FINAL REPORT

FISHERY RESOURCE MAPPING

by

Richard M. Starr
Mark R. Saelens
David S. Fox

Oregon Department of Fish and Wildlife
Hatfield Marine Science Center
Newport, Oregon 97365

July 17, 1989

This project was funded by the National Coastal Resources Research and Development Institute, Newport, Oregon, under contract No. 2-5631-03.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The continental shelf and slope off the Northwestern United States contain critical habitats for fish and shellfish species that provide nationally significant social, economic, and nutritional benefits. The U.S. Department of the Interior, through the Minerals Management Service (MMS), recently began a five year process leading to the sale of oil and gas lease areas on the continental shelf off Washington, Oregon, and Northern California. Additionally, mineral, sand, and gravel mining is expected to occur in the nearshore areas of the Pacific Northwest. If impending development activities for extraction of these non-renewable resources are not carefully planned, valuable fish and wildlife resources could be threatened. Although proper planning is essential, we do not currently have the information needed to help ensure that oil, gas, and mineral development is conducted in a manner compatible with fishery resource use.

Since the MMS lease sale area involves a multistate area and fish move across state boundaries, fishery impacts must be analyzed in a regional context. An impact analysis on this scale requires a consistent regional data base. The states recognized this need early in the lease sale process and have identified interstate coordination of research, impact analysis, and planning as a high priority.

In response to the general need for ocean resource information, the Oregon Department of Fish and Wildlife (ODFW) began work during the fall of 1986 on a long-term project called Ocean Habitat Analysis and Mapping (OHAM). This project combines commercial fishery data with biological and oceanographic data to help define areas of special biological significance and understand how fishery resources respond to changes in environmental variables. The OHAM system will eventually include economic data to improve fisheries management and to help respond to resource use conflicts.

More recently, ODFW responded to the need for interstate coordination and a region-wide data base by designing a project to demonstrate how Washington and California commercial fisheries data can be incorporated into the OHAM system. The National Coastal Resources Research and Development Institute (NCRI) funded the project in 1988 using Coastal Zone Management Act, Interstate Management funds. This report describes the NCRI project, and includes a description of how Washington and California data were processed, how the OHAM system was modified and improved during the project, the final data base products, and a discussion of how information generated through the OHAM system can be used in ocean resource planning and management.

OHAM Development

In the Fall of 1986 ODFW began work on a computerized data base system for habitat analysis. When finished, the system will allow for the inclusion and analysis of a variety of existing and new environmental data bases. In the early stages of the work, the primary project objective was to develop a commercial fisheries catch data mapping system (FISHMAP). The FISHMAP system summarizes commercial fishery catch data by fishery, species, port, month, geographic area, pounds landed, effort expended, catch efficiency, gear type, and net type. The FISHMAP data base can be sorted or summarized on any field. The data can be exported to other programs and be used with a geographic information system to compare commercial fisheries catch attributes with oceanographic and biological attributes. The data can then be used for fishery management or environmental impact analysis.

In the initial phases of the project we developed the computer programs and techniques needed for the FISHMAP system. The programs enabled us to analyze and map fishery logbook data and created a test data base consisting of three years of Oregon commercial shrimp fishery logbook data (1984 - 86) and three years of Oregon commercial groundfish fishery logbook data (1980 - 82).

The test data enabled us to summarize and map Oregon's commercial trawl shrimp and groundfish catch for the three year periods. We mapped bottom sediments with the catch data to show how physical oceanographic information can be used with fishery information to identify important marine habitat. A copy of the final contract report, Identification of Important Marine Habitat (Starr and Saelens 1987), is available from the Oregon Department of Fish and Wildlife's Marine Region office in Newport, Oregon.

NCRI Fishery Resource Mapping Project

The NCRI Fishery Resource Mapping Project was developed to foster interstate coordination of fishery research and management. The primary goals of the NCRI project were:

1) to expand the regional inventory of information available for ocean resource development and planning,
2) to bring California and Washington fishery agencies up to speed on the OHAM system so they could evaluate its usefulness,
3) to improve interstate coordination of ocean resource planning, and
4) to continue developing and refining the OHAM system.

Fulfilling the goals required that we obtain California and Washington data, make the data compatible with our system, process the data, and return the processed data bases to California Department of Fish and Game (CDFG) and Washington Department of Fisheries (WDF). We completed the work by:

1) developing or modifying programs to enter or import logbook and fishticket information from California and Washington,
2) collecting and coding one year of California groundfish fishery data, two years of Washington groundfish fishery data, and one year of shrimp fishery data from each of the two states,

3) entering or importing the fishery data,
4) summarizing the data, including separating groundfish fishery logbook catch by species and developing appropriate statistical parameters for the data, and
5) providing the data to California Department of Fish and Game and the Washington Department of Fisheries.

Completion of the tasks allowed us to achieve the project goals. The regional fisheries data base was significantly expanded by including California and Washington shrimp and groundfish data. Our work with the other states improved interstate communication concerning fisheries data and enabled Washington and California to learn about the approach we are taking to summarize commercial fishery data. Once the states review the data bases, they will be able to evaluate the usefulness of our approach. Task 4 significantly improved the OHAM system by allowing us to summarize groundfish catch by species and to report statistical measures of variability on the effort data.

MATERIALS AND METHODS

The process of developing fisheries data bases for Washington and California was similar to our earlier work with Oregon information. The primary steps in the process included creating a geographic reference grid for the Washington and California offshore areas, acquiring and entering the data, and manipulating the data using our previously developed system modified with new computer programs.

The California and Washington geographic reference system created for the project is consistent with our Oregon system and allows for consistent data summaries throughout the region. New computer programs developed during the project enabled us to summarize groundfish fishery attributes on a species by species basis and calculate statistical measures of variability for the summarize catch-per-unit-effort data. These programs represent a significant improvement to the FISHMAP system and will continue to be used with Oregon fisheries data during future projects. We also developed techniques to electronically transfer California and Washington data to the Oregon system.

Geographic Reference Grid

During the early phases of the OHAM project, we determined that a geographic reference grid provides the most effective format for summarizing and mapping commercial trawl data. The grid provides a series of small geographic units within which attributes of the fisheries can be totaled and summarized. We developed the grid for Oregon waters during an earlier pilot project and extended the grid into northern California and Washington in this contract.

The reference grid consists of regular blocks whose boundaries are defined by a latitude and longitude coordinate system. The grid provides different levels of resolution by using two block sizes. The larger blocks are ten minutes of latitude by ten minutes of longitude. These are quartered into blocks five minute of latitude by five minute of longitude in size to provide finer resolution of the data. The grid is consistent with a system developed during the 1940's to study sardine populations and later modified during the early 1980's for the Washington/Oregon/California uniform groundfish logbook program.

The OHAM system locates and defines each block by using the latitude and longitude coordinate of its southeastern corner. The system differentiates the larger from the smaller blocks by adding a decimal suffix to each 10' block, and sequentially numbers each 5' block from left to right, and top to bottom (Figure 1).

Data Acquisition And Entry

The fishery data collected are divided into two principal components: fishing vessel logbook records (logbooks) and fishing vessel delivery tickets (fishtickets). Trawl vessels in California, Oregon, and Washington are required to keep a logbook of their fishing activity. Logbooks include information such as fishing location, an estimate of catch by species, time fished, and gear used. The logbooks are used to record information for each fishing tow (the process by which the crew of a trawl vessel releases or sets the fishing gear into the ocean, tows the net through the water for a given time, and then retrieves the gear and fish).

Fishtickets provide the state with official landing records. A fishticket is filled out by a licensed fish buyer for the state and port in which the delivery is made. Each time a vessel delivers catch to a buyer a fishticket is filled out showing the actual weight landed of each species, the gear used, and the price paid per pound for each species.

The FISHMAP system is designed to allow entry of logbook and fishticket data directly through keyboard entry, or through the use of computer programs that translate an existing fishery logbook or fishticket file from another computer or data storage medium. The California and Washington shrimp data were entered via keyboard entry and the groundfish data were electronically transferred into the system.

California Shrimp

California Department of Fish and Game (CDFG) provided copies of their 1986 shrimp logbooks. Our data entry staff entered and verified information from each shrimp tow. Data were keyed into the FISHMAP system using the same file structure, field formats, and coding schemes used to enter Oregon shrimp data (Starr and Saelens 1987) with one exception. The way the FISHMAP system identifies trips is to pair landing date with a unique 3-digit vessel number. CDFG staff removed vessel

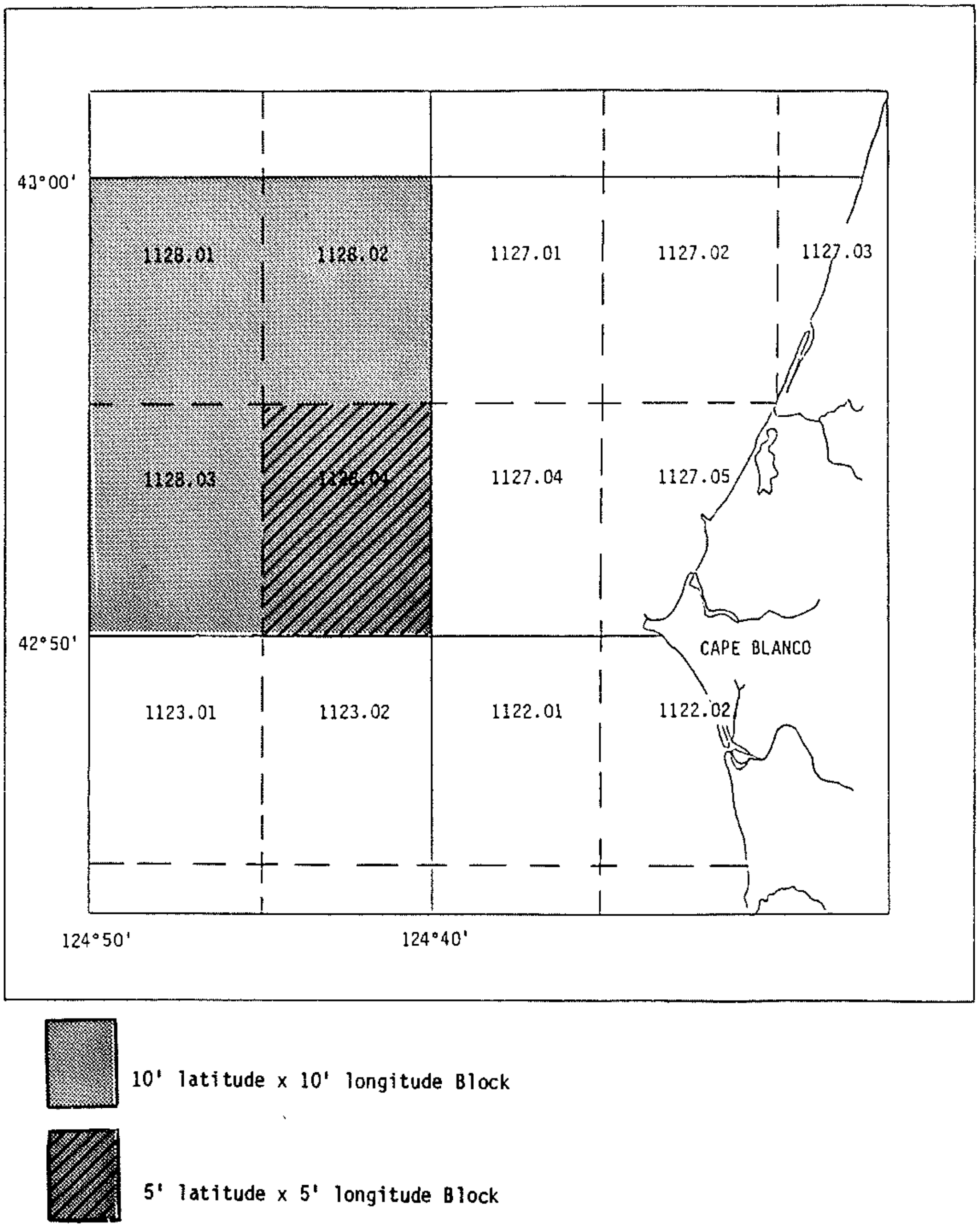

Figure 1. FISHMAP blocks obtained by division of coastwide uniform groundfish catch blocks.

identification from the logbooks to maintain confidentiality of the data. We had to create a sequential trip number and use it in combination with the date of landing to identify individual trips.

Although this exception to file structure creates no difficulties in the normal processing of the data, it limits the generation of certain statistics. For example, we would not be able to report an average catch per vessel because we would not know the number of vessels that provided the logbook data. If California shrimp logbook data continue to be processed with the FISHMAP system in the future, then California vessels should have unique numbers assigned to them. CDFG could maintain confidentiality by not releasing the vessel name associated with each number.

Washington Shrimp

Washington Department of Fisheries staff provided shrimp logbooks for the year 1987. Our entry staff coded, entered, verified, and corrected all of these data without incident. As with the CDFG logbook data, vessel identification was removed to maintain the confidential nature of the data.

California Groundfish

California Department of Fish and Game provided a magnetic tape containing all of California's 1985 groundfish trawl data. This tape was mounted on Oregon State University's Cyber mainframe in Corvallis. The Cyber was used to facilitate transfer of the California data to our microcomputer based FISHMAP program via the Environmental Protection Agency's (EPA) VAX minicomputer in Newport. This file was fairly large so we used an editor on the EPA system to divide the file into more manageable segments. These segments were then downloaded to our microcomputer using a communications program.

The entire process of transferring California groundfish logbook data from their magnetic tape to Oregon State University's computer, then to EPA's computer, and finally to our computer, was very time consuming. In the future we plan to ask agencies contributing data files to segment them into smaller units such as port or month, and when possible to supply the data on MS-DOS formatted diskettes.

After completing the transfer of 1985 California groundfish logbook data to microcomputer, we wrote a program to import the data into the FISHMAP system. This program reads the original fixed field length, non-delimited format, converts it to our standard trawl logbook format, and writes it to a REVELATION data base file. More specifically, the import program accomplishes four tasks. First, it eliminates data fields found in the original file that are not currently recognized by the FISHMAP system. Crew size, gallons of fuel consumed, and return time are examples of some of the data elements which are not brought into the FISHMAP logbook file structure. Second, it calculates data elements necessary for the FISHMAP system that are not directly available on the original file. An example of this is the calculation of the length of a given tow to the nearest tenth of an hour. The import program reads the time set and time lift fields from the original file and calculates the length of the tow.

Third, the program pairs similar data found in both file structures. The original California groundfish file contained fields for bottom depth and new depth. The import program reads the bottom depth field of the original file and writes it to a field called depth. Finally, the import program utilizes the tow number field of the original file (which is tow record based) to reconstruct all of the tows for a given fishing trip into a trip record. This trip record is assigned a sequential number and a date to identify it as a unique record.

Washington Groundfish

The Washington Department of Fisheries provided MS-DOS formatted diskettes containing partially processed groundfish logbook and fishticket data for 1986 and 1987. We wrote a program to import these data into our FISHMAP system. This program reads the original fixed field length, non-delimited format, converts it to a modified version of our standard trawl logbook format, and writes it to a REVELATION data base file with modified record structure.

WDF sub-samples their groundfish logbooks at a rate of one out of every four tows. Consequently, we were not able to reconstruct individual groundfish trips. We overcame this difficulty by converting our standard trip/tow record file structure to a trip/species record file structure. Each record of this modified file contains the proportionately expanded catch and effort for a given species for the entire trip. The sum of the records in our data base, then, would approximate the sum of all the tows from the logbooks that were subsampled. This proportion is generated by dividing the total number of tows for the trip by the number of tows sampled for the trip. As with the CDFG logbook data, vessel identification was removed to maintain the confidential nature of the data.

Data Transformation and Adjustment

After acquiring and entering logbook and fishticket information, we perform a number of data transformations and adjustments before producing condensed summaries. We transform locational information, species and gear codes, time of day, and effort information into standard units. We then make adjustments of estimated catches.

The largest data transformation that occurs is the conversion of locational information. We convert LORAN C information to latitude and longitude (lat/lon) location, then to our block locations. For both California and Washington shrimp logbook data we entered the LORAN C readings recorded in the logbooks. A portion of our FISHMAP program converts a LORAN reading to a lat/lon coordinate. The lat/lon coordinate pair is then used with a look-up table to return the appropriate locational block for each shrimp tow processed. After the data transformation process, each tow has a latitude and longitude coordinate location and a block identifier.

The California groundfish logbook data base already contained uniform groundfish logbook block numbers. These block numbers are the same as our FISHMAP 10' block numbers; consequently no additional locational transformations were necessary. In many cases, tows only had the uniform groundfish logbook block numbers; latitude and longitude coordinates were not available.

The Washington groundfish logbook data challenged the concept of how our FISHMAP system determines block locations. Until 1985 much of Washington's tow location data were reported by fishing grounds; in many cases these areas were rather large and only vaguely defined. In all cases, however, WDF was able to assign a lat/lon location to the approximate center of the area referred to. Beginning in mid-1985, the location of almost all tows was reported as a LORAN C fix, or by uniform groundfish logbook block number. In either case, WDF converted the location to lat/lon.

Because of the locational imprecision in all of WDF's early data and some of the more recent data, they urged us not to attempt to aggregate data on a scale smaller than the uniform 10' groundfish blocks. We accepted this advice and chose to utilize the block or grounds centroid location, presented as lat/lon in their groundfish logbook files, to identify the equivalent 10' block location on our FISHMAP system.

In addition to transformation of locational information, we transform species codes. For fisheries which target on more than one species, we transform the data to account for different species codes that occur between states and within a state between years (Tables 1 and 2). A portion of one summary program recognizes the year that is being summarized, and changes the raw species code to a standard species code, so that information from different years and different states can be combined.

Table 1. Example California groundfish species codes.

Code	Common Name	Scientific Name
190	sablefish	*Anoplopoma fimbria*
195	lingcod	*Ophidon elongatus*
200	sole, unspecified	Pleuronectiformes
206	English sole	*Parophrys vetulus*
207	rex sole	*Glyptocecephalus zachirus*
209	petrale sole	*Eopsetts jordani*
211	Dover sole	*Microstimus pacificus*
247	canary rockfish	*Sebastes pinniger*
250	rockfish, unspecified	*Sebastes* spp.
495	Pacific hake or whiting	*Merluccius productus*
958	rockfish, deepwater reds	

Table 2. Example Washington groundfish species codes.

Code	Common Name	Scientific Name
5	Dover sole	*Microstimus pacificus*
6	English sole	*Parophrys vetulus*
7	petrale sole	*Eopsetts jordani*
8	rex sole	*Glyptocecephalus zachirus*
15	sole, unidentified and Miscellaneous	
21	sablefish	*Anoplopoma fimbria*
31	lingcod	*Ophidon elongatus*
44	Pacific hake or whiting	*Merluccius productus*
51	rockfish, other than nominal Pacific Ocean perch	mostly *Sebastes* spp.
54	Pacific Ocean perch, nominal	*Sebastes alutus* and other *Sebastes* spp.

Gear codes are transformed in a similar manner as species codes. Groundfish data are separated by gear (Table 3) since no appropriate conversion factor has been established to standardize groundfish effort. Regardless of the fishery or state, all of the logbook data we summarized provided the same unit of effort data. This unit of effort is measured as the elapsed amount of time from when a trawl net is set (starts fishing) until the process of recovering the net begins (haul). For shrimp logbooks our staff manually converted the set and haul times recorded on logbooks to elapsed time to the nearest tenth of an hour.

Table 3. FISHMAP groundfish file gear suffix codes.

All Groundfish Gears	A
Bottom and Roller Gear Combined	C
Bottom Gear	B
Midwater Gear	M
Roller Gear	R

For the shrimp fishery data we are able to transform and standardize effort from different gear types. Double-rigged (two nets) shrimp vessels are 1.6 times more effective at catching shrimp than are vessels towing just one net (single-rigged) (PMFC and NMFS 1981). If the shrimp vessel is single-rigged, the elapsed time entered from the logbook is later multiplied by 0.625 (the inverse of 1.6) to convert the effort to double-rigged equivalent effort (DRE). DRE was chosen to represent shrimp effort because double-rigged vessels are the most common type vessel used in the fishery.

After all data are transformed, we adjust the estimated catch from the individual tows in the logbooks (hailed catch or hail) to the official reported catch. The FISHMAP system uses several steps to change species catch data from hailed catch for a sampled tow to a total adjusted catch of a species in a given block for the year. First, at sea, vessel skippers estimate and record (hail) the catch of each major species caught during a tow. The individual hails for the tows of each trip are entered into our system along with the actual total catch of each species delivered for the trip obtained from fishtickets.

The data adjustment process begins by updating the fisher's hails of a given species to the more precise estimate of actual catch for each species caught in a given block. This is done by creating an adjustment ratio for each species caught during a tow. This ratio is calculated by the following formula:

(1) Tow Adjustment $\text{Ratio}_{ij} = (a_{ij} / b)$ where
i = sampled tow number
j = sampled species
a = hail of species j, for a sampled tow i
b = total hailed catch of a given species for the trip

The tow adjustment ratio for each species is multiplied by the actual trip catch of a species to produce the estimated known catch using the formula:

(2) Known $\text{Catch}_{ij} = c_{ij} \times d_j$ where
i = sampled tow number
j = sampled species
c = total adjustment ratio of a species j for a sampled tow i
d = actual trip catch of species j from fishticket

For California and Washington shrimp logbooks we entered the fisher's hail of shrimp for each tow of a trip, and the total catch landed for the trip as indicated by the fishticket. Next, formulas 1 and 2 were used to adjust the logbook hails to the best estimate of known catch by port, month, block, and species.

For California groundfish logbooks, the file we received already contained adjusted catch by species, so no additional adjustment was necessary. The

Washington groundfish logbook data provided a choice between adjusted tow catch or a special field which contained estimated total catch. Estimated total catch is a combination of the known catch from logbooks and the catch that is attributed to landings that did not have corresponding logbooks. Since we were limited to only known data for California's groundfish data and the shrimp data, we chose to work with only known catch for Washington groundfish.

While the process of adjusting catch occurs, the FISHMAP system also calculates effort. Mean catch-per-hour, the associated 95 % confidence interval, and coefficient of variation are generated from catch and effort information. We calculated catch-per-unit-effort (CPUE) in units of catch-per-hour as an index of relative fish abundance. In the calculation of mean catch-per-hour we include only those tows for which accurate catch and effort information is available. Effort information which cannot be associated with a given species is only utilized in generating mean catch-per-hour for the aggregate total of all species caught in a given fishery. To provide an indication of the variability of the generated mean catch-per-hour for a given block we calculate the standard error, 95 % confidence interval, and coefficient of variation.

The following formulas were used to calculate statistics which describe the mean catch-per-hour by block of groundfish and shrimp fisheries for California, Oregon, and Washington:

(4) CPUE = x / y where

CPUE = catch of fish per hour trawled for each sampled tow
Sampled tow = every tow for a given block and species which contains reliable catch and effort data.
x = adjusted pounds of a species caught for a sampled tow.
y = hours trawled for a sampled tow.

(5) SUM OF CPUE = $z_1 + z_2 + \ldots z_i$ where

z = CPUE for a sampled tow
i = sampled tow number

(6) SUM OF CPUE SQUARED = $(z_1)^2 + (z_2)^2 + \ldots (z_i)^2$ where

z = CPUE for a sampled tow
i = sampled tow number

(7) MEAN CPUE = Sz_i / n where

Sz_i = Sum of CPUE
n = number of tows sampled

(8) STANDARD DEVIATION = $\sqrt{\dfrac{(Sz_i^2) - \dfrac{(Sz_i)^2}{n}}{n-1}}$ where

n = number of tows sampled
Sz_i^2 = Sum of CPUE squared
Sz_i = Sum of CPUE

(9) STANDARD ERROR = $\dfrac{s}{\sqrt{n}}$ where

s = standard deviation
n = number of tows sampled

(10) DEGREES OF FREEDOM (df) = n - 1 where

n = number of tows sampled

(11) 95% CONFIDENCE INTERVAL = $\bar{Z} \pm t(s^x)$ where

$\bar{Z}$ = mean CPUE
s^x = standard error
t = value from t distribution table, column .05, row df

(12) COEFFICIENT OF VARIATION = $s(100) / \bar{Z}$ where

s = standard deviation

$\bar{Z}$ = mean CPUE

RESULTS

The data transformation and adjustment process enables the FISHMAP programs to summarize all of the catch, effort, and catch-per-hour information available for a given year of a given fishery for a given state. This information can then be summarized in numerous ways. A typical summary used to define fishing activity in a block shows catch, effort, mean catch-per-hour, 95 % confidence interval surrounding the mean catch-per-hour, and the coefficient of variation of the mean catch-per-hour for each species caught in each block.

For this project we generated summaries of reported catch data for California and Washington groundfish and shrimp fisheries. A portion of the data generated are shown for the 1986 California shrimp fishery (Table 4); the 1987 Washington shrimp fishery (Table 5); the 1985 California groundfish fishery (Table 6); and the 1986 Washington groundfish fishery (Table 7). All gear types are lumped in these examples of the groundfish data summaries. The summaries can also be generated for individual gear types as well. In the shrimp data summaries, single-rigged and double-rigged gears are combined, so only one summary is necessary.

The California and Washington fishery agencies are familiar with the reference grid we selected and the 10' block numbers. Appendix A is an example of the look-up table used to identify locational blocks off the Northern California coastline, including latitude and longitude coordinates corresponding to the southeast corner of the blocks. Appendix B is an example of the FISHMAP look-up table used to identify locational blocks off the Washington coastline.

This report includes examples of the generated data summaries. The entire data sets were also written to floppy disk in comma-delimited MS-DOS formats. Diskettes containing the processed data have been provided to the Washington Department of Fisheries and the California Department of Fish and Game. The fishery agencies will be able to sort or select on areas, species, or gear types and develop a variety of summaries from the data provided on disk.

Table 4. Example of catch, effort, and catch-per-hour by 5 min square block of Lat/Lon for the 1986 California shrimp fishery.

BLK5 NUMBER	TOTAL TOWS	TOTAL HOURS FISHED (DRE)	TOTAL POUNDS CAUGHT	MEAN POUNDS PER HOUR (DRE)	95% CONFIDENCE INTERVAL	COEFF. OF VARIATION
103.01	26	176.8	12650	78.5	51.4	31.7
103.03	46	377.9	13085	33.5	10	14.9
104.02	137	952.1	86575	98.6	20.4	10.5
104.03	1	5.6	0	0	N/A	N/A
104.04	25	199.6	6900	34.2	13.4	19
105.01	1	7.5	1000	133.3	N/A	N/A
105.02	2	14.9	1400	89.5	194.4	17.1
106.01	1	14.0	2000	142.9	N/A	N/A
108.02	1	4.1	150	36.6	N/A	N/A
108.03	1	7.2	300	41.7	N/A	N/A
108.04	1	11.3	600	53.1	N/A	N/A
109.01	250	2023.5	109404	56.8	7.4	6.7
109.02	38	273.7	14300	52.6	11.3	10.6
109.03	409	3082.8	193235	66.7	10.8	8.2
109.04	146	1078.3	44900	41	5.7	7.1
110.01	1	5.6	350	62.5	N/A	N/A
110.02	4	30.4	760	25.7	25.8	31.5
110.03	1	4.0	250	62.5	N/A	N/A
110.04	4	31.4	1150	37.4	29.9	25.1
111.02	1	8.7	600	69	N/A	N/A
112.04	1	9.0	700	77.8	N/A	N/A
114.01	1	8.5	200	23.5	N/A	N/A
114.02	2	11.1	1600	154.7	363.4	18.5
115.01	5	39.2	850	29.3	42.8	52.6
115.02	3	21.9	690	30.1	69.7	53.8
115.03	4	31.3	1775	43.4	56.3	40.8
115.04	3	23.4	850	29.5	54.2	42.7
116.01	744	5214.6	344702	66.3	5.3	4.1
116.02	299	2136.3	133525	70.2	11.8	8.5
116.03	1082	7276.5	584528	85.6	6.1	3.6
116.04	281	2076.7	134427	65.5	6.1	4.7
117.01	4	98.4	4375	36.6	19.4	16.7
117.02	7	75.6	3500	43.8	33.3	31.1
117.03	4	41.2	3150	75.5	84.6	35.2
117.04	24	170.0	13450	79.1	20.9	12.8
118.02	1	4.9	400	81.6	N/A	N/A
118.04	1	18.0	800	44.4	N/A	N/A
121.01	4	19.5	975	43.5	63	45.5
121.02	3	14.4	600	42.1	34	18.8
121.03	4	14.8	50	4	11.1	87.5
121.04	1	6.6	1150	174.2	N/A	N/A
122.01	441	3151.2	225477	71	5.3	3.8
122.02	97	758.9	37455	51.4	10.5	10.3
122.03	181	1323.6	88363	67.5	9	6.8
122.04	262	1925.7	144789	76.6	10.2	6.8

Table 5. Example of catch, effort, and catch-per-hour by 5 min square block of Lat/Lon for the 1987 Washington shrimp fishery.

BLK5 NUMBER	TOTAL TOWS	TOTAL HOURS FISHED (DRE)	TOTAL POUNDS CAUGHT	MEAN POUNDS PER HOUR (DRE)	95% CONFIDENCE INTERVAL	COEFF. OF VARIATION
1227.06	1	4.0	1717	429.3	N/A	N/A
1231.06	1	2.0	2357	1178.5	N/A	N/A
1233.02	1	3.0	2292	764	N/A	N/A
1238.02	1	1.7	2051	1206.5	N/A	N/A
1239.01	2	3.5	388	115.1	438.4	30
1239.02	3	8.0	2179	301.1	318	24.5
1239.04	1	2.0	539	269.5	N/A	N/A
1240.02	1	1.4	184	131.4	N/A	N/A
1244.01	1	2.0	435	217.5	N/A	N/A
1245.01	34	81.9	37285	459.4	97.2	10.5
1245.02	41	102.2	48192	490.6	118.4	11.9
1245.03	12	27.7	7824	299.2	125	19
1245.04	10	20.8	10640	506.5	232.1	20.3
1246.02	7	20.7	9755	467.1	291.2	25.5
1246.04	1	2.3	0	0	N/A	N/A
1247.02	1	1.5	262	174.7	N/A	N/A
1251.01	19	44.5	18488	419.3	139.1	15.8
1251.02	7	19.3	7035	421.5	379	36.7
1251.03	39	86.1	47245	544.9	118.8	10.8
1251.04	20	41.7	28174	643.5	157.2	11.7
1252.01	7	15.4	8091	497.5	280.9	23.1
1252.02	4	8.9	4660	511.3	242.8	14.9
1252.03	5	14.3	3726	243.5	173.2	25.6
1252.04	9	20.3	7234	324	151.5	20.3
1256.01	1	.6	0	0	N/A	N/A
1256.03	1	1.0	208	208	N/A	N/A
1257.01	53	120.7	59582	488	96.6	9.9
1257.02	18	37.0	17296	512.5	185.7	17.2
1258.01	24	51.7	21567	369.5	110.1	14.4
1258.02	33	66.8	34688	550	139	12.5
1259.01	1	1.7	0	0	N/A	N/A
1259.02	11	25.7	7165	244.6	121.2	22.2
1261.01	1	1.9	1555	818.4	N/A	N/A
1262.04	3	8.3	8759	1033.7	2300.4	51.7
1262.07	1	2.5	884	353.6	N/A	N/A
1263.01	48	92.8	59529	728.4	279.8	19.2
1263.02	8	18.5	9074	541.1	363.5	28.4
1263.03	84	172.9	86734	501.9	107.1	10.8
1263.04	21	44.4	25147	590	285.4	23.2
1263.05	95	188.7	91729	496.8	77	7.8
1263.06	14	29.6	14108	497.8	235.7	21.9
1264.01	98	227.3	105202	462.4	75.8	8.3
1264.02	105	227.8	99936	426.2	70.7	8.4
1264.03	98	219.7	115299	535.7	91.7	8.6
1264.04	79	178.6	80526	482.8	96.8	10.1

Table 6. Example of catch, effort, and catch-per-hour by 10 min square block of Lat/Lon for the 1985 California groundfish fishery.

BLK10 NUMBER	SPECIES CODE	TOTAL TOWS	TOTAL HOURS FISHED	TOTAL POUNDS CAUGHT	MEAN POUNDS PER HOUR	95% CONFIDENCE INTERVAL	COEFF. OF VARIATION
102	195	4	9.4	80	8.6	1	3.5
102	205	1	2.0	20	10	N/A	N/A
102	206	9	22.9	2310	99.6	40.6	17.7
102	207	3	6.9	40	5.9	3.4	13.6
102	209	8	20.4	265	13.1	4.7	15.3
102	211	5	7.9	200	24.7	6.9	6.5
102	225	4	8.9	100	11.3	3.8	10.6
102	230	3	6.9	70	10.1	3.4	7.9
102	250	7	18.5	2830	161.1	159.1	40.3
103	159	2	2.8	30	10.7	N/A	N/A
103	175	73	202.1	5966	29.4	5.9	10.2
103	190	18	41.5	460	10.8	3.6	15.7
103	195	115	265.9	5301	19.4	6.9	18
103	205	35	89.5	2323	26.2	6.5	12.2
103	206	148	399.4	33353	84.1	8.4	5.1
103	207	142	380.3	8290	21.8	4.5	10.6
103	209	146	384.9	10240	26.2	3.1	6.1
103	211	97	251.5	28784	115.6	21.8	9.5
103	225	135	361.2	7161	20	2.9	7.5
103	230	46	86.8	590	6.6	1.6	12.1
103	250	58	124.5	17904	394.1	734.8	93.2
103	252	8	8.0	76250	9531.3	4958.9	22
103	712	22	28.9	242	8.5	1.8	9.4
103	800	3	3.0	28	9.3	N/A	N/A
104	175	1	3.0	25	8.3	N/A	N/A
104	190	92	402.1	56035	126	24.9	10
104	195	50	155.2	4165	27.6	11.9	21.4
104	201	31	123.4	1470	14.6	7	23.3
104	206	10	25.2	350	30	59.4	77
104	207	76	338.1	7010	21.1	5.7	13.7
104	209	6	12.1	100	11.3	18.5	51.3
104	211	95	424.1	73740	181.2	30.1	8.4
104	225	3	4.1	25	7.3	47	50.7
104	250	72	273.7	34140	139.6	88.3	31.9
104	262	63	220.3	4253	20.2	10.4	25.7
104	269	9	24.2	35400	2783.9	5740.5	80.2
104	495	19	18.9	667000	38845.9	8540.8	10.5
104	960	14	70.6	7020	99.4	95.7	44.2
105	190	94	556.7	43935	80.1	15.4	9.7
105	206	1	2.5	25	10	N/A	N/A
105	207	21	106.7	1815	17.2	9.1	25
105	211	98	567.4	130950	241.2	33.9	7.1
105	262	96	563.9	66725	126.2	16.4	6.6
105	269	1	2.5	47	18.8	N/A	N/A
106	190	73	378.3	51900	138.3	28.1	10.3
106	211	73	378.3	157900	435.5	52.7	6.1

Table 7. Example of catch, effort, and catch-per-hour by 10 min square block of Lat/Lon for the 1986 Washington groundfish fishery.

BLK10 NUMBER	SPECIES CODE	TOTAL TOWS	TOTAL HOURS FISHED	TOTAL POUNDS CAUGHT	MEAN POUNDS PER HOUR	95% CONFIDENCE INTERVAL	COEFF. OF VARIATION
1304	54	1	2.8	200	71.4	N/A	N/A
1305	5	6	29.3	4600	171.4	117.8	26.7
1305	6	2	10.8	60	6.1	39.4	50.8
1305	7	3	15.8	130	8.6	9.5	25.6
1305	8	3	13.3	320	27.1	55.1	47.2
1305	13	5	23.3	6800	246.8	269	39.3
1305	21	5	24.5	1150	50.5	45.2	32.3
1305	31	1	4.8	20	4.2	N/A	N/A
1305	51	9	37.8	55800	2401.1	2172	39.2
1305	54	1	6.0	300	50	N/A	N/A
1307	5	1	1.0	300	300	N/A	N/A
1307	6	18	27.5	4415	270.6	205.9	36.1
1307	7	8	12.5	485	36.9	30	34.4
1307	10	22	36.4	4655	118.7	43.5	17.6
1307	11	4	8.0	550	68.8	149.9	68.5
1307	12	8	13.2	370	34.1	29.6	36.7
1307	51	3	5.0	205	50.8	99	45.3
1308	5	39	52.9	23270	489.3	224.1	22.7
1308	6	37	42.8	20910	588.3	285.2	24
1308	7	30	38.5	2570	68.5	22.3	15.9
1308	8	24	39.2	6740	180.4	84.8	22.7
1308	10	13	16.4	1080	70.6	26.1	17
1308	11	5	7.0	490	70.5	77.5	39.6
1308	12	20	23.0	2140	103.6	50.7	23.4
1308	13	5	14.6	13800	934.9	1062.1	40.9
1308	21	6	15.4	1502	86.7	84.6	37.9
1308	31	3	3.3	35	11.3	16.8	34.5
1308	51	8	19.1	775	37.8	25.8	28.8
1309	5	14	39.3	11540	295.5	133.9	21
1309	6	4	9.8	240	36.7	72.5	62.1
1309	7	4	12.0	275	24	20.7	27.1
1309	8	11	30.8	3125	106.8	43.9	18.4
1309	12	1	1.3	50	38.5	N/A	N/A
1309	13	10	28.7	23425	852.9	1032.2	53.5
1309	21	12	34.0	5330	197.8	196.1	45
1309	31	4	10.6	1100	104	75.4	22.8
1309	41	2	6.3	70	10.7	31.8	23.4
1309	44	1	2.0	50000	25000	N/A	N/A
1309	51	12	34.5	4100	122.5	53	19.7
1309	54	3	8.5	530	59.2	188.9	74.2
1310	5	5	19.5	1500	98.9	163.5	59.6
1310	6	1	3.0	10	3.3	N/A	N/A
1310	7	2	9.7	190	22.5	67.3	23.6
1310	8	3	8.8	325	39.5	74.4	43.8
1310	13	4	15.5	3300	137.9	284.8	64.9
1310	21	9	39.0	10885	221.1	163.5	32.1

DISCUSSION

The primary purpose of the OHAM system is to provide a thorough and easily referenced data base for use in making ocean resource management decisions. OHAM's applications in resource management include identifying important marine habitat, analyzing the direct and indirect impacts of ocean development, identifying potential conflicts among ocean resource users, and providing information for fishery management decisions. It is premature to identify resource conflict areas with just one year of data summarized for Washington and California, but we can use a hypothetical example of oil and gas development to describe how fishery catch data could be applied to improve resource management decisions.

The first way in which fishery data can be used to evaluate oil and gas development is during the planning and pre-lease stages of the MMS lease sale process. The most obvious time that fishery catch data can be used is in the Call for Nominations step of the lease process. The MMS and the States can use the FISHMAP data to identify areas of high and low groundfish or shrimp fishing activity and production (Fig. 2). The information can be used to identify areas that either should be removed from lease consideration because of their high fishery value, or highlighted as being possible areas for development because of low fishing activity. It is important to realize that the existing commercial fishery data alone should not be used to evaluate the suitability of an area for development. Other environmental, geological, and social information would be needed to further evaluate an area. The fisheries data would quickly highlight areas of primary concern, however.

After the Call for Nominations stage of the MMS lease process, areas are identified as being of interest to oil companies and an environmental impact analysis is required. This example demonstrates how the FISHMAP data can be used for pre-development impact review of: effects resulting from the oil rig's physical occupation of ocean space, effects due to routine oil rig operations, and effects of accidental spills. Impacts within each of these categories can affect fisheries directly by altering either fish populations or fishing activities. Additionally, there are indirect effects on fish populations and fisheries resulting from degradation of habitat or food availability.

During the pre-development review of a proposal, the FISHMAP portion of our system would provide a geographic framework for estimating the impacts resulting from a physical occupation of an ocean area. The first step in the impact analysis would be to project the oil rig's location on maps of groundfish and shrimp catch and effort. The maps would indicate relative importance of fishing grounds at or near the proposed oil rig location (Fig. 3). Average annual catches for 10' blocks or 5' blocks can be portrayed for an aggregation of species, or for individual species. The data would provide an estimate of the loss in fishery production due to a loss of the ability to trawl in an area. With the addition of economic information, states would also be able to estimate the revenue loss to local communities caused by the reduction in fish production.

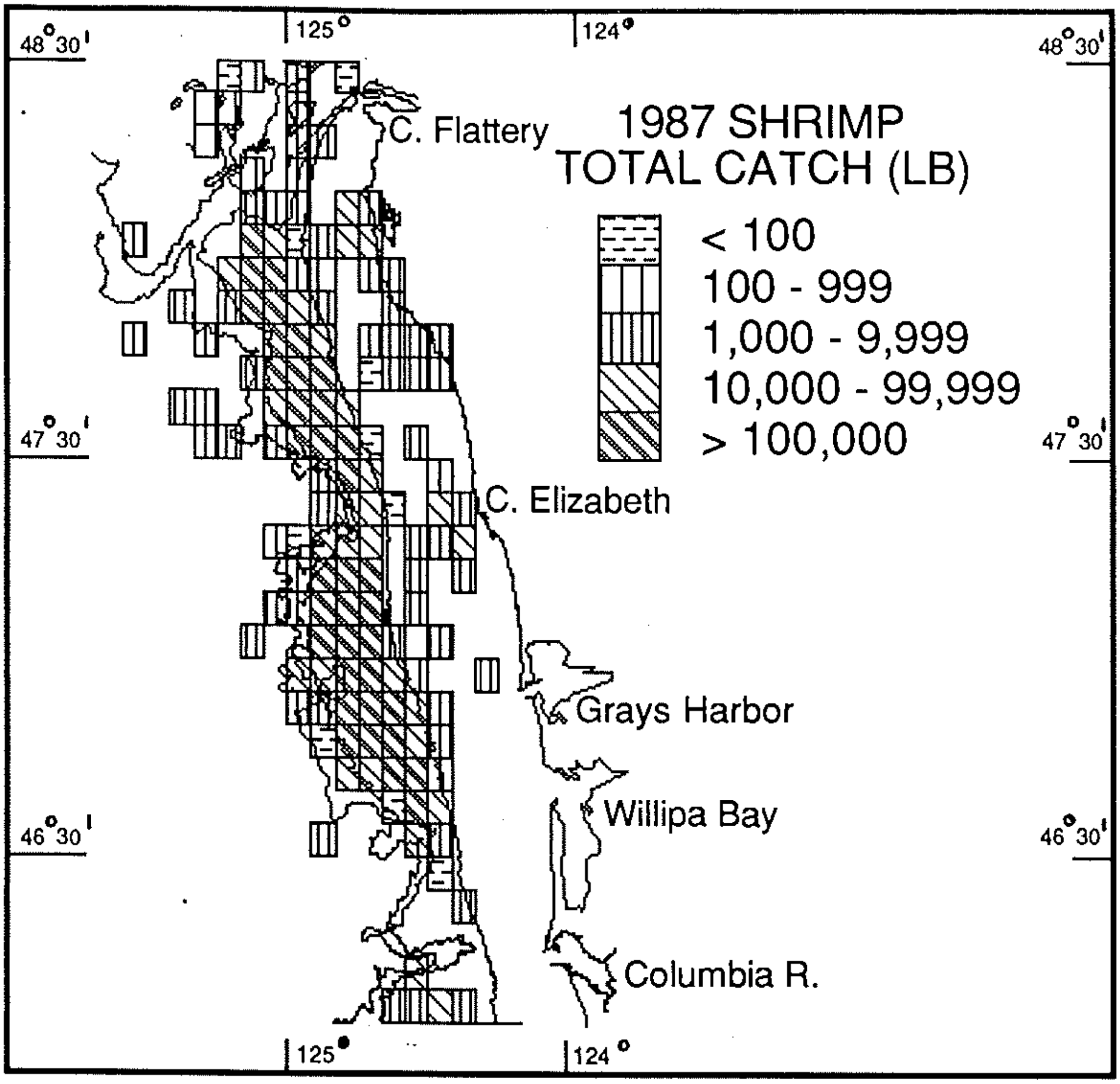

Figure 2. Distribution of the commercial catch of pink shrimp off Washington, displayed in 5' of latitude by 5' of longitude blocks.

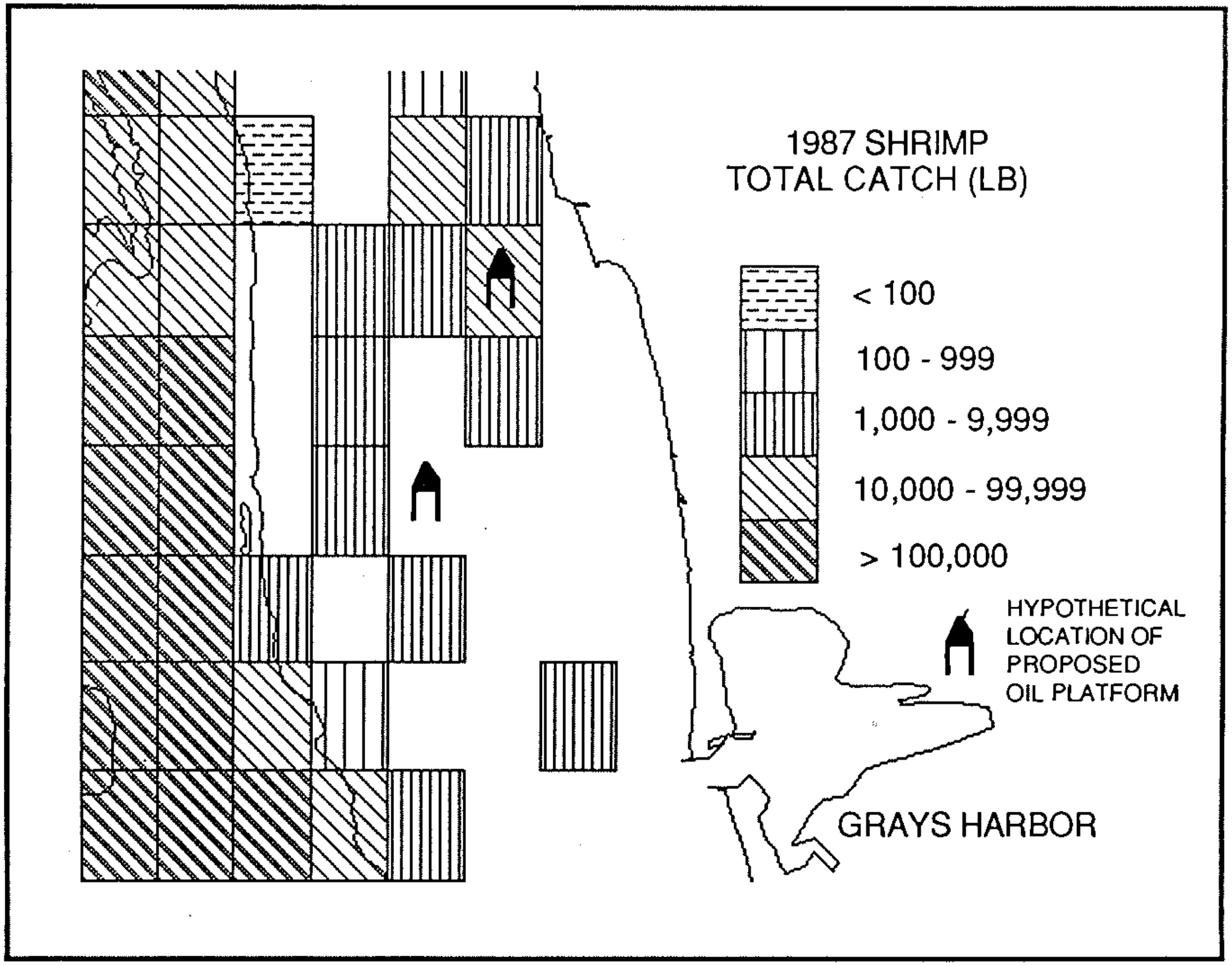

Figure 3. Distribution of the commercial catch of pink shrimp off Grays Harbor in 1987 with hypothetical locations of proposed oil platforms.

In selecting a specific location for an oil rig, it may be desirable to evaluate impacts on a finer scale than 5' blocks of latitude and longitude. The FISHMAP system can be used to select the locations of the individual tows that occurred in the block of interest. After the individual tows are plotted, the potential space use conflict can be confirmed by visually checking the tow locations against the proposed oil rig location, or by comparing the habitat type or contours occupied by the rig with fish species' habitat requirements.

As a component of the physical occupation of space, an oil rig would alter the habitat by providing a hard substrate. Species that typically associate with a hard substrate have been known to increase in numbers around oil platforms. It is not known whether the oil platforms just attract fish or if they actually increase fish populations. Also, it would not be known in advance if the concentration of fish near an oil rig would increase catch efficiencies of the fishing fleet. If catch rates increased near the oil platform, they might offset the loss of fishing opportunity caused by the reduction in area available to fish. The FISHMAP system can be used to monitor and provide information for resolving the question of increase catch efficiency. Figure 4 is an example of a plot of 1987 catch rates of Dover sole and sablefish. Historical data such as presented in Figure 4 can be compared with recent logbook data from vessels fishing near an oil rig to reveal changes in species composition and catch rates. A comparison of recent data with historical records could help determine changes in the fishery that are attributable to the hard structure created by the oil rig.

A second major category of oil rig environmental impacts results from the rig's routine operations. As part of a rig's permit or lease, specific performance standards or conditions could be developed regarding the timing or methods of routine operations. Applying performance standards requires specific knowledge of the resources at the development site; FISHMAP can provide much of this information. For example, FISHMAP's capability of displaying fishing activity, species catch, or relative abundance by month could be used to define a work window within which certain types of activities can be permitted.

Another example of impacts associated with an oil rig's operation is increased vessel activity associated with service of the rig. The increased traffic and debris lost over the side from the oil rig and service vessels could cause loss of grounds for trawl fishing. These conflicts could be identified by overlaying navigation routes on maps of commercial fishing areas or individual fishing tow locations.

Oil spills represent the third major category of potential impacts caused by an oil rig. The FISHMAP system could be used to develop oil spill contingency plans or determine spill response measures. A contingency plan could draw on FISHMAP data to assess environmental risk from spills and set spill response recommendations and priorities. Site specific fishery data from the FISHMAP system, coupled with trajectory analysis, would indicate spill risk for specific species or locations. Specific spill response recommendations can be developed from this information and applied to the area or species in question. Priorities can be set for spill response based on the

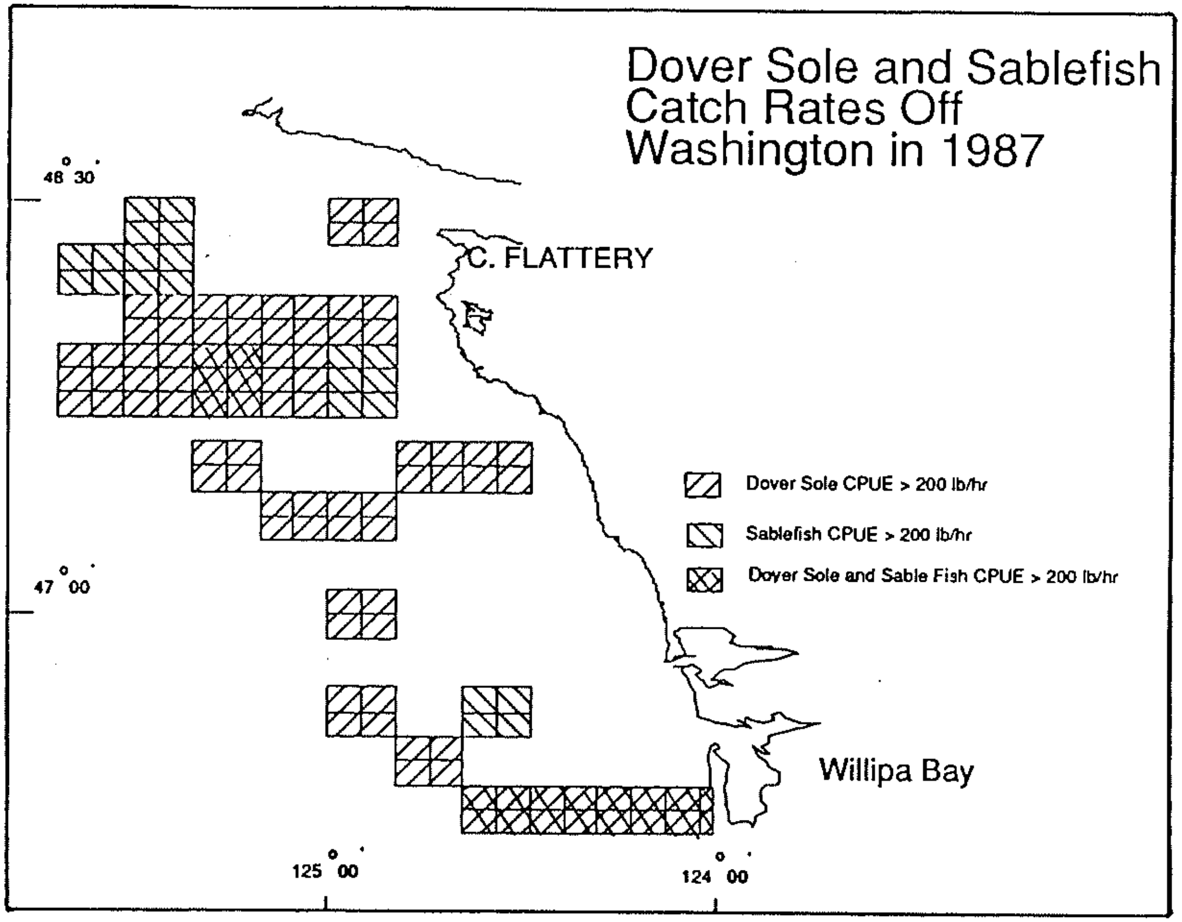

Figure 4. Distribution of areas off Washington in 1987 containing commercial catch rates greater than 200 lb/hr of Dover sole and sablefish.

sensitivity of the species at risk and their economic contribution. During an actual oil spill, the U.S. Coast Guard and state and federal agencies establish spill response strategies based on the contingency plan and the particular circumstances and conditions at the time of the spill. The FISHMAP data would enable spill response personnel to predict direct impacts by overlaying the spill trajectory on maps of known fishing grounds.

Oil spills also indirectly affect fish by changing habitats, reducing abundance of prey organisms, or altering reproductive capability or early life stages of a species. Indirect impacts cannot be evaluated with the current information and analysis methods. Future plans for the OHAM system include assimilating and analyzing biological and oceanographic information related to commercial fish species to determine habitat requirements, species associations, and various life history requirements. This will help define ecosystem interactions associated with the fisheries and significantly increase our ability to assess indirect impacts of an oil spill. After economic data are added to the OHAM system, the potential economic loss to local communities could also be identified.

SUMMARY

ODFW has been developing a long-term program designed to provide an ecosystem-level approach to ocean resource planning. The long-term program, called Ocean Habitat Analysis and Mapping, is intended to help define discrete ocean areas with special biologic, economic, or social significance. The techniques we developed can provide data for impact analysis on a species, fishery, or geographic basis. Future expansion of the OHAM system will enable us to more fully examine ecosystem relationships and assess indirect impacts of marine development. Additionally, we are proposing to develop the capability of associating economic values with specific oceanic locations. This will enable us to make quantitative estimates of the economic impact of marine development, and link changes in the biological environment with changes in the social environment.

The OHAM program is intended to have the capability of responding to ocean resource planning needs in northern California and Washington as well. Interstate communication and a regional fisheries data base are important for sound ocean resource management. In this project we incorporated California and Washington fishery data into the portion of Oregon's Ocean Habitat Analysis and Mapping program that summarizes commercial fishery catch data. The project involved obtaining, reducing, and summarizing commercial fishery catch data from the Washington Department of Fisheries and California Department of Fish and Game. Catch data summarized included California's 1986 shrimp fishery, California's 1985 groundfish fishery, Washington's 1987 shrimp fishery, and Washington's 1986 and 1987 groundfish fishery.

ACKNOWLEDGMENTS

Numerous people helped us complete our project and deserve special recognition. From our own ODFW staff and ocean habitat project we would like to thank Barbara Bond, Kathy Murphy, Susan Riemers and Claire Wood who spent many days coding, entering, verifying and correcting Washington and California shrimp logbooks. Their precise work served as the cornerstone to developing useful and accurate logbook summaries. Steve Jones also assisted with the verification of some of the logbook data. Jim Golden and Gary Hettman helped us understand the idiosyncrasies of the groundfish fishery. Phil Flanders continued to provide us with valuable suggestions on ways to streamline the many computer programs used during this project.

Bill Clark and Greg Konkel of WDF provided us with Washington groundfish data, and a clear understanding of the limitations of how it should be used. Barb McIntosh and Mike Gross provided the same assistance with Washington shrimp data. From CDFG, Larry Duccini provided California groundfish data and Pat Collier provided California shrimp data. Bryan Coleman of the EPA was extremely helpful in offering his assistance and the EPA's computers to transfer CDFG data to our system. OSU's Clay Creech also spent numerous hours helping resolve computer problems.

REFERENCES

Clark, W.G. 1987. User's guide to Washington's expanded trawl logbook data. Washington Department of Fisheries, Olympia.

Clark, W.G. 1986. Washington's trawl logbook data: past and present, Prog. Rpt. No. 228. Washington Department of Fisheries, Olympia.

Downie, N.M., and R.W. Heath. 1974. Basic statistical methods, 4th edition. Harper and Row, Publishers, New York.

PMFC and NMFS. 1981. Discussion draft fishery management plan for the pink shrimp fishery off Washington, Oregon, and California. PMFC and NMFS, Portland, OR and Seattle, WA.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Company, San Francisco.

Starr, R.M., and M.R. Saelens. 1987. Identification of important marine habitat. Oregon Department of Fish and Wildlife, Newport.

Steel, R.G.D., and J.H. Tonnie. 1980. Principles and procedures of statistics: A biometrical approach, 2nd edition. McGraw-Hill Book Company, New York.

APPENDIX A

Portion of the FISHMAP block look-up table used to identify blocks off the northern California coastline, including coordinates of latitude and longitude (expressed in degrees and ten-thousandths of degrees) corresponding to the southeast corner of blocks. The 10' block identifier used for the groundfish data is located to the left of the decimal point. The entire number is used for the shrimp fishery data to identify the 5' blocks.

Appendix Table A. FISHMAP block look-up table used to identify blocks off northern California.

BLK5 NUMBER	LATITUDE. (DEGREES)	LONGITUDE (DEGREES)	STATE AREA	PMFC AREA	LANDMARK
102.01	41.9167	124.2500	18	92	PYRAMID POINT
102.02	41.9167	124.1667	18	92	PYRAMID POINT
102.03	41.8333	124.2500	18	92	TALAWA SLOUGH
102.04	41.8333	124.1667	18	92	TALAWA SLOUGH
103.01	41.9167	124.4167	18	92	PYRAMID POINT
103.02	41.9167	124.3333	18	92	PYRAMID POINT
103.03	41.8333	124.4167	18	92	TALAWA SLOUGH
103.04	41.8333	124.3333	18	92	TALAWA SLOUGH
104.01	41.9167	124.5833	18	92	PYRAMID POINT
104.02	41.9167	124.5000	18	92	PYRAMID POINT
104.03	41.8333	124.5833	18	92	TALAWA SLOUGH
104.04	41.8333	124.5000	18	92	TALAWA SLOUGH
105.01	41.9167	124.7500	18	92	PYRAMID POINT
105.02	41.9167	124.6667	18	92	PYRAMID POINT
105.03	41.8333	124.7500	18	92	TALAWA SLOUGH
105.04	41.8333	124.6667	18	92	TALAWA SLOUGH
106.01	41.9167	124.9167	18	92	PYRAMID POINT
106.02	41.9167	124.8333	18	92	PYRAMID POINT
106.03	41.8333	124.9167	18	92	TALAWA SLOUGH
106.04	41.8333	124.8333	18	92	TALAWA SLOUGH
107.01	41.6667	124.1333	18	92	CHASE LEDGE
108.01	41.7500	124.2500	18	92	POINT ST GEORGE
108.02	41.7500	124.1667	18	92	POINT ST GEORGE
108.03	41.6667	124.2500	18	92	CHASE LEDGE
108.04	41.6667	124.1667	18	92	CHASE LEDGE
109.01	41.7500	124.4167	18	92	POINT ST GEORGE
109.02	41.7500	124.3333	18	92	POINT ST GEORGE
109.03	41.6667	124.4167	18	92	CHASE LEDGE
109.04	41.6667	124.3333	18	92	CHASE LEDGE
110.01	41.7500	124.5833	18	92	POINT ST GEORGE
110.02	41.7500	124.5000	18	92	POINT ST GEORGE
110.03	41.6667	124.5833	18	92	CHASE LEDGE
110.04	41.6667	124.5000	18	92	CHASE LEDGE
111.01	41.7500	124.7500	18	92	POINT ST GEORGE
111.02	41.7500	124.6667	18	92	POINT ST GEORGE
111.03	41.6667	124.7500	18	92	CHASE LEDGE
111.04	41.6667	124.6667	18	92	CHASE LEDGE
112.01	41.7500	124.9167	18	92	POINT ST GEORGE
112.02	41.7500	124.8333	18	92	POINT ST GEORGE
112.03	41.6667	124.9167	18	92	CHASE LEDGE
112.04	41.6667	124.8333	18	92	CHASE LEDGE
114.01	41.5833	124.1000	18	92	FOOTSTEPS ROCKS
114.02	41.5000	124.0833	18	92	KLAMATH RIVER
115.01	41.5833	124.2500	18	92	FOOTSTEPS ROCKS
115.02	41.5833	124.1667	18	92	FOOTSTEPS ROCKS
115.03	41.5000	124.2500	18	92	KLAMATH RIVER
115.04	41.5000	124.1667	18	92	KLAMATH RIVER

APPENDIX B

Portion of the FISHMAP block look-up table used to identify blocks off the Washington coastline, including coordinates of latitude and longitude (expressed in degrees and ten-thousandths of degrees) corresponding to the southeast corner of blocks. The 10' block identifier used for the groundfish data is located to the left of the decimal point. The entire number is used for the shrimp fishery data to identify the 5' blocks.

Appendix Table B. FISHMAP block look-up table used to identify blocks off Washington.

BLK5 NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	STATE AREA	PMFC AREA	LANDMARK
1301.01	46.0833	124.0833	28	82	S. OF COLUMBIA R.
1301.02	46.0833	124.0000	28	82	S. OF COLUMBIA R.
1301.03	46.0833	123.9167	28	82	S. OF COLUMBIA R.
1302.01	46.0833	124.2500	28	82	S. OF COLUMBIA R.
1302.02	46.0833	124.1667	28	82	S. OF COLUMBIA R.
1303.01	46.0833	124.4167	28	82	S. OF COLUMBIA R.
1303.02	46.0833	124.3333	28	82	S. OF COLUMBIA R.
1304.01	46.0833	124.5833	28	82	S. OF COLUMBIA R.
1304.02	46.0833	124.5000	28	82	S. OF COLUMBIA R.
1305.01	46.0833	124.7500	28	82	S. OF COLUMBIA R.
1305.02	46.0833	124.6667	28	82	S. OF COLUMBIA R.
1306.01	46.0833	124.9167	28	82	S. OF COLUMBIA R.
1306.02	46.0833	124.8333	28	82	S. OF COLUMBIA R.
1307.01	46.2500	124.0833	29	75	CHINOOK POINT
1307.02	46.2500	124.0000	29	75	CHINOOK POINT
1307.03	46.1667	124.0833	28	82	COLUMBIA RIVER
1307.03	46.2500	123.9167	29	75	CHINOOK POINT
1307.04	46.1667	124.0000	28	82	COLUMBIA RIVER
1307.05	46.1667	123.9167	28	82	COLUMBIA RIVER
1308.01	46.2500	124.2500	29	75	CHINOOK POINT
1308.02	46.2500	124.1667	29	75	CHINOOK POINT
1308.03	46.1667	124.2500	28	82	COLUMBIA RIVER
1308.04	46.1667	124.1667	28	82	COLUMBIA RIVER
1309.01	46.2500	124.4167	29	75	CHINOOK POINT
1309.02	46.2500	124.3333	29	75	CHINOOK POINT
1309.03	46.1667	124.4167	28	82	COLUMBIA RIVER
1309.04	46.1667	124.3333	28	82	COLUMBIA RIVER
1310.01	46.2500	124.5833	29	75	CHINOOK POINT
1310.02	46.2500	124.5000	29	75	CHINOOK POINT
1310.03	46.1667	124.5833	28	82	COLUMBIA RIVER
1310.04	46.1667	124.5000	28	82	COLUMBIA RIVER
1311.01	46.2500	124.7500	29	75	CHINOOK POINT
1311.02	46.2500	124.6667	29	75	CHINOOK POINT
1311.03	46.1667	124.7500	28	82	COLUMBIA RIVER
1311.04	46.1667	124.6667	28	82	COLUMBIA RIVER
1312.01	46.2500	124.9167	29	75	CHINOOK POINT
1312.02	46.2500	124.8333	29	75	CHINOOK POINT
1312.03	46.1667	124.9167	28	82	COLUMBIA RIVER
1312.04	46.1667	124.8333	28	82	COLUMBIA RIVER
1313.01	46.4167	124.2500	29	75	KLIPSAN BEACH
1313.02	46.4167	124.1667	29	75	KLIPSAN BEACH
1313.03	46.4167	124.0833	29	75	KLIPSAN BEACH
1313.04	46.4167	124.0500	29	75	KLIPSAN BEACH
1313.05	46.3333	124.2500	29	75	LONG BEACH
1313.06	46.3333	124.1667	29	75	LONG BEACH
1313.07	46.3333	124.0833	29	75	LONG BEACH
1313.08	46.3333	124.0500	29	75	LONG BEACH

APPENDIX C
FINANCIAL REPORT

PERSONAL SERVICES		
	Salaries ODFW employees	26030.43
	Benefits	8694.56

	SUBTOTAL	34724.99
	Salaries OSU employees	8664.92
	TOTAL PERSONAL SERVICES	43389.91
SERVICES AND SUPPLIES		445.85
INDIRECT COSTS		7697.97
CAPITAL OUTLAY		8466.27

	GRAND TOTAL	$60,000.00

NCRI TECHNICAL SUMMARY
Fishery Resource Mapping

Project Title: Fishery Resource Mapping

Applicable Area: Washington, Northern California coastal waters

Period of Performance: March 1, 1988 to March 31, 1989

Report Completion Date: April 19, 1989

Cumulative Project Costs: $60,000

Principal Investigators: Richard M. Starr
Mark R. Saelens

Affiliation: Oregon Department of Fish and Wildlife

Address: Hatfield Marine Science Center
Newport, OR 97365

Key Words: Fishery catch data, ocean planning, groundfish, shrimp

Background:

More precise information is needed to adequately plan for increased demands on fishery resources and potential oil, gas, and mineral development. The Oregon Department of Fish and Wildlife (ODFW) is developing the capability to summarize commercial fishery catch data on a finer scale than previously available for ocean resource planning and fishery management. Ocean resource planning on a regional basis is essential; ODFW responded to the need for interstate coordination and a region-wide data base by designing a project to demonstrate how Washington and California commercial fisheries data can be summarized on a finer scale as well.

Objectives:

The NCRI Fishery Resource Mapping Project was developed to foster interstate coordination of fishery research and management. The primary objectives of the project were:

1) to expand the regional inventory of information available for ocean resource development and planning,
2) to bring California and Washington fishery agencies up to speed with Oregon's habitat data management system so they could evaluate its usefulness,
3) to improve interstate coordination of ocean resource planning, and
4) to continue developing and refining Oregon's habitat data management system.

Description:

Fulfilling the project objectives required that we obtain California and Washington data, make the data compatible with the finer scale analysis system, process the data, and return the processed data bases to California Fish and Game and Washington Department of Fisheries. We completed the work by:

1) developing or modifying programs to enter or import logbook and fishticket information from California and Washington,
2) collecting and coding one year of California groundfish fishery data, two years of Washington groundfish fishery data, and one year of shrimp fishery data from each of the two states,
3) entering or importing the fishery data,
4) summarizing the data, including separating groundfish fishery logbook catch by species and developing appropriate statistical parameters for the data, and
5) providing the data to California Department of Fish and Game and the Washington Department of Fisheries.

Project Results

The regional fisheries data base was expanded by inclusion of California and Washington shrimp and groundfish data. Our work with the other states improved interstate communication concerning fisheries data and enabled Washington and California to learn about the approach we are taking to summarize commercial fishery data. Once the states review the data bases, they will be able to evaluate the usefulness of our approach. This project significantly improved our data management system by allowing us to summarize groundfish catch by species and to report statistical measures of variability on the effort data.

Project Products:

The final report describes the project background and development and includes a description of the final data base products, of how Washington and California catch data were processed, of how Oregon's data analysis system was modified and improved during the project, and a discussion of how information generated through the data system can be used to help analyze impacts of offshore development.

Economic Effects on Industry, Business, and Commerce:

Techniques developed by ODFW provide resource agencies with the ability to estimate the volume of fish and shellfish harvested from specific locations. The data can be used to evaluate fishery management alternatives or to provide an estimate of the loss in fishery production due to ocean development. After revenue information are added to the data base in the future, states would not only be able to estimate changes in catch, but also be able to estimate the economic changes to local communities caused by changes in fish production. Industries and businesses would be able to identify peak and slack periods of fishery related economic activity and impacts of proposed development.

ABSTRACT

Since 1986, the Oregon Department of Fish and Wildlife's (ODFW) Marine Region has been developing a long-term program designed to provide an ecosystem-level approach to ocean resource management. The long-term program, called Ocean Habitat Analysis and Mapping (OHAM), is intended to help define discrete ocean areas with special biologic, economic, or social significance. It is built on a reference grid that allows data to be summarized and mapped on a finer scale than has been used in the past. The system is designed to identify areas important for species at critical life history stages, to identify areas important for sport and commercial fisheries, and to help understand how fishers and fishery resources respond to natural or artificial changes in the environment. The OHAM program is intended to have the capability of responding to ocean resource planning needs in northern California and Washington as well.

This report describes a project funded by the National Coastal Resources Research and Development Institute to foster interstate communication and begin to develop a regional fisheries data base. The project incorporated California and Washington fishery data into the portion of Oregon's Ocean Habitat Analysis and Mapping program that summarizes commercial fishery catch data. The project involved obtaining, reducing, and summarizing commercial fishery catch data from the Washington Department of Fisheries and California Department of Fish and Game. Catch data summarized included California's 1986 shrimp fishery, California's 1985 groundfish fishery, Washington's 1987 shrimp fishery, and Washington's 1986 and 1987 groundfish fishery.