AN ABSTRACT OF THE THESIS OF


Title: Capturing Local Knowledge for Cooperative Fisheries Management Using a Participatory Geographic Information System (GIS) Approach in Port Orford, Oregon.

Abstract

This study demonstrates the utility of combining available scientific data with local ecological knowledge in a Geographic Information System (GIS) to support community-based fisheries management. The approach used provides both the framework for capturing important ecological, economic and social information relevant to marine fisheries management, and also offers coastal citizens a process for active participation in management discussions about their local nearshore marine environment. Thirty-three Local Knowledge Interviews (LKIs) were completed with commercial fishermen and recreational users with knowledge and experience observing the nearshore environment. Drawing on acetate overlays on basemaps of navigational charts and bathymetric contours, ocean users delineated areas of personal and observed human uses and locations of specific fish, invertebrate and plant communities. The individual maps were digitized and subsequently aggregated into thematic maps that represent the highest levels of correspondence among interviewees. This participatory GIS process for developing an ecological inventory of the distribution of marine species and human activities provides a more comprehensive understanding of the nearshore marine environment and its human uses than existing scientific data alone. The accompanying maps created also lay the groundwork for more in-depth economic studies and spatial analyses to support long-term community-based management planning.
Capturing Local Knowledge for Cooperative Fisheries Management Using a Participatory Geographic Information System (GIS) Approach in Port Orford, Oregon.

by
Victoria A. Wedell

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Dean of the Graduate School

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Victoria A. Wedell, Author
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Thank you to Laura Anderson, David Revell, and Leesa Cobb. Your dedication, energy, and vision for the future are unparalleled.

Most of all, for his tireless encouragement and unwavering support in all I do, I am forever grateful to my husband Justin Tenke. You continually inspire me to be a better person!

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DEDICATION

This work is dedicated to my Pa, Richard Louis Bartunek. He was one of the most amazing people I know with respect to local knowledge about a special place. In his case, it is three acres of land and a body of water called the West Arm of Lake Nipissing in Ontario, Canada. Our family has benefited in countless ways from his knowledge and experience and his great sense of humor about life. He is much of the reason that I felt inspired to do the work that is contained in this report.
INTRODUCTION

The adoption of the Sustainable Fisheries Act (SFA) in 1996 represented a major policy shift in how fisheries were to be managed in the United States. A new focus on fishing communities was mandated, which requires improved knowledge of traditional fishing grounds and the unique socioeconomic characteristics of fishing communities that are only attainable through the local fisheries knowledge of communities. Some fishing communities, such as Port Orford, Oregon, are utilizing GIS to integrate local fisheries knowledge with scientific information to document the geography of fishing communities and evaluate the impacts of fisheries management strategies from a community perspective. Traditionally, fisheries data used for management are collected and analyzed at scales that obscure the real ecological heterogeneity of habitat types and the social heterogeneity of communities and their territories of use. These data and associated management methods, along with other 1970s and 1980s programs designed to rapidly “Americanize” U.S. Exclusive Economic Zone (EEZ) fisheries, have increasingly led to poorly managed fisheries, overfishing of some stocks, excessive bycatch in some fisheries, overcapitalization of the fleet and overcapacity for fishing, and intense conflicts between different resource users and between fishers and managers. With passage of the SFA, new emphases were placed on taking precautionary approach to management, the protection of essential fish habitat, and the consideration of the impacts of management decisions on fishing communities. Fishery managers today must incorporate spatial considerations and scales and new kinds of information in order to assess how policy decisions will affect both the biophysical condition of fish habitat and the socioeconomic conditions of fishing communities. Implementing these new requirements, however, has been a considerable challenge for fishery managers and is only now beginning to be addressed in meaningful ways. Port Orford is one small fishing community trying to change its role and responsibilities in fisheries
management on the West Coast by participating in a study to document and integrate local fishing knowledge in geographic context.

The Port Orford community mapping project described here was a collaborative effort involving resources from several non-profit organizations and both federal and state agencies. The Cooperative Institute for Marine Resources Studies, a joint NOAA Fisheries and Oregon State University program, provided funding that allowed the author to design and conduct the study. NOAA Fisheries and the Oregon Department of Land Conservation and Development provided additional funding. Three non-governmental organizations provided human and technical resources essential to the study. The entire project team consisted of:

- Laura Anderson – The Port Orford Ocean Resource Team
- Leesa Cobb – The Port Orford Ocean Resource Team
- David Revell – The Surfrider Foundation, Oregon Chapter
- Markus Mead – The Surfrider Foundation, Oregon Chapter
- Sarah Klain – Ecotrust
- Charles Steinback – Ecotrust
- Mike Mertens – Ecotrust

The author developed the interview protocols to document qualitative and spatially explicit information about participation in local fisheries and recreational uses and the ecology of the marine environment. She was also the lead interviewer and transcribed all the local knowledge interviews. Project team members from both the Port Orford Ocean Resource Team (POORT) and the Surfrider Foundation participated in the interview process for double-cover during the recording of interview information. The Surfrider Foundation representatives also provided outreach to the recreational interests in Port Orford for participation in the study and provided some technical
assistance digitizing spatially explicit local knowledge in a GIS. An Ecotrust consultant also provided assistance in digitization. Ecotrust was contracted to develop and implement the spatial analysis of the interview information to create aggregate maps representing the distribution and intensity of some commercial and recreational uses of the environment around Port Orford. The author and the POORT and Surfrider Foundation representatives conducted the community validation workshop. The author analyzed the resulting information to identify potential management strategies of benefit to the development of the Port Orford fishing community.

This thesis is organized as follows. In the Background and Literature Review chapter, the author develops the national, regional, and local context for this study. She examines the changing national priorities in federal fisheries management, especially the increased focus on assessing the impacts to fishing communities of management decisions. In this chapter, the author also examines relevant research on the role of local knowledge and GIS in community-based fisheries management and the potential contributions they have to fisheries management in general. The Research Design and Methods chapter contains the details of the entire Port Orford Community Mapping Project methodology, rather than only the discussion of the author's contribution to the project. In this chapter, the author also examines the utility of the process and data for supporting community-based management goals. The Results and Discussion chapter contains the author's discussion of the products of the community mapping project and the associated qualitative information that describe the community of Port Orford's involvement in marine fisheries and recreation. In this chapter, the author also examines the practical implications of the Port Orford Community Mapping Project for attaining community-based fisheries management objectives, including community profiling and evaluating area-based and quota management strategies. The Conclusions chapter contains a summary of the findings of the study and the author's suggestions for improving the role of co-management systems and local knowledge and community mapping in fisheries policies.
BACKGROUND AND LITERATURE REVIEW

U.S. Fisheries Management and its Evolution

Over the past several decades, fisheries management has undergone great changes in its policy and management focus. Values of fisheries have shifted from a primary focus on fisheries as food production systems to fisheries as part of marine ecosystems that are intimately tied to the socioeconomic systems of humans. The current contraction of the fishing industry is occurring after a period of deliberate expansion and growth during the 1970s and 1980s that was motivated by visions of the sea as an inexhaustible supply of protein for human use and by competition with foreign vessels (Hanna 2000). The resulting overcapacity and overfishing, combined with poor ocean conditions and incomplete science, are responsible for some of the diminished fish populations occurring throughout American waters (The Heinz Center 2000). Values of marine resources for recreational use, aesthetic enjoyment, and biodiversity now compete more strongly with values for commercial uses. The current goals of fisheries management are to attain sustainable fisheries and communities with strong economies that contribute to healthy ecosystems.

In its simplest sense, sustainable use of resources means that the resource can be used in perpetuity. Fishing is sustainable when it operates over the long-term in a way that does not cause undesirable changes in ecological or economic productivity, biological diversity, or ecosystem structure or function (NRC 1999). Fisheries managers are currently challenged to rebuild fish stocks and attain sustainable fisheries with complex legislatives mandates to: maximize sustainable yield, use the best scientific information available, make equitable decisions among fishermen in different states, protect essential fish habitat, eliminate bycatch, and minimize economic impacts to fishing communities. The predominant method for assessing changes in individual fish stocks, which forms the basis of harvest guidelines, depends on field survey data incorporated into numerical models that aggregate single-species survey data and measures of fishing effort across a theoretically homogeneous landscape. However, neither fishing behavior nor fish habitat is homogeneous at those scales.
Ecosystem-based management prescribed by the U.S. Commission on Ocean Policy (USCOP) and the Pew Oceans Commission is a necessary challenge for fisheries managers. It can be argued that the Sustainable Fishing Act of 1996 (SFA) allows for ecosystem approaches to management, but does not force it. The SFA calls for the improved management of several ecosystem components, including eliminating bycatch, protecting fish habitat and providing for the sustained participation of fishing communities. Ecosystem-based measures are needed, such as studies of system components and interrelationships, assessment and ranking of stressors, and development of comprehensive plans that include all components of fisheries and other regional concerns (USCOP 2004). Ecosystem approaches to management promotes that both the human and biological components of fisheries be brought together in one analysis when considering fisheries interactions with resources and activities.

The Magnuson-Stevens Act of 1976 – Americanizing U.S. Fisheries
The Magnuson Stevens Fishery Conservation and Management Act of 1976 (herein after referred to as the Magnuson-Stevens Act or MSA) is the Nation’s principal piece of fisheries legislation and is the single most important factor that shaped the current American fishing industry and many of the fisheries challenges that are present today. The MSA promoted the redistribution of fishery resources from foreign to domestic fleets and the expansion of domestic catches to reduce the reliance on imported seafood. It designated the area from 3-200 miles offshore the U.S. Fisheries Conservation Area (FCA). The FCA was later declared the U.S. Exclusive Economic Zone (EEZ) through an executive order signed by President Ronald Reagan in 1983. The MSA also created a system of eight Regional Fishery Management Councils. The Councils were intended to manage the conservation and allocation of fishery resources within eight biogeographic regions of U.S. waters. The council process and the composition of its membership were intended to provide the public access to and oversight of the Nation's living marine resources. However, the council system was
not prepared to deal with the intense competing American interests, the overcapacity, and the diminished fish stocks that resulted from Americanizing the fishing industry.

In the 1950s and 1960s, the American people considered the ocean to be the new frontier of resource development. Foreign catch in U.S. waters was exceeding American catch and, from 1958-1968, seafood imports had increased from 37 to 76 percent of the total U.S. seafood supply (The Heinz Center 2000). The United States government became dedicated to helping the American fishing industry expand its capacity for fish production and to reducing foreign fishing opportunities off the west and east coasts of the country. The call for increasing American harvest of fish stocks was implemented through federal sponsorship of vessel construction loans, tax-deferred vessel repair and construction programs, fuel tax relief, gear replacement funds, market expansion programs and technical assistance programs (The Heinz Center 2000). Exemplifying this attitude, Senator Warren Magnuson of Washington, who later became a principal sponsor of the MSA, addressed a 1968 conference on the future of the U.S. fishing industry and said:

"You have no time to form study committees. You have no time for biologically researching the animal...Your time must be devoted to determining how we can get out and catch fish. Every activity...whether by the federal or state governments, should be primarily programmed to that goal. Let us not study our resources to death, let us harvest them" (The Heinz Center 2000).

In 1969, the federal Commission on Marine Science, Engineering and Resources, also known as the Stratton Commission, comprehensively reviewed the United States’ coastal and ocean policy and published Our Nation and the Sea: A Plan for Ocean Action. The “Stratton Report,” as it has become known, emphasized a national interest in fishery rehabilitation, development, and expansion to create national wealth and to meet the world demand for food. The Stratton Report also noted the need to better coordinate management authority between the states and federal
government by creating a single independent agency to manage American fisheries. President Nixon created the National Marine Fisheries Service, now called NOAA Fisheries, in the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce. NOAA Fisheries’ management responsibilities involve reviewing, approving or disapproving, implementing, and enforcing fishery management recommendations of the eight regional fishery management councils.

By the 1980s and 1990s it became apparent that “too many boats were chasing too few fish” and societal values had changed (Witherell 2004). High levels of fishing capacity led to pressures on the Regional Fishery Management Councils to keep catch levels high and access to the resources open. Changing environmental conditions, such as the El Niños that decreased ocean productivity for extended periods, resulted in further pressures to protect fish stocks and fisheries. Fishery yields had leveled off or declined nationwide, and it became clear to managers that entry into fisheries had to be limited. By the 1990s, the domestic fleet had developed to the point of full or overcapacity and social impacts were beginning to be taken more seriously. Coastal populations had also grown during this time, as did the stresses that they put on the marine environment. Diverse user groups continued to battle over equitable allocation of fishery resources for commercial, recreational, and environmental purposes. This combination of factors prompted major changes to the Magnuson-Stevens Act.

**The Sustainable Fisheries Act of 1996**

A new era in U.S. fisheries management began in 1996 when Congress passed the Sustainable Fisheries Act (SFA), which revised the Magnuson-Stevens Act to reflect the changing conservation values of the nation. The SFA includes a challenging set of mandates, in addition to those previously stated, to end overfishing and rebuild overfished fisheries while continuously achieving the optimum yield for each fishery. The legislation added three additional national standards to the seven existing standards that govern the Councils’ development of Fishery Management Plans.
(FMPs). The newest national standards are to reduce and minimize mortality of bycatch; to promote the safety of human life at sea; and to assess and minimize management impacts to coastal fishing communities. The SFA also added the requirement for the Councils to 1) designate and describe essential fish habitat (EFH) and the adverse effects to it from both fishing and non-fishing activities, and to 2) recommend actions to minimize adverse effects and identify conservation and enhancement measures. EFH is defined as "the waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (Wallace et al. 1999). The SFA demonstrated the new direction of federal fisheries management to consider ecologic, economic, and social sustainability.

Some of the management objectives set out in the national standards are compatible only when implemented in a truly precautionary fashion, previous to significant harvests or investments in capital. Precautionary measures are those that are taken before there is scientific certainty to protect against an undesired outcome. However, the fishery managers are not in a position to be proactive; they have significant challenges before them. For example, to meet the objective of rebuilding fish stocks, the fishery managers use fishery restrictions that increase social and economic risks to participants and communities. Conversely, reducing risks to communities can increase risks to the resources and to future generations. No single management measure can reduce risk to one component without increasing risks to another component of the system, at least in the short-term.

Sustainability is a balancing act between use and conservation, biology and economy, communities and individuals, and variability and stability. Fishery managers need clear biological and socioeconomic objectives and priorities, measurable criteria, and sufficient data at appropriate scales to be able to assess their achievement of the goals of sustainable ecosystems, fisheries, or communities. To develop the appropriate mix
of management strategies, fishery managers must also be able to identify the risks of management measures and evaluate them for different alternatives.

With specific regard to this research and to fishing communities like Port Orford, the National Standard 8 of the SFA demonstrates the need for a stronger emphasis on communities and socioeconomic concerns without compromising conservation. Specifically, National Standard 8 states that:

“Conservation and management measures shall, consistent with the conservation requirements of this Act, take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities” (NMFS 2002).

Promoting sustainable communities is a broad fisheries goal that has not had specific management objectives identified. Some possible objectives could include: to maximize employment, maximize income, maximize profit, or minimize variability in income. For Port Orford, one could argue that participation in diverse fisheries is an important objective for community sustainability. However, it is likely that each fishing community will have a different set of objectives important to its sustained participation in fisheries. Evaluating these objectives requires knowledge about the baseline condition of the fishing community and its dependence on various fishery resources. Without new tools and new information, managers are unable to holistically and systematically consider the unique environmental, social, and economic trade-offs needed to assess impacts to communities as required in the SFA.

Defining a Fishing Community. In the last ten years, many researchers and managers have been looking into the definition and practical application of the terms ‘fishing community’ and ‘fishing dependency.’ Some fisheries management strategies such as
co-management and community quota systems require an explicitly defined community. The Sustainable Fisheries Act defines a fishing community as:

"a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such a community" (Hall-Arber et al. 2002).

However, the SFA does not define what constitutes "substantially dependent on or substantially engaged in" fishing or seafood processing, although it is usually related to the employment and income of those "vessel owners, operators and crew, and U.S. processors" located in the community. It could also be argued that the members of fishing families, the port management and other local industries are dependent on commercial fishing, although they may not be evaluated in this narrow definition.

Regional fishery management councils interpret the legislation to imply a geographic, or place-based, definition of a fishing community (PFMC 2002). However, other definitions such as gear-based fishing communities or communities divided along target-species groupings may also be valid in certain cases. A rule of thumb for identifying fishing dependent communities determined that fifteen percent direct fishing employment could be one measure to quantify fishing-dependence, although admitted that the percentage is arbitrary (Jacob et al. 2001). Limitations with the measurement of direct fishing employment include the lack of differentiation between forestry and fishing employment in census data; the granularity of census data (i.e., county-level) obscures many communities (PFMC 2002) and (Langdon-Pollock 2004); and severe underestimation of direct fishing employment using census methods (Jacob et al. 2002). However, census and employment data may be useful for describing the background socioeconomic condition of the area, including the cost of living, and poverty and education levels (McCay et al. 2000). The benefit of using census data is its accessibility and consistency, which is important for standardization.
purposes (Langdon-Pollock 2004). Using a definition grounded in a geographical location simplifies data collection for some components of a fishing community, while falling short on others.

Hall-Arber et al. (2002) argues that ports are not economic isolates, but are members of a regional network associated with a natural resource region. Geographic distribution of secondary industries along the coast and the relative isolation of communities to this sector also affect how a fishing community experiences policy changes. Langdon-Pollock (2004) states “It is assumed that smaller, more remote communities have fewer economic choices, influencing the way in which they depend on the local industry” (p. 15). This study used the following parameters to qualify a city as isolated: 1) having a population less than 1,900 people, 2) located not near a major highway, and 3) located at least 35 miles away from a city with a population over 20,000 people. Port Orford meets two of the three criteria, but does not qualify as isolated because Highway 101 runs through the town (as it runs down the entire Oregon Coast). Consequently, other coastal communities like Port Orford are not considered isolated by this criterion. However, communities could be isolated from the sea in addition to being isolated by land.

Other research has suggested that a model for defining a fishing community could involve a threshold percentage of total labor or total income combined with a multiplier effect based on the forward and backwards economic linkages to other industries (Jacob et al. 2001). However, quantifying multipliers is an even greater challenge than accurately quantifying a threshold percentage of income or labor. While describing West Coast fishing communities, Langdon-Pollock (2004) found that creating a fishing dependency index was impractical given the current availability of information. Hall-Arber et al. (2002) determined that simple economic assessments are inadequate, and even harmful when applied to some specific cases.
Other efforts to identify fishing communities and fishing dependence more qualitatively are in the beginning stages. McCay and Cieri (2000), Hall-Arber (2002) and Langdon-Pollock (2004) developed port-profiling approaches for examining social and economic linkages important in indicating a community’s degree of vulnerability to regulatory changes. Port profiles are used to examine patterns of contracts, characteristics of community culture and institutions, local residents’ views about their way of life and fisheries management, zoning and planning issues, the complexity of fishing infrastructure, and the degree of gentrification or specialization. To assess the degree of specialization or diversification of fisheries participation, managers need to also have knowledge of the community’s fleet composition, percent of commercial and recreational use, size of vessels, target fisheries, harvesting strategies and gear types used. Qualitative measures are more difficult to compare across communities, but provide the breadth and depth of knowledge needed to begin to assess changes to communities’ structure and function.

It is impossible for fisheries management to attain goals, such as National Standard 8, without a clear understanding of what constitutes a fishing community. Often the members of the community hold the most important information needed to characterize fishing communities. In all of the port profiling cases discussed above, the authors used interviews with community members to collect the baseline information. Fishing communities are as diverse as the individuals in them and finding one set of criteria is a difficult endeavor. However, defining fishing-dependent communities is the first step needed to adequately identify and assess adverse impacts of fisheries policy changes to these communities.

Assessing Impacts to Fishing Communities. Although National Standard 8 specifies that fishery managers must, to the extent practicable, provide for the sustained participation of fishing communities and minimize adverse economic impacts to them, it is not the only mandate to this end. With the passage of the National
Environmental Policy Act (NEPA) in 1969, the federal government, including NOAA Fisheries, is mandated to assess the impacts of federal decisions on the natural and social environments through the preparation of environmental impact statements (EISs). In addition, the MSA has requirements that fishery managers examine the socioeconomic and cultural impacts to fishing communities of implementing limited entry programs. The primary challenges to assessing impacts to communities are inadequate data and resources for turning the data into useful information.

Under NEPA, the socioeconomic impacts of federal actions alone do not require an EIS. However, an EIS may incorporate a Social Impact Assessment (SIA) to understand the connections between the natural and social environments and assessing impacts to a community’s quality of life (U.S. GSA n.d.). An SIA is the traditional method used to gauge the social consequences of alternative fishery management actions or policies to fishing communities. It is not the same as an economic impact analysis, which assesses whether economic benefits of a federal action outweigh the costs and focuses more on resource supply and demand, prices and jobs (NOAA Fisheries 1991). Executive Order 12898 puts an additional emphasis on including SIAs in EISs with the goal of determining any “disproportional and adverse” impacts to low income or minority populations (NMFS 1995). In either social or economic analyses, the goals are to characterize the existing state of affairs, to forecast how things may change for a given action or policy, and to develop ways of mitigating adverse impacts to affected populations or communities.

The Magnuson-Stevens Act also has a variety of requirements related to social, cultural, and economic issues for fishermen and their communities in addition to National Standard 8. For example, section 303(b)(6) of the MSA states that limited entry programs require an examination of:
“(A) present participation in the fishery, (B) historical fishing practices in, and dependence on, the fishery, (C) the economics of the fishery, (D) the capability of fishing vessels used in the fishery to engage in other fisheries, (E) the cultural and social framework relevant to the fishery and any affected fishing communities, and (F) any other relevant considerations” (NOAA Fisheries, 2003).

In addition, Section 303(a)(9) on preparation of Fishery Impact Statements notes that fishery managers:

"shall assess, specify, and describe the likely effects, if any, of the conservation and management measures on--(A) participants in the fisheries and fishing communities affected by the plan or amendment; and (B) participants in the fisheries conducted in adjacent areas under the authority of another Council, after consultation with such Council and representatives of those participants" (NOAA Fisheries, 2003).

Although it is clear that the mandate exists, it is less certain that fishery managers can implement this standard without improved data or resources. The Pacific Fishery Management Council readily admits on their Community website that they lack substantive information on fishing communities and the resources to complete this research comprehensively:

“Not much information on fishing communities has been systematically gathered. One reason for this is because most funding for fisheries management goes towards assessing fish stocks. For example, the National Marine Fisheries Service’s 2002 budget requests more than $200.8 million for biological fisheries research, compared to $3.4 million for economics, statistics, and other social research” (PFMC 2002).

Several challenges exist for fishery managers or the councils attempting to collect and effectively utilize data on fishing communities. Exactly what data are needed and acceptable to management? Who should be collecting and
maintaining the data, scientists or fishermen? Where and at what scale are data collected? How are those data collected and transformed into information? An additional difficulty is that fishing businesses and communities continue to adapt and evolve in order to stay competitive with changing regulations, markets and environmental conditions, and thus change the baseline conditions from which managers measure change and impacts.

Not only does fisheries management lack substantive data on fishing communities, the data collected are at such a granular scale that it is ineffective at showing the landscape of a fishing community. In a recent study to describe West Coast fishing communities, the scale of demographic data collection was limited to counties to reduce the amount of data fishery managers would have to consider and interviews were conducted with only one person from each county (Langdon-Pollock 2004). A similar spatial argument applies for the identification and minimization of impacts to fish habitat. The large statistical areas used by the groundfish fishery managers to record fishing effort and the areas from the stock assessment models used to assess stock size are too large to see the heterogeneous landscape of fishing communities and habitat (St. Martin 2001). Similar to the methodology used to conduct the Port Orford Community Mapping Project, NOAA Fisheries is developing a project that uses local knowledge interviews to produce GIS maps for the Essential Fish Habitat Environmental Impact Statement (Abbott-Jamieson et al. 2003). Essential fish habitat is tied to life stages of fishes and is therefore, at smaller spatial scales than the range of the species. Habitat maps generated by fishermen will be overlaid with those generated by biologists to ensure that the appropriate areas are targeted in a habitat management context. Other genetic research projects are aimed at collecting

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1 The term “fishermen” is used throughout this document rather than the more scholarly “fishers” or “fisherperson” because this is the terminology that people in the fishing profession of both genders use to refer to themselves and their colleagues.
information at reduced spatial scales to identify potential sub-populations of species. In practice, neither fishing communities, nor essential fish habitat, nor impacts to them can be assessed without the proper kind and scale of socioeconomic data.

NOAA Fisheries and other entities are examining new ways to meet the federal mandates for socioeconomic impact analysis. The agency is exploring a conceptual model for predicting the social impact of fisheries management action alternatives using a limited set of qualitative and quantitative indicators to streamline the Social Impact Analysis process (Abbott-Jamieson et al. 2003). Although it is not a peer-reviewed publication, the Final Report of the Groundfish Fleet Restructuring Information and Analysis (GFR) Project was an innovative GIS project that attempted to further resolve the scale of federal fisheries landings information (Scholz et al. 2005). The distribution of catch areas was linked to homeport communities through vessel information. The impacts of various spatial management and capacity reduction scenarios could then be analyzed for individual ports. The increase in national focus on defining fishing communities and fishing dependency and efforts to collect baseline data at smaller spatial scales are signals that the federal government is trying to respond to the mandates of NEPA and MSA.

Fisheries Management on the West Coast

The Regional Fishery Management Councils set up by the MSA are intended to represent the variety of interests and stakeholders in a decentralized, democratic structure. They make public policy fishery management decisions through command and control management using notice-and-comment rulemaking processes. Typically, managers take a complex situation like the West Coast groundfish crisis and break it down into its component parts (harvest policies, fleet reduction, stock assessment and monitoring, allocation, bycatch, and marketing). They attempt to
solve these issues independently across a very large jurisdictional area with limited staff and finances.

Mounting problems within the council system prompted NOAA to recommend the separation of conservation and allocation decisions in fishery management in the 1980s, a recommendation that is echoed in the recent U.S. Commission on Ocean Policy Report. Poorly resolved areas of authority and responsibility between NOAA Fisheries and the regional councils, interference in council actions through congressional or constituent pressures, and the failure to fund the management system at a level commensurate with its expanding responsibilities caused some of the fisheries management problems experienced today (Eagle et al. 2003). This division of conservation and allocation is intended to reduce the constituent pressures on council decisions to designate one or another harvest level. Allocation disputes take up much of the time and energy of the council system and may impede its ability to effectively respond to changing political, economic, and social conditions with timely, appropriate management strategies.

The Pacific Fishery Management Council (PFMC) has regional authority over federally managed marine species in Washington, Idaho, Oregon and California and is responsible for conservation and sustainable management of Pacific marine fish stocks and habitat, while balancing a variety of human needs. For approximately 80 years, groundfish were managed independently by the states of Washington, Oregon and California. With the enactment of the Magnuson-Stevens Act in 1976, the states and the PFMC jointly managed the fishery until the development and implementation of the Pacific Groundfish Fishery Management Plan (FMP) in 1982, at which time the PFMC became the lead authority. FMPs form the basis for Council management of fish stocks. In addition to the groundfish plan, the PFMC has plans for Pacific coast salmon and coastal pelagic species, and is developing a plan for highly migratory species on the West Coast.
The PFMC manages over 80 different species of groundfish, which are targeted using a variety of gears including fish pots, hook and line gear, and various types of trawl. This leads to gear conflicts and competition. The pot fishery mainly targets black cod\(^2\) and hook and line gear targets black cod, lingcod and rockfish. Trawls target certain groundfish species complexes such as: deepwater slope species for bottom trawls, bottom rockfish for roller trawl, nearshore flatfish for mud gear, and widow rockfish and whiting for midwater trawl (Witherell 2004). Commercial fisheries for groundfish management are divided into three primary sectors: limited entry trawl, limited entry fixed gear, and open access. “Limited entry” refers to the component of a fishery that requires a permit for a vessel to be allowed to participate in a given fishery. This is in contrast to “open access” where no permit is required. In open access fisheries, a portion of the total allowable catch is allocated to those vessels with no permit.

The West Coast Groundfish Crisis

In January 2000, the Secretary of Commerce declared the West Coast Groundfish Fishery a national crisis. Witherall (2004) summarizes the causes of the groundfish decline in three main categories: 1) science-based decisions inappropriate for the life history characteristics of groundfish, 2) poor ocean conditions amplifying the naturally low productivity of these fish species, and 3) incomplete accounting for the total fishing-related mortality due to bycatch and discards at sea. NOAA Fisheries Q&A on the Status of West Coast Groundfish lists a variety of additional issues responsible for the crisis in the groundfish fishery including: inadequate scientific data, overcapacity, overfishing, and the mandate to develop and implement rebuilding plans which must restrict fishing opportunities (NOAA Fisheries 2004e). These combined issues produced a major West Coast groundfish crisis with biological, economic, and social consequences.

\(^2\) “Black cod” is the term used by Port Orford commercial fishermen when referring to the species *Anoplopoma fimbria* that is commonly known as sablefish in the scientific community. This report utilizes the term black cod because of the focus on local knowledge.
In the late 1970s and early 1980s, domestic groundfish landings were stable and increasing and groundfish stocks appeared healthy. In fact, groundfish landings peaked in 1982 at 116,000 metric tons and remained around 92,000 metric tons for several years (Witherell 2004). Facing little information on the sustainability of groundfish stocks, PFMC set allowable biological catches (ABCs) that were based on the amount of historical catches and capped harvest at the current level at that time. Things were about to change quickly for the West Coast commercial groundfish industry.

An overall decline in groundfish landings occurred from 1982 to 1999. During this time commercial ex-vessel groundfish revenues decreased by 47 percent from $100.2 million to $52.9 million (in 1999 dollars) in spite of a 12 percent increase in commercial landings (Witherell 2004). Rockfish of the genus *Sebastes* and flatfish, which together accounted for between 50-60 percent of groundfish landings, declined severely in landings and revenue. Concurrently, recreational fisheries were also switching from salmon to rockfish and lingcod as target species. Since 1999, nine West Coast groundfish stocks have been declared overfished: bocaccio (*Sebastes paucispinis*), canary rockfish (*Sebastes pinniger*), cowcod (*Sebastes levis*), darkblotched rockfish (*Sebastes crameri*), widow rockfish (*Sebastes entomelas*), yelloweye rockfish (*Sebastes ruberrimus*), lingcod (*Ophiodon elongates*), Pacific ocean perch (*Sebastes alutus*), and Pacific whiting (*Merluccius productus*). Most of the depleted stocks are species often caught at depths coincident with the continental shelf, and are known as “shelf species.” Port Orford fishermen target six out of nine groundfish species declared overfished by PFMC and have lost the opportunity to fish for these species, although they perceive some of them as locally abundant. In 2000, the PFMC separated out the major rockfish species and divided the rest into assemblages to improve data collection and management.

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3 As defined by the Pacific Fishery Management Council, a species is declared “overfished” when it is determined to have less than 25% of its virgin (unfished) biomass left in the fishery.
Underreported bycatch and discarding on trawl vessels were partially responsible for the miscalculation of the groundfish biomass that caused management to implement harvest restrictions for the entire groundfish fleet, including the fixed gear and open access sectors (Witherell 2004). The Council applied quota reductions throughout the 1990s to bring harvest levels in line with acceptable biological catches for individual species and assemblages. The PFMC shortened the limit on footrope diameter for roller trawls, intending to keep this gear away from rocky areas important to the declining rockfish species. The Council provided an incentive to fish with mid-water trawls by giving higher trip limits to this gear type. A fifty percent capacity reduction plan for the entire groundfish fleet was introduced in 2000 (PFMC 2000). In reality, the capacity reduction was targeted at trawlers and no small vessels are eligible for the vessel buyback program. For 2002, PFMC revised bycatch rates for several species in the limited entry trawl fishery and also prohibited retention of yelloweye rockfish in both the limited entry fixed gear and open access sectors. For 2003, the Council continued to restrict groundfish harvest levels and introduced a new management regime that included area and season restrictions, including a depth-based restriction to seasonally move fisheries that catch overfished stocks out of the depth zones between 100-250 fathoms (PFMC 2002). The area closure has changed in shape over time, although the relative impacts of these changes to communities have not been evaluated.

Overfished groundfish stocks, dramatic harvest restrictions, declining revenues, and capacity reduction measures have differentially impacted fishing communities along the Oregon coast. Many Port Orford fishermen feel that their fixed gear small vessel fleet has been penalized for detrimental impacts caused by the large vessel trawl fleet, while it is those vessels that are being compensated through the vessel buyback program. Fixed gear and open access sectors can no longer target canary or yelloweye rockfish while the trawlers are allowed some as bycatch, although at drastically reduced levels. Although the entire fishery is in decline and all gear sectors have to be
restricted in order for stocks to rebuild, the fixed gear fleet of Port Orford interprets the resulting conservation measures as socially inequitable management decisions.

**Conflict in the Fisheries Management Process**

It is not surprising that fisheries management decisions are rife with conflict. Fisheries management issues are both highly complex and controversial. Daniels and Walker (2001) suggest that in order to make progress in these kinds of environmental policy decisions, three important facets of conflict should be addressed: the relationships of the participants; the process for making decisions; and the actual substantive aspects of the outcome. Their Conflict Triangle diagram is a useful tool to evaluate the benefits and challenges of various management approaches to fisheries policy development (Figure 1). Although the substantive aspects of public policy are focused on most often (the tip of the iceberg), it is arguable that the process and relationship issues offer the most potential for improvement in spite of high levels of conflict.

A problem often cited by Oregon’s fishing communities is their superficial involvement in the Council process (Conway et al. 2002). Influence of social considerations on a management plan can be affected by: 1) a social impact assessment (SIA) if one is prepared by the Regional Council; 2) public testimony; and 3) the character of individual Council membership (Buck et al. 1995). While there appear to be sufficient opportunities for the public to become involved in the Council process, several challenges exist for meaningful public involvement. These problems include: the accessibility of meetings, time and knowledge needed to provide input at the right stage, and the perception that decisions are predetermined and that viewpoints are easily dismissed (Eagle et al. 2003).
How are stakeholders involved? How is scientific information included? How is local knowledge considered? Who are the stakeholders? What are the power dynamics? What is the history of conflict?

Figure 1: Daniels and Walker (2001) Conflict Triangle

The logistics of Council meetings add to the marginalization of small fishing communities. The venue for council meetings can be anywhere in California, Oregon or Washington and is often a considerable distance from fishermen’s homeport. For example, even a PFMC meeting in Portland, Oregon is about a six-hour drive from Port Orford and would require travel and lodging costs to attend a several-day meeting. This makes attendance difficult and prohibitively expensive for some fishermen.

The development and adoption of fishery management plans is so complex and lengthy that unpaid participants find it difficult to provide input at the correct stages (Eagle et al. 2003). For example, NOAA Fisheries lists at least 61 different steps to develop and adopt fishery management plans and actions (Gade et al. 2002). Public testimony is the primary way that constituents interact with the Council. However, NOAA Fisheries reported that public testimony reflects individual judgments of people affected by the decision, are not presented in a systematic and scientifically
verifiable manner, and therefore cannot be used in a predictive or evaluative way, as is needed for Environmental Impact Statements (NMFS 1995). Several council members in Eagle et al. (2003) reported that the council does not give much weight to public testimony. Many Oregon fishermen feel the Council’s decision has already been made before the public meeting ever begins and therefore feel powerless to affect management decisions (Conway et al. 2002). “The public testimony process at the Council makes you cynical. When you get stepped on, you are hesitant to make the effort. I’ve given up hope” (Interview 758). Communication during the council process does not foster careful deliberation of citizen input and is the source of much contention for the fishing industry.

Many members of the Port Orford fishing community do not perceive their interests as being adequately represented by the interests on the Pacific Fishery Management Council (PFMC). A recent study of the composition of regional fishery management councils agreed that ninety percent of the appointed fishing representatives reported that “they were appointed to represent, and did represent, a particular sector of the fishing industry” (p. 26) (Eagle et al. 2003). The PFMC’s fourteen voting members include state fishery managers, a NOAA Fisheries representative, Treaty Indian tribes, and eight private citizens. Of the eight private citizens, six are recreational interests and two are commercial interests (Witherall 2004). The two commercial fishing representatives are from large trawl vessels, which have little in common with the fixed-gear small-scale fleet of Port Orford. Although the Council should not be expected to have representation of every port under its jurisdiction, the commercial interests are biased towards sectors of the industry with which the members identify. The issue of representation is a large complaint of the Council system in general, as many of the council members themselves believe that the councils do not fully reflect or represent all public constituencies, particularly environmental interests (Eagle et al. 2003).
The fisheries management system has been slow to adopt its plans to accommodate the new national standards and the changes imposed by the 1996 Sustainable Fisheries Act. The relationship between the fishing industry and fishing managers in Oregon is characterized by blame, distrust, and stereotyping (Conway et al. 2002) and fishermen often perceive a lack of respect from scientists and managers. New incentives are needed to help groundfish management make the transition to new goals and objectives such as National Standard 8 (Hanna 2000). Community based fisheries management systems can help address mandates determined by the Sustainable Fisheries Act (SFA) and help find common ground between fishing communities and fisheries management. Community-based management and co-management can improve and challenge the existing management system to incorporate local fisheries knowledge and to consider community-scale impacts.

**Community-Based Fisheries Management and the Roles of Local Knowledge and Participatory GIS**

Community-based and co-managed fisheries systems are ones in which the community has greater responsibility and authority for managing public fisheries resources. The desired outcomes of fisheries co-management, as with consultative management, are appropriate, efficient, and equitable management decisions that insure the sustainability of the resources. Pinkerton (1989) states that the three secondary goals of co-management—decentralized regulatory authority, community-based development, and participatory democracy—are potential ways to achieve primary benefits and thus can be end goals themselves. The overall goal is still sustainable resources and communities, but the scale of focus changes to a more localized area of stewardship using community knowledge.

Decentralizing regulatory authority involves various degrees of delegation of responsibility and authority to the fishing community, thus altering the traditional roles of industry and government (McCay et al. 1996). Potential supporting
management functions that communities could undertake jointly with federal and state management are data gathering and analysis, harvest regulation, and/or harvest allocation. Co-management can alter the relationship between fishing communities and fisheries managers by instituting a shared decision-making process. Collaboration places value on mutual learning and joint responsibility, and therefore has the potential to increase social capacity for decision-making and empowerment of communities (Pomeroy et al. 1994).

A second goal of co-management systems is community-based development. Several management functions can contribute to opportunities for fishing communities to contribute to their own development. However, Pinkerton (1989) asserts that enhancement, planning and habitat protection are some of the main ways that communities begin contributing. The goal is not to sacrifice the environment for the sake of the community, but to craft policies in a way that values the long-time knowledge and expertise of community members who have a vested interest in the continued health of the ecosystem that supports local economies. Increased participation and responsibility promotes increased stewardship ethics because there is a sense of ownership of the process and pride in contributing to sustainable development.

The third goal is to reduce conflict through a process of participatory democracy. The assumption here is that increased participation in management will reduce conflict and opposition because of increased social legitimacy of policy and regulatory decisions. McCay et. al (1996) stated that "there are good reasons to argue that early, systematic and meaningful participation of representatives of user groups in the management process can create the kind of vested interest that works for, not against the collective good" (p.241). The different ways that the public can be involved ranges from requesting information to assessing and recommending solutions to involvement in the final decision (Weiner et al. 2002). This continuum can also be
thought of as a progression of increasing shared power and trust, from cooperation to collaboration (Daniels et al. 2001). An example of this distinction is the level of industry participation in joint research projects. In a cooperative project, a fishing vessel is contracted as a platform from which to conduct a scientific experiment. In contrast, in a collaborative project, the scientist and fisherman would work together in the actual conception, design and implementation of the project.

Socially legitimate environmental policy processes enable public participation and provide opportunities for management to tailor actions and policies to meet local needs while attaining conservation objectives (Daniels et al. 2001). Community-based management provides an open framework for improving communication in fisheries management and encourages collaborative and innovative management strategies to address the unique environmental, economic and social conditions at a manageable geographic scale (Anderson 2001). Direct community participation in developing GIS data that integrates their collective knowledge is one way to improve the fishery management process at the local level and make the community’s knowledge visible using GIS (St.Martin 2004). Improved participatory processes, improved substantive information, and new relationships can bridge the scientific and management gaps and help break the impasse in the conflict between government and industry.

Pinkerton (1989) describes the “completeness” of fisheries co-management systems based on the number of potential management functions that industry can perform in collaboration with fishery managers and scientists. The seven potential management functions described by Pinkerton include:

1) Data gathering and analysis to understanding the state of the resource as the basis for sound decisions (including obtaining research funding);
2) Logistical harvest decisions (who, what, where, when, and how fish are caught);
3) Harvest allocation decisions (how much can be fished by whom) to allow equitable access;
4) Habitat and water quality protection;
5) Enforcement of regulations and practices;
6) Enhancement and long-term planning (where to concentrate management efforts for the future); and
7) Broad policy decision-making.

She states that many incomplete co-management systems can evolve into more complete co-management systems, but also that some systems “may have achieved all that is appropriate or feasible in a particular situation” (p. 6). POORT is already engaged in the first cooperative management function in Pinkerton’s list, data gathering and analysis, and is doing so to better understand the condition of the resources and the patterns of use in the local area. Local knowledge interviews produced important information for evaluating alternatives for the other management functions of habitat protection, long-term planning, and for evaluating the alternatives for logistical harvest decisions.

**Local Fisheries Knowledge in Fisheries Management**

The perceived polarity between “scientific knowledge” and “traditional or local ecological knowledge” is an artificial construction of the current era. It was not until the late 1700s that theoretical knowledge and practical knowledge were categorized and separated (Nader 1996). Although local ecological knowledge differs from scientific knowledge, they also have similarities (Table 1). Traditional ecological knowledge and conventional science both 1) acquire data through empirical observations; 2) observe, compare and classify; 3) see nature as a system of relationships; and 4) work towards acquisition of objective knowledge (Hipwell 1998). However, it has become common for Western theoretical science to consider itself “superior” in some way to indigenous knowledge and to the knowledge of the laypeople from the same society (Nader 1996). It may be that the fishery managers
and the fishing industry are just interpreting the complexity of fisheries dynamics from two different perspectives, as linear and non-linear systems (Smith 1996). In any case, opening up the dialog to include a discussion of different knowledge paradigms may be the beginning of many opportunities for mutual learning. It would seem that modern science and traditional and local knowledge are all just different “ways of knowing,” a continuation of the historic human effort to understand and give meaning to the world.

Table 1: Characteristics of TEK and Scientific Ecological Knowledge

<table>
<thead>
<tr>
<th>Traditional Ecological Knowledge</th>
<th>Scientific Ecological Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly qualitative (although counting may be used, other modes of measurement and analysis are central)</td>
<td>Mainly quantitative (strong preference for quantitative measurement and analysis)</td>
</tr>
<tr>
<td>Emphasizes intuitive and informal modes of knowing</td>
<td>Emphasis is on formal inductive and deductive logic, although intuition can play a role</td>
</tr>
<tr>
<td>Views nature holistically as more than the sum of its parts and includes a spiritual aspect</td>
<td>Tries to explain nature by identifying limited sets of principles or laws, as do chemists and physicists. Specifically excludes a spiritual aspect.</td>
</tr>
<tr>
<td>Mind and matter typically considered together</td>
<td>Mind and matter often separated</td>
</tr>
<tr>
<td>Includes moral values</td>
<td>Ideally value free</td>
</tr>
<tr>
<td>Based on observations &amp; accumulation of facts by trial and error</td>
<td>Systematic, deliberate accumulation of fact through experimentation</td>
</tr>
<tr>
<td>Based on data generated by resource users themselves</td>
<td>Based on data generated by specialized researchers</td>
</tr>
<tr>
<td>Based on long time-series information in one locality (diachronic data)</td>
<td>Based on short time-series information over a large area (synchronic data)</td>
</tr>
<tr>
<td>Primarily concerned with local interest and needs</td>
<td>Concerned with principals of general interest and applicability [i.e., theory]</td>
</tr>
<tr>
<td>Tries to control nature to benefit specific human interests</td>
<td>Tries to control nature to benefit specific human interests</td>
</tr>
</tbody>
</table>
Traditional ecological knowledge (TEK) is a term first coined in the 1980s and has been described using many terms including, “indigenous ecological knowledge,” “indigenous technical knowledge” and “folk knowledge” (Hipwell 1998). Many concepts of TEK include self-management of the resources and knowledge that is closely tied to social or spiritual aspects of culture (Stevenson 1996). Anthropological studies of TEK are relatively recent as compared to studies of traditional knowledge of agriculture or botany (Berkes 1993). The common thread of all the terms for TEK is that the knowledge is of a localized place and it is passed down through time through social and cultural practices.

Non-indigenous or laypeople also have knowledge about the ecology of local areas that is accumulated by experience and shared throughout generations. Local ecological knowledge (LEK) is the terminology used to differentiate ecological knowledge of a non-indigenous society that can be acquired over a single lifetime as well as over several generations. Local fisheries knowledge (LFK) is a particular type of local knowledge acquired through experiences and observations made during fishing and related activities. LFK may include knowledge of: local distribution of fishes and habitats, ecological interactions, local fishing businesses, social dynamics of fishing, fishing communities’ territories of use, local economics and networks of regional economies of which communities are a part, and local fishing culture (Hall-Arber et al. 2002). NOAA Fisheries recently defined LFK as “knowledge about commercial, subsistence, and recreational marine fishing/harvest, including the marine environment and species; fishing culture and society; fishing technology and practices; and business and economic aspects of fishing” (NMFS 2004). LFK can be possessed communally or individually and is tied to a specific place and is locally significant (NOAA Fisheries, 2004d). Fishing communities’ knowledge of territories of use and species distribution is included in LFK. Because the process described in this research documents the knowledge of a contemporary commercial fishing
community and includes both ecological and socioeconomic knowledge, this project involves the communication of local fisheries knowledge.

Several researchers have categorized the differences between TEK and conventional science (Johnson 1992; Berkes 1993; Stevenson 1996). Theoretical knowledge is associated with particular methodologies that validate information through experimental processes. Traditional or local ecological knowledge is associated with people’s knowledge of the ecological relationships of a place, which is developed and validated through experience and transmitted by social and cultural means. Unfortunately these differences have been cited as reasons enough to dismiss local ecological knowledge in resource management (Johannes 1993).

Are the differences between local knowledge and scientific information so vast that the two types of information cannot truly be integrated into one management system? The benefits of local fisheries knowledge include increased spatial resolution of information, more holistic and qualitative analysis, and diachronic data (small area/long time periods) (Hipwell 1998). Incorporating LFK with fisheries management provides substantive information to fishery managers consider when making controversial and complex fisheries management decisions. The NOAA Fisheries web site states that traditional and local ecological knowledge positively contribute to the fishery decision-making processes:

“Local ecological knowledge and traditional ecological knowledge can enhance fisheries science and management, particularly as it contributes information about species range, diet, behavior, seasonal patterns, habitats, and fishing gear. It can support existing scientific knowledge, draw attention to inconsistencies between the two, and provide information that can lead to the creation of testable hypotheses and collaborative research” (NOAA Fisheries, 2004b).
NOAA Fisheries has demonstrated increasing recognition of the value of social and economic local knowledge by increasing the investment in social scientists and socioeconomic and anthropological research at regional offices and science centers. For example, the Senior Social Scientist of NOAA Fisheries recently led a session on “Integrating Local Fisheries Knowledge” at the 2004 Annual Meeting of the Society for Applied Anthropology in Dallas, Texas. The Port Orford Community Mapping Project was presented as an example of integrating scientific and local knowledge systems using GIS. NOAA Fisheries is also currently developing a Community and Port Profile Database (of which Port Orford is a part) (Karma Norman, Northwest Fisheries Science Center, pers. comm., 2004) and piloting a local fisheries knowledge project in New England states (NOAA Fisheries, 2004c). The Essential Fish Habitat Draft Environmental Impact Statement will utilize habitat maps generated by fishermen overlayed with those generated by biologists to ensure that the appropriate areas are targeted in habitat management context (Abbott-Jamieson et al. 2003). Fisheries managers are realizing the value of local fisheries knowledge in crafting socially legitimate policy decisions.

Utilizing LFK in fisheries management demonstrates a movement towards improved recognition of local knowledge systems and potential for mutual learning, which fosters an improved relationship between industry and management (Dale 1989). Some fishing communities are looking to provide information that can be helpful in analyzing the ecological and socioeconomic impacts of fisheries policy and regulatory decisions. By incorporating local knowledge, fisheries management will be better positioned to consider the unique trade-offs needed to create sustainable fishing communities. The information collected through local knowledge interviews can be used to support both traditional and more co-operative fisheries management.

One goal of community-based fisheries management is to enable the current management system to consider the holistic local knowledge about the resource
ecosystem. Some researchers argue that revealing local knowledge to managers relinquishes power to the resource management agency rather than empowering the local community (Johannes 1993). Communities are providing local knowledge to increase their local participation in and shared responsibility for science and management activities for fisheries. Increasing the collaborative potential between diverse groups of people is a central tenet of co-management and community-based management. Community-based management provides fishing communities with an appropriate management context in which to use methods to document and utilize local knowledge for resource management.

Participatory GIS to Compile Local Fishing Knowledge

Public participation GIS (PPGIS) expands GIS science into a framework for effective communication about spatial information of a local place and offers processes that promote active community participation in crafting solutions to local problems (Schroeder 1997). By definition, PPGIS is a bridge concept that looks at the practice of using GIS in a social setting (Schroeder 1997). Since the development of the first GIS in the mid-1960s, its increasing use by community organizations has been made more feasible as costs declined, user interfaces improved, and a trend towards a more human-centric vision of GIS developed (Craig et al. 2002). Communities are now using GIS to develop consensus of a geographical representation of a particular place and to communicate their local knowledge of that place to other people. Participatory GIS also offers communities a framework to integrate local knowledge and conventional science. PPGIS products and processes can be a starting point for meaningful community participation in collaborative science and management, although the challenge of implementation often comes down to a matter of scale.

The term “scale” has several meanings and confusing terminology; it can refer to the geographic extent of something, the spatial resolution of a representation, or to the scale of a map (Longley et al. 2001). The scale of the geographic extent of an
observation indicates the amount of area that it covers. A large-scale activity covers a large area, whereas a small-scale activity covers a relatively small area. The same terminology is used to describe the extent or scope of fiscal and human resources for an activity. For example, a small-scale fishing fleet may require less people and capital to operate. When discussing the spatial resolution of a map (i.e., the level of spatial detail represented), the terminology gets confusing. To clarify, the author uses “fine-scaled” to refer to maps that display records at a high level of detail or resolution and that represent very small objects. The author uses “coarse-scaled” or “granular” when referring to maps do not record small objects and have low resolution or spatial detail. The map scale is the representative fraction that is the ratio between map units and on-the-ground units of measurement.

The scale of scientific information feeds into the development of management options. Local knowledge is place-specific knowledge and tends to necessitate the use of finer-scale maps that focus in on a discreet area. The use of GIS technology in a community can help develop consensus of a common vision of place (Kyem 1998). Participatory GIS projects make visible communities’ geography and ecological knowledge and can put this geography at the center of discussions about management strategies and community development (St.Martin 2001). However, the current usefulness of fine-scale local knowledge is constrained by existing scientific and management mechanisms. In an example from Newfoundland, Canada, locations derived from fishermen’s knowledge of viable fisheries closures was not able to be considered by fishery managers because the refined scale was incompatible with the coarse scale of traditional fisheries data collection and analysis (Macnab 2002). Managers were unable to evaluate the effect of the closures on harvest levels because the unit of analysis was not compatible. However, there is a trend towards refining the current scale of fisheries data collection and analysis to evaluate how management decisions may impact fishing communities.
Public participation GIS provide an opportunity to integrate diverse forms of knowledge and scientific information. Public participation GIS to engage fishermen in management discussions was demonstrated in California where local fisheries knowledge was used to conduct a socioeconomic study of marine protected areas (MPAs) (Scholz et al. 2004). The Channel Islands National Marine Sanctuary also collected and analyzed spatially explicit local knowledge when evaluating marine reserves as a tool for marine resource management (Kronman et al. 2000). The participatory GIS process allows local knowledge to be put in a format useful for environmental impact assessments and other management applications (Johannes 1993).

Participatory GIS in a fisheries policy setting contributes to the community-based fisheries management goals of increased participatory democracy and to the decentralization of management responsibilities. PPGIS can be used by a community to establish a common vision of their place of interest that can serve as the basis for deliberation about public problems (Kyem 1998). Weiner et al. (2002) states that GIS technology enables citizens to understand and prioritize issues, consider alternatives, and reach viable conclusions. GIS in public participation settings has the potential to empower communities to develop consensus about their environment, resolve disagreements and difficulties, and allow them to actively participate in long-term planning (Craig et al. 2002). The process of collecting spatial information and making it available to managers also demonstrates shared responsibility and interest in mutual learning. Increasing the level of community involvement in decision-making processes may also reduce conflict in fisheries management decisions and increase social legitimacy in fisheries policy development.

A danger of any GIS, but especially poignant with participatory GIS, is that the products could be perceived as valid even if the data supporting them are not accurate (Schroeder 1997). Very simply, it would seem that presenting local fisheries
knowledge in a spatial database format lends credibility to the information. Johannes (1993) asserted that more effort is needed to determine the validity of local knowledge and that while local “observations of natural phenomena maybe acute, the conclusions drawn from them may not be accurate.” Ground truthing information through additional research could verify the accuracy of spatially explicit local knowledge. There are other techniques, such as measures or indicators of data quality, which can be included on any map products. For example, the Sea Floor Mapping Lab at Oregon State University developed an indirect assessment of thematic map accuracy for their EFH habitat maps (Romsos et al. 2005). These kinds of “error maps” provide the context for the displayed data and inform the readers about the relative degree of uncertainty of the data used to map the themes.

Although some community organizations have the resources to develop GIS capacity in-house, this is rare in small communities because of limited human and fiscal resources (Sawicki et al. 2002). Benefits of in-house GIS arrangements are local control of access and use of the data. However, many communities do not fully utilize GIS functionality or the advanced spatial analysis capabilities (Weiner et al. 2002). Internet GIS data portals such as the Oregon Coastal Atlas (a web-based portal jointly managed by the Oregon Ocean-Coastal Management Program, Oregon State University, and Ecotrust) can provide an option for finding common ground between controlling access and promoting the use of PPGIS data (Haddad et al. 2005). In this project, the use of individual data layers can be password-restricted until such time that the community is ready to share or use it (Oregon Ocean-Coastal Management Program, 2000). Community organizations need to be using the GIS software often enough to justify the investment in the equipment and training. Also, the additional cost of collecting, maintaining and updating databases needs careful consideration. When participatory GIS work is done in conjunction with universities, government agencies or non-profit organizations, communities may focus on asking the right
questions rather than spending time and money to learn how to use the tool (Sawicki et al. 2002).

**Port Orford, Oregon—A Small ‘Fishing-dependent’ Community**

In 2000, Port Orford began exploring how a community-based framework and comprehensive strategic plan could improve the understanding and management of their local fisheries and recreational uses. Through a non-profit organization called the Port Orford Ocean Resources Team (POORT), science and management questions are being addressed at the scale of a single fishing community. In March 2003, the POORT established a local office (Figure 2) on the street going down to the dock and harbor. Since then, the office has become a hub for community members and scientists to get information and to find assistance for cooperative research projects. Two initial steps are being taken concurrently to facilitate the evolution of a functional community-based management structure in Port Orford: education and empowerment of local stakeholders to contribute to sustainable solutions, and preliminary assessment of the biological, economic, and social health of Port Orford’s nearshore resources.

![Figure 2: POORT’s Office (V.Wedell)](image)
Under POORT’s guidance, the Port Orford Community Mapping Project examined this relatively small fishing community on the South Coast of Oregon with a particular eye as to how it utilizes the ocean area for commercial and recreational uses. Through the local knowledge interviews, qualitative and spatially explicit information were collected that describes some of the changes occurring in this small-scale fishing community. The following information is an excerpt of the Port Orford Fishing Community Profile that the author completed, of which a majority was included in the Northwest Fisheries Science Center’s short form fishing community profile (Appendix A), which is discussed in more detail in the Results and Discussion chapter in the section on community and port profiling.

**Location**

Established in 1851, Port Orford was one of the first Euroamerican settlements on the Oregon Coast and has depended on natural resource extraction throughout its history. The original port facility dates back to 1856, with the port district being formed in 1911. Logging and lumber milling of Port Orford cedar supported the community for many years, reaching a peak during the 1930s. Currently, the port’s only commodity is local seafood. Port Orford’s maritime history includes about 40 fishing families, with some having third generation fishermen with over 50 years of cumulative knowledge passed down through the generations (Anderson 2001).

Port Orford meets two out of the three isolation criteria used by Langdon-Pollock (2004) to study West Coast fishing communities. Port Orford is disqualified because it is located on a major highway, Oregon state route 101. Port Orford has a recorded population of 1,153 (U.S. Census 2000), which is below the 1,900 maximum used in this study. This port is located more than 35 miles away from a major population center; it is approximately 50 miles south of the nearest large population center of Coos Bay/Charleston/North Bend (combined population of ~26,000) and about a
three and a half hour (160-mile) drive to Eugene (population 137,893; 2000 Census), the closest interior city (Figure 3).

This fishing town is situated within a semi-enclosed ocean embayment, unlike most other Oregon ports, which are located within estuary harbors or along river channels (Figure 4). Large sand bars outside the nearest ports of Bandon to the north and Gold Beach to the south, both about 25 miles away, make water-borne transportation into these ports potentially dangerous to the small fishing vessels of Port Orford, especially during poor weather conditions (Interview 193). The relative geographic isolation of Port Orford may contribute to the town’s sense of cohesion and community.

Just 10 miles north of Port Orford, Cape Blanco is a prominent oceanographic feature in the California Current system, separating two distinct oceanographic regions of the Northeast Pacific Ocean (Mackas et al. 2002). The ocean area in front of Port Orford exhibits some characteristics of both these regions. Generally, eastern boundary currents like the California Current induce strong upwelling conditions in the nearshore area and support diverse and abundant marine life including fishes, invertebrates, marine birds and marine mammals. The continental shelf is quite narrow along this section of the Oregon coast, providing the Port Orford fleet access to both nearshore and deeper shelf fish species that would typically be out of range for smaller sized vessels like those in the Port Orford fleet.
Figure 3: Map of Oregon showing Port Orford and other coastal communities.

Figure 4: Air Photo of Port Orford (City of Port Orford)
The Orford and Blanco Reefs are marine extensions of the cape’s rocky headlands, and together, consist of about seven miles of rocky reef and bull kelp (*Nereocystis*) habitat. Several reef features including Fox Rock of Orford Reef break the surface of the water to form small islands that extend the three-mile limit of state jurisdiction to include most of the nearshore reef area near Port Orford. This is evident in Figure 5, provided by the Oregon Coastal Management Program (OCMP). This extension of the Territorial Sea means the inclusion of some deep-water shelf habitat, extending out to 100 fathoms. Small pocket beaches enclosed north and south by rocky headlands make for a diverse range of nearshore benthic and shoreline habitats.

**Fishing Industry Employment in Port Orford and the Groundfish Crisis**

Port Orford is very much a fishing community, supporting about forty local fishing families (Anderson 2001). The relative proportion of fishing-related employment has statutory and management implications as set out by National Standard 8 of the 1996 Sustainable Fishing Act. However, the estimates of local fishing employment vary considerably, from as high as thirty percent to as low as less than seven percent, as reported by Scholz (2003) and the U.S. Census (2000), respectively. Anderson (2001) reports that depending on the season, the community has between 100-150 people...
directly or indirectly involved in the day-to-day activities of commercial fishing, which would represent about ten to fifteen percent of the estimated 2000 population. Radtke and Davis (1997) reported that the port brings 226 commercial fishing-related jobs, representing twenty-two percent of the estimated population in 1996 (U.S. Census Bureau). If employment estimates determine relative fishing dependency, apparent dilution of dependency will occur with increases in non-fishing proportion of populations. In Port Orford, this dilution could result from the immigration of California retirees to the area or with the reduction in fishing employment, such as those moving out of the industry due to lack of fishing opportunity because of the groundfish crisis.

The Port Orford fishing community received more than $800,000 in direct payments from the Groundfish Disaster Outreach Program (GDOP) from 2000-2004, indicating a high level of dependency on the groundfish fishery. With federal appropriation funds, the GDOP worked primarily with two other agencies to aid in transitioning people affected by the groundfish disaster into new careers. The Oregon Employment Department administered the Groundfish Transition Income and the coastal Workforce Investment Agencies provided the actual training for new careers. In Port Orford, the target recipients for the transition income are boat owners and their spouses, deckhands, shore-side baiters, and processor employees from recently closed Premium Pacific Seafood Company (Table 2).

Unique to the Port Orford fishing community are the displaced shore-side baiting crew. A traditional longline vessel’s crew baits the longline gear onboard the actual vessel while at sea. However, Port Orford vessels are too small to have room onboard to bait tubs. ‘Tub gear’ is used in Port Orford and is named so because of the metal tubs that contain the wound up line with hooks and bait. The shore side baiting crews,
Table 2: Statistics of Port Orford Community Involvement in the GDOP.

<table>
<thead>
<tr>
<th>GDOP Retraining in Port Orford (2000-2004)</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel owners and captains</td>
<td>3</td>
</tr>
<tr>
<td>Fishermen’s wives</td>
<td>13</td>
</tr>
<tr>
<td>Deckhands</td>
<td>17</td>
</tr>
<tr>
<td>Shore side baiters and processor employees</td>
<td>16</td>
</tr>
<tr>
<td>TOTAL</td>
<td>49</td>
</tr>
</tbody>
</table>

who are often family members of fishermen, baited tubs seasonally from March thru August until decreasing groundfish quota eliminated the need for their services. With limited opportunities available in Port Orford, many of these people continue to struggle to find jobs. Of the 49 applicants, 29 have completed their transition successfully into new careers, which include dog grooming, nursing aides, truck driving, and mechanical work. Not everyone from Port Orford who participated in the GDOP was successful in transitioning to a new career. Challenges identified by the GDOP Outreach Peer in Port Orford include: willingness to relocate, no GED or high school diploma, no driver’s license, and drugs and alcohol abuse (Leesa Cobb, pers. comm. 2003). The accessibility of other employment opportunities another important factor that affects how relatively dependent a fishing community is on commercial fishing.

Port Infrastructure and Facilities
Of Oregon’s 23 public ports, the Port of Port Orford is one of the smallest ports in size (its taxing district comprises just 150 square miles), but it is relatively large in
terms of economic contribution to the community. Radtke and Davis (1997) estimated that the port brings $4,310,000 of personal income and 226 jobs, with 96 percent of both from fishing-related income and employment. They also estimate that the port generates $915,000 in state and local taxes, from industries closely linked to the port’s activities. Between 2000-2004, the average value per ton of commercial catch landed in Port Orford was $3,443, compared to the average value of $741 for the rest of the Oregon ports (International 2004). This is due to the increase in the live rockfish market, a low-volume and high-value fishery, in which about 30 Port Orford vessels participate. Live rockfish are sold for between $2.00 per pound for Copper rockfish (over 2 pounds) to $7.00 for Grass rockfish. The relatively high landings value of Port Orford in comparison to other Oregon ports is also due in part to the high-volume, low-value landings of other Oregon ports, including whiting in Newport and Astoria and sardines in Astoria.

Port Orford has minimal infrastructure. There are facilities and services that include a dock and jetty, two commercial hoists, one sport crane, dry moorage area and parking spaces, minimal land and buildings for lease, beach access and restrooms and showers. The commercial hoists and limited moorage in the Port of Port Orford constrains the Port Orford commercial fishing fleet in both vessel size and number of vessels (Figure 6). Vessels must meet the weight and dimensional requirements of the commercial hoists that lift them in and out of the water to dry moorage. The vessels in the Port Orford are restricted to a maximum length of 44 feet and a maximum width of 15 feet and no more than 44,000 pounds (Private Public Service Site, 2004a). These requirements effectively homogenize the fleet’s predominant vessel size class. In addition, all vessels must be fitted with special hooks in order to connect to the hoist. This contributes to the predominantly commercial use of the port, as most recreational vessels have not been fitted with hooks. Small vessel size restricts the range and duration of fishing trips, especially during adverse weather, and results in
somewhat discreet traditional fishing grounds for most species except the highly migratory Albacore tuna. The fishing community of Port Orford is a uniquely homogeneous small-scale port on the South Coast of Oregon with relatively traditional fishing grounds determined by vessel size and capacity.

Figure 6: Photo of Port Orford Dock and Hoists (V. Wedell)
RESEARCH DESIGN AND METHODS

“Not everything that can be counted counts,
and not everything that counts can be counted.”
—Albert Einstein

The research discussed in this report tested a process to map local fisheries knowledge in the community of Port Orford, Oregon. The process was designed to develop community support, collect local knowledge about the marine environment, aggregate individuals’ knowledge and validate the resulting map representations of collective fisheries knowledge of the places important to the community of Port Orford. The methodology used here included participant observation, informal and formal discussions, and semi-structured interviews with a variety of community members, especially commercial fishermen. This served as a basis for systematically capturing ethnographic data, such as local fisheries knowledge, that cannot be ascertained by literature review or scientific analysis.

In support of POORT efforts, the goal of the community mapping project was to map local fisheries knowledge of the Port Orford Reef area using participatory GIS. Specific objectives were to:

1. Develop community support for the project, especially the trust and cooperation of the fishermen and their families and partners;
2. Develop and administer a survey and process to draw out relevant spatially-explicit biological and economic information and qualitative data about local participation in Port Orford fisheries;
3. Using these survey data, develop and validate aggregated maps that describe important fisheries from the local community fishing perspective; and
4. Conduct a preliminary analysis of the implications of these data for establishing community-based management of locally important fisheries.
Ethnographic Methods to Develop and Maintain Community Support

Ethnography is a social science method developed within cultural anthropology for studying communities in natural settings (GAO 2003) and typically involves a combination of observation, interviewing, and long-term contact with the subject of study (No Doubt Research 2003). Ethnographic data collection processes are often reflexive, meaning that the fieldwork is dynamic and changes as the project evolves (No Doubt Research 2003). Initial interviews and observations are used to fine-tune the research instruments and redirect the research process itself. New knowledge and information are used not only for understanding and explaining the research, but also for adjusting the approach, design, and methods for a more effective study.

Ethnographic methods are exploratory and are appropriate for studying issues or problems that are not readily amenable to traditional quantitative or experimental methods alone, such as studying the spatial patterns and socioeconomic linkages of fishing communities like Port Orford.

Although commonly used to understand indigenous cultures, ethnography can also be used to inform the design, implementation, and evaluation of public programs and federal actions (GAO 2003). For example, the GAO (2003) reports that NOAA Fisheries uses ethnographic methods with fishing communities to gauge the potential social and cultural consequences of alternative fishery management actions or policies on local communities. Similarly, the local knowledge interviews and informal and formal discussions with community members undertaken as part of this study provided an opportunity to collect qualitative and spatially-explicit information that is not available in scientific literature or governmental reports.

Asking fishermen to share their knowledge about their use of traditional fishing grounds is often controversial because of the historically conflict-ridden relationship
between participants and managers of the fishing industry. Trust is an important element that must be proactively addressed and kept at the forefront of both formal and informal discussions. Acknowledging and respecting the real and perceived power dynamics that currently exist between the fishing industry and fisheries management is also critical. Therefore, developing community support for sharing local fisheries knowledge is essential for the success of implementing community mapping projects like the one undertaken here. To foster cooperation and candid communication, and to build community support, effective ways of dealing with trust and power needed to be incorporated into the interview and GIS mapping methodologies.

Ensuring local control of the process and development and use of the map products was also vital to establishing and maintaining community support for the project. It was important that the project be a successful and positive experience for participants and for POORT, rather than trying to push to get the last data point, or by sharing data when POORT was not ready. People were encouraged to only share information with which they were comfortable. One principal way to communicate sensitivity of the concern of data misuse was to sign a confidentiality agreement (Appendix B) and informed consent document (Appendix C) at the outset of the interview process (discussed in detail in the following section on Data Collection). This committed researchers to protect the anonymity and the proprietary nature of information to the extent practicable under law. Random identification numbers provided anonymity of individual information and spatial representations. Except for the results of the pilot interview where permission was obtained, no individual information was ever shown in a public setting. Contact information was taken only so that the interviewees could be contacted to arrange for the follow-up verification interview. The random identification number referenced an individual’s local knowledge, and appeared on the map overlays, interview notes, and in the computer records. Individual data were securely stored and were not accessible to any person other than the interviewer and
the contractors who input the information into the computer. After all information was collected and verified from all interviews, the acetate maps and written information were either returned to the participant or destroyed. Issues of access, representation, privacy, and confidentiality were incorporated into the process, as they were important to gaining and keeping the community's trust and contributed to the success of gaining community support for participatory GIS.

Long-term contact with a community is another common characteristic of ethnography, allowing the researcher to experience the regular patterns and routines of those being researched (No Doubt Research 2003). Extended stays in Port Orford provided the opportunity to observe activities during different fishing seasons and to develop social relationships with people in the community. Developing a personal relationship with the Port Orford fishing community was essential to their decision to trust the author and research team with collecting and mapping their personal knowledge of fishing and fisheries. The foundation of cooperation involved developing personal relationships with the fishing community, continually collaborating with respected community leaders, and focusing on local ownership of the process and the products of the community mapping project.

Close collaboration with respected community leaders was one of the most important elements of building community support for the mapping project. Probably the most important relationship was developed with the POORT’s Communications Coordinator, Leesa Cobb, who is a member of a Port Orford fishing family with roots in both logging and ranching. Her participation in and support of the community mapping project was essential for the project’s success. With respect to ethnographic study methods, she would be considered both the “gatekeeper” and the author’s “key informant” for the community (No Doubt Research 2003). Gatekeepers help researchers gain access to the community of interest. Key informants are those persons who know the “inside scoop” and can help direct the researcher to other
knowledgeable community members. Her personal knowledge of the dynamics of fishing in Port Orford and her personal relationships with the fishermen, their families and partners was invaluable to learning about Port Orford. Getting her approval and assistance was integral to gaining the trust and cooperation of the local fishing community members.

POORT’s Project Manager, Laura Anderson, was another important community leader who collaborated with the research. Although she has never commercially fished from Port Orford, Anderson has personal experience in Oregon commercial fishing with her family, and her practical and academic knowledge has helped guide the development of POORT and the implementation of the cooperative research projects that they have executed. Through her independent consulting business, she manages POORT contracts and fiscal resources and provides POORT with valuable administration and management assistance. Over the last four years, she has developed a good working relationship with Port Orford fishermen and has credibility with the community that enhanced the development and implementation of the Port Orford Community Mapping Project.

Over the two years of project development and implementation, the author was integrated into the Port Orford community by attending and participating in several community events, spending time in town working from the POORT office, visiting local restaurants and bars, staying in local hotels and inns, and frequenting the dock and shops. Learning about the intricacies of this unique commercial fishing port and the community that depends on it occurred through personal observation and discussions with local people. Formal presentations at POORT planning and informational meetings provided another way to develop strong working relationships with the Port Orford community. The interests expressed by the Port Orford fishing community in both formal and informal discussions guided the topics covered in the
meetings. Examples of meeting topics include marine reserves and protected areas, quota management systems, and GIS technology and processes.

Data Collection Process

The author used several examples of participatory GIS from the literature to create a unique data collection process for the Port Orford Community Mapping Project (Macnab 2002, Kronman et al. 2000, and Scholz et al. 2004). The goal of the project was to test the protocols for collecting, analyzing, and presenting local knowledge using GIS. Focusing this research on the development of the unique mapping process, rather than on the substantive data or set of maps that were derived from the process, was a strategic decision that was intended to preserve local control of the data until the community was comfortable with sharing them. The interviewing and mapping process was an iterative data collection process to ensure that each interviewee was given the opportunity to check for accuracy and to provide an opportunity to make necessary corrections to the spatial and qualitative data collected and represented. Macnab (2002) also suggests that individual user areas could be documented very accurately using a global positioning system and extensive field surveys, although this could be expensive and time consuming. A semi-structured interview and participatory GIS methodology was developed, which documented local knowledge about the status and spatial distribution of marine resources and human activities important to the Port Orford community. The local knowledge was recorded using a database template during interviews and was later combined with spatial layers generated from the interviewees' hand-drawn map layers, creating individual GIS databases for each of the 33 interviews.

Materials and Methods Development

The Port Orford Community Mapping Project process began with creation of the basemaps, draft interview questions, a general GIS framework, and supporting
materials for the interview process. Both materials and methods for the local knowledge interviews were tailored to fit into the frames of reference of participants, so as to facilitate their communication of local knowledge (Table 3). All materials and methods evolved during the development and implementation of the project. Most important, a pilot interview provided an opportunity to refine the interview questions and process, and to improve upon the original design of the supporting materials. For example, the pilot interview took over four hours to complete, a huge time commitment for volunteers. To reduce the amount of time required for participants to be interviewed, improvements were made to the questions, basemaps, and the database template.

Table 3: Materials for Local Knowledge Interview Process

<table>
<thead>
<tr>
<th>Confidentiality Agreement and Informed Consent Document</th>
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</thead>
<tbody>
<tr>
<td>Interview questions</td>
</tr>
<tr>
<td>Checklist of activities/species/resources</td>
</tr>
<tr>
<td>Interview response spreadsheet</td>
</tr>
<tr>
<td>Four large size (36”x36”) basemaps</td>
</tr>
<tr>
<td>1:120,000 “Coos Bay to Gold Beach”</td>
</tr>
<tr>
<td>1:40,000 “Port Orford Nautical Chart”</td>
</tr>
<tr>
<td>1:24,000 “North of Port”</td>
</tr>
<tr>
<td>1:24,000 “South of Port”</td>
</tr>
<tr>
<td>Acetate overlays, scissors, and masking tape</td>
</tr>
<tr>
<td>Colored wax pencils</td>
</tr>
<tr>
<td>Tissue eraser</td>
</tr>
<tr>
<td>Identification guides</td>
</tr>
</tbody>
</table>

The initial development of the interview instrument and GIS database template was guided by the research and management questions generated by the Advisory Board and the Science Advisory Committee (Table 4) and by two examples of ethnographic surveys: one for the Channel Islands National Marine Sanctuary (Kronman et al.
and one for mapping fishermen’s knowledge for marine protected area planning in California (Scholz et al. 2004). The Port Orford Community Mapping Project focused on determining the distribution of biological resources and commercial and recreational human activities. The project also tested a method of documenting the relative socioeconomic value of areas for fisheries. Research projects are already being developed and implemented by POORT to answer some additional questions, including identifying if some fish species are residents of the Orford Reef, the movement patterns of species, and gear selectivity.

Table 4: Spatial Research and Management Questions Developed by POORT

<table>
<thead>
<tr>
<th>Question</th>
</tr>
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<tbody>
<tr>
<td>1. What are the distribution, abundance and diversity of species near Port Orford?</td>
</tr>
<tr>
<td>2. What are the distributions of recreational and commercial effort and socioeconomic value?</td>
</tr>
<tr>
<td>3. Are some species residents? What are their movement patterns?</td>
</tr>
<tr>
<td>4. What is the catch per unit effort of different fishing gear types?</td>
</tr>
<tr>
<td>5. What is the correlation between habitat and species distribution, abundance, and diversity?</td>
</tr>
<tr>
<td>6. Are spatial management strategies appropriate for Port Orford? What kind and where might they be located?</td>
</tr>
</tbody>
</table>

In order to represent the diverse interests of the entire Port Orford community, rather than only commercial fishermen, the maps and questions were designed to facilitate communication of local knowledge in general. Similar to the Channel Islands survey, the protocol and materials were flexible enough to facilitate interviews with variety of audiences. People of different professions or recreational activities see the nearshore and ocean areas in different ways. For example, surfers and beachcombers had more detailed knowledge of the shoreline and beaches, whereas a groundfish fisherman had detailed knowledge of underwater rock structures, including ledges and high spots. In Scholz et al. (2004), commercial fishermen were asked a series of questions on four core areas in a semi-structured format. The Port Orford Community Mapping Project’s interview process was modeled after this “free flowing (style of)
conversations guided by a set of specific questions” (p. 5) (Scholz et al. 2004). This allowed the participant the freedom to elaborate on topics of choice and promoted naturalness of the discussion of the resource and activity categories.

Kronman et al. (2000) also provided a model for collecting a user profile as part of the local knowledge interview questions. This helped categorize the interview participants for later analysis. In this first part of the interview, the age, sex, profession/recreation and primary activities of the interviewee was recorded along with their number of years experience in their chosen activity or profession in the Port Orford area. Several people identified themselves by more than one category, such as commercial fishermen who also enjoyed surfing, or someone who recreationally fished from a kayak. In a few instances, two or more interviewees chose to conduct their interview together. The participants were asked to select a representative for the demographic analysis. Knowing the number of interviewees, their mean age and mean number of years experience can add validity to mapped and qualitative data.

In the Channel Islands survey, information was divided into twenty-four resource or activity categories, whereas the Port Orford Community Mapping Project had a list of over 80. The database format was established based on the resource and activity themes and designed to facilitate data storage, retrieval, and analysis. Although this wealth of information provides the Port Orford community with a very comprehensive baseline inventory, it was costly in terms of interview and digitization time.

Laminated basemaps served as the foundation for the interviews and were extremely important for relaying the spatial components of local knowledge. Using these maps to collect and display local knowledge was a natural outflow from fishermen’s experience using nautical charts for navigation. Much of this methodology is from Macnab (2002), who used digital topographic maps to develop prototype basemaps
depicting most of the community’s harvest area and several local place names, or “toponyms.” The basemaps displayed the relevant National Oceanic and Atmospheric Administration nautical charts, the latest bathymetric data (C. Goldfinger, pers. comm. 2003) displayed as both depth contours and shading, and some local place names. Academics and professional scientists almost always record data on depth in meters. However, depth contours were labeled in fathoms to better relate the maps with the fishermen’s experience of using nautical charts, which display depths in fathoms. Customizing data to meet fishermen’s needs and worldview fosters clear communication.

Four basemaps were needed to cover the Port Orford study area. The smallest scale basemap (i.e., covers the largest amount of area) was 1:120,000 and displayed the South Coast of Oregon from Coos Bay in the north to Gold Beach in the south. However, through interviews, it was learned that these maps did not show the complete extent of the Port Orford fleet’s fishing activity. Albacore tuna, black cod, and salmon are fished beyond the area represented on the maps. For logistical purposes, limits of Port Orford study area had to be defined. Coos Bay and Gold Beach were chosen because most of the Port Orford fishing activities occur within this latitudinal range. Two of the basemaps were larger scale (1:20,000) representing the marine area closer to the port of Port Orford, from north of Cape Blanco to Sisters Rock at Frankport, Oregon. One basemap was modeled after the scale used on the Port Orford nautical chart, 1:40,000. Interviewees were encouraged to utilize any base map that met their needs. Most used three, but several only used the two larger-scale maps due to their need for higher resolution.

Putting toponyms on the basemap of the study area helped orient interview participants to the areas covered by the maps, and therefore facilitated more effective communication. Toponyms also give a sense of familiarity and ownership of the process to the interviewee. The obvious major nearshore rock structures were labeled,
including: Orford and Blanco Reefs, Redfish Rocks, Island Rock, and Sisters Rock. Locating and delineating other local places required additional assistance from the local fishermen and interview participants. There was consistency of local knowledge about safe passageways between the rocks (e.g., the Big Hole, the Little Hole, and Hell’s Gate). Fishermen who target the same species referred to the same places such as the High Spot, the Banana, and the Canyon. The utility of toponyms was not limited to enhancing communication; they also improved the data transcription and digitization processes.

After conducting a few interviews, an ad-hoc focus group was convened to delineate the spatial extent of the most commonly referenced local places. This small group discussion took place at the Hallmark fish shack down on the dock and involved approximately 6-8 Port Orford fishermen. They were asked to provide a consensus as to where and how big an area they were talking about when they would say, for example, “the Banana,” or any other of these local places. The focus group participants drew on layers of acetate taped on top of the laminated basemaps created previously. From this discussion, 20-25 “standard” polygons were collected and used in creating the GIS databases.

Having standard polygons allowed the interview process to proceed more quickly because each interviewee did not have to draw these places on the maps. An abbreviation for the location was documented in the interview template next to the appropriate species or activity and the actual spatial representation, or polygon, was incorporated during the data digitization process. Although these polygons were not standardized in the traditional scientific sense, each interviewee had the opportunity to amend their draft maps in the follow-up interview. A review and clearance process was used to validate the data collected.
**Human Subjects Research Approval**

In order to administer the interviews as part of the author’s graduate research, the Oregon State University Institutional Review Board (IRB) had to approve the research methods. The research community has a responsibility to ensure that the treatment of human participants meets the highest ethical standards. An academic research project involving human participants requires review and approval by the IRB before any recruitment or fieldwork may begin. The approval number for this research was IRB Protocol No. 2271.

The IRB approval process for the Port Orford Community Mapping Project involved the submission of an application that adequately described the project, the intended participant population, the methods and procedures, the potential risks and benefits, and the processes for maintaining anonymity and confidentiality and for obtaining Informed Consent. The application also included the actual materials used to recruit interview participants, the survey instrument and the Informed Consent Document (Appendix B). Each participant had to read and sign the Informed Consent document to participate in this research. The participant’s signature indicated that the research study has been thoroughly explained to them, that all their questions had been answered, and that they voluntarily agreed to take part in the study. Each interviewee received a copy of this form for their personal records. Every Informed Consent Document was turned in to the IRB at the conclusion of the research project.

All researchers that were to participate in the interview process were required to be trained through the IRB. Leesa Cobb, Laura Anderson, David Revell, the author’s academic advisor, and the author all completed an online tutorial in the ethical treatment of human participants in research. Proof of completion was submitted to the IRB for review and approval as part of the application package.
Introducing GIS to the Port Orford Community
Two POORT planning meetings in 2003 were used to introduce and demonstrate the participatory GIS process to be used in the Port Orford Community Mapping Project. At the first meeting, the basic concepts of computer mapping and GIS were introduced, resulting in a valuable discussion of the different types of spatial data and the uses and limitations of GIS. The proposed method of conducting local knowledge interviews was also presented. A local commercial fisherman with over 25 years experience fishing from Port Orford volunteered to participate in a pilot interview. At the second planning meeting, the full pilot interview process and derived information layers were presented to the POORT Advisory Board. To further demonstrate how local knowledge is translated into a GIS layer, a group exercise was conducted to document the navigation routes in and out of the dock. After some healthy deliberation, general consensus was reached that for the community to have input into local fisheries management decisions, relevant information had to be collected and put into a format that would ultimately be digestible to fisheries managers. From that point forward, the Port Orford Community Mapping project became a priority for POORT.

Participant Recruitment
In contrast to more traditional scientific research, where a statistically-significant representative sample of a much larger population is sought, many ethnographic studies do not lend themselves to random sampling and the associated statistical methods. These ethnographic studies use survey methods to collect, analyze and study members of a population. Whereas the goal of a census survey is to interact with every member of the population, the goal of a sample survey is to obtain a large enough sample of participants that “saturation” of knowledge is reached (No Doubt Research 2003). Saturation occurs when additional interviews would not contribute additional knowledge to the data collection effort. For this project, a sample survey was used to select interviewees from the Port Orford community. Fiscal and time
constraints are often the other limiting factors for conducting a sample survey instead of a census, as it was with the Port Orford Community Mapping Project. Sample surveys can have advantages provided they are properly designed and conducted.

The goal of this sampling strategy was to target the most knowledgeable people, but to be inclusive of the community-at-large. Non-probability purposive sampling methods were used to recruit most of the participants for interviews. Whereas probability sampling involves the random selection of participants, non-probability sampling does not (Trochim 2002). In purposive sampling, researchers have one or more specific predefined groups they are seeking to have represented in their sample (Trochim 2002). The methods used for the Port Orford Community Mapping Project targeted people who had direct experiential knowledge about the coastal and ocean resources in the Port Orford area. The sampling from the mapping project was intended to balance obtaining buy-in from the local community and collecting the most accurate data possible.

There are many subcategories of purposive sampling, of which a combination of expert, snowballing, and heterogeneity sampling approaches were used in this application. Expert sampling involves assembling a sample of people with known or demonstrable experience and expertise in some area. Expert sampling started with volunteers from the POORT Advisory Board and community members who attended POORT community meetings. These individuals were primarily commercial fishermen, although also included fishery scientists. Leesa Cobb also helped identify other experts who were not at the POORT meetings, such as port management personnel and fish buyers in Port Orford. She was very cognizant of knowledgeable community members due to being a long-time Port Orford resident and fisherman’s wife.
“Snowball” sampling occurred when interview participants were identified through suggestions made by interviewees or the gatekeeper (No Doubt Research 2003). A local veteran surfer and three members of a local fishing family were identified through snowball sampling. In a small community like Port Orford, word-of-mouth can also be a successful sampling method. Two participants contacted the POORT through a flyer (Appendix D) that was posted at the Port Orford dock and in the *Port Orford Today!* (Downtown Fun Zone, 2003). Another person who is a local beachcomber stopped by the POORT office, was curious about the newly formed organization, and decided to volunteer his expertise and time. The author recruited a local resident who enjoyed watching wildlife during an informal discussion conducted during a hike at the Port Orford Heads State Park.

Flexibility in participant recruitment promoted a truly community-based approach to the design and implementation of the mapping project. Heterogeneity sampling is when all opinions or views are sought and when one is not concerned about representing these views proportionately. A cross-section of the community provides representation of a cross-section of values including: extractive and non-extractive use values, and scientific and recreational values. Community representation was the reason for naming the project the Port Orford Community Mapping Project.

**Conducting Local Knowledge Interviews**

The author was the primary interviewer for the 33 semi-structured interviews and follow-up interviews, although one of the four IRB-trained team members was also present for each initial interview. The author and a consultant documented the information through handwritten notes on a standard database template. Double coverage of interview notes provided a crosscheck for when the author transcribed the interview information into a excel spreadsheet.
The interview process occurred mainly in four steps (Appendix E):

1) Demographic and vessel information, if applicable, were obtained.

2) The interviewees identified the locations of their primary ocean-related activities. If the primary activity was commercial fishing, they were asked about what gear they used for each target species. Fishermen were also asked to assign a value of the relative economic importance of their fishing grounds.

3) The participants were asked to describe their personal observations of other species and human activities and to identify the location of these observations (Appendix F). Additional attributes were also documented at this time.

4) The interviewees were given the opportunity to talk about anything else important to them about the ecological, economic and/or social conditions of the study area. This ‘open microphone’ time helped identify the common themes of important issues to the community to help guide future community-based management efforts.

In order to capture the 33 interviews, flexibility to the schedules and responsibilities of the interviewees was vital. Two interviews had more than one person present at the interview. A local couple interviewed together because they always did their beachcombing and tidepooling together. A trio of commercial fishermen from one fishing family was also interviewed together. The author did not encounter any internal disagreement during these unconventional interviews and therefore included them in the analysis. The location of the initial and verification interviews varied. Most interviews were conducted in the facilities of the POORT office (Figure 2). However, some were conducted in a local café, at the dock, or at another place of work. The last interview was conducted in the middle of the night at the last minute because the interviewee decided to go tuna fishing early the next morning when the interview was originally scheduled. Not everyone who expressed interest in the local knowledge mapping project was actually interviewed due to scheduling conflicts and the good weather conditions that caused them to go out fishing instead. Because the
POORT office is located on the street heading towards the dock, follow-up with these and other experts was made easier.

**Data Compilation and Spatial Analysis**

The author coded the data on the acetate overlays and transcribed the interview notes into standardized excel spreadsheets. These spreadsheets became the GIS polygon attribute tables for each interview (Table 5). Other attributes were populated from the interviewers' notes, although not every category was filled in for each interview. To capture the spatial extent of the location of the resource and activity categories, location information was given to the interviewers in one of four ways: 1) directly drawn on the maps in wax pencils; 2) verbally referenced using a local place name; 3) using a depth or distance associations; or 4) using a species association. Each polygon was given a unique identifier and its own record in the database. The author and the Ecotrust and Surfrider consultants digitized polygons from the individual interviews and joined them with the excel databases to create individual digital map layers comprising all polygons assigned to the activity or species. Each interview generated anywhere from ten to fifty spatial data layers.

The author conducted one-hour follow up interviews with each participant to verify the integrity of the data transcription and conversion process. Every resource or activity theme was shown to the interviewee on the computer. The associated attributes of each theme were discussed in detail. Participants specified any necessary edits to the polygon areas and associated attributes. The author then incorporated these edits into the final GIS databases. Every interview was verified in this way.
Table 5: Attribute Categories and Example Values from LKI Database

<table>
<thead>
<tr>
<th>Attribute Category</th>
<th>Examples of Attribute Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of species or activity</td>
<td>Commercial fishing, surfing, sablefish</td>
</tr>
<tr>
<td>Alternate name of the species</td>
<td>Sea trout, ragmops</td>
</tr>
<tr>
<td>Species/activity descriptor</td>
<td>Female or male, large, spawning, nursery</td>
</tr>
<tr>
<td>Local name of the location area</td>
<td>Big hole, banana, hubbards creek</td>
</tr>
<tr>
<td>Area descriptor</td>
<td>North side, east side</td>
</tr>
<tr>
<td>Basemap utilized</td>
<td>120K, 40K, 24N, 24S</td>
</tr>
<tr>
<td>Percent of effort</td>
<td>1 to 100</td>
</tr>
<tr>
<td>Percent economic importance</td>
<td>1 to 100</td>
</tr>
<tr>
<td>Gear used</td>
<td>Longline, jig, pots, troll</td>
</tr>
<tr>
<td>Description of gear set up</td>
<td>150 pots</td>
</tr>
<tr>
<td>Current level of abundance</td>
<td>Abundant or not abundant</td>
</tr>
<tr>
<td>Trends</td>
<td>Increasing, decreasing, static</td>
</tr>
<tr>
<td>Trend descriptor</td>
<td>Size or abundance</td>
</tr>
<tr>
<td>Season</td>
<td>Spring, summer, fall, winter</td>
</tr>
<tr>
<td>Climatic patterns</td>
<td>Cyclic, intermittent, year-round</td>
</tr>
<tr>
<td>Target species</td>
<td>Dungeness crab, sablefish</td>
</tr>
<tr>
<td>Other communities’ targeting</td>
<td>Bandon, Coos Bay</td>
</tr>
<tr>
<td>Associated species</td>
<td>Octopus, starfish</td>
</tr>
<tr>
<td>Habitat associations</td>
<td>Sand, mud, dark water, water temperature</td>
</tr>
<tr>
<td>Depth associations</td>
<td>30-50 fathoms</td>
</tr>
</tbody>
</table>

A non-profit organization, Ecotrust, provided integral technical support by conducting the spatial analysis that aggregated the individual interview databases and created the draft community inventory maps (Appendix G). Ecotrust converted vector data into 30-meter grids. Each grid cell was assigned a value of 1 for presence of the polygon area and 0 for its absence. Then, they took cumulative totals for each grid cell using an Arc macro language script, or AML. Ecotrust conducted a nearest neighbor analysis with a 6-cell focal mean to smooth the data. The data was then classified using an equal area distribution of 7 classes and re-categorized as low, medium, and high usage, with 1 equal to the lowest level use and 7 equal to the
highest. This categorization scheme gives an indication of the gradation of intensity of use of areas.

It was economically unfeasible for the POORT to have Ecotrust aggregate all the data layers for the first phase of the project. Six layers were chosen for initial aggregation. Recreational activity layers were combined together to produce a composite aggregate map of the intensity of all recreational uses in the Port Orford area. The recreational activities included: surfing, kayaking, diving, wind surfing, recreational fishing, shore fishing, whale watching, bird watching, and beachcombing.

Recreational fishing and shore fishing are differentiated by whether the people are fishing from a boat or from shore. The POORT chose salmon, Dungeness crab, halibut, and black cod as the commercially targeted species to aggregate in the first round of spatial analysis. These fisheries provided a good variety of species that are economically important to Port Orford. These fishes were also chosen because they were a less controversial or competitive subset of the whole Port Orford fishing portfolio. The community maps developed by Ecotrust displayed the spatial distribution and intensity of use of areas targeted for these species and recreational activities. Finally, an additional socioeconomic spatial analysis tested the process for representing the relative economic importance of areas targeted by commercial fishermen for black cod.

Community-Level Validation of Maps
In January 2004, the community inventory maps developed by Ecotrust were validated through an interactive workshop held in Port Orford. Participants could suggest changes to the maps in a few different ways; increasing or decreasing intensity of use in areas, or changing the spatial extent of the area represented as an area being targeted for recreational and commercial uses. The intent of the workshop
was to validate the information provided in the interviews and its interpretation on the
maps showing commercial fishing grounds and recreational areas.

This workshop provided various forums for participants to propose edits in order to
account for the differences in people’s level of comfort making suggestion in front of
a group. People could make suggestions verbally or in writing, individually or in
small groups. Proposals for changes were then discussed with the larger group.
People voted for agreement, disagreement, or abstention. Votes of abstention were
just as important as votes of agreement and disagreement, as not everyone present had
personal observations for the chosen target species or for the recreational activities.
Conflicting suggestions from participants that could not be resolved were kept “as is.”
The agreed-upon edits need to be incorporated into the draft maps when additional
funding is secured by POORT. On one map, no edits at all were suggested. In the
final group discussion, the participants reached consensus that the process accurately
represented their knowledge of the spatial extent and intensity of uses in the study
area.

Storage of and Access to Port Orford’s Local Knowledge

The interview participants made recommendations for immediate uses of the data and
the protocols for sharing the resulting maps at the validation workshop. These
recommendations were voted on by POORT members to further ensure local
ownership of the process and products. The POORT office in Port Orford and the
Terra Cognita GIS Lab at Oregon State University provided short-term secure storage
for the data. Options for long-term storage of the GIS data include: the POORT
office, the Oregon Coastal Atlas, or Ecotrust’s Inforain Server. A permanent solution
for secure data storage will be decided through a series of community meetings, the
first of which outlined the above options.
Workshop participants also recommended immediate uses for the inventory and the level of disclosure. The participants unanimously voted to allow the maps to be published as part of this master's thesis and to be used in professional presentations such as the American Association for the Advancement of Science and the Society for Applied Anthropology Annual Meeting.

Utility of Local Knowledge for Community-based Fisheries Management

Local knowledge inventories, such as the Port Orford Community Mapping Project, provide both data and a process that builds capacity for a community to conduct community-based fisheries management. Using this consensus-building process to learn collaboratively, POORT is building social capacity for long-term resource planning and more participation into management decisions. Local knowledge interviews were a useful tool for developing a more comprehensive understanding of this unique fishing community, its resources, and its dependence on various areas. Mapping local knowledge is a process that can support fisheries management functions including data gathering and analysis, logistical harvest decisions, habitat and water quality protection, and long-term planning, including the identification of economic alternatives (Pinkerton 1989).

This community-based GIS process combined scientific and local knowledge and allowed researchers to collect high-resolution data on a local area. The improved scale of data collected can position the community to be able to assess the potential socioeconomic impacts of fisheries management strategies and communicate these impacts to state and federal fisheries management. GIS and rapid appraisal techniques provide an opportunity to document local knowledge important to fisheries management at scales appropriate for an individual fishing community and in formats acceptable to the fisheries management process (Scholz et al. 2004). Because of
inherent complexity, a comprehensive analysis of the social and economic impacts of fishing regulations will be impossible without new tools.

Using GIS and spatial representation of human uses, economic importance, and species distribution can guide area-based management strategies including: local area management and marine protected areas. This research project can be used to analyze the potential socioeconomic impacts to Port Orford from different spatial management strategies employed in the area. The different spatial management strategies that could be analyzed include: areas with gear limitations (e.g., a no-trawl zone) and exclusive territorial use rights by the Port Orford fleet (i.e., no non-Port Orford vessels). Addressing the community management question “Is there an area off Port Orford for marine protected areas?” remains a significant challenge.
RESULTS AND DISCUSSION

Gaining Community Support

The high level of participant involvement is one measure of support of the project from the Port Orford community. The local knowledge interviews included 36 individuals from the local community who utilize the Port Orford marine environment for their occupation or leisure activities (Table 6). The mean age of the participants was 51 years old. The interviewees had an average of over 20 years experience in their primary activity or profession. The male-female ratio was 31 to 5. The participant sample represented a diversity of professional and recreational categories of marine and coastal uses including: commercial and recreational fishing, surfing, kayaking, beachcombing, tidepooling, birding, whale and seal/sea lion watching, and professional and recreational diving (Table 7). The sample also included scientists, fish buyers and processors, and representatives from the port. The diversity of marine and coastal resource users interviewed demonstrates that the project represented a cross-section of the Port Orford community’s values. Many people were not adequately represented by a single category. Every interviewee coming back for his or her follow-up validation interview demonstrated support. A large proportion of participants and other local people attended the POORT planning meetings and the final validation workshop. Success in gaining community support is also demonstrated by the fact that all the interviewees except one permitted their picture to be taken. By the end of the process, each interviewee wanted to be identified as a participant in the Port Orford Community Mapping Project.

How well does the survey represent the involvement of 1) the community-at-large, 2) the local fishing industry, and 3) the Port Orford commercial fishing fleet? The answer is not as simple as it may appear. By legal definition, a fishing community
“includes fishing vessel owners, operators, and crew and United States fish processors that are based in such a community.” Does this mean that fisheries

Table 6: Port Orford Community Members Participating in Local Knowledge Interviews

<table>
<thead>
<tr>
<th>Local Knowledge Interview Participants</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of people</td>
<td>36</td>
</tr>
<tr>
<td>Total number of interviews</td>
<td>33</td>
</tr>
<tr>
<td>Average age</td>
<td>51 years</td>
</tr>
<tr>
<td>Number of Men</td>
<td>31</td>
</tr>
<tr>
<td>Number of Women</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 7: Local Knowledge Interview Participant’s Self-identified Professional/Activity Categories and Average Experience

<table>
<thead>
<tr>
<th>Categories of Participants in Local Knowledge Interviews</th>
<th>Number of People</th>
<th>Average Years Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Orford commercial fishermen</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Recreational fishermen</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Surfers</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Divers</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Wildlife watchers/Beachcombers/Tidepoolers</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Kayakers</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Local fish buyers</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Port of Port Orford affiliates</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Oregon Department of Fish and Wildlife scientists</td>
<td>2</td>
<td>16</td>
</tr>
</tbody>
</table>
management must only assess impacts to those specific individuals? One could argue that the Port Orford’s fishing families and port management personnel might also be substantially engaged with and dependent on commercial fishing. The community-at-large includes both the fishing and non-fishing populations. This survey sample represents 36 individuals from the community of 1,153 people, equivalent to approximately 3 percent of the total Port Orford community population.

The local fishing industry includes those people who directly participate in the harvesting, buying and processing sectors. Estimates of the fishing portion of a community are difficult to assess because of the difficulty of capturing the actual number of people with fishing-related employment. As previously stated, estimations of the percentage of fishing employment in Port Orford range from 7 to 30 percent. By these percentages, the twenty-four commercial fishermen and three local buyers interviewed could represent anywhere from 33 to 8 percent of the local commercial fishing industry.

The Port Orford fleet includes the owners/captains, deckhands, and shore-side baiters of the approximately forty vessels that homeport in Port Orford or at the dock. The survey had representatives from 50 percent of the Port Orford fishing vessels. Estimating that each vessel has about two to three people involved in actual fishing activity at any one time produces about 120 people as potential crew, including owner/captains. This is a high estimate, as some people in Port Orford own several vessels and crew may work for several owners. However, this estimate of crew does not include any estimate of the number of supporting shore-side baiters. The information in the commercial effort maps is most representative of the fishing fleet. The twenty-four fishermen interviewed represent at least 20 percent of the fishing portion of the Port Orford, using the estimate of approximately 120 crewmembers.
The twenty-four fishermen interviewed had a combined 524 years experience on the ocean and had a mean 25 years experience commercial fishing in Port Orford (Table 8). They work a combined total of over 2000 days/year, averaging over 120 days/year out at sea (includes four recently retired fishermen). Sixteen people were owners and/or captains of their own vessels and eight were deckhands, although some now have purchased their own vessel. Six of the twenty-two fishermen were the second-generation of fishermen in their families, and one was the third generation. This sample of fishermen represented approximately 50 percent of the vessels that homeport in Port Orford. Due to the homogenous nature of the Port Orford fleet in terms of vessel size and fisheries, 50 percent coverage of the forty vessels was an adequate representation of the vessels in the Port Orford fleet. Three representatives from the Port Orford buying/processing sector of the fishing industry participated. While most of their knowledge is not derived from direct at-sea observations, they possess a ‘common knowledge’ of fishing locations and have great insights into the overall picture of the economic activities of this port.

Table 8: Port Orford Commercial Fishermen Participating in Local Knowledge Interviews

<table>
<thead>
<tr>
<th>Port Orford Commercial Fishermen Participating in Local Knowledge Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Orford vessels</td>
</tr>
<tr>
<td>Average vessel length</td>
</tr>
<tr>
<td>Owners and/or captains</td>
</tr>
<tr>
<td>Deckhands</td>
</tr>
<tr>
<td>Total combined days/year on water currently</td>
</tr>
<tr>
<td>Average days/year/person on water currently</td>
</tr>
<tr>
<td>Second-generation fishermen</td>
</tr>
<tr>
<td>Third-generation fishermen</td>
</tr>
</tbody>
</table>
The confidentiality and anonymity protections built into the process gave respondents confidence that the research project intended to protect the proprietary nature of the data. “Open microphone” time during the interviews provided people an opportunity to air other concerns and to communicate in a more conversational manner. The author had many very candid and frank conversations with participants throughout the interview process and in formal and informal discussions, providing insightful and valuable knowledge of the Port Orford area.

That few map changes were suggested at the validation workshop demonstrated the participants’ satisfaction with the outcome and the process. The community group achieved consensus on distribution of areas targeted by Port Orford for commercial and recreational activities represented in the draft maps. It is important to note that the intention of the workshop was to validate the process and results from the interviews, which is different than “groundtruthing” the results. “Groundtruthing” the data would require a scientific comparison of statistically collected data on the actual locations of fishing and recreational activities.

Integration of Local Knowledge and Science

The overall goal of the Port Orford Community Mapping Project was to test the methodology for integrating local knowledge with scientific information using GIS in a social setting. The mapping project used a combination of local knowledge and scientific information to answer some of the spatially explicit scientific questions raised by POORT. The utility of this new spatial information to inform management is dependant on what level of uncertainty is acceptable to managers. New GIS tools are currently being developed and implemented that offer opportunities to further refine mapping processes and information storage and use.
The community inventory maps generated from local knowledge interviews demonstrates a successful process for integrating local fisheries knowledge and conventional scientific information from nautical charts and a bathymetric layer of the Oregon seafloor. Several scientific spatial data layers were compiled in the beginning of the Port Orford GIS development, although not all were utilized in the specific application of documenting the distribution of human uses (Table 9). These data included sampling locations of visual fish and urchin surveys and a two-meter resolution bathymetry of the Orford Reef documented by Oregon Department of Fish and Wildlife (ODFW), data layers obtained from the Oregon Coastal Atlas data portal (Haddad et al. 2005), and a distribution of geological substrate habitat from Dr. Chris Goldfinger’s Seafloor Mapping Lab at Oregon State University. Conventional forms of data included in the Port Orford Community Mapping Project were NOAA nautical charts and a higher resolution (approximately 100 meter) bathymetric grid, also from the Seafloor Mapping Lab. The bathymetric grid was converted to fathoms and represented by depth contours for the community mapping project. Many participants’ knowledge of areas targeted for commercial harvesting was described in terms of depth-associations. Deriving these local areas was possible because of the integration of local knowledge and conventional scientific information.
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Port Orford Involvement in Commercial Fisheries

Local knowledge interviews provided a baseline assessment of the sample population’s local participation in commercial fisheries for 2004. Seventy-two percent of the 24 commercial fishermen interviewed currently participate in four to seven fisheries over a year of fishing activities (Figure 7). At present, this sample of the Port Orford fleet currently primarily targets salmon (86% of interviewees), Dungeness crab (82%), live rockfish (Sebastes) (73%), and sablefish (68%). However, albacore tuna (55%) and Pacific halibut (50%) are also important fisheries, with hagfish (23%) and urchins (14%) making up most of the remainder (Figure 8). Commercial fishing in Port Orford is a year-round profession (Figure 9). Fishing for live rockfish, traditional shelf rockfish, and sablefish are important summer fisheries. Salmon fishing occurs primarily throughout the summer and as the runs hit the North Beach area. The July halibut opener is apparent on the graph as well. Black cod are targeted in the winter months. Dungeness crab is predominantly a winter fishery, with landings peaking in December and January. Tuna fishing is variable, dependent on the water temperature gradient offshore. Hagfish were not landed during this year, although have grown in importance in the last several years. Port Orford fishermen continually change their target fisheries and harvest strategies throughout the year.

Because of the POORT’s fiscal and time constraints and lack of technical expertise, Ecotrust was contracted to aggregate a small subset of the total number of locally important fisheries. It was most important POORT to test the validity of the interview and participatory GIS methodology first, rather than to select the most economically and socially important (and also most controversial) fishery, the groundfish fishery.
Figure 7: Percent of Commercial Fishermen Interviewed Targeting Different Numbers of Fisheries

Figure 8: Percent of Commercial Fishermen Interviewed Targeting Specific Fisheries
Groundfish are a diverse complex of over eighty species divided into two market categories, live and fresh (dead), which are targeted in different areas although some of the target species are the same. The groundfish fishery encompasses rockfish species, flatfish species, and roundfish species, like black cod. Black cod was the only groundfish species that POORT selected for aggregation by Ecotrust because it is an economically important and distinct fishery, separate from both the newer live rockfish fishery and the shelf rockfish fishery of the recent past. Outlined below is a more detailed analogy of the major fisheries of Port Orford, focusing on those that were highlighted through the development of community inventory maps.
Groundfish. Fishing businesses have had to adapt to increasingly restrictive conservation measures associated with the recovery of shelf groundfish fisheries. In Port Orford, the typical adaptation is to change target fisheries. However, few fisheries left can sustain increased fishing effort. At the same time that the shelf groundfish fishery declined, a nearshore live fish fishery was emerging in Port Orford. However, this was not a one-for-one exchange; the same vessels did not necessarily move from one fishery to the other. The short period of time over which regulatory change was imposed on the community is an important aspect to keep in mind. Short time horizons magnify the difficulty of transitions in the fishing industry. Many local fishermen lost a significant portion of their income, as much as 90 percent in one year as reported by one interviewee (899).

Port Orford has a long-established dependency on the groundfish fishery, with local longline vessels primarily targeting lingcod, canary, yelloweye and yellowtail rockfish. Before the harvest restrictions, the canary and yelloweye deep-water shelf groundfish were a valuable fishery for this small-scale fleet, as abundant fishing grounds are accessible due to the short continental shelf. Quota reductions placed on the fishery were coast-wide and encompassed all gear types, effectively shutting down Port Orford’s longline groundfish fishery. This was a major change in the fishing portfolios of Port Orford fishermen. Deep-water shelf rockfishes would have been among the top five target fisheries (73 percent of interviewees). Due to the PFMC quota reduction throughout the 1990s, it is no longer economically viable for Port Orford fishermen to target these species (Interviews 649 and 737).

When a fishery closes, the traditional response by Port Orford fishermen is to shift effort to a new fishery. Although some fishermen did shift some of their effort to the nearshore live fish fishery, these fishermen were primarily from the displaced small boat urchin fleet. In the 1980s and 1990s, Port Orford had a booming local urchin
fishery that supplied product to the local processing plant, Pacific Premium Seafood. The plant closed in 2003 due in part to overfishing in the red urchin fishery in the late 1990s. The urchin fishermen found increased economic opportunity with high-value live fish and knew the grounds well from their experience navigating the Orford and Blanco Reefs diving for urchins. In contrast, the groundfish longline fishermen were reluctant to move into the live fish fishery, recognizing their added pressure could overfish the slow growing, late maturing rockfish. “We stayed out of it, that was those guys only fishery and we had crab, black cod and some salmon fishing” (Interview 207). The live fish fishery did not replace the income lost to longline fishing businesses from the lack of opportunity to fish the shelf groundfish.

The market value of fish landed at Port Orford is very high because of the live fish fishery value. The live fish fishery has been around since 1997 (Interview 138). Because of increased mortality when fishing in depths greater than 27 fathoms, Port Orford fishermen target nearshore groundfish species (such as china rockfish, black rockfish, blue rockfish, and vermillion rockfish) in the live fish fishery (Interview 193). Live fish prices range from $7 per pound for grass rockfish to $4.50 for kelp greenling. Between 2000-2004, the average value per ton of commercial catch landed in Port Orford was $3,443, compared to the average value of $741 for the rest of the Oregon ports (International 2004). Also, by getting such a high price for the fish, the live fish fishery is a high value and economically efficient use of the public resource. It is also a more sustainable fishery because the hook and line gear has minimal impacts to habitat and the ecosystem.

**Black Cod.** The black cod fishery is very important to the economy and the fleet because good fishing grounds are nearby due to the relatively short continental shelf off the coast of Port Orford. The community inventory map (Appendix H1) represents the primary locations fishermen target for black cod. These areas include the slope off the High Spot between 300-500 fathoms and along the north and south sides of the
Canyon. The large area extending from the edge of the High Spot west to the continental slope is intended to represent areas accessible to trap gear, although not to the more common longline gear. However, it is unlikely that this entire area is accessible by traps given that the deepest depth covered is beyond the continental slope, an area not accessible to either gear type.

In the validation workshop, three changes were proposed and accepted the map on the spatial distribution of the areas targeted for black cod. One small area off of the Port of Bandon was determined to be a misrepresentation and will be removed from the final map. Another necessary change was an artifact of utilizing the standard polygon for the High Spot when people did not draw their own polygon. The standard polygon encompassed the plateau of this ridge, whereas black cod fishing is focused along the slope coming off the ridge. The main suggestion for improvement was making high (7) intensity use continuous from 100 to 300 fathoms on the edge of the High Spot and decreasing the intensity of use to medium (3) intensity on the top. These same suggestions will be incorporated for the improvements for the draft map (Appendix H2) showing relative economic importance of black cod.

Presently the black cod season runs from April through October. Fishermen coordinate their landings with the market to maximize their catch and value. The black cod fishery is mainly a bottom longline fishery in Port Orford, although there is some pot fishing in the deeper waters. The longline gear used here is called “tub gear” because long fishing lines with baited leaders are wound up into metal tubs. The predominant setup is 160 hooks per tub (600 foot line) with about 10-20 tub sets. The fishermen make 2-3 sets each trip. There is some variation in the gear set up due to the preference and experience of individual fishermen and their target areas.

Port Orford has long a history of participation in the black cod fishery. Local boats fished black cod and helped develop the West Coast market in the 1970's. During the
Groundfish Limited Entry Program, which began in 1993, about a dozen permits were issued to Port Orford vessels. West Coast permits have been sold and have moved significantly among ports. At Port Orford there are presently eight Limited Entry Groundfish Permits with black cod endorsements and two permits that do not have the black cod endorsement.

The black cod fishery has gone through several changes in the last ten years, many of which are perceived to have marginalized this small vessel, fixed gear fleet. The limited entry program changed the level of historic participation by Port Orford boats in the black cod fishery and restricted their effort. The management scheme developed by the Pacific Fishery Management Council allowed some limited entry vessels to receive a black cod endorsement and also allocated boats into a three-tier system of landings. The Port Orford fishing community perceives this management arrangement as patently unfair and driven by a small, select set of fishermen who benefited greatly by designing a system that put them in the top landing tier (Leesa Cobb, pers. comm., 2004).

Salmon. The community inventory map (Appendix H3) displays the primary areas for targeting salmon. Oceanographic and climatic conditions, as well as the movement of forage species, determine good fishing areas for salmon. All of the Port Orford fishermen target salmon with hook and line gear, specifically troll gear. The Port fishermen have specific routes, or tacks, along which they target salmon. The Do-Da Hole is "everybody’s tack" and a faithful spot to find some salmon (Interview 533). The "North Beach salmon area," a high-intensity use area nearshore between Port Orford and Cape Blanco, is captured in the inventory map created from the local knowledge interviews. This area is very important to Port Orford salmon fishermen because for about three months of the year it is the only area on the Oregon coast that is open to salmon fishing. "North Beach is the only place on the West Coast to fish fresh troll-caught salmon for the three month season North of Blanco is closed and
south of Humbug is closed” (Interview 501). One interviewee discussed a local fisheries conflict that occurs when crab pots are left in this area during salmon season. This area is important to the salmon fishermen from Port Orford due to its proximity and accessibility of the Port Orford fleet and could provide a unique marketing opportunity.

The interview participants proposed three minor changes to the community inventory maps for salmon. The first was an extension of the area targeted to both the north and south, keeping the intensity of use the same as the area contiguous to the extension. This was an artifact of the limited spatial extent of the original basemaps. The community inventory maps display a larger area. Another change was to reduce the intensity of use south of Cape Blanco and north of the mineshaft because this area is difficult to fish with troll gear due to the density of kelp and shallow rocks here. The intensity will be changed to medium (3) and then to low (2) as you approach the cape from the south. The participants disagreed on one proposed change, with one fisherman wanting to increase the intensity of use to the highest level (7) directly west of the port and south of Orford Reef, while another fisherman thought that the map was accurate in its original form. At the beginning of the workshop the participants were instructed that if consensus could not be reached the maps would remain in their original form, as was the case for this suggestion.

Although salmon fishing has decreased in its economic opportunity, salmon are still an important part of fishing opportunities in Port Orford. Port Orford vessels are typical salmon trollers and the fleet used to be dominated by an unofficial cooperative of about 18 vessels (Interview 533). These fishermen regularly communicated about where, what type, how many and how deep the salmon were hitting through a radio code, which was only shared among those in the co-op. Most Port Orford fishermen still choose to target Pacific salmon, but many do so more for the fun of it rather than for the price, which is often low.
**Dungeness Crab.** Dungeness crab is also a very important fishery to Port Orford, although it offers significant challenges for local fishing businesses because of the large amount of instability in this fishery. Crab move inshore seasonally and after a few weeks most of them have been caught. Crab season starts the beginning of December and lasts until May, although most all the crabs are landed during the first few weeks. Port Orford is not considered a significantly robust area for crab. Fishermen describe the history of crab fishing as being a less than average area for production compared to other Oregon coast areas. The issues of soft-shell crab, and more recently increased domoic acid levels in crab, have contributed to poor marketing conditions in some years. Both soft-shell and domoic acid are conditions that occur regionally.

Local perception is that the limited entry program allowed many new vessels into the fishery. The limited entry system for the ocean Dungeness crab fishery went into effect in 1995 and the number of permits issued for that season was 444. Of those 444, the number of active vessels in the fishery was 346. There are 28 crab permits for Port Orford boats.

Each year fishermen and processors fight to set a price and season opening date. It is common for Oregon crabbers to strike for a higher price beginning in December and not fish until after the first of the year. This situation may change because a new arbitration system allows the Oregon Department of Agriculture to bring processors and fishermen's marketing associations together to negotiate the price. Responding to the need for participation in the pre-season negotiations, local fishermen formed the Port Orford Seafood Marketing Association in 2004.

Consider the case of the beginning of the 2003 crab season. Negotiations with the Oregon Department of Agriculture occurred before the season to set the opening price
for the season. It was informally agreed that the price would be $1.55 per pound for the first two weeks. This was a huge improvement over previous years when the price was very low. Federal management allows fishermen to “soak their gear” as early as two days before the start of the season. This means that they can go out and set their crab pots on November 29th, then leave them in the water until the first of December, the first day they are allowed to pull the gear and land the crabs at the dock. Just as the season started in 2003, rough weather blew in, making it a dangerous scenario for those crab fishermen who wanted to go pull their gear. However, if they hesitated to get their gear, they risked product loss through predation by octopus or damage from other crabs. The extreme winter weather at Cape Blanco also contributes to the problems of crabbing. While smaller vessels must stay on the dock to wait out winter storms, large vessels move in from other areas and harvest the local crab and land them at other ports.

The problem of outside, large vessels moving into Port Orford’s historic crabbing grounds after exploiting their local areas around Charleston and Brookings is increasing with each passing year (Leesa Cobb, pers. comm. 2004). In 2004, the number of outside boats exceeded Port Orford vessels with many of the outside boats more than 60 feet long and with capacities of more than 80,000 pounds. In contrast, Port Orford vessels can hold around 9,000 pounds of crab. To make the situation worse, the buyers put the Port Orford vessels on a 1,500-pound landing limit (reportedly because of quality issues with damoic acid), whereas vessels from other ports were not limited. Many fishermen theorized that the main issue was transportation. The primary crab buyer did not have product totes and had limited trucking services to get the product to the processing facilities in Charleston.

The spatial extent of effort for crabbing is determined by the movement of crabs in and offshore with the season and by competition with larger vessels that move in from other ports. For Dungeness crab, three areas of highest intensity are evident in
the draft community inventory map (Appendix H4). These areas correspond to sandier habitat. Accessibility to these grounds is the primary reason for their higher level of use. However, north of Cape Blanco weather can limit use of this area, because traveling above the cape can be difficult for these small vessels. One change suggested and accepted was to increase the intensity of use to the highest (7) level in the North Beach area. The other suggestion was to extend the low (1) priority use south to the state line from 90 fathoms in to shore. Again, this change is most likely an artifact of the limited spatial extent of the original basemaps used during the local knowledge interview process.

Halibut. The community workshop did not suggest any changes be made to this draft map (Appendix H5). The halibut target area is primarily a large off-shore bank known locally as “The High Spot”. This heavily utilized area is determined mainly by fisheries management, which sets a halibut opener (reduced from 72 to 10 hours in recent years). Although fishermen know halibut are located in other areas, when there is only 10 hours to fish, they go to the “money spot.”

**Port Orford Involvement in Recreational Activities**

Pressure on the Port to maximize financial returns involves difficult social and economic tradeoffs. In many of these decisions, the port will have to balance recreational and commercial fishing interests. Several non-water-dependent business ventures are already beginning to compete for the scarce infrastructure on the dock. For example, in a 2003 port planning board meeting, potential investors presented their proposal to place a seaweed spa in the location of the only processing infrastructure on the dock, the old PPS building. RV traffic that flows up and down Highway 101 often finds its way onto the dock area. Although this quaint fishing community intrigues these travelers, the vehicle traffic can often be frustrating and dangerous for commercial fishermen who must pull their boats around on trailers and into parking spots in limited area. Traffic is also a problem in the harbor as
commercial and recreational vessels wait in line to use the hoists. Decisions made by the port authority today have socioeconomic impacts that will greatly influence the characteristics of the Port Orford fleet of tomorrow.

“Recreationalists” in this report refer to people who regularly participate in recreational activities in the ocean or coastal areas. Beachcombing, wave surfing, wind surfing, diving, kayaking, and wildlife (whale, seal, sea lion, and birds) watching are the common non-consumptive recreational activities that occur in Port Orford. Recreational fishing and surf fishing are the primary consumptive recreational activities occurring in the study area. Although some sport fishing does occur near Port Orford, it is less prominent here for a variety of reasons. There are few large rivers nearby, although the Elk and Sixes Rivers attract many anglers looking to catch salmon in the fall and winter. Few recreational vessels have proper equipment installed on their boats to be hoisted from the dock into the ocean and back. The dangerous weather conditions and few safe anchorages keep some recreational fishing interests from this area. However, one advantage to sport fishermen launching from Port Orford is that there is no dangerous bar to cross. Entry to the open ocean is a marketing point for attracting sport fishers and other recreationalists.

At the community validation workshop, four changes were proposed and accepted for the recreational activities inventory map (Appendix H6). All of the edits involve increasing the intensity of use in various areas. Inside ten fathoms from Hubbard’s Creek south beyond Humbug Mountain the intensity will be increased two levels. This creates a gradient of very high (6) intensity in the Port Orford harbor to medium-low (3) along the shoreline. The area adjacent to the west of this, from the Port Orford Heads south to Island Rock into the ten fathom bathymetric contour will be increased one level to low (2) intensity. The North Beach, from the Heads west of Klootney Rocks out to about five fathoms, will be increased to low (2) intensity. The High
Spot will also be increased to medium-high (5), due to high intensity of recreational fishing that occurs there. The large comma-shaped area is Orford Reef, this is a factor of the standardized polygon that was used to input into the GIS database. This was not considered a misrepresentation by the individual interview participants or to those present at the community validation workshop.

Conducting local knowledge interviews in a community-driven setting provided information that answered some of the spatially explicit scientific questions developed by POORT. This process was used to determine the 1) distribution of species near Port Orford, 2) distribution of recreational and commercial effort, and 3) the relative economic value of areas targeted for commercial fishing. The key to success was the triangulation of the most accurate locations. Since every individual will have a slightly different representation, aggregating the individual GIS layers for a particular species or activity was used to determine where the most overlap of observations occurred.

The information collected is useful for the development of a complete baseline community inventory of the distribution of species and uses in the marine area. Because there is such a plethora of species information, the POORT will have to prioritize data for subsequent aggregation and spatial analysis based on immediate need and financial resources. Although only six themes were chosen to test the community mapping protocol, many other themes are possible. The local knowledge inventory documented over sixty other species and human uses, including kelp, invertebrates, birds, marine mammals, fishes, and safe anchorages. Of particular interest to fishery managers will be distribution of groundfish target areas. Groundfish distributions will require additional categorization because the location and relative value of the areas are different depending on the different target complexes (e.g., live rockfishes, lingcod, and shelf rockfishes). The community mapping project also
provided some of the baseline information needed to answer other questions for future research projects.

**Future Analyses**

All uses of GIS are subject to uncertainty and therefore, all decisions based on GIS are too. Error focuses on the differences between measurements or observations and has an intimate relationship to the scale of data collection and analysis. The utility of public participation GIS analyses for contributing to science or informing management depends on how much uncertainty or error can be tolerated before the information is considered unusable. The acceptable degree of uncertainty and the appropriate scale of data are application-specific. They both also depend on what activity or species are being addressed and the context and goals of the analysis.

Longley et al. (2001) states that in many cases there are no natural units of geographic analysis. However, when comparing the commercial fishing maps and the recreational activities map, it is apparent that the recreational observations occur over a smaller area or extent. Even the 1:24,000 scale maps were too coarse a resolution for the small-scale recreational activities that take place within the Port Orford harbor and along the coast. In the future analyses, the recreational activities and live fish fishing effort maps would benefit from finer resolution map of the nearshore area including the rocky reefs. The interviewers often had even more detailed knowledge of certain areas, using descriptors such as “inside of Island Rock” or “outside of Fox Rock.” Unless the interviewee made this detailed knowledge explicit by drawing the area on the basemap, the standard polygon for Island Rock was joined to the attribute data. In this case, the details are only recorded in the attribute description of the area.

Groundtruthing the location and intensity of commercial and recreational uses will require extensive visual or electronic surveys. Verifying the accuracy of these data could be accomplished through a comprehensive Vessel Monitoring System (VMS),
which track the location of a vessel using satellite arrays and receivers called the
Global Positioning System (GPS). Coast Guard surveys could also accomplish the
same purpose, by taking a visual sample of the commercial fishing vessels in a
specified location. However, the Coast Guard would have to be able to determine that
the vessels were from the Port Orford fleet. Groundtruthing the location of
commercial vessels could also be accomplished through comprehensive observer
coverage. Recreational activities in the harbor could also be verified through a
systematic visual survey performed by a researcher. ROV surveys, tagging research,
and genetic sampling could contribute to the verification of the species distributions
provided during the local knowledge interviews. Groundtruthing the data though
actual visual surveys or by electronic means would increase the scientific-credibility
of the maps for use in fisheries management.

Comparing the economic importance data layers with spatial representations of
recorded fish landings or surveys or could verify the accuracy of the level of fishing
effort occurring in the area, if the scale of information was comparable. This might be
possible through an extension of the Groundfish Fleet Restructuring Information and
Analysis Project spearheaded by Ecotrust and the Pacific Marine Conservation
Council. The GFR project used 10 minute by 10 minute (latitude-longitude) cell
blocks as the spatial scale for deconstructing the most likely locations of commercial
fishing activity as reported through landings data collected at the time of sale (Scholz
2003). Voluntary or mandatory logbooks with finer-scale catch blocks would also
provide a record of the economic importance of target areas in a spatial format.

Future analysis of the local biological inventory information collected could include
studies of species diversity. By aggregating the species distribution layers, species
diversity could be analyzed. These analyses could address the overall number of
species or of fish species specifically. However, the propagation of error through this
process could be detrimental to the utility of spatial information. Because each
individual's species distribution layer has a certain degree of error associated with it, the error is propagated through the analysis when the individual layers are aggregated. The error associated with “standard polygons” for local places could be reinforced through the aggregation process. Scientific surveys of the locations in question could inform the precision of the spatial representations of standardized areas like “the Banana.” However, it is possible that the areas determined to have the highest intensity of overlap among the interviews indicates the most precise location of use because of the replication of that observation by interview participants.

Habitat correlations to species distribution or diversity could be examined by overlaying the geologic substrate data layer with the species distributions from the local knowledge interviews. The geologic substrate layer provided by Dr. Chris Goldfinger’s Seafloor Mapping Lab at Oregon State University is an interpolation of a variety of different sources including side scan sonar, multibeam sonar, ROV transects, and geologic sampling points. The “effective scale” of the interpolated product is approximately a 100 meter by 100 meter grid. An analysis to correlate species or diversity to habitat types will also have to deal with the propagation of error from the diverse data sources and the different scales of the GIS layers. Propagation of error is not unique to local knowledge sources.

Other interview processes could have also been successful. New developments like the graphical user interface in the GIS program, OceanMap, developed by Scholz et al. (2004) could reduce the time and fiscal resources needed to transcribe interview data. In OceanMap, the interviewees can digitize their use areas at the computer and document attributes by making selections from drop-down boxes linked to the GIS database. The level of comfort level of the interview participants with this kind of technology should be evaluated before pursuing this option.
Communicating community concerns to managers with systematically collected data is important for a community organization to be considered a legitimate partner in management functions. Groundtruthing would provide scientific verification and increase the legitimacy of this local knowledge and participatory GIS process to provide useful socioeconomic and biological information. New tools, like OceanMap, provide opportunities to refine the process used and improve the efficiency of data collection and database creation. Community groups will be more willing to allocate resources to this kind of research when it is confirmed that fishery managers will value local knowledge when mapped in this way.

Implications for Community-based Management in Port Orford

Port Orford, led by the Port Orford Ocean Resource Team (POORT) is in the beginning stages of evolving a fisheries co-management strategy for the area. The Port Orford Community Mapping Project contributed to several co-management functions described by Pinkerton (1989), including data gathering and analysis and community development planning. It also empowered the community to increase their participation in the identification and evaluation of management strategies. This experience could position the POORT to participate in other co-management functions that positively contribute to attaining the POORT’s goals and objectives.

The interview and mapping process was a consensus-building and mutual learning exercise, which resulted in the development of a common geographical representation of a shared marine environment and an improved understanding of the dynamics of the Port Orford fishing community. Topics discussed in the Port Orford Community Mapping Project shed light on potential market opportunities, rockfish spawning cycles, habitat-species associations, perceptions on and potential locations of marine
parks, and the ecological changes and perceived drivers of these changes in the local area.

Assisting in the design and implementation of the mapping project helped participants develop a foundation of cooperation within the fishing community. Participants in such processes see opportunities to achieve individual goals through collective action, and also become empowered to do so. Identifying and describing the local ocean places of importance to the Port Orford community promotes the collective stewardship of that area. In this respect, the participatory GIS project can bridge the competitive nature of fishing with collaborative learning approaches in community-based management. To address locally relevant scientific and management questions, Port Orford is building social capacity, generating fine-scale data, and beginning to evaluate potential beneficial management and economic strategies such as harvest allocation and regulation, fisheries enhancement, and marketing opportunities. This fishing community is increasing its own capacity to share responsibility and actively participate in fisheries management.

The Port Orford Community Mapping Project makes three significant contributions to community-based fisheries management. This project provided the opportunity to conduct a preliminary profile the Port Orford fishing community, which included developing an understanding of how and where the local residents utilize the coastal and marine environments. It generated information from which to assess local fishing infrastructure planning to maintain marine-dependent industries. Through implementing the project, the author also developed a process and product from which to evaluate area-based resource management measures contribution to local fisheries goals and objectives.
Community and Port Profiling

In-depth knowledge and profiles of ports and their socioeconomic conditions and linkages do not exist for many commercial fishing communities. National Standard 8 of the Sustainable Fisheries Act requires consideration of impacts to fishing dependent communities. However, in order to qualify for consideration, coastal communities will have to meet the definition of a fishing-dependent community as defined by the federal government and their level of “dependency” will have to be measured. A fluid definition of community is problematic for management strategies such as Community Development Quotas (CDQs) and community-based management that require a well-defined community. Federal fisheries management is starting to address this through comprehensive projects to profile the ports and communities (e.g., Hall-Arber et al. 2002). The purpose of these profiles is to provide a concise description of communities and their engagement in or dependence on fishing to fisheries management so that fisheries management might begin to have a minimal understanding of communities and might have something to draw on when policy makers consider who and where might be socially and economically impacted by fishing regulatory changes.

Qualitative information generated from the Port Orford Community Mapping Project is already being integrated into the traditional fisheries management system through a port profiling exercise completed by the author (Appendix A) (K. Norman, Northwest Fisheries Science Center pers comm. Aug. 2004). Although fishing community identification and profiling is at an early stage in the NOAA Fisheries Northwest Region, the first communities to be profiled are those West Coast ports that have significant groundfish fishing activity. This community profile is broken down into three main sections:

- People and Place (location, demographics, history)
- Infrastructure (economy, governance, facilities)
- Involvement in Pacific Fisheries (commercial and sport).
The NOAA Fisheries Northwest Region community profiling project is a two-part study, with "short form" profiles completed in the first phase. In the second phase, a subset of the "short form" communities will have a more in-depth "long form" profile completed based on community research. Surprisingly, the short form community profile template did not include the proportion of the community employed in commercial fishing occupations, although most of the academic research in defining fishing communities includes this measure. Other social and economic linkages were also not explicitly identified in the short form. Local knowledge interviews and time in town provided the author with insights into these demographic and socio-cultural indicators of fishing communities that will be useful in the second phase of this project.

Increased involvement in fisheries management was accomplished through the development of community profile. This profile has increased the visibility of this small-scale fishing community to Pacific fishery managers. The state of Oregon and the Pacific fisheries region need comprehensive information on their fishing communities. However, because state and federal agencies are so limited by staff and resources necessary to conduct profiles, individual fishing communities can use similar processes to develop their own profile for consideration by managers if they have local leadership.

**Planning for Fisheries Infrastructure**
The DLCD Coastal Management Program could be a resource to help the community seize an opportunity to address future development of the city in a proactive way to meet a variety of needs. Statewide planning goals 19 and 9 offer potential avenues to address the implementation of community-based fisheries management in Oregon. The purpose of Goal 19: Ocean Resources is "to conserve marine resources and ecological functions for the purpose of providing long-term ecological, economic, and
social value and benefits to future generations” (2000). Goal 19 also gives higher priority to the protection of renewable marine resources over non-renewable ocean resources, such as oil and gas development. The 2000 amendments to Goal 19 require state and federal agencies to protect areas important to fisheries including: areas of high catch, areas of highly valued fish, seasonally important areas, areas important to commercial or recreational fishing (including those of a particular port or fleet), and important habitats. The other potentially important goal to community-based fisheries management is Goal 9: Economic Development, which is “to provide adequate opportunities throughout the state for a variety of economic activities vital to the health, welfare, and prosperity of Oregon’s citizens” (1973). Goal 9 specifically refers to the planning guidelines and implementation of local comprehensive plans. It states that the plans should emphasize the expansion of and increased productivity from existing industries, like fishing, and allows for land use controls and ordinances for land use.

Special area management plans (SAMPs) may be used in coordination with the statewide planning goals. Communities can develop management plans for marine areas to address the unique management needs for resource protection, resource utilization, and interagency cooperation. In Port Orford, it would be beneficial to focus on the future development of the oceanfront, the port, and related commercial areas along or near Highway 101. The real issue becomes how the local plan and boundary designation get adequate statutory and financial support to be implemented, monitored and evaluated.

Currently, two overarching dynamics are coming together in Port Orford. The first is the prospect of a significant increase in urban or recreational development in the city due to completion of the city's ocean outfall and the lifting of the Mutual Agreement and Order (MAO) with the state DEQ, which has severely limited water and sewer hookups within the city. While much of the development is going to be residential,
commercial development centered on the oceanfront is highly likely. During the period of this MAO, land values in Bandon have skyrocketed due, in large part, to demand stimulated by the Bandon Dunes golf resort. Land values in Port Orford have remained relatively depressed due in part to building restrictions under the MOA. This disparity, coupled with continuing interest in development on the south coast, makes Port Orford properties attractive. New development is likely to be oriented to recreational, tourism and retirement, with an emphasis on the oceanfront, port area, and adjacent Highway 101 "downtown." This likelihood alone should be enough for the city to upgrade its planning, particularly the economic development components, to encourage development that is compatible with community needs. The city's comprehensive plan is more than twenty years old and could use some work to address emerging economic development issues.

The second dynamic is the future of the port area and the sustainability of ocean fisheries that is central to the port and the economic and social well being of the community. At present, a large part of Port Orford's "character" is because it is still a working waterfront and its fleet of small commercial fishing vessels. The community already has a significant investment in this area. Inappropriate development could overwhelm the existing port investments and local fisheries economy which is already vulnerable to a wide range of forces such as market prices, limited processing facilities, distance to markets, regulatory changes in West Coast groundfish fisheries, and insufficient scientific information about fisheries stocks and habitats.

The three main interests in this kind of "special area" planning are the city, the port, and the participants in local fisheries who have strong personal and economic interests in the long-term viability of local fisheries. Much of the fleet has organized through POORT, which is working to create a community-based sustainable fisheries regime to maintain and promote the fisheries based economy as well as the culture and character of Port Orford. Because POORT has members from more than half the
vessels in the local fleet, it is uniquely positioned to participate in this process to ensure that fishermen are represented in this planning process.

These factors create an opportunity to plan for development in Port Orford that will maintain and strengthen the basic identity of the community. A special area plan could address land use and design in the area that the city believes would benefit the most people. Planning of this type will require professional resources beyond the city’s current capability. The Oregon Coastal Management Program (OCMP) in the Department of Land Conservation and Development is in a position to provide the city with financial, technical, and coordination assistance.

**Evaluating Area-based Fisheries Management Strategies**

The inherently spatial nature of GIS and many communities promotes the consideration of place-based methods for community-based fisheries management. Some of the research questions POORT asked were “Are spatial management strategies appropriate for Port Orford’s offshore waters?” and “What kind and where might they be located?” Finding the answers to these questions will require addition deliberation by the community before a final determination can be made. A series of community workshops to fully develop the desired goals and objectives of potential area-based management strategies and to analyze the impacts of possible design alternatives would be required. The participatory GIS maps developed in the community mapping process will likely serve as a foundation for these future discussions. However, the author has taken the first steps to consider the implications of area-based management through the following analysis.

Spatial management strategies can take on many forms and functions depending on the goals and objectives of such areas. The goals and objectives determine the desired restrictions placed on the activities in that area and any associated user rights that are implied through the designation of these places. The POORT developed a goal
statement through a consensus process that occurred during 2001. The POORT’s goal is:

“A sustainable fishery that combines the best science and local experiential knowledge for the community to make local fishery management decisions that:
1) Sustain and improve the local habitat and population base of fish;
2) Provide high quality, high value seafood products to consumers; and
3) Support the economic viability of the Port Orford community.”

Another goal identified through the interview process, but not explicitly stated in the goal statement, was Port Orford’s reliance on participation in diverse target fisheries. Several quotes from interviews illustrate that this is an important aspect of fishing in Port Orford. Interviewee 758 said “The key to success in Port Orford is diversification and to keep alternatives open.” Another interviewee (620) noted, “Port Orford is a real fishing community. They have diverse fisheries including crab, salmon, tuna, halibut, shelf rockfish, and nearshore rockfish, and are not dependent on a single fishery. This makes them better for the resource. They are not hammering one species all year long.” The success of the small-scale Port Orford fishing fleet does depend on a diversity of target fisheries and the flexibility to move from one to another as weather, ocean conditions, regulations, and market conditions change. These goals of sustainable and diverse fisheries, improved local fish habitat and fish populations, and economic sustainability are the starting point for analyzing whether area-based management would be an appropriate management strategy for Port Orford.

The specific management objective for designating a zone is important for measuring the success of the strategies used within that zone. Objectives have to be very specific. For example, the criteria for selecting areas will be different depending on if the objective is to manage areas for the most number of fisheries, or if the area is targeted for a specific fishery. Some members of the Port Orford community thought that area management for some specific fisheries or gear conflicts could contribute to
the community objectives of sustainable fisheries, improved habitat, and economic viability. Groundfish fisheries, fresh and live market categories, and the Dungeness crab fishery were identified during the local knowledge interviews.

**Habitat Protection.** Several Port Orford fishermen indicated that habitat protection from damaging gears could be addressed through area management. Several groundfish fishermen reported that underwater high spots, or seamounts, have suffered impacts from bottom trawls. Possible areas to analyze would be the sensitive shelf habitats or depths that the fixed-gear groundfish fleet uses to target shelf rockfish. These areas are preferred habitat of schooling canary and yelloweye rockfishes. Many fishermen would like to protect the local habitat so that it is still intact if the harvest restrictions are lifted.

- “I don’t think a hook and line fishermen will hurt a reef, but a dragger will” (Interview 501).
- “Roller gear is destroying habitat. They flatten the bottom” (Interview 402).
- “The High Spot is being worn down by roller gear. [It’s] destroying valuable habitat” (Interview 899).
- “Do away with longline, cable gear, and dragging in the nearshore, only (have) longlining in deep water for black cod and halibut” (Interview 103).
- Roller gear destroys rocky habitat (and) should stay outside 50 fathoms” (Interview 444).
- “Get the draggers out of the three-mile limit and also off the High Spot and the Canyon” (Interview 031).

Seamounts and submarine ledges are important habitat types that help sustain local populations of fishes. Because the various life stages of fish species have different habitat type requirements, these local habitats are only a portion of the range of the species. An argument can be made that the protection of these rocky areas from damaging gear types would benefit the entire groundfish fishery. This is demonstrated by the PFMC’s implementation of a gear-type restriction on roller gear to accomplish
the same objective of protecting rocky reef habitat. However, an area-based management strategy that restricts only one sector of a fishery for the perceived disproportionate benefit to another sector or community is politically difficult to accomplish, even if the rationale is scientifically sound.

**Economic sustainability.** Another objective of area-based management could be for retaining the economic benefits of a fishery or fisheries to contribute to the economic viability of the Port Orford community. One interviewee expressed his feelings of social inequity between large trawlers and small fixed-gear vessels. “We need to get rid of damaging gears. Trawl only supports one captain and two deckhands, while it would take 5-6 small boats to take the same amount” (Interview 758). Area-based suggestions for increased economic opportunities in the Dungeness crab fishery and the groundfish fishery were discussed during the local knowledge interviews. Several Port Orford fishermen reported that the discards from trawling “spoil” traditional fishing grounds because fish avoid these areas when the bottom has been littered with decaying fish carcasses.

- “Draggers are the ones that are doing damage to the habitat and our livelihood. Processors should have to stay outside 500 fathoms because of fouling the grounds” (Interview 193).
- “Hake dragger boats sour the water through their discards (Interview 501).
- “Large factory trawlers are souring the bottom 150 fathoms and beyond” (Interview 031).

An area-based management strategy targeted to preserving the economic viability of a local Dungeness crab fishery would be designation of an exclusive use area for Port Orford’s commercial harvest during part of the season. The intent would be to control the effort shift of large crabbing vessels from other communities into the local fishing area of the Port Orford fleet. Combining this management strategy with additional provisions for adjusting the crab season opening date would address the soft shell and domoic acid problems in the Port Orford region. Both of these suggestions have
economic objectives at the heart of the issue and are demonstrations of territorial user rights in fisheries (TURFs).

In co-management fisheries systems, area management methods can involve some sort of territorial user rights in fisheries. Whereas common property resources are those resources to which access is both free and open, TURFs refer specifically to conditions governing access to, not ownership of, the resources. They are the formal declaration of exclusive use rights to a specific community or group for specific fisheries in a given area (Anonymous 1998). These community-held rights of use delegated to the community from a centralized government include certain responsibilities for maintenance and proper management, but also may include restrictions on community use as well.

An example of a TURF in U.S. fisheries management is the Sitka Sound Local Area Management Plan (LAMP) in Alaska (Gretchen Harrington, Alaska Department of Fish and Game, pers. comm 2004). In February 1998, the Alaska Board of Fisheries (BOF), part of the Alaska Department of Fish and Game (ADF&G), and the North Pacific Fishery Management Council (NPFMC) jointly adopted a protocol for developing LAMPs based on a local effort from the citizens of Sitka, Alaska. The Sitka LAMP was to address the issue of localized depletion of halibut stocks in Sitka Sound and the associated user conflicts from large commercial vessels and increased charter operators in the sound. The adopted plan is based on seasonal closures of waters inland of a defined boundary to commercial longline vessels larger than 35 feet and to charter vessels/guided anglers. At the request of commercial and charter operators, the Sitka LAMP allows chartered anglers and commercial operators to fish for salmon in the waters closed to halibut fishing.

The distinction between TURFs has to do with the size and nature of the territory, the kinds of rights that can be exercised, and the specificity of ownership. A TURF
territory can relate to the surface of the water, the water column, or the bottom. The size depends on the intended usage, the resources, and the oceanographic characteristics. It should be sufficient size so that the use outside of the territory does not significantly diminish the value of the use within. The area should be readily defensible and protected by the laws and institutions of the country. The boundaries of the territory should, therefore, be clearly demarcated and identifiable. This qualification describes TURFs as not so much resource-specific as it is site-specific.

The owner of a TURF can be a private individual, a cooperative, an association or community, a national government, or a multinational agency. The effectiveness of the TURF will be greatest where the specificity of the ownership is the highest (Christy 1982). Assigning a right or obligation to a fishing-dependent community can be problematic if the definition for what constitutes a fishing community is too fluid.

Determining the content of TURF-rights is more complex than determining the same kind of property rights on land because the ocean's resources are public resources, the 'area' is actually a three-dimensional volume, and the resources and medium are more fluid (Christy 1982). If TURFs are to be successful from an economic standpoint, certain rights need to be delegated to the community: the right of exclusion (to limit or control access), the amount and kind of use allowed within the territory, the right to extract benefits from the uses within the area, and the rights to future returns in the area (Christy 1982).

Benefits of TURFs potentially include more economically efficient use of resources and the incentive and opportunity to manage them well. The benefits can include user fees or taxes, or the lease or sale of use rights, or in profits to the owner. These benefits can be returns to labor and capital or non-monetary terms, such as larger and more satisfying employment opportunities. Since the owner is entitled to future benefits, there is increased incentive to ensure the flow of future resources and
promotes local stewardship. An example of how this might work in Port Orford would be an exclusive use right with an adjacency requirement.

However, there are both natural and social conditions that may hinder the acquisition and protection of local exclusive use rights in fisheries. Major challenges with TURFs are that they require a redistribution of wealth and that some of the present users will be excluded. Although this may be economically and socially accepted, it may be politically difficult. There may be competition from large powerful interest groups to maintain the status quo if they are capturing a large portion of the catch from the proposed local territory. TURFs break down if there is no strong legal and institutional protection of the use rights, and few countries have these mechanisms in place. Where the costs for acquiring and defending exclusive use rights are greater than the benefits, common property arrangements will continue to exist.

Non-extractive Use Values. Just as community-based fisheries management provides an opportunity for people to discuss what areas of the ocean are important to sustain fisheries and economic viability of communities, it can provide a forum for the discussion of locations that may be valuable for other reasons, such as scientific research and recreational opportunities. The local knowledge interviews indicated that these are also values held by some local fishermen. One fisherman suggested:

"Leave some diversified area for scientists to study. [They] need to be accessible to scientists and people to see the results of their labors. Put a line of buoys around it to make it visible for enforcement. [There] should be a program like the "river keepers" where young adults (19-21) are required to work for the government and enforce MPAs" (Interview 193).

"Marine parks" were mentioned during two local knowledge interviews, although it is uncertain if the participants were referring to that same concept of a marine park. One of these interviewees suggested that this area would be for "recreational diving and some sport fishing" (Interview 123). The other interviewee said that this area could
serve as a trade-off if other more commercially important areas were threatened for closure. Both people voluntarily drew the location of this proposed area, and had significant overlap with the other person’s map (without ever seeing the other map).

Perhaps one of the most controversial discussions in fisheries management today is the utility of marine reserves to achieve fishery management objectives. Marine reserves are typically closed to all extractive uses. In contrast, other types of marine protected areas usually afford more general protection and may prohibit some forms of extractive uses while allowing others. Both of these strategies are generally associated with ecosystem-based management. Ecosystem-based management includes more diverse goals and represents more diverse interests than traditional fisheries management. However, all fisheries are dependent on a healthy ecosystem.

When considering the design of area-based fishery management strategies, the ecological and socioeconomic impacts of both the physical space of the areas as well as the placement of those areas along the Oregon Coast must be considered. Small-scale fishing communities will have differential socioeconomic costs and benefits depending on the “space and place” of marine managed areas. The “space” of a management area is how large the extent of an area is covered. Different socioeconomic costs and ecological benefits occur depending on the size and what spatial configuration it takes. For example one fisherman said, “Making zones concentrates effort in other areas. These can be expensive for Port Orford fishermen because of trip limits. Also there’s the problem of “fishing the line” (Interview 758). The “place” of marine managed areas involves a consideration of where along the coast will the area occur and whether it is inshore or offshore. The included habitats also will have differential impacts due to the correlation of habitat to fishing gear types and therefore, to fishing vessels and communities. The placement of zones also must consider transportation routes and safe anchorages, such as those that were identified in the community mapping process. The permanence of the area is often
one of the most contentious decisions of area-based management. Even though some fishermen support the concept of marine protected areas, most do not support permanent closures. For example, one interviewee stated, "(They) should leave some places sit...have moving area and time closures" (Interview 193). Any type of area management measure is highly controversial and would require extensive discussion and analysis, and is therefore not likely to happen soon.

Implementing spatial management of fisheries resources in the United States involves the federal and state fisheries management agencies that have jurisdiction over the marine area. In Oregon, the Oregon Department of Fish and Wildlife has control over fisheries activities in waters within three nautical miles from the shoreline. Nearshore rocky outcroppings bump out the jurisdictional boundary to include in state waters both of the Orford and Blanco rocky reefs and some deeper shelf habitat out to 100 fathoms (Figure 5). The Pacific Fisheries Management Council and NOAA Fisheries have jurisdiction in areas beyond three miles to the exclusive economic zone (EEZ) boundary, 200 miles offshore. The location of a hypothetical local management zone in ocean space would determine which agencies would need to be involved in the planning and management of such a zone.
CONCLUSION AND RECOMMENDATIONS

The Port Orford Community Mapping Project tested a participatory GIS process for using local fisheries knowledge to answer science and management questions developed by the POORT, namely the distribution of species and human activities in the Orford Reef area. Because this interview process did not answer all scientific, market, or management questions, additional data and projects to supplement this project are being prioritized by the POORT. For example, in order to identify whether there are localized populations of fish species, the POORT is currently involved in several cooperative research projects. One project involves the training of POORT members to take biological and genetic samples from four rockfish species in the Port Orford area. These data are being provided to supplement several state and university cooperative research projects. Another project is a juvenile rockfish study. By working more collaboratively with scientists and managers, the community is proactively developing capacity for increased participation in management discussions.

The maps effectively display the “place” of the Port Orford community and position the community to contribute to discussions about implications of area-based management strategies being considered by fishery managers. It was a good survey of the Port Orford fishing and recreational community, representing approximately fifty percent of the vessels and a diversity of recreational interests. To keep the focus on the larger community, the interview protocol also targeted those people, like the local fish buyers, who have general knowledge of the activities and species occurring in the ocean and coastal area, even though they do not make direct observations out on the water. The participatory GIS process helped develop consensus about how the community utilizes the local marine environment. The map products display the composite knowledge of interviewed individuals and moved the scale information from the individual to the community through a spatial analysis from Ecotrust and the subsequent community validation workshop.
A comprehensive community mapping process would require substantial funding, human resources trained in ethnographic methods, technical assistance and capable local leadership. Although baseline information on communities is greatly needed, it is still a lower priority than most biological research, at least for fisheries management. Although the Port Orford Community Mapping Project did identify other communities that utilize the same areas, it was primarily limited to the fishing components of other ports or recreational fishing in general. However, other communities could utilize the process to document knowledge about their local places provided that the community had sufficient local leadership and organizational and fiscal capacity. Applicability to other communities will also depend on the relative homogeneity of the port community and the degree of trust among those conducting the interviews and among the industry participants. The Port Orford inventory maps had few changes suggested to them partially because the fishermen here are all from small vessels and use slight variations of the same gear. If a comprehensive coastal community mapping project was developed by the state or region, communities and managers could better identify the stakeholders who have an interest in local places. With additional spatial analyses like Ecotrust’s determination of the relative economic importance of areas for targeting black cod, communities and managers might begin to identify the relative economic impacts of spatial management arrangements. With comprehensive information, all affected communities could then be involved in the evaluation of the design of spatial management arrangements.

One limitation of participatory GIS, especially for a small community-based management organization such as POORT, is technical expertise in GIS and financial resources for computer hardware and software and labor. Access to large format plotters, laminating costs, and rolls of acetate also impose considerable costs. New GIS programs with graphical user interfaces and associated database, such as OceanMap (Scholz et al. 2004) have potential to increase the efficiency with which local knowledge and GIS are
combined to produce spatial data for analysis. The integration of participatory GIS products with other GIS technology like the Oregon Coastal Atlas will improve user accessibility when it is wanted and can restrict information dissemination through password protecting data layers (Haddad et al. 2005). The atlas currently allows users to select GIS data layers to display and print out in pdf format. In future fisheries mapping projects, it would be beneficial for the Oregon Coastal Atlas to have a geospatial layer that displays Loran lines from nautical charts because many of the fishermen still utilize this spatial reference frame. As of this project, the author could find no such layer. A public participation tool that combined the user interface and relational database components of OceanMap with the accessibility and display capabilities of Oregon Coastal Atlas would allow communities greater participation in developing GIS capabilities with less cost.

Community organizations like POORT require sustained funding and technical support to remain a viable partner in cooperative fisheries management. POORT relied on funding from various grants through non-profit organizations, academia, and government agencies during the course of this project. However, currently POORT is struggling to maintain the level of funding it had a few years ago. A more stable source of income is necessary to maintain essential organizational infrastructure.

The Oregon Watershed Enhancement Board (OWEB) model should be explored as one possible alternative. OWEB is a state agency with a policy oversight board that consists of members from state natural resource boards and commissions, private citizens, and non-voting federal representatives. OWEB administers a watershed monitoring and assessment program and grants program “to help create and maintain healthy watersheds and natural habitats that support thriving communities and strong economies” (website address or statute). They assist with the development of locally integrated action plans believing that management techniques and programs for the protection and enhancement of watersheds are most effective and efficient when voluntarily initiated at the local level.
OWEB works cooperatively with volunteer local watershed councils through their grants and enhancement programs to foster locally driven watershed protection projects. Coastal and fishing communities would benefit from a coastal equivalent of the watershed councils and the OWEB management framework.

The federally approved Oregon Coastal Management Program (OCMP) and its Ocean Policy Advisory Council (OPAC) could be another opportunity for state support of community-based management programs. Administered through the Oregon Department of Land Conservation and Development (DLCD), the OCMP uses a combination of state planning and regulatory provisions, state criteria and standards, and state review to manage Oregon's ocean and coastal resources. Any state or federal action in the coastal zone must be consistent with the standards set forth by the OCMP. Through the OCMP, coastal cities and counties have developed local comprehensive plans to address specific coastal and ocean issues at the community scale. However, the local plans have not traditionally addressed commercial fisheries issues, possibly because of the perceived lack of decision space and the focus on city lands. Coastal communities could form local groups, similar to the watershed councils, and propose coastal and nearshore resource protection and management plans for evaluation by OPAC. Federal and state funds could be guided through OPAC to support small projects or project coordination. The strength of a networked coastal management program is that it can be comprehensive and flexible, while promoting local involvement.
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Appendices
Appendix A

Port Orford Community Profile
PORT ORFORD COMMUNITY PROFILE
Victoria Wedell
Sept. 15, 2004

In 2000, Port Orford began exploring how a community-based framework could improve the understanding and management of their local fisheries and recreational uses. Through a non-profit organization called the Port Orford Ocean Resources Team (POORT), science and management questions are being addressed at the scale of a single fishing community. In March 2003, the POORT established a local office (Figure 9: POORT office) on the street down to the dock and harbor. Since then, the office has become a hub for community members and scientists to get information and to find assistance for cooperative research projects.

POORT recognizes the importance of strategic alliances and has partners at national, regional, and state levels, from academia, government, and conservation perspectives. Twenty-six local commercial fishermen and recreationalists have joined the POORT Advisory Board (AB). The AB is guided in part by a Science Advisory Committee, consisting of state, federal, non-governmental and academic scientists. Through early scoping efforts, POORT established its vision:

"A sustainable fishery on the Port Orford Reef that combines the best science and local experiential knowledge for the community to make local fishery management decisions that:
1) Sustain and improve the habitat and population base of fish;
2) Provide high quality, high value seafood products to consumers; and
3) Support the economic viability of the Port Orford community."

POORT’s mission is “To engage Port Orford fishermen and other community members in developing and implementing a strategic plan and framework that ensures the long-term sustainability of the Port Orford fishery ecosystem and the
social system dependent on it.” Developing a comprehensive strategic plan is a long-term goal for POORT. Two initial steps have been taken concurrently to facilitate the evolution of a functional community-based management structure in Port Orford: education and empowerment of local stakeholders to contribute to sustainable solutions, and assessment of the biological, economic, and social health of the Orford Reef, shoreline, and uses including fisheries. As a result, fishermen, recreational users, and scientists have come together to plan and execute cooperative research and expand the knowledge base the community has about Port Orford’s nearshore resources.

Within the last few years Port Orford fishermen assisted in several cooperative research projects including: NOAA Fisheries survey of sea lion populations, an Oregon State University graduate project on sea urchins ecology, and the NOAA Fisheries Observer Program. In addition to the GIS work, the POORT is participating in several biological projects in 2004: fish biological and genetic sampling, and a project design for a subsequent fish tagging and gear selectivity study. The POORT will also conduct more in-depth economic surveys and spatial analyses and visual ecological surveys using a remotely operated vehicle.

**Local Fisheries Context**

Established in 1851, Port Orford was one of the first Euroamerican settlements on the Oregon Coast and has depended on natural resource extraction throughout its history. Originally settled by Captain William J. Tichenor with hopes of tapping into the gold mining industry, Port Orford still has some pioneer families who own and execute mineral rights in nearby rivers (Interview 007). The original port facility dates back to 1856, with the port district being formed in 1911. Logging and lumber milling supported the community for many years, reaching a peak during the 1930s, mainly with the logging, processing, and shipping of Port Orford cedar. Shipping of lumber stopped shortly after the jetty was completed in 1968. This was primarily due to poor
market conditions and the decline of local timber supply (Private Public Service Site, 2004a). Currently, the port’s only commodity is local seafood. Many current commercial fishermen were also loggers, or come from logging families. Port Orford’s maritime history includes about 40 fishing families, with some having third generation fishermen with over 50 years of cumulative knowledge passed down through the generations.

The geographic isolation of Port Orford may contribute to the town’s sense of cohesion and community. By both land and by sea, Port Orford is physically isolated relative to other Oregon port communities. Port Orford’s ‘claim to fame’ is being the most westerly-incorporated city in the contiguous United States (Private Public Service Site, 2004b). This fishing town is situated within a semi-enclosed ocean embayment, unlike most other Oregon ports, which are located within estuary harbors or along river channels. Large sand bars outside the nearest ports of Bandon to the north and Gold Beach to the south, both about 25 miles away, make water-borne transportation into these ports potentially dangerous to the small fishing vessels of Port Orford, especially during poor weather conditions (Interview 193). The Port Orford Lifeboat Station provided rescue services to the southern Oregon coast from 1934 through 1970 when it was decommissioned (Port Orford Heritage Society, 2003). Currently, the commercial fishermen (and often recreationalists) here must depend on each other when trouble arises out at sea. Port Orford fishermen have often risked their own safety and financial liability for others’ property and personal well-being.

This port is also relatively isolated from other cities and ports by land; located approximately 50 miles south of the nearest large population center of Coos Bay/Charleston/North Bend (combined population of ~26,000) and 70 miles north of the port of Brookings, population 5,447 (2000 Census) and the Oregon-California boarder. It is about a three and a half hour (160-mile) drive between Port Orford and
Eugene, Oregon (population 137,893; 2000 Census), the closest interior city. Port Orford has the basic amenities: grocery stores, gas stations, restaurants, motels and RV parks, some small businesses and an elementary-middle school. The town is relatively isolated because of its geography and infrastructure and has a unique blend of both traditional independence of fishermen and a true sense of community offered by close personal and professional ties.

Just 10 miles north of Port Orford, Cape Blanco is a prominent oceanographic feature in the California Current system, separating two distinct oceanographic regions of the Northeast Pacific Ocean (Mackas et al. 2002). Therefore, the ocean area in front of Port Orford exhibits some characteristics of both these regions. Generally, eastern boundary currents like the California Current induce strong upwelling conditions in the nearshore area and support diverse and abundant marine life including fishes, invertebrates, marine birds and marine mammals. The continental shelf is quite narrow along this section of the Oregon coast, providing the Port Orford fleet access to both nearshore and shelf fish species that would typically be out of range for smaller sized vessels like those in the Port Orford fleet.

The Orford and Blanco Reefs are marine extensions of the cape’s rocky headlands, and together, consist of about seven miles of rocky reef and bull kelp (*Nereocystis*) habitat. Several reef features including Fox Rock of Orford Reef break the surface of the water to form small islands that extend the three-mile limit of state jurisdiction to include most of the nearshore reef area near Port Orford. This extension of the Territorial Sea means the inclusion of some deep-water shelf habitat, extending out to 100 fathoms. Small pocket beaches enclosed north and south by rocky headlands make for a diverse range of nearshore benthic and shoreline habitats. For example, in a shoreline less than 20 miles south of Cape Blanco, you find North Beach, then Port Orford Heads, then Battlerock Beach, then Rocky Point, and finally other small beaches before you finally reach Humbug Mountain, a major littoral cell boundary.
Winds and rains are seasonal, but often fierce because Port Orford juts out into the Pacific. Late fall, winter, and early spring account for 81 percent of the 72 inches of annual precipitation (Western Regional Climate Center - Desert Research Institute, 2003a). January brings winter storms and gale force winds out of the southwest, from which there are no safe anchorages for mariners. “The only time its calm in Port Orford is when the wind is blowing the same from both directions” a local fisherman only halfway joked during an interview (Interview 447). As the spring rains decrease, winds switch directions and come from the northwest through most of the summer. Moderated by the Pacific Ocean, temperatures range from 45 to 61 degrees F through the entire year (Western Regional Climate Center - Desert Research Institute, 2003b).

*Governance*

The city of Port Orford was established as an incorporated city in 1935. It has a city manager form of government, which gets policy guidance from a six-person city council. Port Orford has a 15-person volunteer city fire department and a small police department. Other city services include city planning, sewer, water, and parks. The city also has several committees that provide advice on budgets, ordinances, personnel, watershed management, parks, and emergency planning, and other matters. The City of Port Orford has a comprehensive plan and land use ordinances that serve as the basis for planning and development decisions, including the oceanfront and the port dock and facilities. Portions of the land and water there are reserved for development that is water dependent—that is, uses and activities that must be on the water to operate effectively. The local plan and zoning thus play an important role in defining the future of the port and adjacent lands.

While ports do not have land use planning responsibilities under Oregon law, they have great influence over promoting development of ocean resources in a way that is both economically and environmentally sound. Ports help decide what kind of
businesses and infrastructure are maintained in the port district, and thus shape the face of the port community. Ports must assess short- and long-term tradeoffs, and also balance both socioeconomic and environmental impacts. The environmental impacts include air and water pollution, dredging, public access, aquatic nuisance species, loss of wildlife habitat, and land use. It often comes down to recreational and tourism activities poised against industrial and commercial activities. In order to retain commercial fishing infrastructure and facilities in spite of a West Coast groundfish crisis, Oregon ports must have a clear vision and make strategic coastal land use planning decisions that prioritize commercial fishing as an important activity in their waterfronts.

Since the mid-1970s many cities are revitalizing their urban waterfronts to increase their value. Redevelopment is currently threatening the survival of traditional maritime enterprises such as commercial fishing. Erosion of the infrastructure and industries necessary to maintain local fishing fleets results in loss of jobs and businesses to other ports. The waterfront area is a scarce resource imperative to the activities and businesses that require contiguity to navigable waters. Recreational interests value the area for its recreational and aesthetic qualities. Waterfront revitalization often transforms abandoned wharves, docks and piers into attractive destinations for tourists. However, there is a growing sentiment that something real has been lost and may not be able to be recaptured as waterfronts displace the activities that made them the authentic working water-fronts tourists come to see.

The Coastal Zone Management Act of 1972 recognized the importance of ports and maritime industry to coastal and ocean resource management. The CZMA is a statute designed to encourage coastal and Great Lakes states to plan and manage uses of the land and water in the nation's coastal zone. It designates urban water-fronts as Geographical Areas of Particular Concern (Goodwin 1988). Salient parts of the CZMA identify national policies for conserving historic and cultural resources,
restoring urban waterfronts for public use, and reserving land for water-dependent industries. The significance of this is that water-dependent activities have a fundamental need for access to the waterfront to support water-related commerce or recreation. Examples would be a fish processing plant or boat launch/hoist. Water-related activities are businesses associated with the water that do not require waterfront access to operate. Examples of water-related activities are a nautical museum and gift shop. The CZMA along with Oregon’s legislation and planning goals can provide guidance to fishing communities interested in maintaining their traditional maritime activities.

Oregon is ahead of the land use planning game having passed its statewide planning goals in 1973. Goals 17 and 19 directly support the goals of the Oregon Territorial Sea Plan. Oregon’s Statewide Planning Goal 17 (Coastal Shorelands) prioritizes “marine-dependent” activities over “marine-related” activities in the limited space of waterfront areas (OAR 660-015-0010(2)). Goal 19 (Ocean Resources) prioritizes the maintenance and restoration of the long-term benefits derived from renewable marine resources over non-renewable resources (OAR 660-015-0010(4)). It encourages the protection of renewable marine resources; biological diversity and the functional integrity of the marine ecosystem; important marine habitat; and areas important to fisheries.

Oregon’s public ports are institutions of local government. They are unlike any other local government entity in the state because they serve both public and private purposes. Oregon Revised Statutes Chapter 777 establishes ports in Oregon as "municipal corporations." Ports are not subject to state oversight, but are considered to be independent local government organizations subject only to the enabling statutes that outline port authority and powers. Ports are formed by a vote of the people who live in the proposed port district. At the initial election, voters determine a port's boundaries and elect the first board of commissioners, which governs the port
district. While managed on a day-to-day basis by either full or part-time staff, ultimate responsibility and authority over each port’s activities and facilities reside in the hands of locally elected boards of port commissioners.

The objective of the port authority and its businesses is to spur economic growth in the local community through economic development and transportation (Port of Hood River, n.d.). In order to do this, ports are given an unusual collection of powers and authorities. Like other local governments, ports are authorized to levy taxes, borrow money, issue bonds, and charge for services. A very small portion of most ports’ revenues is derived from taxes. Oregon ports also operate like businesses through negotiating economic development projects, leasing land, buildings and equipment, and promoting their facilities and districts for potential economic growth and opportunities. Oregon law allows ports to partake in water-related commerce, transportation, and other commercial and industrial activities. The primary role of Oregon’s smaller ports, like the Port of Port Orford, is to encourage economic activities within the district’s boundaries.

Ports often must improve their bays, rivers, and harbors through dredging to support navigation needs for shipping and commercial fishing activities, a major factor for the Port of Port Orford. Ports can construct and own warehouses, industrial parks, shipping terminals, and other commercial buildings. They can develop and operate piers, docks, jetties and wharves and associated facilities and infrastructure. Oregon ports also own and operate marinas and recreational facilities and can even promote tourism.

Ports also work closely with the Ports Division of the Oregon Economic Development Department to increase funding for the Port Revolving Fund. This fund
provides capital for development of public facilities such as sewer and water as well as providing job development assistance to existing or new industries located in port districts. The Oregon Port Revolving Fund provides long-term loans to ports at below-market interest rates (Oregon Economic and Community Development Department, 2004). The 23 public ports in Oregon are the only entities eligible for Port Revolving Fund loans. Individual loans may be made to a maximum of $700,000 per project and the total amount loaned cannot exceed $2 million at any time. The program may not refinance existing debt. Funding may be used for port development projects (infrastructure) or to assist port-related private business development projects. A large variety of projects are eligible and include water-oriented facilities, industrial parks, airports and eligible commercial or industrial developments. Projects must be located within port district boundaries.

Demographic Profile
As other coastal towns in Oregon have seen much larger and more rapid increases in population, Port Orford has almost refused to grow. Its population has increased only 10 percent in the last 30 years, while at the same time, Oregon port communities on average grew 28 percent (Center for Population Research and Census, 2000). In the year 2000, Port Orford had a recorded population of 1,153 and of those 48 percent were male and 52 percent were female (Figure A1).
It is likely that Port Orford’s population will continue to grow, most likely at an increased rate, as retirees and other new migrants settle in this quiet, livable oceanfront community. However, despite the fact that coastal areas of the US are projected to receive over half the nation’s expected population growth in the next 15 years (Beach 2002), only a little of that growth is likely to end up along the southern Oregon coast, particularly in small communities like Port Orford. Common perceptions held by the community are that the immigrating people are predominately Californian retiree, who because of their significant skills and experience, increasingly take the limited number of available living-wage jobs in the community.

The median age for Port Orford in the year 2000 was 50.5 years, whereas the national median was 35.3 years old. The racial structure of the population of Port Orford is
not very diverse, with the predominant race being white (Figures A2 and A3). Approximately 85 percent of those people 25 years and over had graduated from high school or had higher degrees. Of those 25 and over, 19.7 percent had a bachelor's degree or higher. In 2000, about 84.2 percent of the population was part of the potential work force, aged 16 and above. Out of the population age 16 and over, 41 forces, and 55.5 percent were not in the labor percent were employed, 3.5 percent were unemployed, 0 percent was in the armed force (Figure A4). The per capita income in the year 2000 for Port Orford was $16,442 and the median household income was $23,289. About 17.8 percent of individuals in Port Orford’s population were below the poverty level in 2000.

2000 Racial Structure
Port Orford, Oregon
Data Source: US Census

2000 Hispanic Ethnicity
Port Orford, Oregon
Data Source: US Census

Figure A2
Figure A3
Port Orford is very much a fishing community, supporting about forty local fishing families (Anderson 2001). The relative proportion of fishing-related employment has statutory and management implications as set out by National Standard 8 of the 1996 Sustainable Fishing Act. However, the estimates vary considerably, from as high as thirty percent to as low as less than seven percent, as reported by Scholz (2003) and the U.S. Census (2000), respectively. Anderson (2001) reports that depending on the season, the community has between 100-150 people directly or indirectly involved in the day-to-day activities of commercial fishing, which would represent about ten to fifteen percent of the estimated 2000 population. Radtke and Davis (1997) reported that the port brings 217 commercial fishing-related jobs, representing twenty-two percent of the estimated population in 1996 (US Census Bureau). Apparent dilution of dependency occurs with increases in non-fishing proportion of populations, as with immigrating California retirees to Port Orford, or with the reduction in fishing employment such as those moving out of the industry due to lack of fishing opportunity.
Social and Cultural Linkages to the Fishing Industry

The dock is the fishing community’s hub of social activity in the town. Port Orford has several local organizations associated with the commercial fishing industry, including the Port Orford Ocean Resource Team (POORT), the Port Orford Fishermen’s Association and the Port Orford Women’s Fishery Network (a.k.a. “the fish wives”). During the Port Orford Forth of July Jubilee, the fish wives and their fishermen co-host the annual Salmon Bake and the men compete in the Dinghy Race. For 2003 the theme of the Forth of July festivities was “Fishing the Wild Sea.” The Blessing of the Fleet Ceremony occurs annually in summer and honors those fishermen who have died at sea and prays for the continued safety of those who make their living out on the ocean. In 2003, the ceremony, complete with bagpipe accompaniment, took place at the new Fishermen’s Memorial overlooking Port Orford harbor. The Port Orford Arts and Seafood Festival also celebrates Port Orford’s fishing history. The cultural importance of the ocean and of commercial fishing is even evident in the many maritime murals and ocean-related names that adorn small businesses and schools in Port Orford as well as residential homes.

Port Infrastructure and Facilities

Of Oregon’s 23 public ports, the Port of Port Orford is one of the smallest ports in size (its taxing district comprises just 150 square miles), but it is relatively large in terms of economic contribution to the community. In 1997, the port district owned the fourth-smallest amount of land at 18 acres, and had the fifth smallest operating budget of $310,000. The small, partially-enclosed harbor is maintained at a depth of 16 feet (Radtke et al. 1997). Radtke and Davis (1997) estimated that the port brings $4,310,000 of personal income and 226 jobs, with 96 percent of both from fishing-related income and employment. They also estimate that the port generates $915,000 in state and local taxes, from industries closely linked to the port’s activities. Between 2000-2004, the average value per ton of commercial catch landed in Port Orford was $3,443, compared to the average value of $741 for the rest of the Oregon ports.
(International 2004). This is due to the increase in the live rockfish market, a low-volume and high-value fishery, in which about 30 Port Orford vessels participate. Live rockfish are sold for between $2.00 per pound for Copper rockfish (over 2 pounds) to $7.00 for Grass rockfish. The relatively high landings value of Port Orford in comparison to other Oregon ports is also due in part to the high-volume, low-value landings of other Oregon ports, including whiting in Newport and Astoria and sardines in Astoria.

The fishing community of Port Orford is a uniquely homogeneous small-scale port on the South Coast of Oregon with relatively traditional fishing grounds determined by vessel size and capacity. The commercial hoists and limited moorage in the Port of Port Orford constrains the Port Orford commercial fishing fleet in both vessel size and number of vessels. Vessels must meet the weight and dimensional requirements of the commercial hoists that lift them in and out of the water to dry moorage. The vessels in the Port Orford are restricted to a maximum length of 44 feet and a maximum width of 15 feet and no more than 44,000 pounds (Private Public Service Site, 2004a). The same Port Orford resident built many of these traditional salmon trollers in the 1970s. For the Port Orford Community Mapping Project, the author interviewed people from approximately 50 percent of the vessels in the Port Orford fleet. The average length of these fishermen’s vessels was 34 feet. Port Orford has minimal infrastructure. There are facilities and services that include a dock and jetty, two commercial hoists, one sport crane, dry moorage area and parking spaces, minimal land and buildings for lease, beach access and restrooms and showers. About forty vessels call the dock at Port Orford home. You will find them either parked on the dock on trailers or moored in the harbor during the summer (weather conditions permitting).

The original jetty was built in 1968 and is in desperate need of repair. It is close to being totally compromised in the middle with enough damage for waves to break
through and further displace rocks from the structure. The jetty's inability to deflect storm waves keeps many vessels from mooring in the harbor. The port commission and community do not consider repairing the existing jetty a priority because the original design of the jetty created the extreme shoaling problem. One local perspective is that the old jetty does not fit the new dock (Interview 169). The Port Orford dock was recently renovated and rebuilt between 1999-2002. The previous structure was made of wooden-pilings whereas the new structure has steel-sided construction. The old dock often had to be rebuilt due to damage from the severe weather and waves off this coast, however it allowed sediment to more naturally circulate in and out of the harbor with the flow of water and this helped with the shoaling problem. There is a strong desire to make significant design changes to the jetty in the repair process and that work would require engineering assistance and a great deal of money from the Army Corp of Engineers.

With the sediment circulation disrupted by the solid base of the new dock, sand accumulates more often inside the harbor. Annually, usually in the fall and winter, the harbor must be dredged in order to remove the accumulated sediment. In spite of annual dredging, the port has been unable of to keep the area in front of the commercial hoists cleared of sand, which creates an untenable situation for the Port Orford fishing fleet. The first big southerly storm that moves a high volume of sand into the harbor makes the basin too shallow to hoist boats in or out of the water on anything but high tide. This restricts fishing opportunity for Port Orford vessels and is dangerous for vessels that may be caught out in a storm and are unable to get to the dock and hoist out of the water. However, launching into the open ocean gives Port Orford fishermen an advantage over other small-boat fleets of not having a dangerous bar to cross. This allows them to spend more time during the winter on the ocean than small boats leaving from other ports.
Economics of the Port

Mooring on a dry dock in the open ocean is an expensive operation and incurs expenses unique to the Port Orford fleet and port district. Costs to the port include purchasing the new cranes, maintenance of cranes, and operation of the cranes by a team of employees. In the winter, the ocean waves regularly overwhelm the dock and cause damage to the infrastructure. The design of the new dock drain system is not adequate to remove the flooding water, causing damage to the electrical systems. Maintenance and repair costs have to be passed on to the fishermen via their moorage rate. One parking space for a vehicle and one boat trailer costs $170 dollars per month as of June 2004. “Unlimited” hoist use is included in the monthly charge, but is actually limited otherwise due to sport and recreation use of the hoists and water depth limitations imposed by tidal fluctuations not providing enough clearance for vessels to approach the dock. Other income to the port includes a tax on fuel and landings. The port sells both diesel and gasoline, marking up prices 20 percent. The port also charges a 1 percent poundage fee for each pound of fish landed. This means that the fish buyers pay one cent of every dollar earned from fishing to the port authority. The port district attempts to balance the operation costs with the maximum amount of revenue the fishing fleet can afford to pay for services. Mooring on a dry dock also imposes additional costs to fishing businesses for upkeep and repair to their vessels from the stress of hoisting in and out of the water daily.

Limited space and building infrastructure on the dock restricts the expansion of commercial fishing. For example, the port has very limited gear storage space. As of the summer 2004, five businesses lease land, buildings, or other facilities on the Port Orford dock. Three product hoist areas occupy the Port Orford dock: NorCal, Hallmark and the old Premium Pacific Seafood hoist. Recently a local fishing family is leasing the old PPS hoist using Oregon Bait & Seafood Company as their business name. Currently, two fish buying stations at the port, Hallmark Fisheries and NorCal Seafood, purchase almost all of the Port Orford fleet’s seafood products. However,
NorCal buys only live product, including Dungeness crab and live rockfish. (Interview 138). The combination of the decline in local sea urchin harvesting and the increase in live rockfish fishing has diminished the demand for local fish processing. As a result, the other buying station and processing plant, Pacific Premium Seafood (PPS), closed in 2003. The port has retained possession of the PPS building on the dock and currently leases out the usable portion to NorCal Seafood; the entire second story is in disrepair and essentially unusable. The port applied for loans to rebuild the decaying building, but only was approved for money for the roof while the walls holding them up would continue to rot away.

Port Orford does not currently offer ice or cold storage, which is burdensome to the fleet. Premium Pacific Seafood (PPS) had a small ice machine that is no longer available. Hallmark ships in ice from Charleston and holds it in totes in their container freezer. During tuna season, fishermen drive their own totes to Charleston or actually go into Charleston with the boat to pick up ice. However, in 2004 a grant was awarded to the port to repair freezers in the old PPS building and store ice purchased from the Port of Brookings Harbor. With the upgrade to the freezers in the old PPS building in 2004 the port hopes to attract a pacific eel processor. This would create more opportunity for fishermen and provide a tenant for the processing building.

There are no vessel repair shops in Port Orford. Most of the vessels are repaired right on the dock or towed to a personally owned shop in town. Some supplies are bought from local hardware and auto supply stores. However, most of the repair supplies come from Coos Bay and almost all of the gear comes from Englund Marine or Basin Tackle in Charleston.

The other marine businesses on the dock include Dock Tackle and Pac Nor West Charters. Dock Tackle is a combination of tackle and gift shop, nautical museum, and
fish market. It supplies seasonal fresh fish, fish and chips and chowder, and a limited amount of gear (i.e., jigs and line) for the sport and commercial rockfish fishery. Pac Nor West Charter opened in 2003 and has a small office on the dock from which the owners run recreational scuba and fishing trips. A floating dock for recreational fishing boats on the side of the pier can be drawn up in bad weather.
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Appendix B

POORT Confidentiality Agreement
The Port Orford Ocean Resources Team (POORT)
Confidentiality Agreement

POORT is conducting Local Knowledge Interviews with Port Orford commercial fishermen, recreationalists, and other citizens. The purpose of this interview is to establish a foundation for incorporating local knowledge into local management decision-making. Through analyzing the information gathered, POORT seeks to identify ocean resource use, abundance and distribution in the Port Orford area. This information will be used to design cooperative research projects that will assess the condition of the study area. This agreement between the POORT and the Interviewee assures the Interviewee complete confidentiality of the information provided to the POORT.

Individual data will not be accessible by any person other than the Interviewer and the person who will input the data into the computer using geographic information system (GIS) software. Raw interview data will be securely stored until such time that all data are entered and verified. At that time, the information will be returned to the Interviewee, destroyed, or stored at said location with the Interviewee’s permission.

Interview information will be aggregated with data from other interviews to produce compilation maps, which will NOT display any one individual’s information. Furthermore, the POORT will NEVER share any one person’s information without express written consent of the Interviewee.

The unique identification number below will be used to identify this interview in the computer database. The only place where your name and ID number will appear together is on this form, which will be securely stored indefinitely. By signing here you agree to the conditions of this confidentiality agreement.

Date: ____________________

POORT Interviewers:

________________________________________

Interviewee:

Identification number: ________________

Name (please print and sign): ____________________________________________

Address: ____________________________________________________________

Phone: ________________________________
Appendix C

Human Subjects Research Informed Consent Document
INFORMED CONSENT DOCUMENT

Project Title: Port Orford Ocean Resources Inventory
Principal Investigator: Jim Good, Marine Resources Management Program
Research Staff: Vicki Wedell, Laura Anderson, Leesa Cobb, Dave Revell

PURPOSE
The purpose of this research study is to conduct an inventory of the local knowledge of species, resources, and activities that occur in the marine environment important to the community of Port Orford. Computer mapping is used to document and display the information shared in the interview process. The purpose of this consent form is to give you the information needed to help you decide whether to be in the study or not.

We are inviting you to participate in this research study because you utilize the Port Orford marine environment for your occupation or recreational activities. A snowball sampling approach will be used to get an estimated 40 people in this interview process. Volunteers from POORT Advisory Board will be recruited first, while other willing participants will be identified through suggestions made by interviewees or other POORT members.

PROCEDURES
If you agree to participate, your involvement in the interview process will last for three hours total. A two-hour interview will be followed a few weeks later by a one-hour consultation to verify the accuracy of the maps created. A community workshop will allow another opportunity to make modifications to the composite community map.

The following procedures are involved in this study. At least two interviewers are present for each interview. A random identification number will be used to reference your local knowledge maps. Confidentiality agreements are offered and signed at the onset of the interview. Then, you refer to a list of potential species and human uses and describe your personal observations of those that occur in the Port Orford study area. Identification guides are on-hand for reference, if needed. You use wax pencils to draw the areas of your observations on clear plastic mylar, which is overlaid on base maps having fathom contours and the relevant nautical chart displayed. Information shared at the interview process is taken back and digitally documented in map form. The maps are brought back to you after a few weeks for a 1-hour consultation where any necessary modifications are identified and corrected. After all consultations are completed for all participants, species and use maps will be aggregated and presented as the Port Orford Ocean Resources Inventory.

RISKS
There are no foreseeable risks associated with participating in this research project. Sensitive information is protected through random identification numbers.

BENEFITS
There may be no direct personal benefit for participating in this study. However, society may benefit from this study by learning about a participatory process for computer mapping of local ecological knowledge.
COSTS AND COMPENSATION
You will not have any costs for participating in this research project. You will be compensated with a rockfish poster even if you withdraw early.

CONFIDENTIALITY
Records of participation in this research project will be kept confidential to the extent permitted by law. Individual data are not accessible to any person other than the interviewer and the person who will input the information into the computer. Raw interview data are securely stored until such time that all the data are entered and verified. Then the data are returned to the interviewee or destroyed. Information is aggregated with data from other interviews and compilation maps generated for exclusive use by POORT. Maps and information are not shared with outside groups without express written consent of the POORT Advisory Board members.

VOLUNTARY PARTICIPATION
Taking part in this research study is voluntary. You may choose not to take part at all. If you agree to participate in this study, you may stop participating at any time. You are also free to skip any question in the interview that you prefer not to answer.

QUESTIONS
Questions are encouraged. If you have any questions about this research project, please contact: Vicki Wedell at 541-619-4699 or vwedell@coas.oregonstate.edu or Jim Good at 541-737-1339 or good@coas.oregonstate.edu. If you have questions about your rights as a participant, please contact the OSU Institutional Review Board (IRB) Human Protections Administrator, at (541) 737-3437 or by e-mail at IRB@oregonstate.edu.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Participant's Name (printed): _______________________________________________________

(Signature of Participant) ____________________________________________________________________ (Date)

RESEARCHER STATEMENT
I have discussed the above points with the participant. It is my opinion that the participant understands the risks, benefits, and procedures involved with participation in this research study.

(Signature of Researcher) ____________________________________________________________________ (Date)
Flyer for Local Knowledge Interviews for the
Port Orford Community Mapping Project
Port Orford Ocean Resource Team

POORT is engaged in a community-based management effort and is conducting a local inventory of the ocean region important to the Port Orford community. We want to talk to commercial and recreational fishermen, recreationalists (divers, kayakers, surfers, etc.), and other citizens who have personal knowledge about the resources, species, and human activities that occur in the Port Orford ocean area.

Local knowledge interviews will be conducted in the POORT office:

351 W 6th St

Get involved! We want to talk to YOU!!! Sign-up in the POORT office or call us to be a part of this unique opportunity!
Appendix E

Local Knowledge Interview Questions
Port Orford Ocean Resources Team - Local Knowledge Interviews

Interview questions:

1. User profile
   a. Identification number
   b. Age
   c. Sex
   d. Profession/activity (owner, captain, deckhand, recreational activity)
   e. Duration
      1. Start/end year
      2. Number of days/year in area
      3. How many years have you maintained this level of activity?
   f. What generation fisherman are you? (if applicable)
   g. What vessel(s) do you fish from? (if applicable)
      1. What are its length and size of engine?

2. Where are your primary (fishing) zones? (if applicable)
   a. What are the primary fisheries in each zone?
   b. What are the primary gears in each zone?
   c. What is the percent of fishing effort spent in and the relative economic importance of each fishing area? (Divide 100 pennies among sites)

3. What “resources” do you use or have you observed in the study area? (Use list)
   a. Where do you use/observe resource X?
   b. What is the current status of the resource in the study area? (abundance)
   c. Has the location or status of this resource changed since you have been involved in your activity in the study area? If so, how and why?
   d. What are the seasonal changes of this resource in the study area? (spawning locations, nursery grounds)
   e. What other changes have occurred with respect to this resource? When and why did they occur?

4. Is there anything else about the ecology, economic, social, or cultural factors of this area that you want to tell us?

5. Anything else?
Appendix F

LKI’s Species, Resources and Activities List
Resource, Activity and Species Categories

*Invertebrates and Plants*
- Kelp
- Mussels
- Sea anemones
- Sea cucumbers
- Sea urchins (red and purple)
- Scallops
- Red abalone
- Starfish
- Pacific eels (slime eel/hagfish)
- Octopus
- Squid
- Shrimp
- Dungeness crab

*Other animals*

- Birds
  - Albatross
  - Murres
  - Puffin
  - Pelican (brown)
- Marine Mammals
  - Whales (gray, orca)
  - Dolphins
  - Sea lions
  - Seals (harbor or elephant)
  - Sea otter

- Turtles

*Humans*

- Recreation
  - Diving
  - Kayaking
  - Wave/wind surfing
  - Whale/bird watching
  - Power boating
  - Shore-fishing
  - Recreational fishing

- Other Commercial fishing
  - Small trawlers
  - Large trawlers
  - Non-Port Orford vessels

- Safe Anchorages
- Navigational hazards

*Fish*
- Salmon/Steelhead
- Albacore tuna
- Black Cod (aka sablefish)
- Halibut
- Slope Rockfish
  - Darkblotched
  - Pacific Ocean Perch
  - Redbanded
  - Rougheye
- Shelf Rockfish
  - Canary
  - Yelloweye
  - Yellowtail
  - Chilli pepper
  - Greenstripe
  - Rosethorn
  - Rosy
  - Boccacio
  - Shortbelly
  - Tiger
  - Vermillion
  - Widow
- Other Shelf
  - Cabezon
  - Sea Trout (aka greenling)
  - Lingcod
- Nearshore Rockfish
  - Blacks
  - Blues
  - Quillback
  - Copper
  - China

- Whiting
- Sturgeon
- Flounder
- Sole
- Sculpin
- Surperch/Surf smelt/Sand lance
- Sardines Anchovies
- Pacific mackerel
- Skates
- Sharks
Appendix G

Ecotrust GIS Analysis Methods
Introduction
The following description explains the methods used regarding the spatial analysis of the Port Orford local knowledge inventory for community based fishery management. The analysis was broken up into three phases.

1. Assess the current structure of the local knowledge dataset and aggregate the data appropriately in order to perform the analysis.
2. Analyze the recreational activities and targeted commercial species data in grid based on a 30 meter cell size for the study region. A 30-meter cell size was determined as the best spatial resolution to use due to the size of the study area and the desired scale of accuracy we could obtain.
3. Evaluate the relative economic importance of black cod.

Phase One – Organization, Compilation, and Initial Assessment of the Local Knowledge Dataset

We initially assessed the current structure of the dataset and determine how best to aggregate the data used to evaluate the recreational and commercial activities in Port Orford. The data was originally organized by interview, which meant for each interviewee, a shapefile was created for every recreational activity or commercially targeted species that interviewee identified. Based on a brief introduction to the dataset and procedures used to conduct the local knowledge surveys we decided to aggregate the data into two sub-directories, 1) Recreational and 2) Commercial.

Phase Two – Analyze recreational activities and targeted commercial species (Black cod, Crab, Halibut, and Salmon)

Recreational Activities

The recreational activities included in this analysis are as follows; beach combing, bird watching, kayaking, boating, diving, shore fishing, recreational fishing, wind and wave surfing, and whale watching. Each shapefile that was created for an interviewee that identified one of these activities was converted to a coverage and placed in a subdirectory organized by activity. In cases where there were overlapping polygons for one interviewee, multiple coverages were created so that they were evaluated separately once they were converted to grids.

Once all the shapefiles were converted to coverages within each activity subdirectory, an aml (arc macro language) was created to perform the analysis. The basic routine of the aml consisted of converting each coverage to a grid with a 30-meter cell size. Once each coverage was converted to a grid, we identified the minimum and maximum inputs (xmin, ymin, xmax, ymax) in order to set our analysis window to the appropriate extent. After the analysis window was set, a conditional statement was executed on each grid consisting of:
output grid = \text{con(is null (input grid) ,0,1)}

The output grid now has a value of 1 for each cell where an activity was identified and a value of 0 where there is no data (is null). After this condition was performed for each grid, all of the output grids were added together to create a resulting summary grid. This resulting summary grid now has cell values ranging from 0 to the maximum number of input grids.

Example: If there were three interviewees that identified the same area for surfing, each area was converted to a grid with a 30-meter cell size and each cell was given a value of 1. After adding the three grids together, if each interviewee identified the same cell for surfing then the resulting cell from the summary grid would now have a value of 3, if only two interviewees identified the same cell for surfing the resulting cell from the summary grid would now have a value of 2, if only one interviewee identified a cell for surfing the resulting cell from the summary grid would have a value of 1, and if none of the interviewees identified a cell for surfing the resulting cell would have a value of 0.

After creating a composite grid that scored all of the recreational activities (surfing, bird watching, boating,...) separately, we wanted to evaluate all of the recreational activities together in our final analysis. We did this by adding each of the composite grids together to create a final grid that contained a cumulative cell value for every cell were a recreational activity was identified. The reason why we didn’t initially evaluate all of the recreational activities at the same time was due to the processing capabilities in the grid environment, where the maximum number of input grids that can be added together is 50 and there were more then 50 grids representing areas used for recreational activities. This is why we chose to organize and perform the preliminary analysis for each unique recreational activity separately.

Example: If the composite grid for surfing had a cell with a value of 3 (meaning 3 interviewees identified that cell for surfing) and the same cell for the composite grid of bird watching had a value of 4 (meaning 4 interviewees identified that cell for bird watching) the final cell value in the final grid would have a value of 7 (meaning 7 interviewees identified this particular cell for a recreational activity).

Finally a nearest neighbor, focal mean using a circle with a radius of 6 was performed on the resulting final recreational grid to smooth out the data. The radius is identified in cells measured perpendicular to the x- or y-axis. Any cell center encompassed by the circle or wedge will be included in the processing of the neighborhood.
Only cells that had a value greater than 0 were displayed for mapping purposes. The displayed areas utilized by recreational users who participated in the survey were classified using an equal area distribution, with 7 classes, and re-categorized into low, medium, and high usage. Cells that have the greatest value represent high usage areas and cells that have the least value represent low usage areas.

**Commercial – Targeted Species (Black cod, Crab, Halibut, and Salmon)**

The species identified as commercial important and targeted by fishers included; black cod, crab, halibut, and salmon. Each shapefile that was created for an interviewee that identified an area or areas where they targeted one of these species was converted to a coverage and placed in a subdirectory organized by specie. In cases where there were overlapping polygons for one interviewee, multiple coverages were created so that they were evaluated separately once they were converted to grids. For this part of the analysis each specie will be evaluated separately.

Once all the shapefiles were converted to coverages within each specie subdirectory, an am! (arc macro language) was created to perform the analysis. The basic routine of the am! consisted of converting each coverage to a grid with a 30-meter cell size. Once each coverage was converted to a grid, we identified the minimum and maximum inputs (xmin, ymin, xmax, ymax) in order to set our analysis window to the appropriate extent. After the analysis window was set, a conditional statement was executed on each grid consisting of:

\[
\text{output grid} = \text{con} \left( \text{is null (input grid)}, 0, 1 \right)
\]

The output grid now has a value of 1 for each cell a fisher identified as where they targeted a particular specie and a value of 0 where there is no data (is null). After this condition was performed for each grid, all of the output grids were added together to create a resulting summary grid. This resulting summary grid now has cell values ranging from 0 to the maximum number of input grids for that specie.

**Example:** If there were three interviewees that identified the same area for targeting black cod, each area was converted to a grid with a 30-meter cell size and each cell was given a value of 1. After adding the three grids together, if each interviewee identified the same cell for targeting black cod then the resulting cell from the summary grid would now have a value of 3, if only two interviewees identified the same cell for targeting black cod the resulting cell from the summary grid would now have a value of 2, if only one interviewee identified a cell for targeting black cod the resulting cell from the summary grid would have a value of 1, and if none of the interviewees identified a cell for targeting black cod the resulting cell would have a value of 0.
Finally a nearest neighbor, focal mean using a circle with a radius of 6 was performed on the resulting final recreational grid to smooth out the data. The radius is identified in cells measured perpendicular to the x- or y-axis. Any cell center encompassed by the circle or wedge will be included in the processing of the neighborhood.

This process was used to evaluate each specie (black cod, crab, halibut, and salmon) individually.

Only cells that had a value greater than 0 were displayed for mapping purposes. The displayed areas for each specie targeted by a commercial fisher who participated in the survey were classified using an equal area distribution, with 7 classes, and re-categorized into low, medium, and high usage. Cells that have the greatest value represent high usage areas and cells that have the least value represent low usage areas.

Phase Three – Evaluate the Relative Economic Importance of Black cod

We evaluated the relative economic importance of black cod by assessing the answers given by each interviewee, when asked, “of the areas they target black cod, which area is relatively more important than another, a.k.a., “100 pennies question”. The “100 pennies question” asks each fisher, “based on the number of areas they use to target black cod, place a weighted percentage or number of pennies, out of 100, that describes how economically important that areas is compared to another.

In the previous analysis for areas targeted by commercial fishers, we assigned a value of 1 for each cell a fisher identified as where they targeted a particular specie and a value of 0 where there is no data. For evaluating the relative economic importance of black cod, we assigned the value based on the number of pennies the fisher placed in that area, with all of the areas totaling 100 for each fisher. After all of the grids for each interviewee that specified a “100 pennies” value for their areas were created, the grids were then combined into a resulting summary grid by adding of them together. The resulting summary grid now has a range of cell values from 0 to the maximum number of fishers that provided an answer to the “100 pennies question” x 100. (e.g. 13 fishers provided answers = 1300 total pennies)

Example: One fisher specifies three areas they target black cod. Of those three areas, they placed 30 pennies in one, 20 pennies in another, and 50 pennies in the last area. This means each cell in each of those areas they specified, has the same value as the number of pennies they placed in it. We will call it the “relative economic importance” of each area. Another fisher specifies only one area where the target black cod and places 100 pennies in that area. This area completely overlaps all three of the other fishers’ areas and extends past them to the south. When these two grids representing the “relative economic importance” for each fisher are added to together, the area where they overlap will have the resulting cell values of 120, 130, 150, and the cells in the area to the south where they don’t overlap will have a value of 100.

By adding all of the grids together based on the number of pennies placed in each area by an interviewee, we are able to determine why fishers target one area vs. another area based on it’s “relative economic importance”. Only cells that had a value greater
than 0 were displayed for mapping purposes. The “relative economic importance” was displayed for black cod areas targeted by a commercial fisher who participated in the survey were classified using an equal area distribution, with 7 classes, and re-categorized into low, medium, and high usage. Cells that have the greatest value represent the greatest areas of “relative economic importance” and cells that have the least value represent the areas of the least “relative economic importance”.
Appendices H1- H6

Draft Maps from Port Orford Community Mapping Project
Appendix H1

Spatial Distribution of Areas Targeted by Commercial Fishermen Harvesting Black Cod
Appendix H2

Relative Economic Importance and Spatial Distribution of Areas Targeted by Commercial Fishermen Harvesting Black Cod
Appendix H3

Spatial Distribution of Areas Targeted by Commercial Fishermen Harvesting Pacific Salmon
Appendix H4

Spatial Distribution of Areas Targeted by Commercial Fishermen
Harvesting Dungeness Crab
Appendix H5

Spatial Distribution of Areas Targeted by Commercial Fishermen
Harvesting Halibut
Appendix H6

Spatial Distribution of Areas Used by the Port Orford Community for Recreational Activities