Fisheries and Oceans (DFO) of Canada, and the four state fishery agencies of the U.S. Pacific coast. Throughout the 1960s and 70s, the Data Series represented the most extensive databases containing coastwide groundfish catch and effort statistics, and these data were the primary information used to construct the broadly utilized Technical Subcommittee (TSC) reports (see section 1.2 for a detailed discussion regarding the Data Series and TSC). It was decided that with certain enhancements to the PacFIN system the Data Series could be eliminated. The following additions to the PacFIN system were deemed necessary: 1) fishing effort (in trawl hours) by PSMFC area and month, 2) logbook-adjusted estimates of catch by PSMFC area and month, 3) logbook-adjusted estimates of species composition, and 4) groundfish catch data from the DFO.

In May 1987, the PacFIN central database was expanded to include fishery-related data collected by the Department of Fisheries and Oceans (DFO) of Canada. The DFO PacFIN coordinator submits catch data twice a year to the PacFIN system. The DFO database within PacFIN currently includes the years 1981 to the present. By 1987, only two of the five fishery agencies were able to provide effort data in trawl hours and logbook-adjusted estimates of catch. The Data Series and PacFIN system merger was never completed in its original form. Although this merger was generally unsuccessful, it did initiate three very important advances in the evolution of the PacFIN system. First, the DFO became a PacFIN data source and user. Second, in 1988, the PacFIN system started providing an annual report to the TSC that included domestic groundfish landings for the entire North American Pacific coast. Finally, the attempted merger of these two coastwide databases generated information that was beneficial during the specification and development stages involved in the redefinition project of the PacFIN system (see below).

6.3 PacFIN System After 1987

6.3.1 Redefinition Project - Specification

Although the PacFIN system had undergone significant improvements since its inception in 1981, additions and revisions to the central database were needed. First, the ability to provide input data to the central database at the PSMFC-area level was never fully achieved on a coastwide (including Canada) basis. That is, not all agencies could provide their data in a format that allowed the distributions of catch by area and species to be combined with the fish ticket data, which was necessary to produce the aggregated-catch transactions for input to the PacFIN system. Another shortcoming was the inconsistency between the PacFIN central database and the Research Database associated with the Southwest Regional Office of the NMFS. In 1987, the Research Database was the only coastwide (Washington, Oregon, and California) data system that contained individual fish ticket and vessel data. Fishery researchers and managers occasionally found contradictory information within these two databases, which complicated analyses that utilized these data. A third unresolved issue was that the PacFIN system did not include specific market categories for species of rockfish. Finally, fishery economists had recommended for some time that a primary consideration while developing and expanding the PacFIN system should be the inclusion of all species of fish that are commercially harvested from U.S. Pacific coast waters.

The above requests led to what has generally become known as the "redefinition project" for the PacFIN system. The Data Committee appointed a subcommittee in December 1988 to investigate the feasibility of redefining the PacFIN system, and then to proceed with specification and development stages if the project was deemed a viable one. The subcommittee solicited input from various users of the PacFIN central database regarding their data needs and ways to improve the overall system. The most important requests are summarized below.

1. Groundfish catch statistics by PSMFC area for all relevant data submitted by the participating fishery agencies.

2. Catch, effort, and economic data for all species (not just groundfish) commercially harvested from marine waters off the North American Pacific coast.

3. Fish ticket data on an in-season basis.

4. A historical database that contains detailed fish ticket information that has not been summarized or reduced.

5. Detailed species-composition data that have not been summarized or reduced.

6. A policy whereby agencies submit all fishery-related data to a single, centralized database system (e.g., PacFIN), which would eliminate the need to resolve inconsistencies in multiple databases that reside in various locales.

6.3.2 Redefinition Project - Development

In October 1990, the Data Committee authorized implementation of the new system, and development began in January 1991. The PacFIN office, in conjunction with the PSMFC, decided to employ a private computer software company to help with the development. By April 1992, the redefined system was able to correctly process all of the 10 new transaction types, and by April 1993, all data for 1981-91 were incorporated into the new, redefined central database.

Following the modifications to the transaction-processing portion of the PacFIN system, the focus turned to developing new software to summarize the fish ticket data and combine the summaries with data on species composition and catch by area. A primary goal of the summarization procedures was the re-creation of the summary-catch tables for 1987-92 (see section 6.4.2 for a description of these data and tables). In the redefined system, the summary-catch tables are built directly from the fish ticket, species composition, and catch by area information submitted to the PacFIN system by the fishery agencies. Summary-catch tables (1987-92) for the U.S. Pacific coast states (Washington, Oregon, and California) became available from the redefined PacFIN database in October 1994.

The first significant users of the new, redefined system was the Groundfish Permit Office of the Northwest Regional Office (NWR) of the NMFS. During 1993, the staff of the NWR verified the fishing history for at least 950 groundfish permit applications using the redefined database. The development process of the redefinition project was formally completed in early 1994.

6.3.3 Vessel Summaries Subsystem

A number of other useful applications based on the redefined system were implemented long before the project was entirely completed. One of these was the "vessel summaries" subsystem. As the redefinition project was being developed, economists involved with the U.S. Pacific coast fisheries, as well as the U.S. Coast Guard, generally recommended that a set of catch summaries by vessel be generated for the years 1981 to the present. The newly requested summaries, which would be expanded later to include detailed information regarding the vessels, were intended to replace the vessel summaries that were originally part of the Research Database located at the Southwest Regional Office.

The subsystem produces and maintains two kinds of files. The vessel summary file contains aggregated landings and landed value information, and 13 other descriptors for each vessel; the trip-principal file contains other characteristics of the fishing vessels, such as principal port, principal gear type, and principal species landed.

Monthly and weekly vessel summaries were being distributed by September 1993. After a few enhancements had been incorporated, based on responses from economists and other interested parties, the vessel summaries project concluded in February 1994. Since then, the subsystem has received only minor changes.

6.3.4 Transition to UNIX/Oracle Computing Environment

In May 1993, the NMFS formally announced that all of the primary computing resources affiliated with the agency would be replaced by homogeneous hardware and software, namely the UNIX operating system and the Oracle relational database management system. This stipulation meant that the overall PacFIN system would need to be restructured, including discontinuing the current Unisys B7900 computer system. The new system, generally referred to as "Orca," was first made available to users, such as PacFIN, in February 1994, but because of various difficulties with configuring the Oracle software, effective use of Orca started in September 1994.

The PacFIN system resided on the same computer system from February 1981 until March 1995, when the Unisys B7900 system was shut down permanently. Prior to this event, the system had been redesigned for the Oracle environment, all necessary tables had been created, and all data had been transferred to the UNIX system and loaded into Oracle tables. Development and testing continued during 1995, and by March 1996, the transition was completed, including all changes that needed to be made to the QSM subsystem, transaction processing systems, aggregated-catch summaries, as well as fish ticket, species composition, and catch by area tables, which collectively are used to produce the final summary-catch tables.

As of August 1996, two major subsystems have yet to be converted to the new Orca system: the vessel summaries subsystem, and a suite of retrieval programs that generate standard reports. Both of these subsystems, once completed, will include capabilities otherwise not available to the PacFIN user community.

6.3.5 Limited-Entry Permit Subsystem

In August 1995, the PacFIN system began accepting limited-entry permit data that were being collected from specific groundfish fisheries. In October 1995, it became possible to access and retrieve limited-entry permit data from the PacFIN system. The limited-entry permit data are collected from each applicant by the Permit Office of the Northwest Regional Office, stored in a computer system developed and maintained by the Permit Office, and then submitted to the PacFIN system twice a month.

6.4 Current PacFIN System

6.4.1 Overall Data Flow

All information included in the PacFIN system is received from the following data sources: four state fishery agencies (ADFG, WDFW, ODFW, and CDFG), two NMFS Regional Offices (AKR and NWR) and a NMFS Science Center (AFSC), U.S. Coast Guard (USCG); and Department of Fisheries and Oceans of Canada (DFO). Information contained in the PacFIN system is originally submitted as a transaction type or as a data file by one of the nine data sources above (Table 6.1).

All data destined for the PacFIN central database are imported into the Orca computer system using one of five methods: 1) file transfer directly into Orca using Internet communications initiated at either the sending or receiving end, 2) file transfer to a computer bulletin board at the PacFIN office and via the Internet to Orca, 3) diskette delivered to the PacFIN office, with the data then transferred to Orca, 4) 8-mm UNIX tape containing an ASCII file, with subsequent data transfer to Orca conducted by operations staff at the PacFIN office, or 5) 9-track tape, which in recent years has not been used by the data sources to transfer data.

Data are submitted or updated at different times, depending on the agency. Data are submitted monthly by WDFW, ODFW, and CDFG. The AFSC submits data on a weekly basis for the Pacific hake vessels that process catches at sea. The ADFG and AKR also provide data weekly. The DFO is scheduled to provide preliminary data each May for the previous calender year, with a final update due in November. Data for the limited-entry history file are submitted twice-monthly by the NWR. The USCG provides the vessel data file annually. It is important to note that data are not always submitted according to the above schedules. For example, data have arrived in the PacFIN office as much as a year behind the agreed-to schedule. For the most part, agencies submit their data in a timely fashion, e.g., the WDFW, ODFW, and CDFG consistently provide data by the 14th of each month. Data completeness varies, however. The ODFW data are normally 90-95% complete 15 days after the end of each month, whereas CDFG data are usually about 90% complete 2-3 months after the end of each month.

6.4.2 PacFIN Database Tables

All of the data submitted by the fishery agencies are validated, to some degree, and then stored in PacFIN database tables (Table 6.2). For purposes of brevity, database tables have been grouped into broad categories, and descriptions are general and primarily applicable to groundfish fishery data that are submitted by the WDFW, ODFW, and CDFG.

Code list tables

Code list tables for descriptors such as species, area, gear type, port/country/JV, and agency are created with data that: 1) originated from within the PacFIN system, or 2) have been submitted by the agencies (data sources). For the most part, code list tables are used to validate, update, retrieve, and provide general descriptions of the data that populate the central database of PacFIN. Currently, there are 11 code list tables: 6 that are created from data originating within the PacFIN system, referred to as species (SP), area (AR), gear type (GR), port/JV/country (PC), agency (AG), and code list (CL) tables; and 5 that address the relationships between codes created by the agencies and codes created within PacFIN, referred to as agency-species (ASP), agency-area (AAR), agency-gear type (AGR), agency-port (APR), and agency-processor (APC) tables.

The species codes used in the various PacFIN database tables, such as the fish ticket tables discussed below, do not necessarily denote a single species of fish, but may refer to a collection of species that have been landed within a single market category. For example, although fish ticket information submitted by the ODFW and CDFG contains a listing for yellowtail rockfish, this reference is actually a market category that contains primarily yellowtail rockfish, but often includes other species as well. Market categories for rockfish are sampled by the state fishery agencies to determine the actual species composition of the categories (see sections 2.4, 3.4, and 4.4 for detailed discussions of the species-composition sampling programs conducted by the individual states). However, in other database tables, species codes do refer to a single species. For example, in the proportion tables described below, the proportion estimates for rockfish are based on additional data that have been collected from the sampling programs for rockfish species composition.

Fish ticket tables

Fish ticket information provided by the fishery agencies is included primarily in two database tables. The fish ticket (FT) table contains delivery-specific information, where each row of the table contains attributes of a completed fish delivery. The fish ticket lines (FTL) table contains market category-specific information, where each row of the table contains attributes of the market categories included on a corresponding fish ticket.

Proportion tables

The PacFIN central database contains three tables that are collectively referred to as proportion tables (ACM, SCM, and ECM tables). The data contained in these tables, along with data from the fish ticket tables, largely distinguish the redefined PacFIN system from the earlier system.

The catch-by-area composition (ACM) table contains proportions that are used to distribute catch to PSMFC areas for specified "strata" (e.g., species/port/gear type/time period). A fifth attribute, grade (size of fish), is commonly included with the four attributes above to specify strata for landings of sablefish. Catch-by-area transactions are used by the WDFW and ODFW, but are not currently utilized by the CDFG, which uses ports to identify specific PSMFC areas where catches were made (see sections 2.6, 3.6.1, and 4.6.1 for discussions regarding procedures used by the individual states to apportion catches to geographical areas).

The species-composition (SCM) table contains proportions that are used to distribute catch to individual rockfish species for specified strata (e.g., rockfish market category/port/gear type/PSMFC area). Species-composition transactions are used by the WDFW, ODFW, and CDFG. The estimated proportions of species composition for rockfish market categories are determined from data collected through sampling programs conducted by the individual states (see sections 2.4, 3.4, and 4.4 for further discussion regarding these data collection programs).

The effort-by-area composition (ECM) table contains proportions that are used to distribute effort to PSMFC areas for specified strata (e.g., management group/port/gear type/time period). Management group refers to the actual fishery that the data were collected from, such as the groundfish, salmon, or shrimp fisheries. This table is similar to the catch-by-area composition table, but the fishery descriptor that is being apportioned is effort (number of deliveries and trawl hours) rather than catch. Effort-by-area transactions are currently used only by the ODFW.

Summary tables

Catch and effort statistics that have been summarized within the PacFIN system are included in four primary database tables: summary-catch (SC) table, detail-catch (DC) table, summary-effort (SE) table, and detail-effort (DE) table. All statistics contained in these tables are derived from detailed information residing in other areas of the PacFIN central database.

The summary-catch tables contain reduced catch statistics that can be retrieved easily and quickly. The detail-catch tables are similar and related to the summary-catch tables. During 1981-86, aggregated-catch transactions (as opposed to individual fish tickets) were the only types of transmissions that could be used to submit catch data to the PacFIN system. The ADFG, AKR, AFSC, and DFO continue to use this process to submit catch data. Currently, the WDFW, ODFW, and CDFG use fish ticket and proportion tables to submit catch data, which are then modified into aggregated-catch transactions internally within the PacFIN system. The data contained in aggregated-catch input records are permanently stored in the detail-catch tables. The detail-catch tables (1981-86) for the WDFW, ODFW, and CDFG contain the original daily aggregated-catch records submitted by the respective agencies. The detail-catch tables (1987 to the present) for the WDFW, ODFW, and CDFG contain internally generated monthly aggregated-catch statistics. The summary-catch and detail-catch tables are consistent with each other for all years 1981 through the present.

The summary-effort (SE) and detail-effort (DE) tables contain three "measures" of fishing effort: number of deliveries, trawl hours, and days fished. Number of deliveries is essentially the number of fish tickets. Trawl hours is an estimate of the number of hours a fishing vessel is actually engaged in the act of fishing with its net in the water. Days fished is derived from information included in the fish ticket tables.

The summary-effort and detail-effort tables are structured in a similar fashion as the summary-catch and detail-catch tables, with the important distinction that summary statistics for effort can be obtained for certain management groups, but not for individual species. For example, the SC and DC database tables contain summarized catch statistics for sablefish, but do not include information regarding the number of deliveries or trawl hours associated with sablefish catches. The effort data for sablefish are combined with effort statistics for other groundfish species and presented as a single value for the entire groundfish management group, which is included in the SE and DE database tables. Summary-effort and detail-effort database tables are available for the years 1981-94; however, because these tables are currently receiving modifications, 1995-96 data are not yet available.

Other tables

The PacFIN central database includes several tables that are used in conjunction with the tables described above to produce various statistics on a routine or requested basis. Statistics generated through the Quota Species Monitoring and limited-entry permit subsystems are contained in QSM and limited-entry permit tables, respectively (see sections 6.3.5 and 6.4.5 for further discussion regarding these two subsystems within PacFIN). The state-vessels (SV) database table contains information regarding the commercial fishing vessels registered by each state to harvest fish. The USCG vessels (CG) database table contains selected attributes from the USCG's Merchant Vessels data file. Some of the vessel attributes included in this table are gross weight, length, horsepower, and the year the vessel was built. The non-vessel (NV) database table is an ancillary table that contains vessel identification information, which is created when the SV table is used to translate agency vessel plate numbers to either a USCG vessel identification number or a state marine board identification number.

The average-weights (AW) database table contains estimates of average weight that are subsequently used to calculate total estimates of the number of fish landed within a specified strata, such as species/port/gear/PSMFC area. The average-weights table is used exclusively by the ODFW for species of salmon, sturgeon, and shad.

The update-log (UL) and detail-log (DL) database tables contain information that is generated during processing operations within the PacFIN system. The dates associated with amended database tables are stored in the update-log table. The amount of data that enters the system following an update is included in the detail-log table; this information is subsequently used to determine how complete data transmittals are for each PacFIN data source (see section 6.4.5 for further discussion regarding data completeness).

6.4.3 Central Processing - Update

Update processing within the PacFIN central database is now conducted within a UNIX/Oracle environment. The suite of "update" software utilized in the PacFIN system is composed of the following programs and languages: Oracle's PL/SQL, Oracle's SQL*Plus, Oracle's SQL*Loader, and the 'C' programming language. Data submitted by the agencies are validated, to some degree, during update processing. Agency transactions that are "flagged" as invalid are reviewed by the agency's PacFIN coordinator, who is responsible for resolving the errors.

Although the central processing system includes some routines to validate submitted data, the content of each data file (i.e., the value of each datum) is strictly the responsibility of the individual agencies. That is, although input data are generally reviewed for possible errors, the central processing system does not include comprehensive validation routines at this time.

For the original fish ticket lines (FTL) data provided by WDFW, ODFW, and CDFG, the redefined PacFIN system includes update routines that provide estimates of landed value for catches that do not include price information. The FTL rows containing actual prices are used to build a temporary table of information on total pounds and landed value classified by market category, condition (e.g., dressed vs. whole), disposition (e.g., animal vs. human food), grade, port/country/JV, and gear type. This table of actual prices is then searched to determine an estimated price for each FTL row that is missing a price. Similar procedures are used to derive estimated landed values from the aggregated-catch transactions provided by ADFG, AKR, and AFSC. The DFO data source does not provide any economic data, and the PacFIN system does not attempt to estimate the landed values of Canadian catch transactions.

An important focus of the redefinition project was to improve and streamline methods for generating aggregated-catch statistics, which inherently involved modifications to internal summarization procedures for fish ticket data. The catch-by-area and species-composition data that are received by the WDFW, ODFW, and CDFG are applied to summarized fish ticket information (FTL data) to provide aggregated-catch statistics on a monthly basis. The following steps are used to process catch data that are received by the agencies: 1) monthly aggregates of FTL data are created, 2) catch-by-area proportions (ACM tables from agencies) are applied to the aggregated-FTL data, 3) species-composition proportions (SCM tables from agencies) are applied to both the aggregated-FTL data and summations resulting from the application of catch-by-area proportions to certain FTL aggregates, and 4) aggregated-catch transactions are generated.

The computation of monthly aggregates of FTL data begins by identifying those months that need to be summarized. This is determined by finding each month that occurs at least once in the set of FTL, ACM, and SCM transactions that have been processed. The aggregated fish ticket data are summarized by month, species, port, gear, and PSMFC area. This aggregation contains the following attributes of the catches: round-weight equivalent pounds, number of landings, number of fish, pounds that were actually priced, and estimated landed value. Statistics for the number of landings and the number of fish may not be available for certain species/species groups. It should be noted that all FTL data for the selected months are involved in this aggregation exercise, not just those that will be subsequently apportioned.

Catch-by-area (ACM) proportions that are submitted by the agencies are then applied to the monthly aggregations of fish ticket data for only those cells (i.e., month/species/port/gear type/PSMFC area) that have corresponding proportions in the ACM table. Note that many of the monthly aggregations of fish ticket data do not generally need to be apportioned by the catch-by-area proportions. The catch-by-area (ACM) proportions submitted by the agencies are then applied to the monthly aggregations of fish ticket data, but only for those aggregate combinations that have corresponding proportions in the ACM table. In general, many of the monthly aggregates do not need to be apportioned to catch by area because the data for area of capture on the fish tickets cannot be further refined. Those monthly aggregates that need adjustment for catch by area are aggregated over area, and the ACM proportions are applied so that each month/species/port/gear type aggregate is partitioned into one or more month/species/port/gear type/area aggregates. Currently this process only apportions the data into PSMFC areas. The new aggregates replace the original ones so there is no "double counting" and no changes in the total pounds landed. Data on number of landings are set to null for any aggregation derived by applying either catch-by-area or species-composition proportions. The present system makes adjustments for catch-by-area to three categories of groundfish data: WDFW data from Puget Sound, WDFW from coastal waters, and ODFW data with area equal to "unknown."

At the next step of processing, the monthly aggregates for rockfish market categories are apportioned into monthly aggregates by rockfish species. This processing is applied both to the aggregates that were apportioned to area and those that were not. Species-composition proportions (in table SCM) are currently applied only to rockfish market categories, but similar proportions could be applied to any market categories for which the agencies were able to provide species-composition proportions. The SCM proportions are applied by matching them with the monthly aggregates of fish ticket data based either on month/species/gear type/area/port or based on month/species/gear type/port. The aggregate values for round weight, number of fish, pounds priced, and estimated landed value are apportioned by multiplying each by the corresponding SCM proportion. Data on number of landings are unavailable for any aggregations that were derived by applying either ACM or SCM proportions.

The fourth and last step of update processing generates aggregated-catch transactions to update the summary tables (DC, DE, SC, and SE); for example, to delete outdated summary statistics and replace them with recent statistics. The sources of these transactions can either be the agencies (ADFG, AKR, AFSC, or DFO) that directly provide aggregated data or the previous steps in the summarization process (for the FTL data provided by WDFW, ODFW, and CDFG).

The following example illustrates the process. Suppose new landing data are received. The new information is validated and then inserted into the detail-catch (DC) and detail-effort (DE) tables. In addition, a copy of each transaction is saved and used to update corresponding summary statistics in the summary-catch (SC) and summary-effort (SE) tables. For each transaction to the DC and DE tables, five vectors are developed to update the data in the SC and SE tables, one each for period, species, area, gear type, and port. For all possible combinations of the items in these vectors, values are generated for the summary-statistics round weight in pounds, number of landings, number of fish, estimated landed value, and pounds with prices. The generated values are then used to modify the information in the SC and SE tables. A single change to the data in the DC table results in a multitude of changes to corresponding data in the SC table because the information is contained in a suite of alternative summarizations in the SC table.

For example, if the new data represented catches of Dover sole taken in May from PSMFC area 2C by longline gear and landed at the port of Astoria, then the period vector would include items for the month of May and for the annual period; the species vector would include items for Dover sole, flatfish, and groundfish; the area vector would include items for PSMFC area 2C, INPFC area Columbia, Pacific Council region, and all regions; the gear-type vector would include items for longline, hook and line, and all gear types; and the port vector would include items for Astoria, the Columbia River (Oregon) port group, all Oregon ports, all domestic ports and at-sea processors, and all ports/joint ventures/foreign countries.

6.4.4 Central Processing - Retrieval

There are two primary methods for retrieving data from the central PacFIN database: using SQL*Plus routines or using specialized reporting programs. SQL*Plus is a general-purpose database query language that is an integral part of the Oracle relational database management system. PacFIN users who have access to the Orca computer system in Seattle can develop their own SQL*Plus routines. Alternatively, the PacFIN staff have developed a large suite of SQL*Plus routines for retrieving information from the PacFIN central database. A document entitled "Using Unix and Oracle to Access PacFIN Data," which is available upon request from the PacFIN office, gives an introduction to these SQL*Plus routines, as well as other information for new users. These routines can be used to retrieve selected data or can be used as templates for users who wish to develop their own custom retrievals.

The other mechanism for retrieving information from the PacFIN database is to use one of the six reporting programs that have been developed as exact replacements for the reporting programs that were part of the earlier PacFIN system. Examples of the reports produced by these programs, which have become known as the "PacFIN standard reports" (see section 6.2.1), can be found on the PSMFC homepage on the World Wide Web (http://www.psmfc.org). As of this writing, the subsystem for generating PacFIN standard reports is still in development. When it is complete, Orca users will be able to generate their own standard reports; but until then, selected standard reports will be produced by the PacFIN office and made available as described above (see section 6.2.1).

6.4.5 Data Completeness

Data completeness for each PacFIN data source is determined using a variety of indicators; two straightforward methods are presented here. One method involves tracking the amount of data that enters or leaves the PacFIN system during update processes. The detail-log database table includes the total pounds that have been added (or deleted) for each month for all groundfish transactions. Another method used to help determine data completeness is to compare the historical catches that are presented in the summary-catch tables. For example, the monthly totals for catch for the most recent year can be compared to catches from earlier combinations of year and month to obtain rough percentage estimates of completeness in the most recent year.

6.4.6 Confidentiality of Data

The PacFIN central database contains "confidential" information, where the economic history of individual fishing vessels and fish processors can be determined from the contents of the fish ticket tables (FT and FTL tables).

Access to confidential data is regulated through rules established by NMFS, under the National Oceanic and Atmospheric Administration (NOAA). The rules stipulate that the only information that can be made available to the general public are those statistics that do not reveal the economic activity of individuals or corporations. In order to adhere to the confidentiality rules set forth by NOAA, the PacFIN office requires users of confidential data to sign a "Certificate of Non-disclosure of Confidential Fisheries Data." Access to confidential data is restricted to individuals participating in PFMC activities that require the use of confidential information. However, other individuals who have contracted with the PFMC on particular projects are also granted access to confidential data, given they sign the above Certificate and agree to destroy the data after completing the study. Only employees of NMFS and other Data Committee member agencies are considered for on-line access to the PacFIN system.

6.5 Acknowledgments

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6.6 Citation

Daspit, W. P. 1996. A description of the Pacific Fishery Information Network (PacFIN) 1981-1996. Unpubl. manuscr., 39 p. plus appendices. (Available from Pacific States Marine Fisheries Commission-PacFIN F/AKC, Building 4 - Room 2066, 7600 Sand Point Way NE, Seattle, WA 98115.)

Table 6.1. Data files and transaction types submitted by agencies that contribute information to the PacFIN system (1996). The letter "x" denotes the transaction type or data file that is submitted, and an empty cell denotes the information that is not submitted to the PacFIN system.

Data file/ Transaction type	Agency*								
	CDFG	ODFW	WDFW	ADFG	AKR	AFSC	DFO	USCG	NWR
Agency code list	x	x	x						
Fish ticket	x	x	x						
Fish-ticket lines	x	x	x						
State-vessels	x	x	x						
Species-composition	x	x	x						
Catch-by-area composition		x	x						
Average-weights		x							
Effort-by-area composition		x							
Aggregated effort	x	x	x				x		
Aggregated catch				x	x	x	x		
Merchant vessels (U.S.)								x	
Limited-entry permit									x

*Agency titles follow: CDFG is the California Department of Fish and Game, ODFW is the Oregon Department of Fish and Wildlife, WDFW is the Washington Department of Fish and Wildlife, ADFG is the Alaska Department of Fish and Game, AKR is the Alaska Regional Office of the National Marine Fisheries Service (NMFS), AFSC is the Alaska Fisheries Science Center of the NMFS, DFO is the Department of Fisheries and Oceans of Canada, USCG is the U.S. Coast Guard, and NWR is the Northwest Regional Office of the NMFS.

Table 6.2. Database tables maintained within PacFIN.[a]

Table	Acronym	Description
Species code list	SP	PacFIN codes for species of fish
Area code list	AR	PacFIN codes for area fished
Gear-type code list	GR	PacFIN codes for types of fishing gear
Port/JV/Country code list	PC	PacFIN codes for ports/joint ventures/countries
Agency code list	AG	PacFIN codes for agencies (data sources)
Code list	CL	PacFIN codes for miscellaneous fields
Agency-species code list	ASP	Agency codes for species of fish and corresponding PacFIN codes
Agency-area code list	AAR	Agency codes for area fished and corresponding PacFIN codes
Agency-gear type code list	AGR	Agency codes for types of fishing gear and corresponding PacFIN codes
Agency-port code list	APR	Agency codes for ports and corresponding PacFIN codes
Agency-processor code list	APC	Agency codes for fish processors
Fish ticket	FT	Fish ticket data, one entry for each delivery of fish (i.e., each fishing trip)
Fish-ticket lines	FTL	Fish ticket data, one entry for each category of fish delivered
Catch-by-area composition	ACM	Area fished data
Species-composition	SCM	Species-composition data
Effort-by-area composition[b]	ECM	Fishing effort data
Summary-catch	SC	Catch summaries for combinations of time period, species, area, gear type, and port
Detail-catch	DC	Catch summaries aggregated by day, week, or month
Summary-effort	SE	Effort summaries for combinations of time period, species, area, gear type, and port
Detail-effort	DE	Effort summaries aggregated by day, week, or month
State-vessels	SV	State-vessel registration records
U.S. Coast Guard vessels	CG	Selected attributes from U.S. Coast Guard vessel registration records
Non-vessel	NV	Data not found in SV table, primarily tribal ID data
Average-weights[b]	AW	Average-weight data
Update-log	UL	Processing data, one entry for each update transaction
Detail-log	DL	Processing data, catch added during each update event by management group and month

[a]For a thorough description of each database table, see:

Daspit, W. P. 1996. A description of the Pacific Fishery Information Network (PacFIN) 1981-1996. Unpubl. manuscr., 39 p. plus appendices. (Available from Pacific States Marine Fisheries Commission-PacFIN F/AKC, Building 4 - Room 2066, 7600 Sand Point Way NE, Seattle, WA 98115.)

[b]Tables contain only data submitted by the Oregon Department of Fish and Wildlife; AW table includes only average-weight data for salmon, sturgeon, and shad.

CHAPTER 7

COMPARISON OF THE WASHINGTON, OREGON, AND CALIFORNIA GROUNDFISH DATA SYSTEMS AND DISCUSSION OF POTENTIAL FOR IMPROVEMENTS

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7.1 Introduction

The working group's main purpose in preparing this Technical Memorandum was to describe the existing systems in Washington, Oregon, and California for data collection and data processing of shoreside landings and associated effort for the commercial groundfish fisheries. The groundfish fisheries off the U.S. Pacific coast face common management problems, and in many cases involve stocks that are fished by fleets based in more than one state. There are broad similarities between the groundfish fisheries in each state. Each state has landings that are dominated by trawl fishers (ranging from about 75% of the landed biomass in California to 96% in Oregon). The bulk of the landings occurs at relatively few discrete ports in each state. Even in California, where the fishery is spatially most diffuse, approximately 70% of the landed biomass of groundfish occurs at just five ports in the northern half of the state. The states also share many of the same important species and species groups. Sablefish, Dover sole, Pacific hake, and a diverse group of rockfish, including thornyhead and widow rockfish, are important in all of the fisheries.

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Thus, there is potential that increased standardization of the commercial groundfish data systems of the Pacific states would either improve the information available to fisheries managers or allow the same information to be collected more efficiently. We believe that an important preliminary step to improving and evaluating potential benefits of adopting any further standardization of coastwide protocols was to prepare the description of the existing systems contained in the preceding chapters. Much can be learned by considering the similarities among the state systems and exploring why differences exist. Also, the preceding chapters collectively represent an important source document for users of the groundfish data produced by the individual states. Many important characteristics of the various databases and estimated quantities documented in the previous chapters would be difficult for users to uncover in a reasonable period of time. This review of the general sampling designs and data systems used by the three states will be useful for those involved in the production and management of fisheries data in other regions.

7.2 Similarities and Differences Among the State Systems

The commercial groundfish data systems that have evolved in the three states have the following major components: 1) fish receipt systems in which landings are reported by market categories, 2) logbook systems in which fishing hours and locations of fishing are reported, and 3) sampling programs in which the composition of landings in various market categories is evaluated. The data collection systems for fish receipts are fundamentally similar in each of the states. The fish receipt systems are intended to function as complete censuses of the quantities of commercially landed groundfish. In practice some landings certainly go unreported, and there can be undetected errors in data entry. Dealers are required to submit receipts (also called fish tickets) at the time fish are sold. These receipts include the weight in each of a number of market categories and the values of those categories. Some market categories are essentially equivalent to single species, other market categories (particularly for rockfish) represent mixtures of different species, with the exact composition unknown, and still others represent subcategories within a species (e.g., different size classes). All three states stress rapid initial data entry so that reported landings can be forwarded to PacFIN (Pacific Fisheries Information Network) for use in in-season quota management. Data entry is then followed by various methods of error screening and correction.

The major practical difference among the states in their fish receipt systems is that different numbers of market categories, representing differential amounts of sorting, are defined. For example, in California, rockfish are landed in 57 categories as of 1992, while only six rockfish market categories are defined in Oregon. In California, market orders are often made for specific types of rockfish, which has led to subsorting of categories prior to actual sampling visits by port biologists. We suspect that these same market forces could cause the frequency of such subsorting to increase in Oregon and Washington in the future.

Logbooks originated as a method for monitoring fishing effort (hours of fishing). These data are important for defining the geographic location of both catch and effort. A standardized and mandatory trawl logbook is used coastwide, compliance is monitored, and the resulting data are computerized and maintained by all three states. Although logbooks exist for other components of the groundfish fishery, in most cases these are voluntary or there are compliance problems. In general these other logbooks are not integrated into the groundfish data systems, and much of the information is neither computerized nor maintained in long-term agency databases. Because a standardized trawl logbook is used, the raw data for all three states are similar. In each state, the original logbooks contain estimates of the species composition and magnitude of the catch on a tow-by-tow basis, along with information on the location of tows, gear used, depth fished, fuel used, ports of departure and landing, and other related information. Some differences arise in the way logbook data are edited, keypunched, and processed because of differences in how the data are currently being used and how they have been used in the past. For example, in California and Oregon, the logbook data are matched with the fish receipt data to produce an adjusted logbook database, with total trip landings for a market category matching the landings for that trip in the fish receipt database. This approach allows allocation of accurate information on retained catch from individual trips recorded on fish receipts to specific locations, as might be desired in the preparation of environmental impact statements or for a Geographic Information System (GIS). Washington does not match the logbook data to fish receipts on a trip-by-trip basis, and thus does not produce an adjusted logbook database. Furthermore, the particulars of how fish receipts without matching logbooks are handled differ between California and Oregon. Another difference among the states is in the precision with which location of catch data are keypunched.

For management purposes, it is necessary to assign landings to an area of capture. In Washington and Oregon, this is done for the trawl fishery using logbook data because information on area of capture in the logbooks is more accurate and complete than in the landing receipt data. In California, landings are assigned to the same area in which they are landed. The proximate explanation for the different approach in California is that there has been a backlog of logbook data to be keypunched for a number of years. As a consequence, logbook data could not be used in a timely fashion. This backlog, however, is the result of a choice in how limited resources were used. This choice can be best understood by considering how the composition and behavior of the California fishing fleet differs from that in the other two states.

The vessels operating in California are generally smaller and fish closer to their home ports than the fleets in Oregon and Washington. The greatest number of vessel-months of fishing are made in California, but with the smallest average landings per trip, whereas the fewest vessel-months of fishing with the largest average landings per trip are made in Washington (GMT 1991). These differences are seen within the trawl fleet and are further accentuated by the greater importance of non-trawl gear in California, which is usually operated from smaller vessels. It is also the case in California that major ports are generally located far from the boundaries of International North Pacific Fisheries Commission (INPFC) areas for which landings are reported.

Although both Oregon and Washington use logbook data to assign landings to specific management areas, they do this in substantially different ways. In Oregon, logbook data are matched to the fish receipt data to identify the catch location for individual landings. In

Washington, fish receipts and logbook records are not matched on a trip-by trip basis. Instead, the distribution by area of catch for each market category is calculated from the hailed weights in the logbooks. This distribution is used to apportion landings to areas. A similar approach is used by Oregon to allocate landings for those cases where a fish receipt record cannot be matched in the logbook database. In Washington, logbook data are used to apportion landings to areas much more rapidly than is the case in Oregon.

Each of the states have programs for sampling portions of the groundfish fishery. Each state samples rockfish landings and participates in coastwide sampling programs for sablefish. Oregon and California participate in a federally organized sampling program for lingcod that started in 1991, while Washington samples lingcod as part of an ongoing state sampling program. Oregon and California also participate in a federally organized sampling program for shore-processed Pacific hake. Each of the states also has sampling programs for species that have special importance locally. Differences among the states' sampling programs generally reflect the relative importance of different species or groups of species to each of the states' fisheries.

In each state the primary purpose of the rockfish sampling program is to provide information on the species composition of rockfish market categories, which often consist of several to many species. This allows total landings to be estimated for individual species. Sampling is also done to provide information on age, length and sex compositions, and other biological information for targeted species.

The sampling process for determining species compositions of landings of rockfish is similar in California and Oregon. In Oregon, estimates of species composition are made for each market category by port, quarter, gear, and area of capture. Data are partitioned similarly for estimates in California, except that all landings from a given port are assumed to have occurred in a single known area. The samples consist of two or more fixed-weight clusters (basket subsamples) selected from a market category contained within a boat trip. The fish in these samples are then counted and individually identified. There is no attempt in this sampling scheme to completely describe individual trips, because all market categories are not sampled on each trip.

The sampling approach to determine species compositions of rockfish landings in Washington differs fundamentally from that used in the other two states. The sampling plan reflects greater attention to the process of assigning species-specific landings to management areas. Only landings of market categories that can be assigned to an individual Pacific States Marine Fisheries Commission (PSMFC) statistical catch area are sampled. The sampler will examine the landings from a trip for a given market category and record the PSMFC area and, based on a visual examination, the species composition of that market category. The estimated landings by species for the sampled landings are then used to obtain estimates for each area within a given time period. In California and Oregon, the sampled landings from a trip could come from more than one PSMFC area.

The use of visual estimates in Washington allows a higher sampling rate and more frequent complete sampling of all market categories within a trip than would be possible following the sampling protocols used in California and Oregon. The approach in Washington allows more information to be compiled on a trip-by-trip basis, but there may be a greater potential for sampler selection bias. There is, however, evidence that samplers can estimate the species composition of a trip reasonably well by visual inspection. Currently, it is not feasible to compare objectively the sampling schemes used by each state, because the relative variability in the resulting estimates from each state is unknown. While the species compositions are very accurate for sampled clusters in California and Oregon, and the within-trip variability is known to be low, relatively limited numbers of trips are sampled due to the increased time needed to process these subsamples.

The greater fragmentation of rockfish landings into different gear types and market categories in California sometimes leads to unsampled "cells" (market category/port/quarter combinations) (Pearson and Almany 1995). This has led to a process by which unsampled landings in particular categories are assumed to be similar to other categories or the same category sampled in other locations and places. The frequency of unsampled "cells" is less in the other two states, although it is not uncommon for non-trawl gear in Oregon. When this situation occurs in Washington, the species composition is left as "unknown." In Oregon, sample data are "borrowed" to fill in missing cells as in California, although the process differs in the details of its application.

Washington and Oregon determine biological characteristics of the rockfish landings, such as age, sex, and length compositions of the catch, by taking special samples of targeted species. California, by contrast, collects this information by examining fish in a subset of the samples used for determining species compositions. Although only targeted species are sampled for purposes of age determination, the sex and length are recorded for all of the fish in the California species-composition samples. In part, this difference may be due to the greater diversity of the catch in California. One consequence of the biological sampling program used in Washington and Oregon is that boat trips with relatively small landings may go unsampled because of the difficulty in obtaining a sufficient number of fish for a sample.

Age and length compositions are widely used in stock assessments of groundfish, but currently none of the states provide such estimates or the raw data to the PacFIN system. California regularly produces estimates of age and length compositions for rockfish, thornyhead, and Dover sole for the trawl fishery, weighting the samples by the size of the market category landings. Oregon produces estimates of age and length compositions by special request for species included in their biological sampling program. The Oregon calculations are done using weighted or unweighted estimators, depending upon how the researcher requests the information. Washington also generates age compositions by special request, and produces weighted or unweighted estimates as deemed appropriate by an individual analyst. Routine generation of age or length compositions is not done as part of any of the federal sampling programs. When needed, age compositions have been generated from the raw data by particular scientists who are involved in assessments concerning stocks sampled through the federal programs.

7.3 Logistical Constraints

Attempts to improve data collection and processing systems need to keep in mind the physical constraints of the systems and the limits of personnel and money that inherently constrain most sampling programs. Historically, one problem faced by the port sampling programs has been that data requests from outside parties have often been generated in isolation from one another. In practice, however, it is the same people who sample Pacific hake, rockfish, and sablefish, and any increase in sampling intensity for one of these species usually results in less sampling of the others. There is a clear and urgent need for coordinated management of all the data requests being made of these sampling programs.

The dynamic nature of the groundfish fishery needs to be kept in mind as data systems are designed and revised. Because the fishery is changing rapidly and will continue to do so, it is unreasonable to view the evaluation of sampling designs and estimation methods as a one-time task. Choices about how to "fill in" unsampled ports and market categories, or where and when to allocate sampling effort, will need to accommodate the changes in the fishery.

Finally, we note that the features of the U.S. Pacific coast groundfish fishery, like those of most fisheries (e.g., Tomlinson 1971), prevent us from often obtaining truly random samples. Although analysis of existing data could suggest possible ways to improve sampling, any such analyses should keep in mind the reality of the sampling situation as distinct from the ideal models on which discussions in many sampling texts are based. In virtually all cases, samples and subsamples that are treated as being selected at random are in some sense being selected systematically. Subsamples taken within trips are deliberately selected from different parts of the catch, and within time periods there are usually attempts to sample trips spread out over time; however, for a given trip it is often more efficient to sample more than one market category. Also, some portions of the fishing fleets may be over- or underrepresented because of the relative ease of obtaining samples. All of these facts could act to make calculated means and totals and their variances differ from actual ones in a systematic fashion. The danger of introducing such unforeseen biases should always be kept in mind when considering ways to improve the sampling programs. Because the fisheries differ among the states, an approach that works well in one state might well have serious problems in another state.

7.4 Opportunities for Standardization

The PacFIN system is one source of aggregated data, estimates, and original data that are used in fishery assessments and for other purposes. Currently, the PacFIN system provides access to original fish receipt data for Washington, Oregon, and California in a standardized form. Other data are provided to PacFIN in an aggregated format or as estimates for specified strata. Within the context of this revised PacFIN system, we believe that greater comparability of estimates could be achieved by standardizing routine calculations across the states before the aggregated or estimated quantities are provided to PacFIN. Even when calculations differ between the states because of variations in sampling design or characteristics of the data, consideration for the same sets of issues and concerns in each state could make data more compatible across state boundaries. Further pooling of ideas and experiences for common data-processing problems (e.g., how to assign landings to areas) could potentially increase the quality of the data and could prevent the use of different ad hoc procedures by the individual states for the same problems.

One area for possible standardization is in estimating species compositions for unsampled market category, time period, and gear combinations. A first step would be to evaluate the current approaches and possible alternatives. Another example where standardization is possible is in the calculation of variances for estimated species compositions. The current revisions to PacFIN will allow variance estimates (coefficients of variation) for estimated proportions to be included in the species-composition records in the system. Although other measures of performance are possible (e.g., sampling rates per ton of landings or estimated confidence intervals), we think that regular reporting of these variances within the revised PacFIN system provides the most immediate potential for providing information on the quality of the species-composition data. Large coefficients of variation may indicate small sample sizes and incomplete sampling coverage, and small coefficients of variation may reflect strata that have been 'over-sampled.' However, unless the estimators used by the different states account for the same sources of variation and make logically compatible assumptions, it will be difficult to compare the estimates objectively.

California and Oregon have essentially identical sampling programs for species composition, and unless the characteristics of the data are quite different, these states should probably calculate variances in the same way. In any case, given the similarity of the sampling programs, it seems reasonable that the same considerations and alternatives should be addressed in each state. Sen (1984, 1986) discussed various potential estimators in light of the California system as it existed in the early 1980s. Crone (1992a, 1992b, 1995) has discussed variance estimators for the Oregon system. These existing studies could form the foundation for adopting a common approach to variance estimation.

Although the species-composition sampling program in Washington differs substantially from that used in Oregon and California, similar issues and considerations need to be addressed in estimating variances for the species compositions. For example, there is still the need to combine the within-trip (and market category) component of the variance with the between-trip component. In Washington, the within-trip component arises from differences between the sampler's visual estimate and the actual composition for the trip.

For some purposes (e.g., environmental impact assessments that require geographic information on catch locations, and stock assessments that require age and length compositions), researchers require types of data that are not in the PacFIN system or data that are in their original unprocessed and unaggregated form. For these data, adoption of coastwide standards could also provide benefits. Such standard databases could facilitate the use of original data by stock assessment scientists and other researchers. A common format would reduce the amount of documentation and learning required to use the data and avoid unnecessary pitfalls. The resources needed to develop, maintain, and document the standards would be considerable. Such a system would have to be dynamic to accommodate the changing nature of the fisheries it would support. The most significant impediment to standardization may well be the inevitable hesitancy of the current users within each state to support and develop a system that focuses primarily on general problems common to all of the states and secondarily on state-specific problems.

Although complete standardization may be unobtainable, standardization in some areas could be achieved. We believe that there would be benefits by standardization of the logbook databases to make detailed information on catch and effort available from the entire region. The creation of uniform processed logbook databases could facilitate GIS applications of the data for fishery management, environmental impact assessments, and fundamental research. This would need to be done with care so that useful information available in the existing databases for some states (e.g., precise positions, individual tow information, and adjusted catches) is not lost in the quest for uniformity. Another concern is that the confidentiality of information provided by individual vessels would need to be maintained.

Complete standardization of species composition and biological sample databases is currently impossible because each of the states collects the information in different ways. At this point, attention may be better directed at considering the differences in how the data are collected and summarized, and whether standard approaches are advisable.

As noted above, Washington uses a fundamentally different sampling approach for determining rockfish species composition than the other states. A comparison of the sample selection approaches would require collecting information in each of the states on costs and lost sampling opportunities, as well as information regarding the magnitude of the within-trip variability associated with the sampling program in Washington. Substantial resources, both money and manpower, would be needed to develop and conduct a research study that addresses these very important issues regarding optimal features of commercial fishery sampling designs.

Currently, only California generates standard reports with estimated age and length compositions. The other states support software for generating these compositions but respond to specific requests and allow flexibility in the algorithms used, the major option being whether to weight the samples by the size of the landings. The analytical approaches used in Oregon and Washington provide additional flexibility by allowing a suite of estimation procedures to be employed that best accommodate the sample data. However, a rational choice among estimation methods could require extensive analysis of the original data, a consideration of how they were collected, and substantial knowledge regarding sampling theory and application. Consequently, we believe that a review of this issue would result in considerable benefit, perhaps leading to general recommendations and standardization in analysis.

The consequences of the different methods for collecting biological sample data among individual states also need evaluation. In Oregon and Washington, special biological samples are taken for targeted rockfish species. In California, biological data are collected for all rockfish appearing in species-composition samples. The California sampling approach allows some evaluation of changes in the population structure of minor species (e.g., Pearson and Ralston 1990), but reduces effort that could be exerted toward major species. The difference among the states may be reasonable, given the greater diversity of the landed rockfish species in California. However there would be value in quantifying the actual costs and benefits associated with the biological sampling programs currently in place in each of the states.

Another possible area for standardization concerns how landings are allocated to area of catch. The three states use different approaches, and only Washington takes area of catch into account in the choice of species-composition samples. The approach of each state seems reasonable in isolation, but in no case is it known how the estimates would vary using an alternative approach. Standardization across all three states would require major changes to the data-processing systems used in at least two of the states. However, existing data could be used to evaluate the sensitivity of the results generated from a particular approach.

7.5 Other Opportunities to Improve the System or Increase Efficiency

There are potential improvements to the data collection systems that do not necessarily require more standardization. One example is the process by which species compositions for rockfish in California are derived for market category, port, time period, and gear combinations for which there are no sample data. Although the process used in the past is reasonable, there are other equally plausible approaches. This is an area that has recently been explored by analysis of existing data (D. E. Pearson, NOAA, NMFS, Southwest Fisheries Science Center, Tiburon Laboratory, 3150 Paradise Drive, Tiburon, CA 94920. Pers. commun., December 1995). The emphasis of these analyses has been to identify certain types of samples that should be collected, or places where sampling effort could be reduced. This is critically important because the large number of market category/gear combinations in California appears to be market driven, may increase over time, and similar fragmentation may well occur in Oregon and Washington.

In Oregon and California, rockfish species-composition samples consist of two or more subsamples (clusters) from a market category. These subsampling protocols are also part of the lingcod and sablefish sampling programs. This is done primarily to allow the within-trip (and market category) component of the variance to be estimated. However, it is known through analysis of existing data that this component of the variance is usually small for rockfish, and this second-stage variability is likely small for lingcod and sablefish as well. In the past, for species-composition sampling of rockfish landings, the cost of selecting a second subsample for each sample was considered negligible because identifying trips to sample, rather than time spent sampling, was often limiting. However, with the increasing numbers of market categories and landings by small non-trawl vessels, this may no longer be true (B. A. Erwin, California Department of Fish and Game, 411 Burgess Drive, Menlo Park, CA 94025. Pers. commun., November 1995).

The absence of replicate subsamples would require additional assumptions to be made in variance calculations so that the within-trip component of the variance could be determined without compromising the validity of the estimates. There may be relatively little danger in this when the within-trip component of the variance is relatively small. Changes in sampling procedures involved in a multistage approach should not be adopted until investigations are conducted that address optimal sample-size allocations at each stage of the design.

Another opportunity to improve the system is to use existing information to regularly report performance measures for sampling programs. This could include coefficients of variation or variances for each derived or estimated quantity.

7.6 Recommendations

In our discussion of opportunities above, there are many implicit recommendations. An overarching recommendation is that more resources be devoted to analyzing existing procedures on an ongoing basis. These analyses need to be coordinated across the states to avoid redundancy and so that the approaches are acceptable to all parties involved. This kind of work would need to be directed by a coordinating group involved in coastwide sampling. It is clear that implementation of such work would require specialized skills and substantial efforts. The same coordinating group could also track ongoing sampling programs and intermittent data requests, and make recommendations to the agencies regarding priorities of different sampling programs. We strongly recommend that critical investigations be established to address the inherent issues of limited sampling resources and tradeoffs between data collection programs and the dynamic nature of the U.S. Pacific coast groundfish fishery.

Within the many specific areas where we have recognized potential opportunities for standardization and improvement, a few stand out as being critical areas for immediate work.

1. We believe that variance estimates associated with all species compositions should be estimated and that the methods used should be reviewed coastwide with a view towards standardizing assumptions, at least at the conceptual level.

2. Substantial efficiencies, both statistical and financial, would likely result from a detailed and thorough analysis of the costs and benefits of the different approaches used by the individual states to sample and estimate species compositions of rockfish landings and age compositions of landings associated with targeted species of groundfish.

3. **A critical evaluation of the methods used by the different states to allocate landings to fishery management areas (e.g., PSMFC areas) is urgently needed to ensure that stock assessments appropriately consider the spatial attributes of the sample information and, most importantly, to ensure that management advice is based on accurate representations of the sample data.**

4. We recommend that the logbook databases be scrutinized in a much more rigorous and timely fashion than currently is done. We feel that there likely exists a great deal of information in these logbooks that can benefit current stock assessments and the overall management of the groundfish fisheries off the U.S. Pacific coast. For example, changes in the spatial demographics of the fishing fleet and the targeted fish populations could be monitored using data contained in fishers' logbooks, and it may be possible to derive usable estimates of relative abundance (i.e., catch-per-unit-effort) that subsequently could be used to 'gauge' the reliability of the output produced from stock assessment modeling procedures.

7.7 Acknowledgments

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7.8 Citations

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Appendix A

Appendices A-1 - A-4 - Examples of fish tickets used in Washington, Oregon, and California

U

FISHER OR OWNER

ADDRESS DATE

BOAT NAME DEALER

GEAR WDF BOAT REGISTRATION BUYER

Fisher Signature
Under penalty of perjury, I certify that the information contained herein is true and complete.

Dealers Signature
Under penalty of perjury, I certify that the information contained herein is true and complete.

STATE OF WASHINGTON DEPARTMENT OF FISHERIES

MARINE FISH RECEIVING TICKET

Number of Days Fished

FISH CAUGHT INSIDE 3 MILES

FISH CAUGHT OUTSIDE 3 MILES

FISH CAUGHT OUTSIDE ENHANCEMENT ZONE

Catch Area

CIRCLE PHYSICAL GEAR ACTUALLY USED

OTTER TRAWL	32	SET NET	16	SET LINE	43	DRAG SEINE	12	HAND LINE	42	SHRIMP TRAWL	33	POT	23	TROLL	41	OTHER (specify)

DEALER USE	SPECIES CODE	SPECIES DESCRIPTION	POUNDS	PRICE	AMOUNT
	205	DOVER SOLE			
	206	ENGLISH SOLE			
	207	PETRALE SOLE			
	209	ROCK SOLE			
	212	STARRY FLOUNDER			
	231	LING COD			
	241	TRUE COD			
	221	SABLE FISH-SMALL ROUND			
	221	SABLE FISH-SMALL DRESSED			
	221	SABLE FISH-LARGE ROUND			
	221	SABLE FISH-LARGE DRESSED			
	251	ROCK FISH			
	254	PACIFIC OCEAN PERCH			
	283	DOG FISH-HUMAN USE			
	283	DOG FISH			
	244	HAKE			
	122	HERRING-BAIT			
	122	HERRING			

TAKE HOME FISH

Name and Signature of Person If Other Than Fisher

DEALER USE	SPECIES CODE	SPECIES AND DESCRIPTION	NO. OF FISH	POUNDS

NAME

SIGNATURE

NAME

SIGNATURE

1	2	3	4	5	6	7	8	9	10	TOTAL AMOUNT	LESS DEDUCTIONS		AMOUNT PAID

FORM FIS-DP-097 REV 10/93

Appendix A-1. Washington Department of Fish and Wildlife Marine Fish Receiving Ticket.

STATE OF OREGON
218942 95

FISH RECEIVING TICKET

3

GROUNDFISH & SHRIMP FISH RECEIVING TICKET

OREGON Fish & Wildlife

BOAT NAME & BOAT NUMBER	COMMERCIAL LICENSE NO	DATE
FISHERMAN'S NAME		DEALER NO / PORT OF FIRST LANDING: PORT CODE, PORT NAME
		DEALER NAME

GEAR: CIRCLE ONE	HOOK & LINE	BOTTOM LONG LINE	SHRIMP TRAWL SINGLE	SHRIMP TRAWL DOUBLE	MIDWATER TRAWL	BOTTOM TRAWL	FISH POTS	OTHER (SPECIFY)	AREA (DEPT USE ONLY)
	4	5	RIG 7	RIG 8	6	9	0		

DESCRIPTION		CODE		GROSS POUNDS	PRICE PER POUND $	CENTS	WEIGH BACK	NET POUNDS	AMOUNT
Pacific Cod (True Cod)		201	00						
Sole — Petrale		608	00						
— Sand		634	00						
— English		626	00						
— Rex		610	00						
— Dover		624	00						
Sand Dab		604	00						
Arrowtooth Flounder		606	00						
Rockfish large		410	00						
Widow Rockfish		431	00						
Yellowtail Rockfish		433	00						
Pacific Ocean Perch		413	00						
Black Rockfish		442	00						
Canary Rockfish		451	00						
Lingcod		484	00						
Sablefish	x-small	477	1						
Circle One:	small	477	2						
• Round 0	medium	477	3						
• Dressed 2	large	477	4						
Shrimp		801	00						
TOTAL (For Dealer Use)									
TAKE HOME FISH AND OTHER DEALER ADJUSTMENTS									

FD 1078 Rev 4/95

I CERTIFY THAT THE ABOVE IS TRUE AND CORRECT

DEALER'S SIGNATURE

FISHERMAN'S SIGNATURE

GROUNDFISH & SHRIMP RECEIVING TICKET

Appendix A-2. Oregon Department of Fish and Wildlife Fish Receiving Ticket. This ticket reflects revisions through 1995 (e.g., black rockfish and canary rockfish have separate market categories).

CALIFORNIA DEPARTMENT OF FISH AND GAME

PERMIT # | MONTH | DAY | YEAR | C | SEE 2ND PAGE

FISHERMAN LAST NAME | F. I. | I.D. NUMBER L | PORT OF FIRST LANDING | LOCATION WHERE FISH WERE CAUGHT

VESSEL NAME | VESSEL I.D. | FISH BUSINESS NAME | FISH BUSINESS I.D.

FISH NAME	POUNDS	PRICE	TOTAL AMOUNT	CONDITION	GEAR
1) CALIFORNIA HALIBUT 222	, .	$.			
2) WIDOW 269 ROCKFISH	, .	$.			
3) BOCACCIO ROCKFISH 253	, .	$.			
4) CHILIPEPPER ROCKFISH 254	, .	$.			
5) GRASS 652 ROCKFISH	, .	$.			
6) KELP 659 ROCKFISH	, .	$.			
7) YELLOWTAIL ROCKFISH 259	, .	$.			
8) BLACKGILL ROCKFISH 667	, .	$.			
9) BOLINAS 957 ROCKFISH	, .	$.			
10) GOPHER 962 ROCKFISH GROUP	, .	$.			
11) ROCKFISH 959 GROUP RED	, .	$.			
12) ROCKFISH UNSPEC 250	, .	$.			
13) ROCKFISH SMALL 960	, .	$.			
14) LINGCOD 195	, .	$.			
15) SHEEPHEAD 145	, .	$.			
16)	, .	$.			
17)	, .	$.			
18)	, .	$.			
19)	, .	$.			

PRIMARY GEAR USED

GEAR LEGEND

- 01 HOOK & LINE
- 03 VERTICAL H&L PORTUGUESE LONGLINE
- 05 SET LONGLINE
- 08 TROLL (GROUNDFISH)
- 21 FISH TRAP
- 54 MIDWATER TRAWL
- 56 BOTTOM TRAWL
- 66 SET GILL NET
- OTHER

(BIOLOGIST USE) FISH CODE

TOTALS # ______ $ ______

NOTE PAD

CORRECTIONS - FOR FIELD BIOLOGIST USE ONLY

LINE #	FISH CODE	POUNDS	PRICE	CONDITION	GEAR
		, .	$.		
		, .	$.		
		, .	$.		

CHANGES ON BACK

FISHERMAN/PERMITTEE SIGNATURE ______

RECEIVED BY ______
CERTIFIED UNDER PENALTY OF PERJURY AS TRUE AND CORRECT

F&G 625-C (8/93) | WHITE = DEPT. OF FISH & GAME COPY — YELLOW = FISHERMAN COPY — PINK / GOLDENROD = FISH BUSINESS COPY (2)

Appendix A-3. An example of a California Department of Fish and Game Landing Receipt that is reserved for groundfish landings.

CALIFORNIA DEPARTMENT OF FISH AND GAME

PERMIT # | MONTH | DAY | YEAR | X | SEE 2ND PAGE

FISHERMAN LAST NAME | F. I. | I.D. NUMBER L | PORT OF FIRST LANDING | LOCATION WHERE FISH WERE CAUGHT

VESSEL NAME | VESSEL I.D. | FISH BUSINESS NAME | FISH BUSINESS I.D. -

FISH NAME	POUNDS	PRICE	TOTAL AMOUNT	CONDITION	GEAR
1) DOVER SOLE DW 211	,	$.			
2) DOVER SOLE SW 211	,	$.			
3) SABLEFISH LG. 190	,	$.			
4) SABLEFISH MED. 190	,	$.			
5) SABLEFISH SM. 190	,	$.			
6) SABLEFISH X-SM. 190	,	$.			
7) THORNYHEAD LG. 262	,	$.			
8) THORNYHEAD MED. 262	,	$.			
9) THORNYHEAD SM. 262	,	$.			
10) WIDOW 269 ROCKFISH	,	$.			
11) BOCACCIO ROCKFISH 253	,	$.			
12) PACIFIC WHITING 495	,	$.			
13) GRENADIERS 198	,	$.			
14)	,	$.			
15)	,	$.			
16)	,	$.			
17)	,	$.			
18)	,	$.			
19)	,	$.			

PRIMARY GEAR USED

GEAR LEGEND

- 5 SET (LONGLINE)
- 21 FISH TRAP
- 54 MIDWATER TRAWL
- 56 BOTTOM TRAWL
- OTHER

(BIOLOGIST USE) FISH CODE

TOTALS # | $

NOTE PAD

CORRECTIONS - FOR FIELD BIOLOGIST USE ONLY

LINE #	FISH CODE	POUNDS	PRICE	CONDITION	GEAR
		,	$.		
		,	$.		
		,	$.		

CHANGES ON BACK

FISHERMAN/PERMITTEE SIGNATURE

RECEIVED BY

CERTIFIED UNDER PENALTY OF PERJURY AS TRUE AND CORRECT

F&G 625-X (8/93) | WHITE = DEPT. OF FISH & GAME COPY —— YELLOW = FISHERMAN COPY —— PINK / GOLDENROD = FISH BUSINESS COPY (2)

Appendix A-4. Another example of a California Department of Fish and Game Landing Receipt that is reserved for groundfish landings.

Appendix B

List of common and scientific names for species of fish included in this document

Appendix B. List of common and scientific names for species of fish included in this document.*

Common name	Scientific name
Rockfish	
Rougheye rockfish	*Sebastes aleutianus*
Pacific ocean perch	*Sebastes alutus*
Brown rockfish	*Sebastes auriculatus*
Aurora rockfish	*Sebastes aurora*
Redbanded rockfish	*Sebastes babcocki*
Shortraker rockfish	*Sebastes borealis*
Silvergrey rockfish	*Sebastes brevispinus*
Copper rockfish	*Sebastes caurinus*
Greenspotted rockfish	*Sebastes chlorostictus*
Darkblotched rockfish	*Sebastes crameri*
Splitnose rockfish	*Sebastes diploproa*
Greenstriped rockfish	*Sebastes elongatus*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*
Chilipepper	*Sebastes goodei*
Rosethorn rockfish	*Sebastes helvomaculatus*
Shortbelly rockfish	*Sebastes jordani*
Cowcod	*Sebastes levis*
Quillback rockfish	*Sebastes maliger*
Black rockfish	*Sebastes melanops*
Vermilion rockfish	*Sebastes miniatus*
Blackgill rockfish	*Sebastes melanostomus*
Blue rockfish	*Sebastes mystinus*
China rockfish	*Sebastes nebulosus*
Tiger rockfish	*Sebastes nigrocinctus*
Speckled rockfish	*Sebastes ovalis*
Bocaccio	*Sebastes paucispinus*
Canary rockfish	*Sebastes pinniger*
Redstripe rockfish	*Sebastes proriger*
Yellowmouth rockfish	*Sebastes reedi*
Rosy rockfish	*Sebastes rosaceus*
Yelloweye rockfish	*Sebastes ruberrimus*
Bank rockfish	*Sebastes rufus*
Stripetail rockfish	*Sebastes saxicola*
Pygmy rockfish	*Sebastes wilsoni*
Sharpchin rockfish	*Sebastes zacentrus*
Shortspine thornyhead	*Sebastolobus alascanus*
Longspine thornyhead	*Sebastolobus altivelis*

Appendix B. Continued.

Common name	Scientific name
Flatfish	
English sole	*Pleuronectes vetulus*
Dover sole	*Microstomus pacificus*
Petrale sole	*Eopsetta jordani*
Rex sole	*Errex zachirus*
Flathead sole	*Hippoglossoides elassodon*
Rock sole	*Pleuronectes bilineatus*
Sand sole	*Psettichthys melanostictus*
Butter sole	*Pleuronectes isolepis*
Pacific sanddab	*Citharichthys sordidus*
Speckled sanddab	*Citharichthys stigmaeus*
Starry flounder	*Platichthys stellatus*
Arrowtooth flounder	*Atheresthes stomias*
Pacific halibut	*Hippoglossus stenolepis*
Roundfish	
Jack mackerel	*Trachurus symmetricus*
Pacific cod	*Gadus macrocephalus*
Walleye pollock	*Theragra chalcogramma*
Pacific hake	*Merluccius productus*
Lingcod	*Ophiodon elongatus*
Sablefish	*Anoplopoma fimbria*
Sharks and Skates	
Skates, miscellaneous	Rajidae
Longnose skate	*Raja rhina*
Spiny dogfish	*Squalus acanthias*
Pacific dogfish	*Squalus suckleyi*
Blue shark	*Prionace glauca*
Soupfin shark	*Galeorhinus zyopterus*
Mud shark	*Hexanchus griseus*
Thresher shark	*Alopias vulpinus*
Miscellaneous	
Cabezon	*Scorpaenichthys marmoratus*
Red Irish lord	*Hemilepidotus hemilepidotus*
Pacific grenadier	*Coryphaenoides acrolepis*
Kelp greenling	*Hexagrammos decagrammus*
Rock greenling	*Hexagrammos lagocephalus*
Whitespotted greenling	*Hexagrammos stelleri*
Green sturgeon	*Acipenser medirostris*

Appendix B. Continued.

Common name	Scientific name
Pacific salmon, miscellaneous	Salmonidae
Surfperches, miscellaneous	Embiotocidae
Redtail surfperch	*Amphistichus rhodoterus*
Striped seaperch	*Embiotoca lateralis*
Pile perch	*Rhacochilus vacca*
Sculpins, miscellaneous	Cottidae
Wolf-eel	*Anarrhichthys ocellatus*
Pacific hagfish	*Eptatretus stouti*

[a]List follows:

Robins, C. R., and six coauthors. 1991. List of common and scientific names of fishes. American Fisheries Society Special Publication 20.

Recent NOAA Technical Memorandums NMFS
published by the
Northwest Fisheries Science Center

NOAA Tech. Memo.
NMFS-NWFSC-

30 **Grant, W.S. (editor). 1997.** Genetic effects of straying of non-native hatchery fish into natural populations. Proceedings of the workshop, June 1-2, 1995, Seattle Washington. 130 p. NTIS number pending.

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27 **Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996.** Status review of west coast steelhead from Washington, Idaho, Oregon, and California. 261 p. NTIS PB96-210166.

26 **McCabe, G.T., Jr., and S.A. Hinton. 1996.** Benthic invertebrates and sediment characteristics in freshwater beach habitats of the lower Columbia River, 1994-95. 111 p. NTIS PB96-186879.

25 **Hard, J.J., R.G. Kope, W.S. Grant, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1996.** Status review of pink salmon from Washington, Oregon, and California. 131 p. PB96-162607.

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21 **Reppond, K.D., and J.K. Babbitt. 1995.** Frozen storage stability of fillets, mince, and mixed blocks prepared from unfrozen and previously frozen pink salmon (*Oncorhynchus gorbuscha).* 57p. NTIS PB-95-239828.

20 **Hinton, S.A., and R.L. Emmett. 1994.** Juvenile salmonid stranding in the lower Columbia River, 1992 and 1993. 48 p. NTIS PB-95-199352.

Most NOAA Technical Memorandums NMFS-NWFSC are available on-line at the Northwest Fisheries Science Center web site (http://www.nwfsc.noaa.gov).