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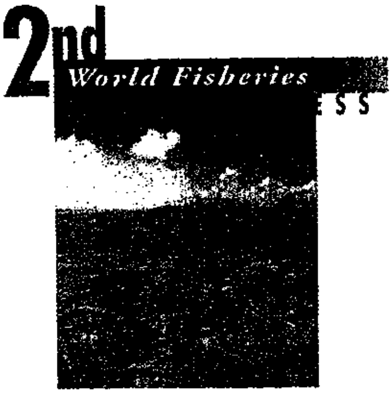

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Can Fishery Catch Data Supplement Research Cruise Data? A Geographical Comparison of Research and Commercial Catch Data

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Summary

Log-books maintained by participants in the US west coast groundfish trawl fishery provide a detailed set of catch and effort data with broad temporal and spatial coverage. We developed a geographical information system (GIS) to compare 10 years of data from the Oregon commercial trawl fishery with data from US National Marine Fisheries Service research cruises conducted at the same time in the same area. We compared log-book and research catch locations by overlaying catch-per-unit-effort maps and evaluating the geographic co-occurrence of the polygons defined by isopleths. We also compared biomass estimates produced by the two data types. Our results indicate that commercial fishery log-books provide data about fish distribution and abundance that are comparable to research surveys. We believe that log-books can be used to augment research studies and improve estimates of the distribution and abundance of selected species.

Introduction

As the number and size of fishing vessels increased in the 1960s and 1970s, there was a corresponding increase in the world harvest of marine fish species. For the past 20 years, however, catches have been declining in many world fisheries. During that time, the technology available to locate and capture fishes outpaced the availability of information with which to manage fisheries. Presently, fishermen have a much greater capability to locate and harvest fish than scientists have of assessing fish stocks.

One way to increase information available for fishery management is to use information collected by harvesters. The west coast of the United States is home to a well-developed commercial trawl fishery. Over 377 vessels operated in the Oregon, Washington, and California groundfish trawl fishery in 1991 (PFMC 1991); they are all required to maintain log-book records. These fishery log-books provide a detailed set of catch and effort data with broad temporal and spatial coverage. With the availability of efficient geographical information systems (GIS), tools now are available to display and analyse large spatial data bases.

We developed and used a GIS to compare data from the Oregon commercial trawl fishery with data from US National Marine Fisheries Service (NMFS) research cruises conducted at the same time in the same area (Fig. 1). In this paper, we suggest that log-

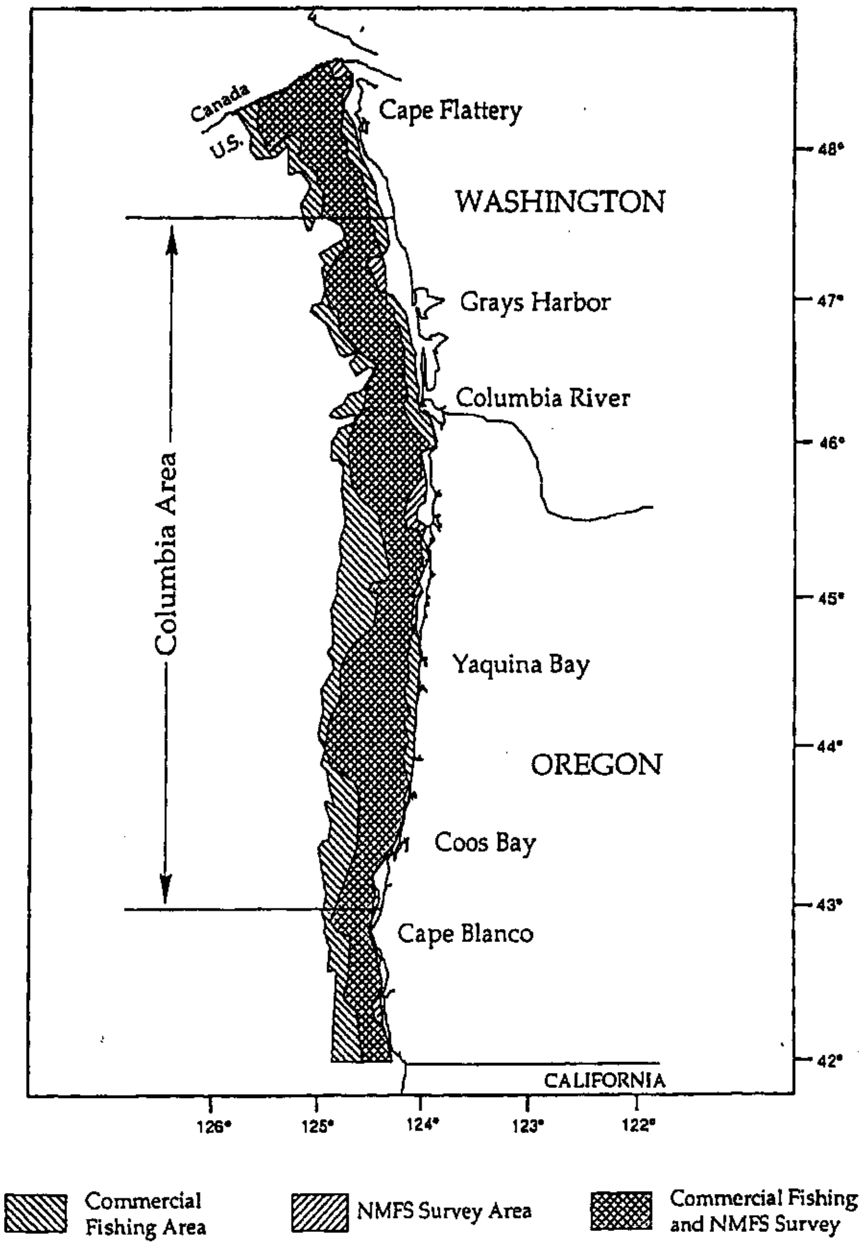

Fig. 1. Commercial fishing and NMFS survey areas in the Columbia Management Area along the Oregon and Washington coast.

book data can complement research data and be used to improve estimates of the distribution and abundance of selected species.

Methods

The research catch data used in this study originated from a series of NMFS Pacific west coast bottom-trawl surveys of groundfish resources conducted in 1980, 1983, 1986, and 1989. The surveys, often referred to as triennial trawl surveys, contained excellent spatial and temporal overlap with the commercial fishery data set. The NMFS triennial trawl survey methods are described by Gunderson and Sample (1980); Weinberg *et al.* (1984); Coleman (1986); Coleman (1988); Weinberg (1994) and Weinberg *et al.* (1994).

Commercial fishing data used in these analyses were compiled from groundfish bottom trawl fishery log-books collected by the Oregon Department of Fish and Wildlife (ODFW) from 1980–1989. This ten-year log-book data base contains over 130 000 individual records, each representing a single trawl tow. Information for each record includes vessel number, gear type, port of landing, date, latitude and longitude, effort in trawl hours, and catch in pounds for each species or market category reported.

Our analysis included five species: Dover sole (*Microstomus pacificus*), English sole (*Pleuronectes vetulus*), sablefish (*Anoplopoma fimbria*), yellowtail rockfish (*Sebastes flavidus*), and shortspine thornyhead (*Sebastolobus alascanus*). We computed

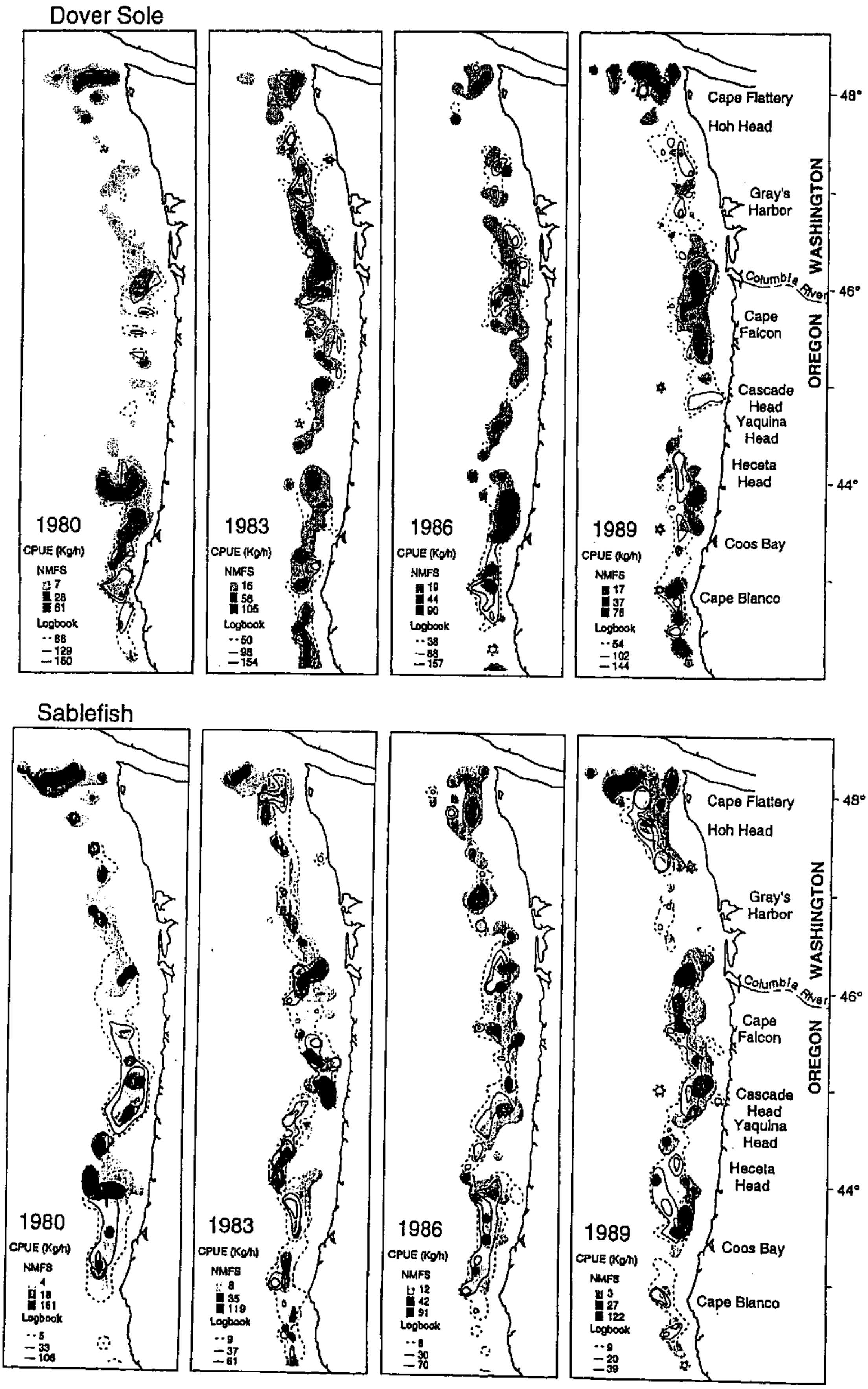

Fig. 2. Isopleths of the 50th, 75th, and 90th percentile of CPUE for commercial fishery and NMFS triennial trawl cruises for a) Dover sole, b) sablefish,

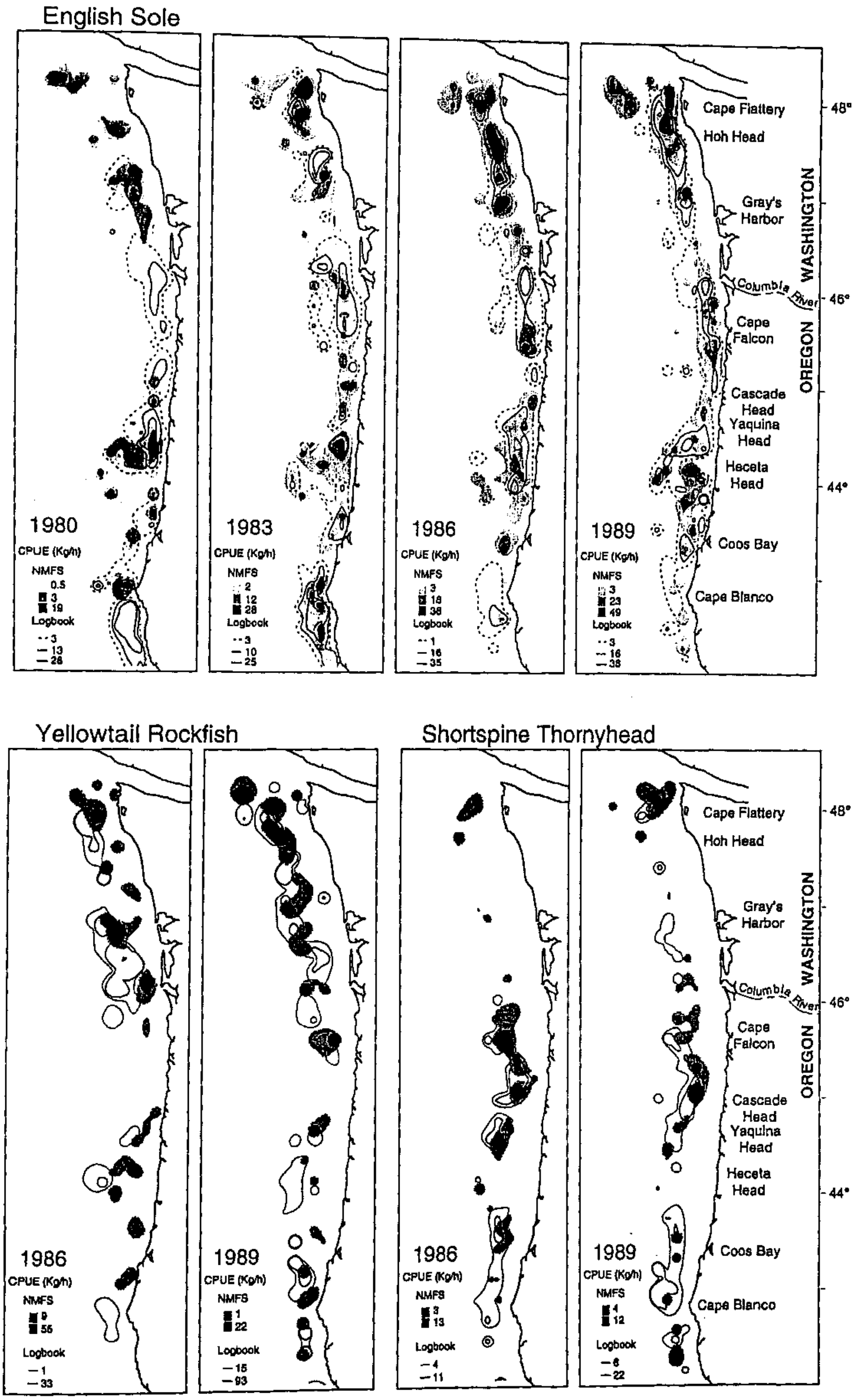

Fig. 2. Isopleths of the 50th, 75th, and 90th percentile of CPUE for commercial fishery and NMFS triennial trawl cruises for c) English sole, d) yellowtail rockfish, and e) shortspine thornyhead.

catch-per-unit-effort (CPUE), expressed in kg/h, for each species in each tow in both the research and commercial fishery databases.

Isopleths representing the 50th, 75th, and 90th percentile levels of CPUE were computed and plotted for each species, year, and data type, using commercial GIS and contouring software packages. For each species, log-book and research catch locations were compared by overlaying the CPUE maps and evaluating the geographic co-occurrence of the polygons defined by the isopleths. We computed the total surface area of polygons and the total area of overlap between the two data types. We also compared biomass estimates from the log-book data with similar values generated from NMFS data. We estimated biomass from the log-book data using an area swept methodology similar to that employed by NMFS (Gunderson and Sample 1980).

Results

For all species, the 50th, 75th, and 90th percentile levels of CPUE were of similar magnitude and spatially co-occurred (Fig. 2). In each of the data sets, areas of high catch rates occurred in similar locations from year to year. In a few cases, one of the data sets did not identify a high catch location. In those cases, the discrepancy was caused by lack of either commercial or research sampling effort.

In terms of percent overlap between data types, more than 66% of high log-book catch locations (defined by isopleths of 50th percentile of CPUE) occurred in the same area as high research catches for Dover sole, English sole, and sablefish (Table 1). Overlap ranged from 60–81% for the 50th percentile polygons, from 23–63% for the 75th percentile polygons, and from 13–47% for the 90th percentile polygons (Table 1). Overlap of surface area for shortspine thornyhead CPUE isopleths averaged 58% and 57%, for the 50th and 75th percentile of CPUE respectively. Overlap of surface area for yellowtail rockfish CPUE isopleths averaged 59% and 19%, for the 50th and 75th percentile of CPUE respectively.

Log-book biomass estimates for all species were similar in magnitude to those derived from research data, with the exception of log-book biomass estimates for Dover Sole which were three to six times greater than those derived from research catches (Fig. 3). Biomass estimates for English sole, sablefish, and yellowtail rockfish exhibited overlapping 95% confidence intervals for all years compared.

One of the primary advantages to using commercial catch data for understanding stock dynamics is that the fishery data provide a larger data set with which to interpret trends. In this study, log-book data showed trends different from those of the research data. Log-book biomass estimates for Dover sole exhibited a general decreasing trend from 1980 through 1985, and the trend appeared to be flat or slightly increasing from 1986 through 1989. The biomass trend derived from research catches was flat for Dover sole for the entire time period.

Log-book biomass estimates for sablefish exhibited a general decreasing trend with slight increases in 1986 and 1987. Biomass trends derived from research catches fluctuated out-of-phase with log-book estimates. Log-book biomass estimates for English sole exhibited a flat trend from 1980–1985, then a sharply increasing trend from 1985–1989. Biomass trends derived from research catches were similar. Log-book biomass estimates for yellowtail rockfish exhibited an increasing trend from 1985–1989. The two research data points resulted in a flat trend in biomass. Log-book biomass estimates for shortspine thornyhead rockfish exhibited a flat trend from 1984–1988. The biomass estimate for 1989 was twice that of previous estimates. The two research data points resulted in a decreasing trend in biomass.

Table 1. Summary of spatial overlap between NMFS and commercial catch areas. Values are percent overlap of surface areas enclosed by the 50th, 75th, and 90th percentile CPUE isopleths of each data type. Data reflect only areas that included sampling effort for both NMFS and log-book data sets

Species	Year	Percentiles 50th	75th	90th
Dover sole	1980	60.3	47.1	15.4
	1983	74.4	44.1	25.0
	1986	75.9	41.4	33.3
	1989	60.8	22.6	12.5
Average		67.9	38.8	21.6
Sablefish	1980	65.0	44.8	23.1
	1983	80.5	62.9	46.7
	1986	76.1	41.7	44.4
	1989	72.6	51.9	25.0
Average		73.6	50.3	34.8
English sole	1980	66.7	54.5	40.0
	1983	65.0	47.2	33.3
	1986	66.7	48.3	30.8
	1989	66.7	50.0	22.7
Average		66.3	50.0	31.7
Yellowtail	1986		41.4	16.7
rockfish	1989		38.5	21.4
Average			40.0	19.1
Shortspine	1986		64.7	80.0
thornyhead	1989		51.7	33.3
Average			58.2	56.7

Discussion

In the 1980s, fishery log-books were used by Gabriel and Tyler (1980), Gabriel (1982), and Tyler *et al.* (1984) to describe the distribution of commercial fishing effort off Oregon and Washington. Since that time, west coast fishery log-book data have received only limited use in stock assessments because scientists and managers have assumed that log-book CPUE data do not provide an accurate index of fish abundance. This assumption is based upon the concept that research catches reflect actual fish distribution and abundance, but commercial

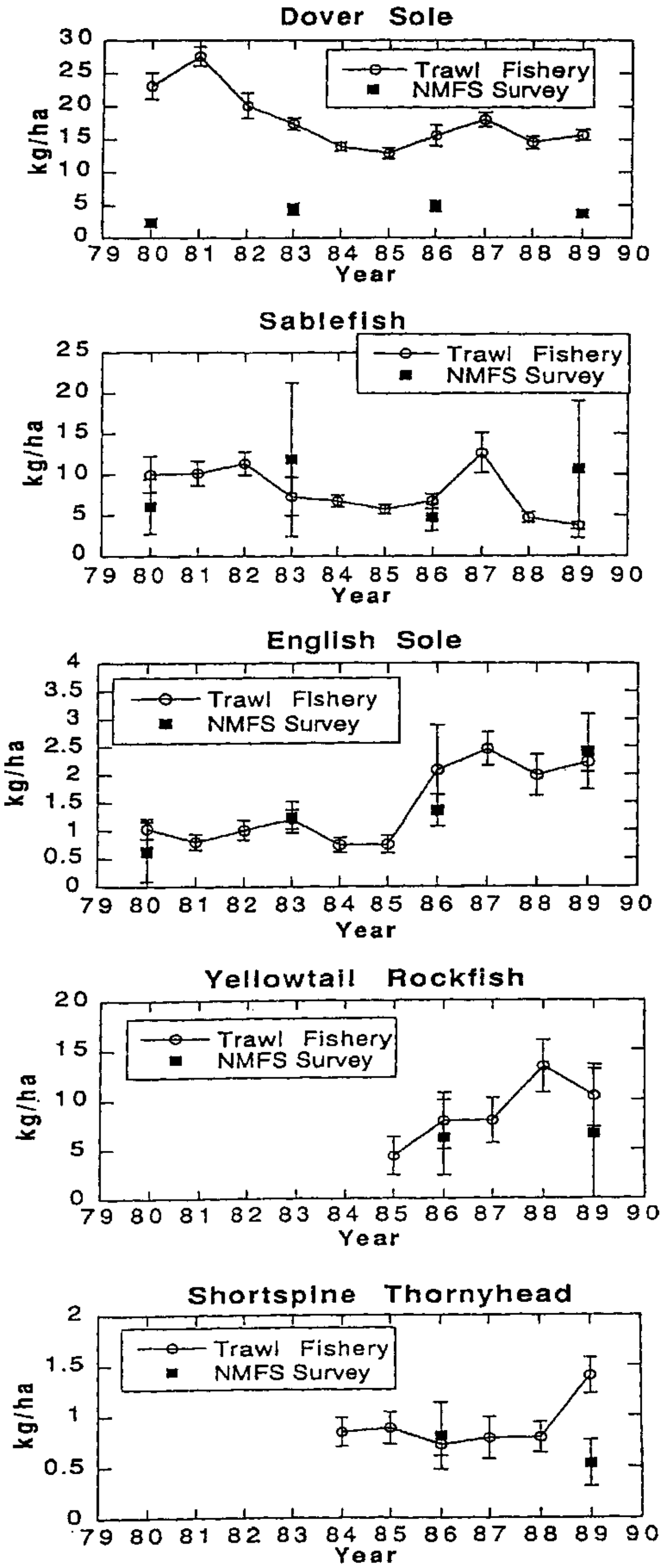

Fig. 3. Biomass estimates and 95% CI derived from trawls conducted from July to September in the commercial fishery and NMFS triennial trawl cruises.

fishing patterns and catches are more greatly influenced by market conditions, regulations, weather, and proximity to port.

Our analyses, however, indicated a reasonable correspondence between log-book and research data with a few exceptions. Both log-book and research data sets clearly showed specific areas that consistently produced high catch rates. The relationship between research and log-book biomass estimates varied from good to poor, depending on species. The relationship between data sets was stronger for species that were broadly distributed and for which fishing techniques were similar between research and commercial vessels.

The increased number of biomass estimates generated by log-book data provided a different view of biomass trends for several of the species, and also provided a greater degree of certainty in evaluating biomass trends. Both research and log-book estimates of biomass for yellowtail rockfish were highly variable. The high variance in the data indicates that neither research trawl nor commercial trawl gear adequately estimate the relative abundance of yellowtail rockfish. This suggests that, for some species, methods of estimating abundance other than trawl surveys are necessary.

Factors affecting the use of commercial fishery data

Cooperation from a large number of commercial fishermen is obviously critical for log-books to be useful. Proper collection, preparation, and screening of log-book data are also essential to maximizing the usefulness of the information. The procedures we used for collecting and processing log-book data included catch recording by fishermen, log-book collection, log-book screening, computer data entry, and error checking. The numerous fishing vessels and trips provided a large quantity of data, so we were selective of information included in the analyses. Only those log-books that were complete, legible, and had location information for each tow were analysed. We used only those log-books that had closely corresponding fish landing records, enabling the use of weights recorded at the dock. Computer error checking procedures included automated and manual review checks to detect tows that had unreasonable locations with respect to depth or distance from a previous tow. The application of these quality assurance steps resulted in retention of about 50% of the tows executed by the fishery.

The discard of fishes in the commercial fishery provides a potentially major discrepancy between log-book and research estimates of fish abundance. The problem is especially difficult to address if discard occurs at differential rates in different locations. If discard rates are known and are consistent in time and space, however, biomass estimates derived from log-books can be scaled for comparison with research estimates.

A critical assumption in the use of any trawl surveys is the fishing efficiency of the gear and resulting catchability of fishes. For estimating biomass, NMFS assumed a catchability of 1.0 for their surveys, indicating that all fish in the path of a trawl would be caught, and there is no herding effect (Methot *et al.* 1994). We made the same assumption for commercial trawls. For short periods, constant catchability may be a valid assumption. Over longer periods, such as a decade or more, the assumption of constant catchability is probably invalid. The technological advances in navigational electronics and fishing gear that have occurred in the last decade suggest that fishing efficiency and catchability have probably changed. Studies to determine catchability should be conducted periodically to ensure that CPUE estimates are comparable from year to year.

Use of log-book data to augment research

Our results suggest that commercial fishery log-book data provide estimates of fish distribution and abundance that are similar to research data. It follows, then, that commercial fishery log-book data may be used to evaluate or augment research data. Designing large research efforts typically involves compromises in terms of costs, temporal and spatial coverage, and sampling intensity within the study area. The commercial fishery samples every month of every year, in all trawlable areas, and at many thousand sites. Log-book data, then, may provide information to help identify sampling error, increase sample size, or fill spatial and temporal gaps in research data.

The additional information provided by log-books may be useful in tuning population models and helping managers to identify the degree of risk and uncertainty in stock assessments; thus aiding in the development of risk-based fishery models, such as proposed by Hilborn *et al.* (1993). Additionally, log-books may become increasingly important if area-specific management techniques become more common. Log-books may become the only cost-effective way to increase the amount of information available in specific areas.

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