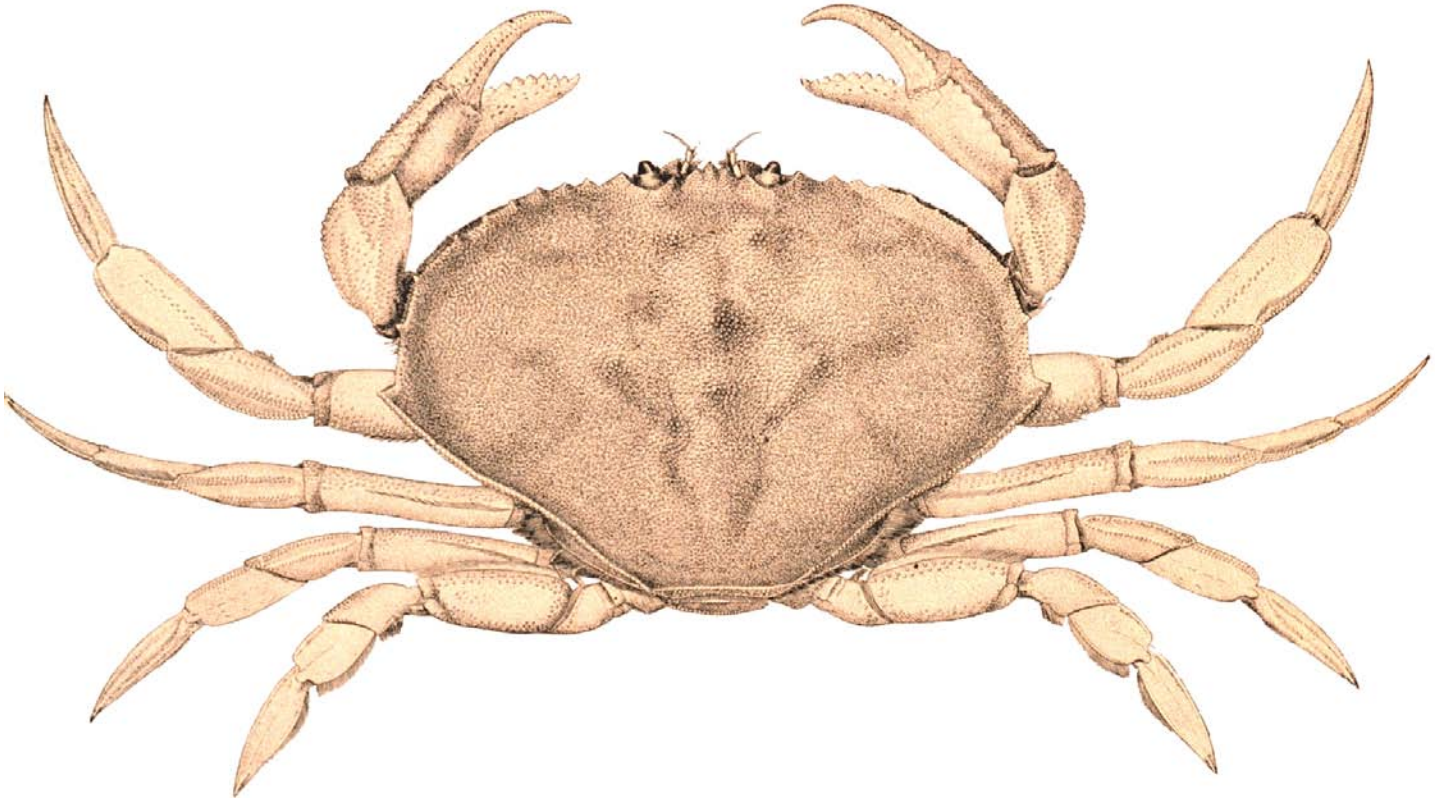
SCIENTIFIC CERTIFICATION SYSTEMS

MSC Public Certification Report

OREGON DUNGENESS CRAB FISHERY

Ver. 5, 30 November 2010



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Versions Issued

Version No.	Date	Description Of Amendment
1	30 March 2010	Report for Client Review
2	7 May 2010	Report for Peer Review
3	17 September 2010	Report for Public Review
4	27 October 2010	Final Report
5	30 November 2010	Public Certification Report

MSC scheme documents:

MSC Accreditation Manual Issue 4
MSC Fisheries Certification Methodology (FCM) v.6
MSC TAB Directives
MSC Policy Advisories

Contents

PREAMBLE

This report is the sole responsibility of SCS. All advice and comments from Assessment Team members, peer reviewers, client, fishery managers and the MSC have been reviewed by SCS and incorporated into the report by SCS as deemed warranted.

ABBREVIATIONS

3S	Size, Sex & Season
AHP	Analytical Hierarchy Process
ASI	Accreditation Services International
CB	Certifying Body
CPUE	Catch Per Unit Effort
ETP	Endangered, Threatened and Protected species
FAO	Food and Agriculture Organization [of the United Nations]
FMP	Fisheries Management Plan
LRP	Limit Reference Point
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
ODCC	Oregon Dungeness Crab Commission [Client]
ODFW	Oregon Department of Fish & Wildlife [Management Authority]
PI	Performance Indicator
SCS	Scientific Certification Systems
SG	Scoring Guidepost
TAB	Technical Advisory Board [of the MSC]
TAC	Total Allowable Catch
TRP	Target Reference Point

1. INTRODUCTION

The Marine Stewardship Council (MSC) is a non-profit organization dedicated to the long-term protection or "sustainability" of marine fisheries and related habitats. First started as a joint initiative between Unilever and the World Wildlife Fund (WWF), the MSC is now a fully independent organization that is governed by an independent Board of Directors advised by a panel of scientific, economic, and fishery experts.

The MSC's original mission statement promoted responsible, environmentally appropriate, socially beneficial, and economically viable fisheries practices, as well as the maintenance of biodiversity, productivity and ecological processes of the marine environment. The current MSC mission statement (redrafted in 2001) provides a slightly more focused mission and reads,

"To safeguard the world's seafood supply by promoting the best environmental choice".

Dedicated to promoting "well-managed" or "sustainable" fisheries, the MSC initiative intends to identify such fisheries through means of independent third-party assessments and certification. Once certified, fisheries will be awarded the opportunity to utilize an MSC promoted eco-label to gain economic advantages in the marketplace. Through certification and eco-labeling, the MSC intends to promote and encourage better management of world fisheries, many of which have been suggested to suffer from poor management.

The Marine Stewardship Council developed the original standards for sustainable fisheries management in a three-step process (May, Leadbetter, Sutton, and Weber, 2003): 1) Assemble a group of experts in Bagshot (UK) to draft an initial set of Principles and Criteria; 2) Conduct an 18-month process to review the standard in 8 major international venues; and 3) Convene a second set of experts in Warrenton, Virginia (Airlie Conference Center, USA) to revise and finalize the MSC Principles and Criteria.

The MSC Fisheries Certification Methodology used for this report is Version 6, issued September 2006, and has since been used as the basis by which this fishery has been evaluated under the MSC program.

1.1 The Fishery Proposed for Assessment

The fishery evaluated in this report is:

Species:	Dungeness crab (*Cancer magister*)
Geographic Area:	Dungeness crab extends on soft bottom habitat from Santa Barbara, CA to Unalaska, AK. Management area covered under this assessment is state waters off the coast of Oregon.
Fishing Method:	Crab Pots
Fishery Management:	Oregon Department of Fish & Wildlife with cooperation from the Tri-State Dungeness Crab Committee.

2. SUMMARY

2.1 The Assessment Process

Scientific Certification Systems, Inc. conducted a pre-assessment of the Oregon Dungeness Crab Fishery as recommended by the MSC program. After review of the pre-assessment, the applicants for certification authorized the formal, full assessment of the fishery. All aspects of the assessment process were carried out under the auspices of Scientific Certification Systems, Inc., an accredited MSC certification body, and in direct accordance with MSC requirements.

To be thorough and transparent, SCS provided opportunities for input at all stages of the assessment process, whether required or not by MSC procedures. The general steps followed were:

- Team Selection (December 2004)
  At this first step of the assessment process, SCS sought input from interested parties. SCS sent out an advisory through direct email and posting on select web sites requesting comment on the nominations of persons capable of providing the expertise needed in the crab assessment.

- Setting Performance Indicators and Scoring Guideposts (November 2005 – May 2006)
  In accordance with the assessment procedures required by the MSC at the time, the assessment team prepared the 'Performance Indicators' and 'Scoring Guideposts' for use in assessing the Dungeness Crab Fishery. The draft Performance Indicators and Scoring Guideposts were posted on the MSC website in September 2005. No stakeholder comments were received.

- Meetings with industry, managers and potential stakeholders. Input on fishery performance (May 2006)
  Once performance indicators were finalized, SCS requested that the clients compile and submit written information to the assessment team illustrating the fishery's compliance with the required performance indicators. At the same time, SCS requested that stakeholders submit their views on the fishery management system's functions and performance. An announcement was posted on the MSC website on the 21 November 2005. In the case of the Dungeness crab, the client and ODF&W provided some of the information needed prior to the initial interviewing process. However, a number of documents and/or data were provided on an ongoing basis as the assessment team, the managers, or the applicants found them to be relevant. And again, SCS was able to both ask questions and receive answers from the stakeholders when reviewing the information and making sure the assessment team understood the information provided.

- Review of data, report drafting and requirement for further research (June 2006 – February 2010)
  After review of all data and documentation presented the assessment team determined that the Oregon Dungeness Crab fishery was deficient in some certain aspects related to Principle 1 that would preclude the fishery achieving a combined, weighted score of 80 for that principle as required by the MSC scheme documents. SCS provided the client with a Gap Analysis in the form of a "Road Map" stipulating outcomes that would address the observed deficiencies in research and data required for Principle 1. By January of 2010 the client was able to provide results of various research projects that it felt satisfactorily addressed the points raised in the Road Map.

- Selection of peer reviewers (February 2010)
  SCS, as required, released an announcement of potential peer reviewers soliciting comment from stakeholders on the merit of the selected reviewers. No comments were received from stakeholders.

- Scoring fishery (March 2010)
  The assessment team scored the fishery using the required MSC methodology without input from the client group or stakeholders.

- Drafting report (March 2010 - September 2010)
  The assessment team in collaboration with the SCS lead assessor drafted the report in accordance with MSC required process.

- Release of Public Comment Draft Report (September 2010 - October 2010)
  SCS released the Draft Report for Public Comment on 21 September 2010 for public comment, soliciting stakeholder response through posting on MSC website and direct email to known potential stakeholders. No comments were received.

- Release of Final Report with Certification Determination (October 2010)
  SCS released the Final report with certification determination for the required objection period and the end of which no objections were received.

- Release of Public Certification Report (December 2010)
  This report satisfies this requirement.

2.2 Certification Determination

It is the consensus judgment of the assessment team and of the SCS Certification Determination Committee that the Oregon Dungeness Crab Fishery complies with the MSC Principles and Criteria. Therefore, SCS as the certification body of record recommends that the fishery be issued an MSC Fishery certificate. The lead assessor for the assessment team presented all evidence to the SCS Certification Panel, which agreed with the assessment team's decision and authorized certification of the fishery. The client has submitted for approval, and SCS has approved, an Action Plan (See Section **12**) for meeting all Conditions placed on the certificate.

2.3 Meeting Conditions for Continued Certification

To be awarded an MSC certificate for the fishery, the applicants must agree in written contract to develop an action plan for meeting the required 'Conditions'; a plan that must provide specific information on what actions will be taken, who will take the actions, and when the actions will be completed. The Action Plan must be approved by SCS as the certification body of record. The applicant must also agree in a written contract to be financially and technically responsible for surveillance visits by an MSC accredited certification body, which would occur at a minimum of once a year, or more often at the discretion of the certification body (based on the applicant's action plan or by previous findings by the certification body from annual surveillance audits or other sources of information). The contract must be in place prior to certification being awarded. Surveillance audits will be comprised in general of (1) checking on compliance with the agreed action plan for meeting pre-specified 'Conditions', and (2) sets of selected questions that allow the certifier to determine whether the fishery is being maintained at a level of performance similar to or better than the performance recognized during the initial assessment.

2.3.1. General Conditions for Continued Certification

The general 'Conditions' set for the ODCC are:

- Client must recognize that MSC standards require regular monitoring inspections at least once a year, focusing on compliance with the 'Conditions' set forth in this report (as outlined below) and continued conformity with the standards of certification.
- Client must agree by contract to be responsible financially and technically for compliance with required surveillance audits by an accredited MSC certification body, and a contract must be signed and verified by SCS prior to certification being awarded.
- Client must recognize that MSC standards require a full re-evaluation for certification (as opposed to yearly monitoring for update purposes) every five years.
- Prior to receiving final certification, the Client shall develop an 'Action Plan for Meeting the Condition for Continued Certification' and have it approved by SCS.

2.3.2. Specific Conditions for Continued Certification

In addition to the general requirements outlined above, Client must also agree in a written contract with an accredited MSC certification body to meet the specific conditions as described in Section 10 and summarized below (within the timelines that will be agreed in the ' Action Plan for Meeting the Condition for Continued Certification' to be approved by SCS).

Specific Conditions are:

1.1.2 All removals from the Dungeness crab population are known, including the commercial and recreational catch, by-catch in the trawl fishery, and the catch and return of female Dungeness crabs and undersized males.

Score 70

Condition 1.1.2: Present results of sampling Dungeness crab fishing to determine the rate at which females are caught, whether hard or soft shelled, and time to release. Present an estimate of the mortality rate of released female crabs. Review estimates of recreational catch, by-catch in the trawl fishery and the catch of undersized males. Where data are lacking, conduct the sampling/monitoring necessary for estimates. Present a crude (or better) estimate of recreational catch, by-catch in the trawl fishery and the catch of undersized males.

By the 1st annual surveillance audit, Provide a list of the data available for each category requested and the planned approach.
By the 2nd annual surveillance audit, provide a list of who will accomplish each requirement and any results available.
By the 3rd annual surveillance, provide all requested results; including data, analyses, and a description of sampling in place for future data.

1.1.4 The dependence of productivity on abundance has been estimated and used to estimate potential TRPs and associated uncertainties.

Score 70

Condition 1.1.4: By the 2nd Annual Surveillance, update analysis of both yield-per-recruit (YPR) and eggs-per-recruit (EPR) that evaluates the trade-off in yield involved in a policy of not fishing females by incorporating values for mortality of catch and release mortality of females, and growth of females.

This analysis should include some evaluation of the effects of uncertainty on the conclusions regarding management policy. It should include the relevant conclusions in Methot (1989).

1.1.5 A Limit Reference Point (LRP) has been established and its level is computed at appropriate time intervals to determine whether the stock is depleted.

Score 75

Condition 1.1.5: By the 1st annual surveillance develop a method for integrating a measure of CPUE (or other estimate of abundance) with the long-term data available from the catch series to formulate a Limit Reference Point.

By the 2nd annual surveillance the Limit Reference Point and explicit management responses need to be formulated and in the process of being adopted by the ODF&W as regulatory instruments.

By the 3rd annual surveillance the Limit Reference Point and explicit management responses need to be adopted by ODF&W as a regulatory instrument.

3.1.3 The management system incorporates and applies an effective strategy to assess the socioeconomic potential and socioeconomic impacts of the fishery.

Score 70

Condition 3.1.3: A plan for the regular collection and assessment of economic and social data on the Dungeness crab fishery should be developed. The data should support the assessment of the socio-economic potential of the fishery, the socio-economic impacts of the fishery and the socio-economic impacts on the fishery of implementing no-take marine reserves.

By the 1st annual surveillance, a synthesis of existing data shall be developed.
By the 2nd annual surveillance, a draft plan shall be developed.
By the 3rd annual surveillance, the data collection plan shall be implemented.

3.1.6.1 The management system has a plan for research needed to support the harvest strategy.

Score 75

Condition 3.1.6.1: A strategic Research Plan for the Oregon Dungeness crab fishery should be developed to include

- biological, ecological and economic elements,
- a strategy for securing research funding support, and
- identified information gaps, needed research, and a strategy for filling information gaps.

The identification and synthesis of existing research should be completed by the time of the 1st annual surveillance audit.
The Plan shall be developed by the 2nd annual surveillance audit.
The Plan shall be implemented by the 3rd annual surveillance audit.
Evidence of procured research funding should be available by the end of the 5 year certification period

3.1.6.2 The management system has a plan for research needed to support the understanding of the ecological impacts of fishing.

Score 75

Condition 3.1.6.2: Research on the ecological impacts of fishing should be included as part of the research plan to be developed under Condition 3.1.6.1.

3.4.4 There is a process in place for rapid development of a recovery plan for Dungeness crab populations should significant depletion occurs, as did the population near San Francisco in the late 1950s. Significant depletion can be defined as dropping below the LRP.

Score 60

Condition 3.4.4: The definition of an LRP and plan for implementation of the management response required if the LRP is breached, as specified in the condition for 1.1.5, will meet the 80 scoring guidepost.

3.6.2 The management system provides for external assessment and review.

Score 75

Condition 3.6.2: As described in the Dungeness Crab Conservation and Management Act, biennial reporting shall be implemented on the status and management of the fishery including:

- stock status and trends throughout its range;
- description of the research and scientific review processes used to determine stock status and trends; and
- measures implemented or planned to prevent or end overfishing.

An updated report compliant with the specifications of the Act should be completed and submitted to Congress by the time of the 1st annual surveillance audit. In addition, a plan for the external review of the biennial reports to Congress and of management performance should be developed by the 1st annual surveillance audit and implemented by the time of the second annual surveillance audit. The plan should include a description of the primary data sources supporting the assessment, data management processes and funding.

3.6.3 The management system identifies research needs and directs appropriate funding and other resources to these problems.

Score 70

Condition 3.6.3: Actions to address Condition 3.1.6.1 and the research plan it describes will also address PI 3.6.3.

3. BACKGROUND TO THE REPORT

3.1 Assessment Team/Authors

Dr. Chet Chaffee, Project Manager, (formally of) SCS
Dr. Chaffee directed this assessment. Dr. Chaffee has over 20 years experience in the field of marine sciences, and more than 10 years of experience in environmental certification and eco-labeling. Dr. Chaffee has conducted or participated in certification projects for both small and large (Fortune 50) companies in a wide variety of industries from chemical manufacturing to food. Dr. Chaffee also has significant experience in conducting a variety of full assessments, from some of the largest and most complicated fisheries assessed and certified under the MSC program (Alaska salmon, British Columbia salmon, Bering Sea Pollock and Aleutian Islands Pollock - one of the largest commercial fisheries in the world, and Gulf of Alaska Pollock) to small community based fisheries (Lakes and Coorong Fishery in South Australia and Spiny Lobster in Baja California, Mexico).

Dr. Louis Botsford - University of California at Davis – Professor, Dept. Wildlife, Fish & Conservation Biology
Dr. Botsford is an internationally recognized expert on modeling and analysis of population dynamics as well as management of fisheries and marine protected areas.

Dr. David Armstrong - University of Washington – Director, School of Aquatic and Fishery Sciences
Dr. Armstrong brings expertise in crustacean ecology, fisheries population dynamics as well as aquaculture and fisheries enhancement.

Dr. Susan Hanna – Oregon State University – Professor, Dept. of Agricultural and Resource Economics
Dr. Hanna is affiliated with the Coastal Oregon Marine Experiment Station and Oregon Sea Grant. Her expertise is in fishery economics, fishery management and marine policy.

Dr. Sabine Daume, SCS
Dr Sabine Daume is responsible for leading SCS's Sustainable Seafood Certification program, which includes both fishery and chain of custody certification under the auspices of the Marine Stewardship Council (MSC), using the MSC methodology and standards. Dr. Daume has been involved and/ or lead numerous pre and full assessments, including the Western Australian Rock Lobster fishery; Mexican Spiny Lobster fishery, Mexican Sardine fishery; Australian Icefish fishery; the Australian Lakes & Coorong fishery and the North Pacific Halibut fishery and the North Pacific Sablefish (Black Cod) fishery. In addition Dr. Daume has been trained by the MSC to use the Risk Based Framework (RBF) of the new Fisheries Assessment Methodology for data deficient fisheries as well as is a Lead Auditor under the ISO 9001:2001 standard. Dr Daume is a marine biologist with special expertise in the biology and ecology of exploited marine resources. She has over 10 years experience working very closely with the fishing and aquaculture industry in Australia. In her role as the Senior Research Scientist at the Department of Fisheries in Western Australia, she lead research projects related to fishery enhancement and fisheries habitats of temperate and tropical invertebrate species.

3.2 Summary of Meetings

The sites and people chosen for visits and interviews were based on the assessment team's need to acquire information about the management operations of the fisheries under evaluation. Agencies and their respective personnel responsible for fishery management, fisheries research, fisheries compliance, and habitat protection were identified and contacted with the assistance of the client group and stakeholders.

The assessment team met with managers and scientists in May 2006. As with all assessments, there are always a number of issues that come to light when reviewing all the information with critical management and scientific personnel. Questions that arose after the meeting were handled through email and phone calls with the client and any other necessary entities. **Table 1** provides a general list of the people and organizations met during the onsite assessment process.

Table 1 Assessment Meetings & Attendees

22 May 2006 Newport, OR	▪ **Stock Status & Harvest Strategy** ▪ **Ecosystems** ▪ **Management**	Nick Furman, ODCC Cyreis Schmitt, Marine Policy Project Leader, ODFW Mitch Vance, Shellfish Project Leader, ODFW Jean McCrae, Shellfish Program Leader, ODFW Keith Matteson, Research Biologist, ODFW David Fox, Marine Resource Program Asst. Mgr., ODFW
23 May 2007 Newport, OR	▪ **Stakeholders**	No stakeholders expressed interest in attending.

3.2.1. Stakeholder meetings and interviews

Stakeholders were identified through a variety of means, including recommendations made by the client and the assessment team members utilizing their expert knowledge of the region's fisheries. These potential stakeholders were approached directly by email.

Advisory Notices were also posted on the MSC website. Advisory Notices included:

- the announcement of full assessment; posted 5 August 2004
- the announcement of assessment team; posted 19 April 2005
- the announcement of draft assessment tree; September 2005
- the announcement of assessment/stakeholder visit; posted 21 November 2005
- the announcement of potential peer reviewers; posted 23 February 2010
- the announcement of Public Comment Draft Report, posted 21 September 2010

In addition, public notification of full assessment was given in the print and electronic versions of

- *The Pacific Coast Federation of Fishermen's Associations*, November 2005
- *The Business Journal of Portland*, 9 August 2004
- *Marine Fish Conservation Network,* 14 September 2004, via email distribution list

To date no stakeholders have officially engaged (by email, written letter, phone, or fax) SCS at any time during the assessment process.

3.3 Submission of Data on the Fishery

One of the most significant, and difficult, aspects of the MSC certification process is ensuring that the assessment team gets a complete and thorough grounding in all aspects of the fishery under evaluation. In even the smallest fishery, this is no easy task as the assessment team typically needs information that is fully supported by documentation in all areas of the fishery from the status of stocks, to ecosystem impacts, through management processes and procedures.

Under the MSC program, it is the responsibility of the applying organizations or individuals to provide the information required proving the fishery or fisheries comply with the MSC standards. It is also the responsibility of the applicants to ensure that the assessment team has access to any and all scientists, managers, and fishers that the assessment team identifies as necessary to interview in its effort to properly understand the functions associated with the management of the fishery. Last, it is the responsibility of the assessment team to make contact with stakeholders that are known to be interested, or actively engaged in issues associated with fisheries in the same geographic location.

In the Oregon Dungeness Crab Fishery the client played a role in gathering information for use by the assessment team. Often the assessment team found information submitted by the client to be inadequate or insufficient to properly address the performance indicators and instead relied on their on expertise in the fishery.

4. THE OREGON DUNGENESS CRAB MANAGEMENT SYSTEM

The Pacific Ocean fishery for Dungeness crab (*Cancer magister*) is administered in the State waters of California, Oregon, and Washington and in the exclusive economic zone adjacent to those States. A related tribal fishery is conducted under court order (*United States* v. *Washington*, D.C. No. CV–70–09213) in designated "usual and accustomed" (U&A) areas.

4.1 Management History

The Pacific Fishery Management Council (PFMC) first reviewed options for Dungeness crab management in 1978, a year after the Council's formation. Management options under consideration included license limitation, taxes on catch and gear, and individual catch quotas (PFMC 1978). The Council subsequently declined to implement a federal Fishery Management Plan for the Dungeness crab fishery and no state license limitation plans were imposed at that time (Didier 2002).

A federal FMP has never been developed for the west coast Dungeness crab fishery. Instead, regulations for the conservation and management of Dungeness crab are implemented and enforced by the three states and tribal governments. These regulations include limits on the size and sex of crab that can be legally harvested, the timing of season openings and closings and—in the case of tribal fisheries—areas and times when harvest is limited to tribal fishermen. All three states have enacted laws which limit entry into the crab fishery and which prohibit non-permitted vessels from landing crab in the state. A Memorandum of Understanding is in effect among the three states which requires cooperation in setting size, sex, and season limits (U.S. House of Representatives 1998b; Anon. 2005).

The basic management structure has been stable over time. Washington, Oregon and California standardized measurement methods and opening dates in the 1960's. Other regulations developed by the three states' legislative and administrative processes were generally consistent. A 1980 Memorandum of Understanding committed the state management agencies to take mutually supportive crab management actions. In 1990, at the request of the crab industry, the Pacific States Marine Fisheries Commission (PSMFC) formed the Tri-State Dungeness Crab Committee (Fisher 1998). The Committee comprises one member from each state management agency, each with five industry advisors, and is chaired by the PSMFC (P. Burke 2007; D. Colpo 2007). It is advisory to the three member states.

In 1993, the PSMFC conducted a survey of the crab fleet to assess the support for limited entry. Based on the results of the survey, the Tri-State Dungeness Crab Committee participants sponsored independent crab licensing limitation efforts in each state. These programs became effective in 1995 and the 1995–1996 crab season was the first in which all coastal crab fisheries operated license limitation (Fisher 1998).

Despite the history of interstate cooperation in the management of Dungeness crab, the lack of state authority over fishing outside state waters became an increasing problem. Because a portion of the fishery occurs in the federal exclusive economic zone, the states were limited in their ability to enforce regulations against vessels registered under the laws of other states. Agreements between the State of Washington and tribal governments to accommodate tribal treaty fisheries were complicated by Washington's lack of authority over Oregon and California vessels which could legally fish in those portions of the tribal U&A areas outside state waters (U.S. House of Representatives 1998b)

In recognition of this confusing management problem, Congress enacted section 112(d) of the 1996 Sustainable Fisheries Act (amending the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 104–297 (16 U.S.C. 1856 note)) providing limited interim authority for the three states to enforce certain state regulations against all vessels operating in the exclusive economic zone and fishing

for Dungeness crab. That interim authority was to expire upon development of a shellfish fishery management plan by the PFMC or in 1999. (U.S. House of Representatives 1998b).

The PFMC convened an *ad hoc* committee to develop options to respond to this statutory direction. The Council adopted two options for public review: 1. Develop a FMP with some delegation of authority to the states; 2. Request Congress that it make permanent the interim authority for state management (PFMC 1997a). The PSMFC Tri-State Dungeness Crab Committee served as a forum for public hearings on these options (Tri-State Dungeness Crab Committee 1997).

The Tri-State Committee unanimously agreed that the Council should request Congress to make the interim authority permanent with extensions of state authority. The PFMC adopted this recommendation and forward it to Congress as its required report (PFMC 1997b). Council recommendations were subsequently incorporated into the 1998 Dungeness Crab Conservation and Management Act (HR 3498) (U.S. House of representatives 1998c). In passing this legislation Congress recognized that to ensure continued conservation, accommodate tribal treaty rights, and provide the states some means of addressing the growing problem of overcapitalization, some regulatory authority was necessary in the exclusive economic zone. It was further recognized that given the PFMCs budget constraints and increasing workload of developing new FMPs for coastal pelagic and highly migratory species, the development of a Dungeness crab FMP would strain the Council's capability to implement these plans effectively. H.R. 3498 represents Congress' recognition of the fishery's special circumstances and a conclusion that the fishery was being successfully conserved and managed under state and tribal authority (U.S. House of Representatives1998b;c).

4.2 State Authority for Management

The west coast Dungeness crab fishery is conducted in both state (0-3 nm from shore) and federal (3-200 nm) waters of Oregon, Washington and California. Most fishing is conducted within 50 miles from shore. (ODFW 2006c). A fishery spanning both state and federal zones is normally managed through a federal fishery management plan (FMP) developed through a regional fishery management council, with explicit state-federal coordination. The Dungeness crab fishery is an exception to this rule.

Section 302(e) of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) exempts the Dungeness crab fishery from the requirement of a federal FMP and instead authorizes the states of Washington, Oregon and California to adopt and enforce state laws and regulations governing Dungeness crab fishing and processing in the federal exclusive economic zone adjacent to each state. The interim state management authority established in the 1996 reauthorization of the MSFCMA was extended in the 2006 reauthorization until 2016, or until the implementation of a federal FMP (16 USC SS 1856(a)).

The Act specifies that under the granted state management authority any law or regulation adopted by a state shall apply equally to vessels engaged in the fishery in the exclusive economic zone and vessels engaged in the fishery in the waters of the state, and without regard to the state that issued the permit under which a vessel is operating. This means that a regulation such as a pot limit for Oregon-permitted vessels must also apply in an equal way to those permitted or licensed by the other states when they are fishing off Oregon. State regulations do not apply to vessels fishing under tribal treaty rights except as provided in *United States v. Washington,* and shall include any provisions necessary to implement tribal treaty rights pursuant to the decision in *United States v. Washington* (D.C. No. CV-70-09213).

The Act further specifies that:

- limited access systems established by each state apply only to those vessels fishing under that state's permit;
- a state permit or treaty right is required to fish;
- each state has authority to regulate fishing, fish processing and fish landing; and
- state management authority will continue until a federal FMP is implemented.

Under the MSFCMA Washington, Oregon and California have jurisdiction over their respective permit holders and permit conditions (such as gear and seasons) as well as control over conditions for making landings within a state. Regulatory issues that affect more than one state's fishery are negotiated through the Tri-State Dungeness Crab Committee coordinated by the PSMFC.

The PSMFC is required to submit to the Senate Committee on Commerce, Science, and Transportation and the House Committee on Resources a biennial report on the status and management of the fishery including:

- stock status and trends throughout its range;
- description of the research and scientific review processes used to determine stock status and trends; and
- measures implemented or planned to prevent or end overfishing.

The latest comprehensive description of the fishery was conducted under the auspices of the PSMFC in 2002 (Didier 2002.)

Independent of federally granted management authority, Oregon's Fishery Conservation Zone Statute (ORS 506.755) authorizes the Fish and Wildlife Commission (OFWC) to regulate fisheries out to 50 miles from shore.

Oregon Revised Statutes (ORS) contain rules and requirements related to licensing, fees and limited entry. Administrative rules adopted by the OFWC (Oregon Administrative Rules [OAR]) specify seasons, gear and fishery operational requirements.

A limited entry program (ORS 508.921) for the Oregon ocean Dungeness crab fishery was implemented in 1995. In recognition that the fishery was overcapitalized, that overcapitalization had led to economic destabilization of the industry and coastal communities, and that it could further result in excessive harvesting pressure, the limited entry legislation was designed to:

- promote the economic well-being of the crab industry and coastal communities;
- protect the livelihood of participants who had historically and continuously participated in the fishery; and
- prevent the concentration of fishing effort (ODFW 2006a).

Oregon's food fish management policy (ORS 506.109) specifies that "food fish shall be managed to provide the optimum economic, commercial, recreational and aesthetic benefits for present and future generations of the citizens of this state. In furtherance of this policy, the [relevant] goals of food fish management" are:

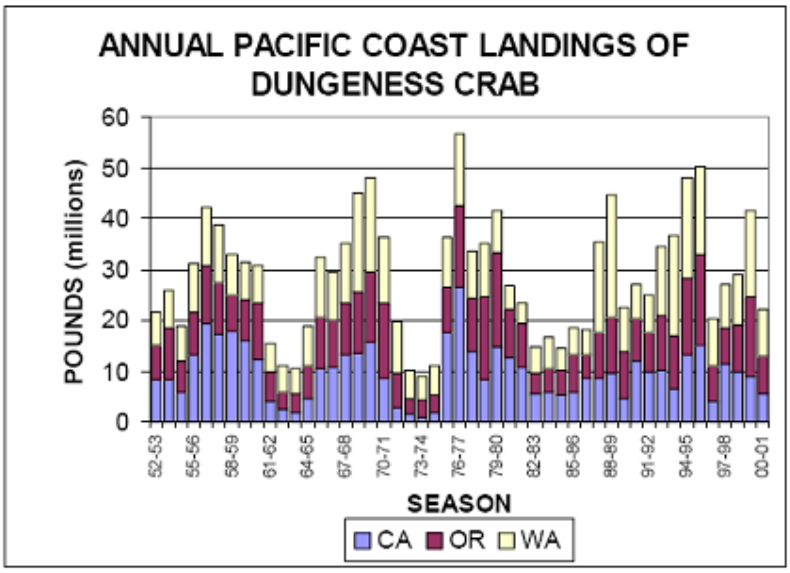
- maintain sustainable fisheries;
- maintain orderly fisheries; and
- minimize waste (ODFW 2006a).

By OFWC rule adopted in October 2005, Oregon commercial ocean Dungeness crab permits are not valid off Washington (0-200 miles) (OAR 635-005-0042). Similarly, Washington coastal Dungeness crab licenses are not valid off Oregon (0-200 miles). This arrangement is called LE-200 and involves geographic restrictions on the location of their permit holders to the state and federal waters adjacent to each adopting state. Presently only Washington and Oregon have adopted the plan. Consequently, vessels with only a Washington coastal crab license cannot fish off Oregon and no pots are allocated to these vessels. California currently does not have the authority to implement similar measures, so vessels having only a California commercial crab license may fish in federal waters off Oregon (3-200 miles). If they fish off Oregon, these California vessels are subject to the same pot limit plan as Oregon-permitted vessels (ODFW 2006a).

4.3 The West Coast Dungeness Crab Fishery

Landing of Dungeness crab in the coastal fisheries of California, Oregon, and Washington exhibit a cyclic pattern over time (**Figure 1**) with the bulk of the landings made in December of any given year. For the time period extending to 2006 (beyond that represented in Figure 1) landed catch has ranged between 8 million and 84 million pounds on an approximate 10-year cycle. 2006 west coast landings were a record high of 84.1 million pounds. Of this total Oregon landings were 33.3 million pounds (an increase of 88% over 2005). Of the U.S. total 2006 landings, Oregon landings comprised 37%. Most was caught within 3 miles of shore (NMFS 2007).

Figure 1. Annual landings of Dungeness crab in coastal fisheries in California, Oregon and Washington



Source: Didier 2002

Dungeness crab is commonly sold live, or as fresh or frozen "cooks" (whole cooked crab). Other products include sections, single legs and picked meat. Value-added products include canned and pasteurized meat, and "snap-'n-eats" (pre-cooked, pre-cracked crab claws) (Seafood Business 1999; Cascorbi 2004). Average 2006 ex-vessel price per pound was $1.68 (NMFS 2007). Ex-vessel prices of Dungeness crab typically vary within season, rising at the start of the season through April, then falling (Radtke and Davis 2005.) Oregon legislation exempting fishing organizations from anti-trust laws has been used in the crab fishery to negotiate a season opening price (Radtke and Davis 2005.)

4.4 Vessels and Permits

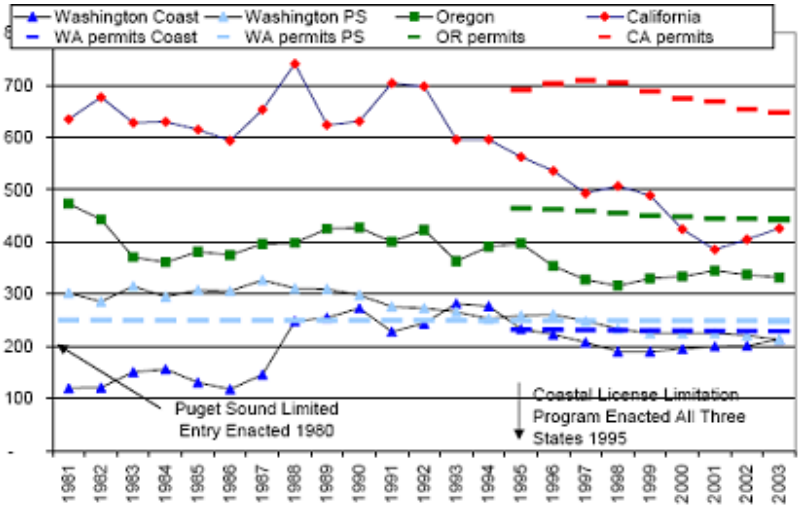
The number of vessels and permits in the Dungeness crab fishery has been on a declining trajectory since the early 1990s. The time series in **Figure 2** ends at 2003 and does not include the effect of the limited entry groundfish vessel buyback program, which also included Dungeness crab and pink shrimp permits. In this program 121 crab and shrimp permits were removed from the West Coast fleet (Pacific Fishery Management Council 2006).

Despite the reduction in vessels and permits, the number of traps being fished increased over that same time period (Dewees et al. 2005; Radtke and Davis 2005).

4.5 Oregon Fishery

In 2004 Oregon had 464 authorized and 433 active Dungeness crab permits. Three hundred forty-six vessels earned at least $500 landing Dungeness crab with Oregon permits in that same year; average gross revenue from Dungeness crab was $122,840. The top ten producing vessels in the fleet averaged $725,556 in gross revenues. In 2005 there were 433 permitted vessels, with 327 making landings to Oregon ports (ODFW 2006a). The availability of Dungeness crab combined with declining availability of other fisheries and the absence of limits on the amount of gear fished led to an increase in the amount of crab pots being fished (Radtke and Davis 2005).

Figure 2. Count of active Dungeness crab vessesls by home port state and cout of permits by state from 1981 to 2003.



Notes: 1. Vessels can be permitted in more than one state. Washington home port vessels can be both coast and Puget Sound.
2. Includes only non-tribal vessels with Dungeness crab landings in their home port state.
3. Vessels are assigned to states by the port group where they had the most revenue.

Source: PacFIN January 2003 to August 2004 extractions for vessel counts. ODFW, WDFW, CDFG for permits.

Dungeness crab landings have been at record high levels in recent years during which crab has been the most valuable fishery in Oregon (ODA 2006). The number of pots being fished increased over time, as did the length of time they were fished during the season (ODFW 2006a). In 2006 the OFWC adopted a tiered system of pot limits to control the level of gear capacity in the fishery (ODFW 2006f).

4.5.1. Fishery Management in Oregon

Oregon's Dungeness crab fishery regulations are implemented by the legislature and administrative branch. License requirements, fees, and limitations on entry generally require legislative action. These regulations are found in the Oregon Revised Statutes (ORS).

Oregon's regulations concerning the time, place, and conduct of the coastal crab fishery are administrative rules adopted by the OFWC (Oregon Administrative Rules [OAR]). Oregon Dungeness crab fishery is managed by the "3-S" system, which refers to size, sex and season. Only male Dungeness crab are harvested commercially, and the minimum commercial harvest size is a carapace width greater than 6.25 inches (159mm), measured by the shortest distance across the back immediately in front of the lateral spines. The minimum size limit is designed to protect sexually mature crab from harvest for one or two seasons, and season scheduling is designed to provide some measure of protection to crabs during times when molting takes place. Output quotas are not used in the fishery. No pre-season forecasts of stock abundance, and harvest levels are based on recruitment into acceptable harvest categories (Didier 2002).

The "3-S" management approach has been stable over time. Oregon implemented regulations prohibiting the sale of female Dungeness crabs in the late 1940s. Minimum size regulations were first implemented by California in 1903, and have remained substantially unchanged since 1911. Methods of measurement were standardized in the mid-1960s. Season opening dates have generally remained the same since the late 1960s (Didier 2002; Chaffee and Botsford 2003).

Regulations are generally consistent across states. A 1980 interstate Memorandum of Understanding (MOU, subsequently amended), commits the state management agencies to take mutually supportive crab management actions. In addition to the basic regulatory structure, the states require 4.25-inch diameter escape rings (for undersize crabs) on all pots, biodegradable escape mechanisms, and identifying marks on pot buoys. A pre-season "soak" time during which baited pots may be placed on the fishing grounds allows harvest on the season opening day (Didier 2002).

4.5.2. Season Opening

Based on discussions of the Tri-State Dungeness Crab Committee provisions to provide formal multi-state preseason quality testing of Dungeness crabs were added to the state agencies' crab MOU in 1993 and subsequently amended in 1996. The provision includes a pre-season sampling and testing protocol to estimate whether large numbers of post-molt soft shell crabs will be present on December 1. If the meat recovery percentage from crabs in the test area is projected to be below 23%, the fishery opening in Washington and northern Oregon waters is delayed by 15-day increments until that standard is reached, or until January 15. Even if the season in the northern area is delayed, some segments of the coastwide fishery may still open as scheduled on December 1. (Didier 2002). The opening of the central California fishery takes place two to three weeks earlier than the northern California, because crabs in central California molt earlier and achieve adequate market condition at an earlier date (Leet et al. 2001).

Legislation to authorize a similar pre-season soft shell testing program in California was introduced during 1994, and industry-funded pre-season testing began there prior to the 1995-96 season. Modeled after the northern area agreement, the protocol includes tests monitored by the PSMFC and a minimum meat recovery of 25%. The Tri-State Dungeness Crab Committee endorsed the California testing program in 1996, and in 1997 recommended that the management agencies in Washington and Oregon enact complementary regulations (Didier 2002).

Oregon enacts in-season regulations to control the pace of the fishery at the end of the season. A weekly trip limit is imposed from June to August to lower the potential for expansion of the summer live softshell crab fishery (PSMFC 1999).

The summer-fall closed periods are intended to prevent fishing on soft-shelled male crabs when they are vulnerable to fishery-related handling mortality and would have market quality well below their potential (Leet et al. 2001).

4.5.3. License Limitation

By the early 1990s license limitation schemes were in effect for all or portions of the West Coast salmon (both ocean troll and Columbia River gillnet), scallop, and pink shrimp fisheries, and a permit limitation plan was implemented for the West Coast groundfish fishery in 1994. Participants in the Dungeness crab fishery were concerned that license limitation in other fisheries could lead to speculative participation in the then unlimited Dungeness crab fishery. Development of state crab license limitation programs followed. The OFWC set a 2001 entry qualification control date in 2002. The Oregon license limitation program (HB 3094) was implemented in 1995. The fleet consists of 433 permitted vessels, although only

327 of those Oregon permitted vessels made landings into Oregon ports during the 2004-2005 season (ODFW 2006a).

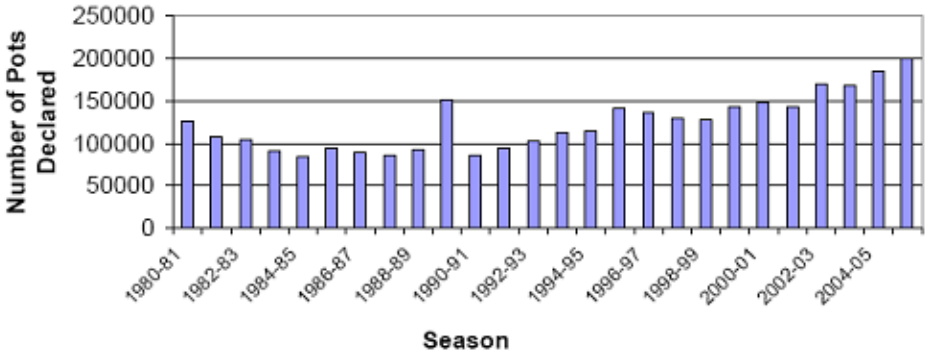
Pot Limits: The Oregon Fish and Wildlife Commission (OFWC) implemented pot limits in the limited entry Dungeness crab fishery in 2006. Concern had been growing within the industry and among managers about the amount of crab gear being fished. Over time more crab pots were reportedly being fished per vessel for longer periods of time during the season. The estimated number of pots declared by Oregon license holders had been increasing since the1990-91 season to a high of almost 200,000 in 2005 (**Figure 3**). Initial estimates for the 2006-07 season were approximately 235,000, for Oregon license holders alone (ODFW 2006a;c).

As noted in the ODFW material prepared for the OFWC (ODFW 2006a;c), the increase in number of crab pots was exacerbating the concentration of early-season fishing effort. Oregon industry participants had a number of concerns about the transport and deployment of growing amounts of gear in winter months which were all diminishing the ability to conduct an orderly fishery:

- increases in gear loss (loss rate: 10-15%. Gear loss for 2004-05: 18-20,000 pots, Oregon-permitted vessels only);
- gear conflicts within the crab fishery and with other fisheries;
- gear used to "reserve real estate" on the ocean floor during the early season
- resource waste;
- repeat exposure of non-target (female and small) crab to gear/removal/discard; and
- navigation risks.

These concerns were also shared by managers at ODFW. A one-year interim pot limit plan proposed to the OFWC in August 2002 was not adopted. However, the OFWC did establish a date of August 14, 2001 as a control point for eligibility criteria for any future pot limit plan.

Figure 3. Oregon crab pots declared by season



Source: ODFW 2006

In 2004 Oregon crab industry representatives wrote to ODFW detailing the urgent need to control the growing amount of gear used in the fishery (Pazar et al. 2004). A survey of all Oregon permit holders conducted by the Oregon Dungeness Crab Commission (ODCC) in 2005 showed a majority in favor of pot limits. Also in 2005 ODFW and ODCC sponsored a Crab Industry Summit to gauge interest in a pot limit program for Oregon. Summit participants were challenged to develop a consensus proposal to reduce gear in the fishery. Significant progress towards consensus was made but a final pot allocation approach was not resolved. In 2005, at the direction of the OFWC, ODFW staff worked with the crab industry, and enforcement personnel to develop program options. These were presented to the OFWC in March 2006. A final vote was taken in June 2006 approving a three-tiered pot limit plan (ODFW 2006f).

By OFWC rule (OAR 635-005-0042) adopted in October 2005, Oregon commercial ocean Dungeness crab permits are not valid off Washington (0-200 miles). Similarly, Washington coastal Dungeness crab

licenses are not valid off Oregon (0-200 miles). Consequently, vessels with only a Washington coastal crab license cannot fish off Oregon and no pots are allocated to these vessels. Since California does not currently have a pot limit plan, vessels having only a California commercial crab license fishing in federal waters off Oregon (3-200 miles) are subject to the same pot limit plan as Oregon-permitted vessels.

4.5.4. Fishery Data

Landed catch and ex-vessel value are recorded through the fish ticket systems of the ODFW and archived by the PSMFC in the Pacific Fisheries Information (PacFIN) database. In Oregon, the volume and value of landed catch is reported annually in the Oregon Agricultural and Fishery Statistics (ODA 2006). In addition, annual fishery summaries have been jointly contracted by the Oregon Coastal Zone Management Association (OCZMA) and the ODFW (cf Radtke and Davis 2004; 2005). Also, fleet profiles and landings distributions were summarized to evaluate the impacts of various pot limits (Kaiser et al. 2002).

Aside from sale price, no additional economic data is regularly collected. Most economic and social information is anecdotally provided at meetings and hearings or developed through occasional research projects. Notable exceptions are the research projects looking at economic options for the Dungeness crab fishery and the economic implications of management funded by CalCOFI and California Sea Grant (Dewees et al 2004; Hackett et al. 2003; 2004; Hankin et al 2005).

5. TRACKING AND TRACEABLITY

Traceability of product from the sea to the consumer is vital to ensure that the MSC standard is maintained. There are several aspects to traceability that the MSC require to be evaluated: Traceability within the fishery; at-sea processing; at the point of landing; and subsequently the eligibility of product to enter the chain of custody.

5.1 Traceability within the fishery

For the Dungeness crab fishery, all landings are recorded and reported. Landed catch and ex-vessel value are recorded through the fish ticket systems of the ODFW and archived by the PSMFC in the Pacific Fisheries Information (PacFIN) database.

Commercial fishers must retain copies of fish landing receipts for a minimum of 90 days on board vessels landing Dungeness crab. The receipts must be available for inspection by authorized enforcement officials and by employees of ODFW.

5.2 At-sea processing

Processing at sea does not occur in this fishery. Processing occurs on shore. Dockside sampling is conducted and thereby monitoring product origin and throughput at the processing facility.

5.3 Points of landing

Dungeness are landed primarily in the ports of Newport/Waldport, Charleston, Brookings/Gold Beach and Astoria/Seaside. Some landings also take place at the ports of Garibaldi/Pacific City, Port Orford, Florence/Winchester Bay and Depoe Bay.

5.4 Eligibility to enter Chains of Custody

Dungeness crab landed by any licensed vessels is eligible to enter further chains of custody. Companies buying directly from this fishery are required to have chain of custody certification and shall keep a record of the landing slip to ensure that product originated from the certified fishery.

This report does not cover processing beyond the point of landing. This report acknowledges that sufficient monitoring takes place to identify the fishery of origin for all landed Dungeness Crab via

landing slips. This is sufficient to allow a Chain of Custody to be established from the point of landing forward for all products derived from the fishery. MSC chain of custody certifications were not undertaken in this project, and therefore, needs to be undertaken on a separate and individual basis for those entities that may wish to identify and/or label products derived from the fishery.

5.5 Actual Eligibility Date

The Actual Eligibility Date for this fishery is set as 1 December 2010 to coincide with the beginning of the fishing season.

6. MSC PRINCIPLES AND CRITERIA

MSC Principle 1 – Stock Status and Harvest Strategy

A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted; the fishery must be conducted in a manner that demonstrably leads to their recovery.

Intent:
The intent of this principle is to ensure that the productive capacities of resources are maintained at high levels and are not sacrificed in favor of short term interests. Thus, exploited populations would be maintained at high levels of abundance designed to retain their productivity, provide margins of safety for error and uncertainty, and restore and retain their capacities for yields over the long term.

MSC Criteria:

1. The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity.
2. Where the exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level consistent with the precautionary approach and the ability of the populations to produce long-term potential yields within a specified time frame.
3. Fishing is conducted in a manner that does not alter the age or genetic structure or sex composition to a degree that impairs reproductive capacity.

MSC Principle 2 – Ecosystem

Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

Intent:
The intent of this principle is to encourage the management of fisheries from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

MSC Criteria:

1. The fishery is conducted in a way that maintains natural functional relationships among species and should not lead to trophic cascades or ecosystem state changes.
2. The fishery is conducted in a manner that does not threaten biological diversity at the genetic, species or population levels and avoids or minimizes mortality of, or injuries to endangered, threatened or protected species.

3. Where exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level within specified time frames, consistent with the precautionary approach and considering the ability of the population to produce long-term potential yields.

MSC Principle 3 – Management

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

Intent:
The intent of this principle is to ensure that there is an institutional and operational framework for implementing Principles 1 and 2, appropriate to the size and scale of the fishery.

MSC Criteria:

A. Management System Criteria:

1. The fishery shall not be conducted under a controversial unilateral exemption to an international agreement.

The management system shall:

2. demonstrate clear long-term objectives consistent with MSC Principles and Criteria and contain a consultative process that is transparent and involves all interested and affected parties so as to consider all relevant information, including local knowledge. The impact of fishery management decisions on all those who depend on the fishery for their livelihoods, including, but not confined to subsistence, artisanal, and fishing-dependent communities shall be addressed as part of this process;
3. be appropriate to the cultural context, scale and intensity of the fishery – reflecting specific objectives, incorporating operational criteria, containing procedures for implementation and a process for monitoring and evaluating performance and acting on findings;
4. observe the legal and customary rights and long term interests of people dependent on fishing for food and livelihood, in a manner consistent with ecological sustainability;
5. incorporates an appropriate mechanism for the resolution of disputes arising within the system;
6. provide economic and social incentives that contribute to sustainable fishing and shall not operate with subsidies that contribute to unsustainable fishing;
7. act in a timely and adaptive fashion on the basis of the best available information using a precautionary approach particularly when dealing with scientific uncertainty;
8. incorporate a research plan – appropriate to the scale and intensity of the fishery – that addresses the information needs of management and provides for the dissemination of research results to all interested parties in a timely fashion;
9. require that assessments of the biological status of the resource and impacts of the fishery have been and are periodically conducted;
10. specify measures and strategies that demonstrably control the degree of exploitation of the resource, including, but not limited to:
    a) set catch levels that will maintain the target population and ecological community's high productivity relative to its potential productivity, and account for the non-target species (or size, age, sex) captured and landed in association with, or as a consequence of, fishing for target species;
    b) identify appropriate fishing methods that minimize adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;

c) provide for the recovery and rebuilding of depleted fish populations to specified levels within specified time frames;
d) have mechanisms in place to limit or close fisheries when designated catch limits are reached;
e) establish no-take zones where appropriate;

11. contain appropriate procedures for effective compliance, monitoring, control, surveillance and enforcement which ensure that established limits to exploitation are not exceeded and specify corrective actions to be taken in the event that they are.

B. MSC Operational Criteria:
Fishing operations shall:

12. make use of fishing gear and practices designed to avoid the capture of non-target species (and non-target size, age, and/or sex of the target species); minimize mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive;
13. implement appropriate fishing methods designed to minimize adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;
14. not use destructive fishing practices such as fishing with poisons or explosives;
15. minimize operational waste such as lost fishing gear, oil spills, on-board spoilage of catch, etc.;
16. be conducted in compliance with the fishery management system and all legal and administrative requirements; and
17. assist and co-operate with management authorities in the collection of catch, discard, and other information of importance to effective management of the resources and the fishery.

Interpretations of MSC Principles for Performance Assessments

Along with developing a standard for sustainable fisheries management, the MSC also developed a certification methodology that provides the process by which all fisheries are to be evaluated. ASI accredits certification bodies that can show that the expertise and experience necessary to carry out MSC evaluation is present in the organization. In addition, each certification body must demonstrate its fluency with the MSC standards and evaluation methods through the use of these in a fishery evaluation

The methods are provided in great detail through documents that can be downloaded from the MSC website (www.msc.org).

The MSC Principles and Criteria are general statements describing what aspects need to be present in fisheries to indicate that they are moving toward sustainable management. The certification approach or methodology adopted by the MSC requires that any assessment of a fishery or fisheries move beyond a management verification program that simply provides third-party assurances that a company's stated management policies are being implemented. The MSC's 'Certification Methodology' is designed to be an evaluation of a fishery's performance to determine if the fishery is being managed consistent with emerging international standards of sustainable fisheries.

7. THE MSC STANDARD AND CERTIFICATION METHODOLOGY

The Marine Stewardship Council standards for sustainable fisheries management were developed through an 18-month process (May, Leadbitter, Sutton, and Weber, 2003). An original draft was developed by an expert working group, which met in Bagshot, UK in 1996. The draft standard was then presented through a series of 8 workshops that lasted 3 days each. Comments from each of the workshops, and from written submissions to the MSC were compiled and made available to a second expert working group at Airlie House in Virginia, USA.

The scope of the MSC Principles and Criteria relates to marine fisheries activities up to but not beyond the point at which the fish are landed. The MSC Principles and Criteria apply at this stage only to marine fishes, fresh water fishes, and invertebrates (including, but not limited to shellfish, crustaceans and cephalopods). Aquaculture and the harvest of other species are not currently included. Issues involving allocation of quotas and access to marine resources are considered to be beyond the scope of these Principles and Criteria.

Sustainable fishing Principles and Criteria have been identified by the MSC to recognize the diversity of fisheries across the world. The MSC derived an evaluation methodology that would maintain the intent and rigor of its Principles and Criteria but allow enough flexibility in the application of the standard to permit scientists to make sound judgments about the sustainability of any given fishery regardless of differences in species composition, geographic location, oceanographic conditions, or fishing methods.

The flexibility in the MSC evaluation methodology is achieved in two ways: first, the scientists conducting an evaluation translate the MSC Principles and Criteria into a set of sub-criteria and performance indicators to provide appropriate and specific measures of performance for the fishery or fisheries being assessed. In addition, a set of "scoring guideposts" is provided to describe the basis by which fisheries will be measured against the indicators. Once the sub-criteria, indicators, and scoring guideposts are finalized, the evaluation team of scientists prioritizes and weights the sub-criteria and indicators to indicate the importance of each of the factors to the overall sustainability of the fishery or fisheries.

Section 9.1 contains the set of sub-criteria, indicators and scoring guideposts used in the assessment of Oregon Dungeness crab fishery. Most fisheries that have been assessed to date use the standard approach of examining stock specific abundances and the strategies employed to maintain abundance above some threshold levels deemed sustainable. The management of the Oregon Dungeness crab fishery is not managed in the same way. They do not use fishery management infrastructures to address an annual assessment of productivity and all the parameters necessary to achieve a given level of productivity.

Due to the fact that the Dungeness crab fishery in Oregon is managed in a different manner than the fisheries previously assessed under the MSC program, the assessment team has found it necessary to adjust the way in which it asks questions about the performance of the management system and the requirements for verification that the system is performing sustainably. We have drafted a set of performance indicators and scoring guideposts that hopefully capture the rigor and flexibility necessary to address performance in fisheries that use a very different management strategy to protect stocks and the ecosystem without significantly altering the level of performance required to achieve certification.

Under the MSC assessment protocols, each indicator must receive a score between 0 and 100. Therefore, scoring guideposts are provided to illustrate what the assessment team will be looking for in assigning scores to an indicator.

Scoring guideposts labeled as '100' indicate the best performance achievable for an indicator. This is the highest mark any fishery could be expected to receive. The '80' scoring guidepost references the level of acceptable performance for an indicator; whereas, the '60' scoring guidepost indicates the minimal threshold allowable in an MSC evaluation. Indicator scores between 80 and 100 do not require any further action. A score between 60 and 80 for an indicator, points out that the evaluating scientists identified a minor deficiency that needs corrective action. An indicator score of 60 or lower indicates a major deficiency in the fishery that needs corrective action. The scoring guideposts used to rate an indicator are

meant to be hierarchical in that to meet a particular score, the scoring guideposts of all lower scores should also have been met.

A fishery is considered to pass the MSC evaluation process and recommended for certification when it receives a weighted score of 80 or above on each of the three MSC Principles. For fisheries where the weighted score of each MSC Principle is 80 or above, but specific indicators achieve a score between 60 and 80, the fishery is considered to have passed the MSC evaluation process but certification can only be awarded if the applicant fishery agrees in writing to correct the identified deficiencies specified by the evaluation team. In fisheries where given indicators score 60 or below, a fishery cannot pass the evaluation process and cannot be awarded certification until the major deficiency is corrected to the satisfaction of the evaluation team.

All sub-criteria and indicators are also weighted indicating their relative importance in setting the overall scores for the fishery. The weighting process will proceed after the evaluation team has received public comments on this draft and been able to incorporate the comments to create a final set of sub-criteria, indicators, and scoring guideposts for use in the evaluation process.

8. SCORING PROCESS AND PISGS

After completing all the reviews and interviews, the assessment team is tasked with utilizing the information it has received to assess the performance of the fishery. Under the MSC program, the process for assessing the fishery is performed by prioritizing and weighting the indicators relative to one another at each level of the performance hierarchy established when the assessment team developed the set of performance indicators and scoring guideposts for the fishery. Subsequent to this, the assessment team assigns numerical scores between 0 and 100 to each of the performance indicators. All of this is accomplished using decision support software known as Expert Choice, which utilizes a technique known as AHP (Analytical Hierarchy Process). A full description of the AHP process can be found on the MSC web site (www.msc.org). In essence, the process requires that all team members work together to discuss and evaluate the information they have received for a given performance indicator and come to a consensus decision on weights and scores. Scores and weights are then combined to get overall scores for each of the three MSC Principles. A fishery must have normalized scores of 80 or above on each of the three MSC Principles to be recommended for certification. Should an individual indicator receive a score of less than 80, a 'Condition' is established that when met, would bring the fishery's performance for that indicator up to the 80 level score representing a well-managed fishery.

9. PERFORMANCE INDICATORS AND SCORING GUIDEPOSTS

This section contains the set of sub-criteria, indicators, and scoring guideposts used in evaluating the Oregon Dungeness crab fishery.

The key to understanding the criteria is to understand the differences between the MSC Principles. Principle 1 focuses on the target population, defined as target species or target stocks. Under this principle the fundamental building blocks for sound fisheries management are considered:

1. The definition of the target stocks;
2. The quality of monitoring and stock assessment programs;
3. The specific management goals for target stocks;
4. The procedures to facilitate the recovery of target stocks that are depleted; and
5. The fisheries are conducted in a manner that will not compromise the age, size and genetic structure of the target stocks.

Principle 2 focuses on the impact of the fishery on the ecosystem and non-target populations. Here we are assessing how the fishery management operations deal with:

1. The importance of maintaining a productive, functional and diverse ecosystem;
2. Provisions to minimize the fishery impacts on endangered, threatened, protected or icon species; and
3. Procedures for the recovery of depleted non-target stocks.

Principle 3 focuses on the management and operational framework that has been put in place to achieve the management goals. Some indicators under Principle 3 appear to overlap with indicators under Principles 1 and 2, however, the Principles 1 and 2 are concerned with the outcomes of a management system respecting the fact that the resources are maintained at the desired levels of abundance, while Principle 3 is concerned with evaluating whether all of the processes for reaching management objectives are in place. Components unique to Principle 3 include:

1. The evaluation of the consultation process;
2. The procedures used to control fisheries;
3. The extent of internal and external review of the management system;
4. The compliance with legal and administrative requirements; and
5. The implementation of responsible fishing practices.

The management of fisheries has often been divided into five major components:

1. Resource inventory;
2. Pre-season planning;
3. In-season management (i.e. conducting the fisheries);
4. Post-season evaluations; and
5. Research and stock assessment.

Each of these components is covered by the proposed evaluation criteria. Criteria under Principles 1 and 2 address most of the issues associated with resource inventory and pre-season planning while Principle 3 criteria address in-season management and post-season evaluations. Issues associated with research and stock assessment are included under each of the three MSC Principles as they apply to target stocks, non-target stocks and the management of fisheries.

10. ASSESSMENT TEAM FISHERY PERFORMANCE EVALUATIONS

After completing all the reviews and interviews, the assessment team is tasked with utilizing the information it has received to assess the performance of the fishery. Under the MSC program, an Assessment Tree is determined for this task. The proposed Assessment Tree is made available for public comment for a period of 30 days. All comments are considered and the Assessment Tree revised where appropriate. The finalized Assessment Tree is used to evaluate the performance of the fishery. Unless determined unsuitable for the particular fishery, the MSC Default Assessment Tree is used whereby the weighting of the Performance Indicators is pre-determined. The Risk-Based Framework may also be used for data poor fisheries. The Assessment Tree may also be modified to suit the specifics of the fishery. In such a case, the process for assessing the fishery is performed by prioritizing and weighting the Performance Indicators (PI) relative to one another at each level of the performance hierarchy established when the assessment team develops the Assessment Tree for the fishery. Each PI has three associated Scoring Guideposts (SG) set at 60, 80 and 100. The SGs have specific elements that must be met for the fishery to get at least a partial score for the particular SG. Each PI under each Principle is weighted so that each of the three Principles is equal to one another. If a fishery scores less than 60 for any PI, it is excluded from certification. The process requires that all team members work together to discuss and evaluate the information they have received for a given performance indicator and come to a consensus decision on weights and scores. Scores and weights are then combined to get overall scores for each of the three MSC Principles. A fishery must have normalized scores of 80 or above on each of the three MSC Principles to be recommended for certification. Should an individual PI receive a score of less than 80, a 'Condition' is established that when met, would bring the fishery's performance for that indicator up to the 80 level score representing a well-managed fishery.

Below is a written explanation of the assessment team's evaluation of the information it received and the team's interpretation of the information as it pertains to the fishery's compliance with the MSC Principles and Criteria.

10.1 MSC Principle 1

A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery.

Under MSC Principle 1, previous assessments have started by addressing the definition of the stock, so that it will be well defined in subsequent indicators that refer to it. The next area of inquiry has typically been to address the effects of the fishery on the stock, i.e., by asking whether removals and escapement are estimated, and whether productivity is estimated. This information is used to assess whether the fishery is managed in a way that prevents overfishing while allowing sustainable catches. This step typically asks whether there is a pre-agreed harvest control plan in place, and it usually involves some aspect of the Precautionary Approach, e.g., Limit Reference Points, Target Reference Points, greater caution with greater uncertainty, appropriate placement of the burden of proof. To satisfy the second criterion, assessment teams ask whether stocks are depleted and whether there is a recovery plan in place if depletion has occurred. To satisfy the third criterion, questions are structured to determine whether fishing has changed age, genetic or sex structure in such a way as to impair reproductive capacity in the fishery.

In formulating the performance indicators for Principle 1, we seek to avoid lowering the bar below the requirements for more intensively managed fisheries, but rather our goal is to shape the criteria so that they allow a broader range of methods for guaranteeing the same level of sustainability. The principle guiding our approach is the trade-off between the amount of risk inherent in the management tactics

employed and the amount of monitoring consequently required. Higher risk tactics, such as high removal rate and depletion of spawning potential, implies more intensive monitoring is required to avert fishery collapse, and vice versa.

Management of the Oregon Dungeness crab fishery does not involve the fishery management infrastructures typically in place to allow a fishery to meet the above requirements. For example, the Oregon Dungeness crab fishery has no annual assessment, hence management does not respond annually to changes in abundance, catch or escapement. The question for the assessment of sustainability of the Oregon Dungeness crab fishery then is whether the Dungeness crab fishery, which does not employ exactly the same devices employed by other fisheries, maintains a level of sustainability the same as that maintained by other fisheries that meet MSC assessment criteria by more conventional means. We allow for the fact that Oregon Dungeness crab managers may have chosen not to spend their resources on annual stock assessments, but rather to account for the consequent greater uncertainty by adopting less risky harvesting strategy. That would be consistent with the Precautionary Approach to fisheries management.

In formulating the performance indicators for Principle 1, we sought to avoid lowering the bar below the requirements for more intensively managed fisheries, but rather our goal is to shape the assessment criteria so that they allow a broader range of methods for guaranteeing the same level of sustainability, possibly with less monitoring and analysis but equally rigorous accounting of sustainability. The principle guiding our approach is the trade-off between the amount of risk inherent in the management tactics employed and the amount of monitoring consequently required. Higher risk tactics, such as high removal rate and depletion of spawning potential, implies more intensive monitoring is required to avert fishery collapse, and vice versa. Consistent with the Precautionary approach we allow for strategies that are explicitly risk averse: uncertainty regarding the status or productive capacity of a fishery can be accounted for by greater caution in setting target and limit reference points.

The tactic employed in management of Dungeness crab that reduces the risk inherent in fishing is single sex harvesting. The effects of male only harvesting can be understood in terms of a common indicator of population persistence, lifetime egg production (LEP). Lifetime egg production describes the degree of replacement of individuals in a population through reproduction throughout their lifetime. It is commonly used as a reference point in more intensively managed fisheries, where it is calculated from a stock assessment as the Spawning Potential Ratio (SPR) (Goodyear 1993). The SPR is the ratio of current LEP to LEP of the natural, unfished population. The value required for individuals to replace themselves has commonly been taken to be near 35 percent (Mace and Sissenwine 1993, Clark 2002) , but recent collapses, such as that of the groundfish off the west coast of the U.S. have suggested that larger values are necessary for some species (Ralston 2002, Dorn 2002).

The implications of this indicator relevant to the Dungeness crab fishery is that in male only fisheries, as long as (1) female mortality is not increased by the fishery and (2) male abundance remains high enough that fertilization is not reduced, the value of SPR is 100 percent, far above the value commonly expected. The consequent low value of fishery-induced risk associated with this tactic implies that monitoring, such as that required in a Limit Reference Point, need not be as intensive. However, some monitoring is still required. High LEP in a single sex fishery is not a guarantee that a fished population will not collapse. It is merely an indication that the effect of the fishery on the age structure, as it affects reproduction, is negligible. The collapse of the Central California Dungeness crab fishery is an example of a fishery with single sex management that did collapse to low abundance in the late 1950s.

This approach is conceptually consistent with other approaches to management of data-moderate or data-poor fisheries. For example, in the management of federally managed U.S. fisheries an approach to data deficient fisheries is to use a value of fishing mortality rate corresponding to values of SPR of 20-60 percent (Restreppo, et al. 1998). In the Oregon Dungeness crab fishery, the effective value of SPR is 100 percent, if there is no female mortality and fertilization rates are at 100 percent.

The cost of this approach is minimal: less decline in population density than would occur if females were also harvested. This is similar to the buck-only hunting in deer management, where there is also no control on density. In the case of Dungeness crab, modeling studies indicate that size selective harvest of males only does not lower the equilibrium population density, and the narrowing of the adult size distribution tends to make the population more susceptible to environmental variability (Botsford and Wickham 1978, Botsford 1986). Thus the cost of lower risk by not fishing female Dungeness crab is a greater propensity toward cyclic variability.

With regard to the cyclic variability observed in Dungeness crab populations in Oregon, one can read many different points of view regarding "the" cause of the cycles. It is most prudent to say that the cycles are a result of the combination of: (1) a propensity for cycling inherent in the population dynamics (i.e., some form of density-dependent recruitment) and (2) random fluctuations in environmental conditions (Botsford and Wickham 1978, Botsford 1986, Botsford, et al. 1998, Botsford and Lawrence 2002).

1.1.1

The geographic extent of the stock being fished is known, including the geographic extent beyond the managed fishery's boundaries and the enhancement of the managed-fishery population by larval and adult ingress from neighboring states, as well as the larval and adult egress to neighboring states.

SG 60	SG 80	SG 100
The extent of the Dungeness crab population is known to extend far beyond the management boundaries. The full extents of adult and larval movements are only poorly understood.	The extent of the Dungeness crab population is known. Larval exchange, including inter-annual variability is estimated to within an order of magnitude, or can be shown to be inconsequential. Adult exchange is estimated with a precision of 50 percent or better.	The extent of the Dungeness crab population is known. It can be assumed without strong disagreement within the management community that larval and adult exchange between a single state and neighboring states does not involve strong source/sink effects (i.e., movement in one direction). There is some information on adult movement, and it is relatively low.

Score: 85

The offshore extent of the population is well known, and alongshore the metapopulation of Dungeness crab extends on soft bottom habitat from Santa Barbara, CA to Unalaska, AK (Jensen 1995). Larval dispersal distance is poorly known, but adult movement in the alongshore direction is typically only several kilometers, and rarely as much as 85 km (Collier 1983, Diamond and Hankin 1985). From this one can conclude that the adult exchange is a low percentage of total abundance. This estimate would have a precision of 50 percent or better. Larval exchange has not been estimated. Because larvae occur as far as 400 km offshore (Hobbs, et al. 1992), larvae would likely be transported to the north in the Davidson current, then to the south in the California Current or the nearshore coastal jet due to upwelling winds. We are not aware of efforts to estimate net larval exchange with parts of the metapopulation in neighboring states.

1.1.2		
All removals from the Dungeness crab population are known, including the commercial and recreational catch, by-catch in the trawl fishery, and the catch and return of female Dungeness crabs and undersized males.		
SG 60	**SG 80**	**SG 100**
Commercial landings are known. Recreational catch, trawl by-catch, and mortalities to catch of females and undersized males are not well known, but generally believed to be at levels low enough to avoid compromising status of the stock.	Commercial landings are known. There are estimates of the effect of fishing on female mortality. There are at least crude estimates of recreational landings, trawl by-catch, and mortalities of undersized males after capture.	Commercial landings are known, there is a data-based estimate of recreational landings, there is a data-based estimate of trawl by-catch and there are estimates of mortalities due to return of females and small males after capture

Score: 70

Commercial landings of Dungeness crab are well known. The managers asserted a belief while recreational catch, trawl by-catch, and mortalities due to catch of females and undersized males are not well known, they are generally believed to be at levels low enough to avoid compromising status of the stock. This belief is based on anecdotal and historical information. There is some cause for concern because of the closures and low allowed catches in the salmon fishery (which may shift recreational effort to Dungeness crab), and the increasing targeting of Dungeness crabs by commercial passenger fishing vessels (party boats).

Condition 1.1.2: Present results of sampling Dungeness crab fishing to determine the rate at which females are caught, whether hard or soft shelled, and time to release. Present an estimate of the mortality rate of released female crabs. Review estimates of recreational catch, by-catch in the trawl fishery and the catch of undersized males. Where data are lacking, conduct the sampling/monitoring necessary for estimates. Present a crude (or better) estimate of recreational catch, by-catch in the trawl fishery and the catch of undersized males.

By the 1st annual surveillance audit, Provide a list of the data available for each category requested and the planned approach.
By the 2nd annual surveillance audit, provide a list of who will accomplish each requirement and any results available.
By the 3rd annual surveillance, provide all requested results; including data, analyses, and a description of sampling in place for future data.

1.1.3		
Reproductive capacity of the population is monitored to determine the effects of fishing on reproduction.		
SG 60	**SG 80**	**SG 100**
An index of female abundance and fraction fertilized is estimated every five years. It is greater than 50 percent.	An index of female abundance is estimated every five years, and the fraction fertilized is estimated annually. It is greater	Female abundance is estimated annually, and fraction fertilized is estimated. It is greater than 90 percent.

	than 80 percent.	

Score: 80

This indicator evaluates two estimates: and estimate of an index of female abundance and an estimate of the fraction of females fertilized. Both of these are necessary to monitor the reproductive capacity of the Dungeness crab populations because of the assumption that harvesting crabs does not affect LEP is the fundamental basis of the precautionary approach taken here. Perhaps the more important of the two issues is that there is some evidence and expectation based on the biology of the species that fertilization rates are high to ensure that fishing is not affecting the LEP. Monitoring is necessary to ensure that this does not change over time. Even if fishing is not causing changes to fertilization rates, any change in the population where fertilization rates fall below an acceptable level (typically between 35-60 percent) would suggest that management needs to change fishing effort to compensate for the problem.

The Oregon Dungeness Crab Commission contracted Prof. Alan Shanks (Dunn 2009) of the University of Oregon to measure fertilization rates in the summer of 2009. The sampling took place in 2009 at three locations along the coast, Brookings, Coos Bay and Newport. The catch-per-unit-effort of female Dungeness crabs was 0.33 crabs per trap hour off Coos Bay and 0.24 off Brookings in 2009. The catch of female crabs per unit effort calculated from these samples fulfill the requirement for estimating an index of female abundance at least once every five years. The CPUE from Newport should also be included if available. The females were taken to the laboratory to determine the fraction that have molted and the fraction that have mated. The procedures to be followed were similar to those followed by Hankin, et al. (1989) who made similar measurements in California. The resulting data suggest that a majority of female crabs examined (69%) mated this year, and when combined with crabs that still carried sperm from previous mating encounters, the percent of females that would have produced viable eggs is 83 percent. This fulfills the requirement for annual sampling of fraction of females fertilized. The score of 80 presumes this sampling will be repeated each year.

1.1.4

The dependence of productivity on abundance has been estimated and used to estimate potential TRPs and associated uncertainties.

SG 60	SG 80	SG 100
A yield-per-recruit analysis has been performed, with results accounting for uncertainties.	The dependence of productivity on abundance has been estimated and used to determine that current levels of catch and size limit are within the range of uncertainty about a TRP (accounting for reproduction and potential environmental effects).	The dependence of productivity on abundance has been estimated and used to determine a TRP. Size limits and effort are set accordingly (while accounting for reproduction and potential environmental effects).

Score: 70

Oregon presented a report by Selina Heppell (2009) to satisfy this indicator. The only prior analysis we know of for this fishery is the study by Methot (1989). He performed a partial yield-per-recruit analysis with the information available at the time (i.e. existing mortality estimates and a hypothetical growth model). He concluded that a precise estimate of the best lower size limit would be difficult because of

existing uncertainties in growth and mortality rates. Yield analyses have been conducted for other populations of Dungeness crab (Siddeek, et al. 2004, Zhang, et al. 2004).

The Heppell (2009) report used an age structured model of both male and female Dungeness crab. The report shows how increasing female catch by changing the size limit and allowing the females to be landed would increase yield-per-recruit. However, it does not show the cost of that policy, i.e., the decrease in eggs-per-recruit by those policies. In the examples of the current policy of not landing females, the total annual mortality due to females being caught and released is set between 0.2 and 0.6. This figure seems high. Female growth is represented in the model in such a way that few females are caught in the fishery, and they are not caught until the cohort is eight years old, and thus substantially reduced by natural mortality. Neither the female mortality, nor the growth are related to data.

Condition 1.1.4: By the 2nd Annual Surveillance, update analysis of both yield-per-recruit (YPR) and eggs-per-recruit (EPR) that evaluates the trade-off in yield involved in a policy of not fishing females by incorporating values for mortality of catch and release mortality of females, and growth of females.

This analysis should include some evaluation of the effects of uncertainty on the conclusions regarding management policy. It should include the relevant conclusions in Methot (1989).

1.1.5		
A Limit Reference Point (LRP) has been established and its level is computed at appropriate time intervals to determine whether the stock is depleted.		
SG 60	**SG 80**	**SG 100**
An LRP has been defined, has been estimated every ten years, and when last estimated it was above the minimum level.	An LRP has been defined, is estimated every five years, and when last estimated it was above the minimum level.	An LRP has been defined, it is estimated annually, and is currently above the minimum level.

Score: 75

Oregon presented a recommended LRP condition in Part II of the Heppell (2009) report:

> *"Recommended LRP: Decline in catch sustained over 4 years (approximately 1 generation time) and an overall reduction in catch of >=80% from the 20 year average (approximately 5 generations; current floor would be 2.8 million pounds)."*

We interpret that to mean that the fishery would have breached the LRP if the catch declined 4 years in a row, and the catch after the last decline was less than the average catch over the 20-years prior to the beginning of the four sequential years of decline.

The basis for the choice of this LRP was the fact that the catch record for Dungeness crab had never gone through a period of decline lasting more than 4-years. This definition did not define the management response to breaching the LRP condition, which is a necessary part of an LRP.

The major shortcoming of the LRP condition is the fact that it is based on catch, rather than an index of abundance such as catch-per-unit-effort. As such it could be breached by management actions or market conditions alone, rather than a decline in abundance.

Condition 1.1.5: By the 1st annual surveillance develop a method for integrating a measure of CPUE (or other estimate of abundance) with the long-term data available from the catch series to formulate a Limit Reference Point.

By the 2nd annual surveillance the Limit Reference Point and explicit management responses need to be formulated and in the process of being adopted by the ODF&W as regulatory instruments.

By the 3rd annual surveillance the Limit Reference Point and explicit management responses need to be adopted by ODF&W as a regulatory instrument.

1.2.1		
A recovery plan has been implemented, and the population is making a timely recovery.		
SG 60	**SG 80**	**SG 100**
A recovery plan is available that includes moderate decreases in fishing, the plan is to be implemented, the population will at least being monitored through the catch, and recovery is estimated to begin in the near term.	A recovery plan has been implemented that includes provisions to substantially decrease fishing to return the population to levels above the LRP, the population is being monitored periodically, and recovery is estimated to be on track.	A recovery plan has been implemented that includes provisions to substantially decrease fishing to return the populations fished to levels significantly above the LRP, the population is being monitored annually and there is a track record to prove that the recovery is on track.

Score: N/A

Fishing is conducted in a manner that does not alter the age or genetic structure or sex composition to a degree that impairs reproductive capacity.

1.3.1		
The effects of the fishery on age, sex and genetic composition of the population have not impaired reproductive capacity.		
SG 60	**SG 80**	**SG 100**
Fertilization rates have been estimated at least once.	Fertilization rates are monitored every 5 years. There is research on the genetic selective effects of size selective fishing.	The age or size dependence of the male contribution to reproduction is known and monitored every year. Genetic selective effects of size selective fishing have been studied and the effects on reproduction are well understood.

Score: 90

The plans for monitoring fertilization rates in Oregon are described above under Indicator 1.1.3. We know of no research on the genetic selective effects of size selective fishing in the fishery. However, Methot (1989) noted "this heavily exploited fishery regulated by size limit has potential for genetic selection for slow growing traits."

Oregon addressed this indicator by submission of Part III of the Heppell (2009) report, «Literature Review: Potential Consequences of Selective Harvest in Dungeness Crab, *Cancer magister*. This is a sound review of the genetic effects of size selective fishing in general, and it focusses on conclusions specific to the Dungeness crab.

10.2 MSC Principle 2

Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

Intent: To encourage management of the fishery from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

Three primary criteria guide evaluation of performance indicators under this principle; all ask if the fishery:

- Is conducted in a way that maintains natural functional relationships among species to avoid trophic cascades and ecosystems state changes. Ability to score PI under this criterion requires degrees of information about other species, habitats, and linkages within the community where the fishery occurs.
- Is conducted in a manner that does not threaten biological diversity at the genetic, species or population levels, and avoids or minimizes adverse impacts on threaten or endangered species.
- In the event that exploited populations of non-target species are depleted the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level within specified time frames, consistent with the precautionary approach and considering the ability of the population to produce long-term potential yields.

Many fisheries that use a variety of nets (seines, mid-water, benthic trawls, gill nets, purse seines) can exert considerable adverse effects on the marine community where the fisheries are intense. Impacts may include habitat destruction, bycatch of many non-target species in the community, capture and handling mortality of sublegal portions of the target population, and ongoing capture and mortality due to lost gear. Since Dungeness crab are fished with pots on a seasonal basis there is relatively little physical impact from deployment and retrieval of gear. Bycatch is not high and few species are vulnerable to pots where fished. Lost gear and “ghost pot” fishing is probably the most significant adverse physical consequence of the fishery; handling mortality of sublegal individuals is likely the most important biological issue.

Pot Fishery: Individual Dungeness crab pots are set on open sand substrate and marked with a surface buoy. Since they are not allowed to be linked in sequence (no longline configuration), there is little adverse physical effect of deployment and retrieval since pots are not dragged on the bottom or towed in some fashion akin to operation of dredges and trawl nets that may cause considerable damage to biogenic structure.

While there is some concern in other pot fisheries that thousands of buoy lines concentrated in small areas of intense effort might pose threat to taxa like marine mammals (e.g. lobster and crab pot lines affecting right whales in the NW Atlantic), there is no such evidence of similar perturbation in areas of concerted Dungeness crab fishing. Sea otter could be vulnerable to pots and Ames et al. (abstract provided by Cal F&G) voiced concern that present dimensions of pot openings (4” x9”) could make smaller, young otter susceptible to drowning after entering pots. But we know of no data that document even infrequent instance of dead otters in pots and so judge that the risk is low.

Ghost pot fishing: A significant percentage of pots set in the winter fishery are lost each year and may continue to fish as “ghost pots”. Why crab continue to enter lost pots after bait is exhausted is not clear but could be attraction to structure or conspecifics, possibly including a cannibalistic response to smaller or molting individuals. Present regulations require a biodegradable cotton seam (rot cord) in the lid or

sides of pots that will break down and allow escape. Each pot is also built with 2 escape rings that allow individuals smaller than legal limit means to exit the gear. Considering both the quantity of gear lost annually (1000s of pots), and rate of cotton panel breakdown, there is certainly a significant annual mortality caused by ghost pot fishing that has not been accurately computed. Loss of legal males in this fashion might be considered part of regular fishing mortality but the loss of sublegal makes and females is a population impact not considered at present.

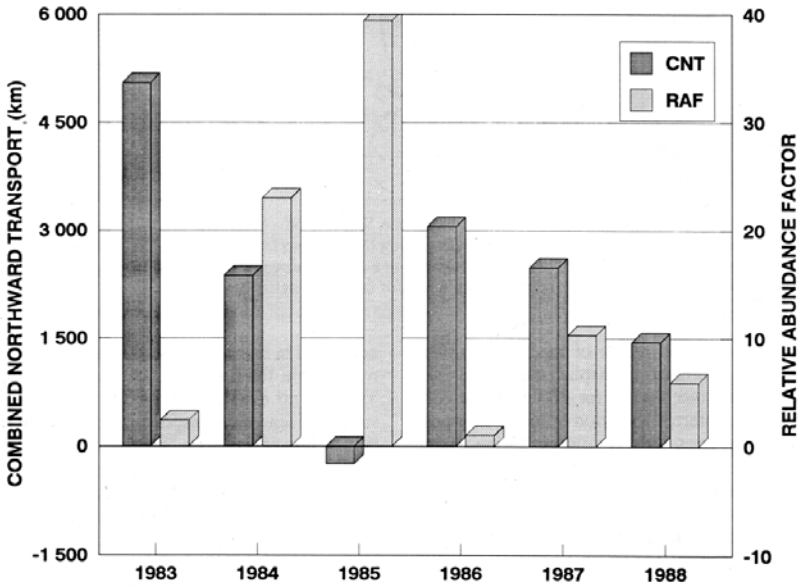
2.1.1		
Nature and distribution of habitats relevant to the fishery are known.		
SG 60	**SG 80**	**SG 100**
Broad areas of habitat preferred by the target species are known. Distribution of fishing operations in space and time is broadly understood.	The dominant habitat type is known with respect to general community composition in the area of the fishery. Distribution of fishing operations in space and time are known seasonally.	The nature and distribution of different habitats relevant to the fishery are known in detail and mapped across appropriate geographic range. Biological communities associated with dominant habitats are known. Distribution of fishing effort and deployment of gear is known at scales of km and regularly reported.

Score: 85

Across their range of distribution from Unalaska, AK, to Santa Barbara, CA (Jensen 1995), Dungeness crab (*Cancer magister*) occupy a variety of habitats throughout their life history. Three distinct ontogenetic shifts in habitat use occur from post-settlement to adult-hood, which correspond to the following life-history stages; young of the year (0+ yr or YOY), subadult (1-3 yr), and adult (>3 yr).

YOY Crab: Crab larvae generally move northward in ocean currents and eventually settle as young-of-the-year (0+; "YOY"), but there is a certain east-west onshore-offshore component to direction as well. Crab settle broadly along the coastal shelf which is often less than 15 km wide, and a majority of settlement may be in relatively shallow depths less than 46 m (**Figure 4**; Tasto 1983; McConnaughey et al. 1992; McConnaughey et al. 1994). Although they may occupy a range of bottom types from sand and mud to gravel and beds of macroalgae, crabs

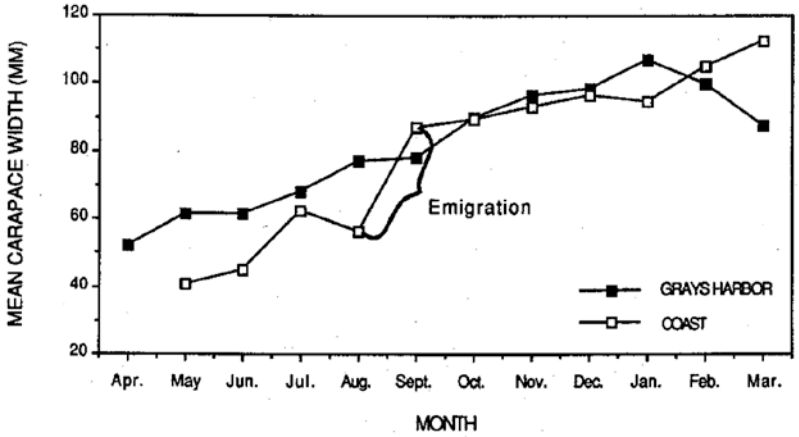
Figure 4. Comparison between Dungeness crab settlement magnitude and total northward transport during the pelagic larvel phase. *McConnaughey et al (1992)*



The relative abundance factor (RAF) is a ratio of mean young-of-the-year abundance during June-September of years indicated to the period of lowest abundance (1986). Combined northward transport (CNT) is the sum of geostrophic transport and the alongshore component of Ekman transport during the proceeding January-May pelagic larval phase.

are most abundant on sand and mud (McConnaughey et al. 1992) since burial in these substrates provides refuge from predation and abundant prey species contribute to increased survival (Schmitt 1921; McConnaughey et al. 1992). Despite their occurrence in sandy subtidal habitats along the coast, the highest densities of juvenile *C. magister* are found in coastal estuaries (Armstrong et al. 1989; Gunderson et al. 1990), systems with geomorphologies ranging from small embayments (i.e. Yaquina Bay and Coos Bay, OR) to large complex systems such as San Francisco Bay (CA) and Willapa Bay (WA). Growth rates of juvenile crabs are nearly twice as high in shallow, warm-water estuaries as in adjacent oceanic nearshore habitats (**Figure 5**; Methot and Botsford 1982; Gutermuth and Armstrong 1989; Methot 1989; Gunderson et al. 1990), and since survival is greater for individuals that grow quickly and obtain a size refuge from predation at an earlier age (Reilly 1983; Fernandez 1999), the enhanced growth and survival of estuarine populations may contribute significantly to the coastal fishery (Stevens et al. 1984; Gunderson et al. 1990; Armstrong et al. 2003).

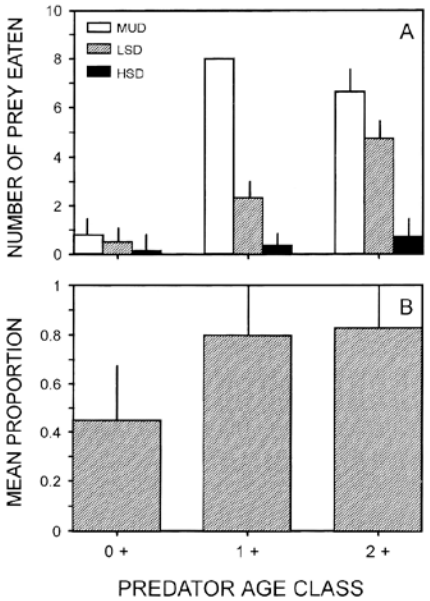
Figure 5 Change in mean size of 1+ Dungeness crab in the inner Grays Harbor estuary and intermediate depths (15-40 m) off the coast, April to March 1986.



Source: Gunderson et al. (1990)

Intertidal habitats characteristic of coastal estuaries provide critical refuge for settling YOY crabs, as well as conditions ideal for growth (Dumbauld et al. 1993; Fernandez et al. 1993b; Dumbauld et al. 2000). Survival is highest for crabs that occupy complex biogenic habitats, such as oyster shell or eelgrass beds, which offer shelter from myriad predators such as staghorn sculpin and cannibalistic conspecifics (**Figure 6**; Fernandez et al. 1993b; Armstrong et al. 1995; Eggleston and Armstrong 1995; Fernandez 1999). In some cases, survival of YOY crab within complex shell habitats may be reduced through predation and spatial exclusion by conspecifics (Fernandez et al. 1993a; Eggleston and Armstrong 1995) and native crabs such as the shore crab, *Hemigrapsus* spp. (Banks and Dinnel 2000; Visser et al. 2004). Nonetheless, in general YOY juvenile crab survival is highest in complex structured habitats which they continue to occupy throughout their next 4-5 molts (3-4 months)) until they emigrate to subtidal channels in late summer upon reaching ~30 mm carapace width (CW; Orensanz and Gallucci 1988; Dumbauld et al. 1993; Fernandez 1999). Most growth and activity occurs during the warm, highly productive, summer months (~June – August; Stevens and Armstrong 1984; Gutermuth 1987), and juvenile crabs migrate into deeper subtidal areas, or emigrate from estuaries to nearshore habitats, as water temperature decreases in late September (**Figure 5**; Gunderson et al. 1990). Growth is

Figure 6. Effect of habitat complexity on cannabalism rate.

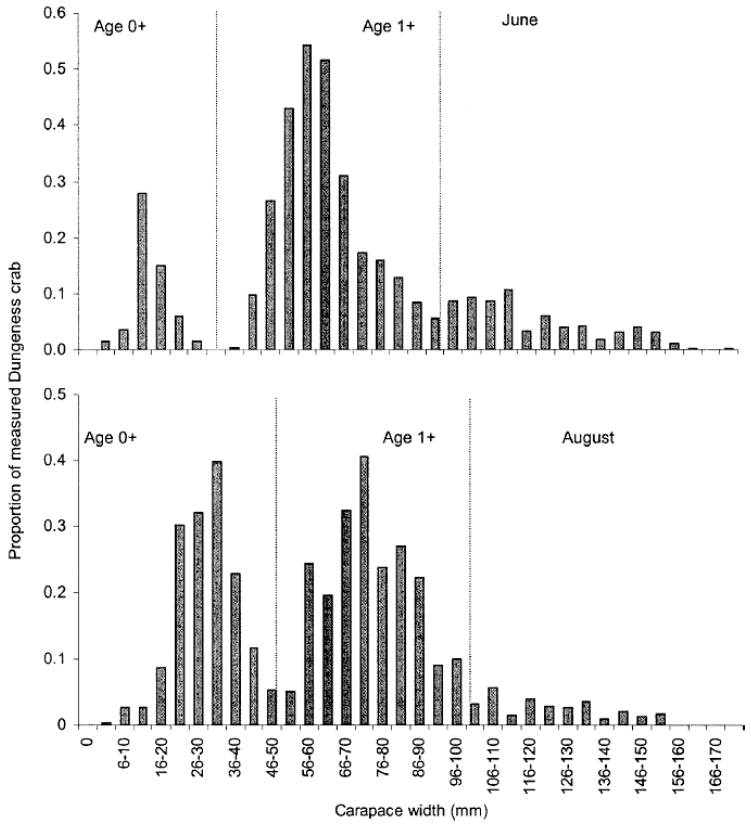


(A) Mean number of 0+ (9 to 18 mm carapace width, CW) Dungeness crab eaten by 0+ (21 to 29 mm carapace width), l + (60 to 70 mm CW), and 2+ (90 to110 mm CW) Dungeness crab in mud, low shell density (LSD), and high shell density (HSD) habitats Vertical Lines indicate 1 standard error; l + crabs consumed all the prey in all the trials in the mud habitat. (B) Mean proportion of the consumed 0+ Dungeness crab (9-18 mm) for which no remains or only small piece of carapaces were found when 0+, 1+, and 2+ conpecifics were the predators. Vertical lines indicate 1 standard error. Number of replicates always >10. *Source: Fernandez (1999).*

minimal during winter months but resumes the following spring after crabs return to shallower, estuarine waters (Stevens et al. 1984; Gutermuth 1987; McMillan et al. 1995).

Subadult crab: Subadult crab (1+ and 2+ immature crab) along the outer coast are typically found in sandy nearshore areas less than 18m but up to 37m in depth (Tasto 1983). However densities of subadult crab in coastal habitats are much lower than those observed in estuaries and as such most research has focused on use of estuarine habitats. From these studies it appears that a portion of the subadult crab population continues to utilize estuarine systems until they reach sexual maturity at about 2 years of age (100 mm CW for females, ~130 mm CW for males; **Figure 7**; Gutermuth and Armstrong 1989) and then migrate to nearshore waters (Collier 1983). Overall growth is higher in warm estuarine systems and subadult crab are larger and more abundant in estuarine systems than in adjacent oceanic regions (Collier 1983; Emmett and Durkin 1985; Gutermuth and Armstrong 1989; Wainwright and Armstrong 1993; Wainwright 1994).

Figure 7. Size frequency plot of juvenile Dungeness crab caught in June and August 2000 in Yaquina Bay, Oregon, all habitats combined.

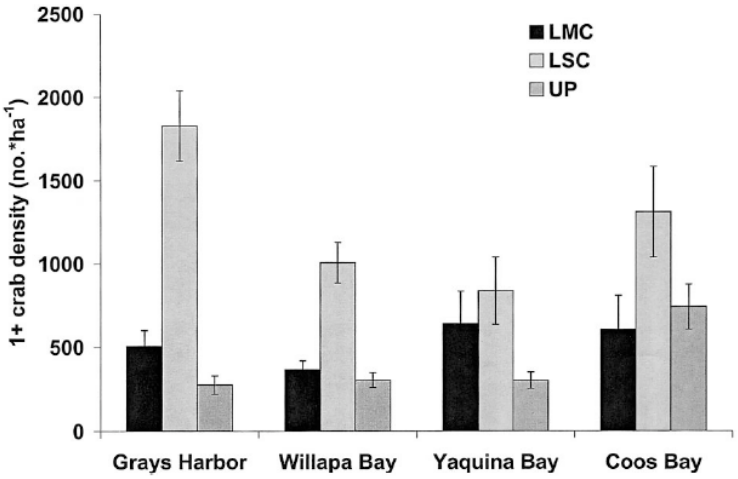


This distribution is typical of juvenile size structure in all four estuaries during summer, and was used to apportion trawl survey catches into age classes to compute density, abundance, and eventual adult contribution to coastal fisheries.
Source: Armstrong et al. (2003).

Subadult *C. magister* are largely absent from intertidal habitats at low tide (Stevens et al. 1984; Fernandez et al. 1993a; Fernandez et al. 1993b), yet they are most abundant in secondary side channels (Rooper et al. 2002; termed "lower main channels" that crisscross intertidal regions) surrounded by extensive intertidal habitats (**Figure 8**). Subtidal trawl surveys conducted in Grays Harbor and Willapa Bay (WA), and Coos and Yaquina Bay (OR) in the mid 1980's and late 1990's indicated higher densities and biomass of crabs during low tide in shallow secondary subtidal channels ("lower side channels") than in larger main channels (**Figure 8**; Rooper et al. 2002). The high density of crabs in these channels in conjunction with catches of subadult crabs in intertidal habitats at high tide (Gotshall 1977; Stevens et al. 1982; Stevens and Armstrong 1984; Stevens et al. 1984; Hosack et al. 2006) suggest that *C. magister* continue to make forays into intertidal habitats throughout the estuarine portion of their life history. Recent studies further indicate that daily migrations to intertidal foraging areas are an integral component of the estuarine life-history of subadult crab. Holsman et al. (2003) found that in coastal estuaries of WA intertidal foraging accounts 80-90% of the daily energetic demand of crabs in side-channel habitats, and such forays are necessary to support observed production rates in estuaries. Realized patterns of *C. magister* movement into intertidal areas is likely governed by energetic tradeoffs between foraging efficiencies and accessibility of prey resources and physical or competitive interactions that may act as deterrents. Intertidal forays to complex habitats with elevated prey densities are not common, possibly due to the difficulty of finding and capturing prey, and larger crabs whose size reduces the risk of predation may choose to forage in unstructured littoral habitats (ULH, see **Figure 9**). The risk of stranding during low tide coupled with

reduced foraging efficiency and increased agonistic encounters with crab species resident in complex habitats likely deter most subadult *C. magister* from using structured intertidal areas despite the high density of potential prey species in such habitat (**Figure 10**; Holsman 2006; Holsman et al. 2006). Thus, complex biogenic habitats that are critical to YOY crab appear to be avoided by subsequent age classes (**Figure 9**; Holsman et al. 2006).

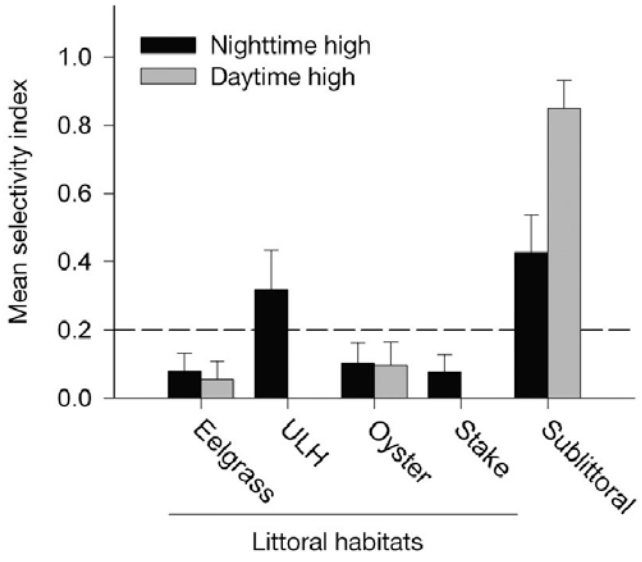
Figure 8. Average (+/- SEM) density of 1+ Dungeness crab in each of three habitat strata (Lower main channels, LMC; Lower side channels, LSC; Upper channels, UP) within the four estuaries.



Data are grouped as all trawl stations in each habitat combined from June and August of all years sampled. Grays Harbor was sampled in 9 yr, Willapa Bay in 7, Yaquina and Coos Bay in 3 (see text for details of years). *Source: Armstrong et al. (2003).*

Intertidal foraging is a significant pattern in the estuarine life histories of subadult *C. magister* and has implications for future conservation and use of estuarine habitats. Anthropogenic modifications that continue to threaten intertidal habitats of northeastern Pacific estuaries could adversely impact populations of crab in northern California, Oregon, and Washington (for a review of estuarine intertidal modification see Simenstad and Fresh 1995). Continuing perturbations in these systems include physical alterations of tidelands from dredging and filling associated with mariculture and ship canal maintenance (Wainwright et al. 1992; Simenstad and Fresh 1995; Dumbauld et al. 2000), altered hydrology from freshwater diversion (Nichols et al. 1986), and the direct application of pesticides to tidelands which reduce intertidal prey biomass as well as cause mortality of crabs that consume recently contaminated prey (Feldman et al. 2000). In some coastal estuaries the rapid expansion of *Spartina alterniflora* also threatens historic tidelands, increasing deposition rates, elevating tideflats, displacing invertebrate communities (Zipperer 1996; Feist and Simenstad 2000), and otherwise eliminating accessible intertidal foraging habitats for Dungeness crab.

Figure 9. Cancer magister. Mean selectivity indices (+1 SE) for each intertidal habitat for nighttime and daytime high tides (ULH, unstructured littoral habitats).

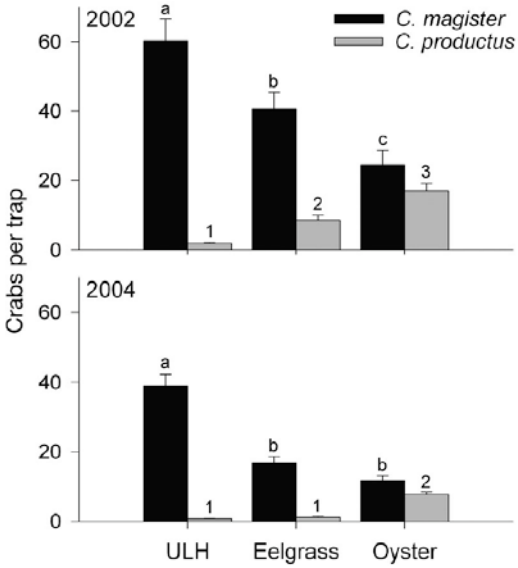


Dashed line indicates random selectivity (0.2); values above and below the line indicate preference and avoidance, respectively.
Source: Holsman et al. (2006).

Despite prevalent use of unstructured habitats by subadult crab, structured habitats likely still play a critical role in the survival of molting subadult crabs. Predation rates and risk of injury increase considerably during molting when exoskeletons are soft and crabs are unable to defend themselves (Ryer et al. 1997). During molting periods crabs typically increase their movements, seeking shallow, sheltered microhabitats and activity decreases significantly just prior to molting (Wolcott and Hines 1990). Thus, subadult *C. magister*, which have otherwise achieved a size refuge from predation, may seek shelter from predators and conspecifics (also cannibalistic predators) in eelgrass or oyster habitats during molting (Holsman 2006).

Adult Crab: In contrast to YOY and subadult age classes that rely on intertidal habitats for refuge from predators or foraging grounds, adult crabs are rarely found in the intertidal and are, overall, less abundant in estuarine areas and generally occupy cooler coastal subtidal habitats. Data on adult habitat use is derived primarily from commercial fishing that occurs in coastal waters less the 40m deep (PMFC 1978) on soft bottom sandy and muddy habitats. Despite a lack of physical barriers to movement adult crabs generally remain relatively sedentary and only migrate inshore to mate during spring and summer months. Collier (1983) observed one crab moving over 85 km but large movements appear to be an anomaly for adult crabs. Male and female crabs appear to exhibit differential season patterns of movement and habitat use (Stone and O' Clair 2001). Diamond and Hankin (1985) found that female adult crab movement in northern California is fairly restricted, with nearly 46 % of tagged crabs recovered one year later within 2 km of their release location. They also found that female crabs undertake inshore migrations to shallow sandy coastal areas during the spring, likely in order to increase success of molting, mating, and egg survival (Diamond and Hankin 1985). Ovigerous female crabs in SE Alaska show high site fidelity (Stone and O' Clair 2002) and may annually return to the same brooding locations and form large partially buried aggregations in sand habitats (Scheding et al. 2001; Stone and O' Clair 2002). In some areas of Alaska sand substrate is believed to be a limiting resource for ovigerous female crab although it is not likely that sand habitat is a limiting resource for female crab along the Oregon and California shelf. In general adult female crabs carrying eggs remain relatively inactive during winter months (November to mid-April), abruptly migrate into shallow water to release larvae in spring, and return to cooler deeper foraging areas in summer. Male crab remain relatively active during winter months as evidenced by high catch rates during the winter coastal fishery. Movement patterns are somewhat similar to females when they make a spring migration to shallower water but, in contrast to female crabs, males do not undertake migrations to deeper water until early fall (Stone and O' Clair 2001).

Figure 10. *Cancer magister* and C. productus. Mean (+1 SE) number of crabs captured in baited traps placed in eelgrass, oyster, and unstructured intertidal habitats (ULH).



Traps were immersed for 24 h during the 2002 survey, and 12 h (nighttime) during the 2004 survey. Habitat types not sharing a common letter (for *C. magister*) or number (for *C. productus*) differed significantly ($p < 0.05$) according to Tukey's HSD pair-wise comparison tests.
Source: Holsman et al. (2006).

Distribution of fishing operations in space and time: The commercial fishery for adult male *C. magister* along the west coast of North America began in San Francisco in 1848 (Dahlstrom and Wild 1983) and presently occurs in nearshore coastal waters (< 40 m deep) from California to Alaska. In Oregon and California the fishery is highly cyclic with decadal oscillations in crab landings (**Figure 1**; Johnson et al. 1986; Methot 1989; Pauley et al. 1989). A number of authors have explored factors that may influence the commercial fishery and have cited potential drivers that include overfishing (for a review see Hankin 1985), variation in ocean circulation and upwelling that results in periodic pulse recruitment events (Wild et al. 1983; McConnaughey et al. 1992), and pre- and post-settlement density-dependent mortality (Botsford 1984; Eggleston and Armstrong 1995; Higgins et al. 1997). In addition, the collapse of the central California crab fishery in the late 1960's has fueled various investigations into the causes of this protracted collapse. Although other biotic (salmon predation, nemertean worm predators, disease, exotic species) and abiotic (water pollution, elevated sea surface temperatures, changes in offshore current regimes) causes have been proposed (Wild and Tasto 1983; Botsford et al. 1989), loss of intertidal habitat could have led to a substantial reduction in the foraging base of juvenile crabs in these

systems and a subsequent decline in the overall production of *C. magister* in central California (Holsman et al. 2006). Additionally, a recent paper by Shanks and Roegner (2007) provides interesting evidence that scale of commercial fisheries correspond to timing of the spring transition 4 years prior. This hypothesis links higher abundance and survival of the settling megalops stage to earlier timing of the transition. A long history of late annual spring transitions computed for Central California is suggested as potential cause for the unusually long history of low landings from the 1960s into the late 1990s.

The seasonality of the fishery is known and tightly regulated in California, Oregon and Washington States (**Table 2**), and typically opens December 1st in most areas but may be subject to change or delay based on pre-season soft-shell testing (Didier 2002). In recent years, the California and Oregon fisheries have been closed June 30th - November 31st and August 15th – November 31st, respectively. Distribution of fishing effort and deployment of gear may be inferred on a large geographic scale based on port landings (Armstrong et al. 2003) but specific data are lacking. Some information is available through the Pacific Fisheries Information Network (PacFIN), which provides data enabling agencies and industries to track commercial fish catches by port. The PacFIN central database includes fish-ticket and vessel registration data provided by WDFW, ODFW, and CDFG. Although each permitted vessel declares the number of pots that could be fished on any trip, the actual number of pots used and locations deployed are not recorded. Thus it is impossible to calculate effort with certainty. Moreover, deployment of gear over the scale of km is not available and fish-ticket information is attributed to the port where landings are made without regard to the spatial distribution of effort and catch.

However, ODFW has recently implemented a logbook program that requires several fields of information that will provide data on spatial and temporal effort. Essential to characterize effort going forward are information on vessel, permit, date gear are pulled, depth, number of pots, lat/long at deployment and retrieval, estimated pounds, and port of landing. We presume ODFW will enter and evaluate all such data on an annual or biennial basis. The nature and coverage of the data will help inform regarding status of stocks relative to the LRP now based on annual landings.

Table 2 Fishing seasons in Oregon 1950-2001.

Season	OREGON				Season	OREGON			
	California border to Cascade Head		Cascade Head to Columbia River			California border to Cascade Head		Cascade Head to Columbia River	
	Open	Close	Open	Close		Open	Close	Open	Close
1950-51	Nov 15	Aug 15	Dec 15	Sept 15	1980-81	Dec 1	Sept 15	Dec 1	Sept 15
1951-52	Nov 15	Aug 15	Dec 15	Sept 15	1981-82	Dec 1	Oct 15	Dec 1	Oct 15
1952-53	Nov 15	Aug 15	Dec 15	Sept 15	1982-83	Dec 1	Sept 15	Dec 1	Sept 15
1953-54	Nov 15	Aug 15	Dec 15	Sept 15	1983-84	Dec 1	Sept 1	Dec 1	Sept 1
1954-55	Nov 15	Aug 15	Dec 15	Sept 15	1984-85	Dec 1	Aug 15	Dec 1	Aug 15
1955-56	Nov 15	Aug 15	Dec 15	Sept 15	1985-86	Dec 1	Aug 15	Dec 1	Aug 15
1956-57	Nov 15	Aug 15	Dec 15	Sept 15	1986-87	Dec 1	Aug 15	Dec 1	Aug 15
1957-58	Nov 15	Aug 15	Dec 15	Sept 15	1987-88	Dec 1	Aug 15	Dec 1	Aug 15
1958-59	Nov 15	Aug 15	Dec 15	Sept 15	1988-89	Dec 1	Aug 15	Dec 1	Aug 15
1959-60	Nov 15	Aug 15	Dec 15	Sept 15	1989-90	Dec 1	Aug 15	Dec 1	Aug 15
1960-61	Nov 15	Aug 15	Dec 15	Sept 15	1990-91	Dec 1	Aug 15	Dec 1	Aug 15
1961-62	Dec 1	Aug 15	Jan 1	Sept 15	1991-92	Dec 1++	Aug 15	Dec 1++	Aug 15
1962-63	Dec 1	Aug 15	Jan 1	Sept 15	1992-93	Dec 1	Aug 15	Dec 1	Aug 15
1963-64	Dec 1	Aug 15	Dec 1	Aug 15	1993-94	Dec 1	Aug 15	Dec 1	Aug 15
1964-65	Dec 1	Aug 15	Dec 1	Aug 15	1994-95	Dec 1	Aug 15	Dec 16***	Aug 15
1965-66	Dec 1	Aug 15	Dec 1	Aug 15	1995-96	Dec 1	Aug 15	Dec 16***	Aug 15
1966-67	Dec 1	Aug 15	Dec 1	Aug 15	1996-97	Dec 1	Aug 15	Dec 1	Aug 15
1967-68	Dec 1	Aug 15	Dec 1	Aug 15	1997-98	Dec 1	Aug 15	Dec 1	Aug 15
1968-69	Dec 1	Aug 15	Dec 1	Aug 15	1998-99	Dec 1	Aug 15	Dec 1	Aug 15
1969-70	Dec 1	Sept 15	Dec 1	Sept 15	1999-00	Dec 1	Aug 15	Dec 1	Aug 15
1970-71	Dec 1	Sept 15	Dec 1	Sept 15	2000-01	Dec 1	Aug 15	Dec 15***	Aug 15
1971-72	Dec 1	Sept 15	Dec 1	Aug 15					
1972-73	Dec 1	Aug 31	Dec 1	Aug 15					
1973-74	Dec 1	Aug 15	Dec 1	Aug 15					
1974-75	Dec 1	Aug 15	Dec 1	Aug 15					
1975-76	Dec 1	Aug 15	Dec 1	Aug 15					
1976-77	Dec 1	Sept 15	Dec 1	Sept 15					
1977-78	Dec 1	Sept 15	Dec 1	Sept 15					
1978-79	Dec 1	Sept 15	Dec 1	Sept 15					
1979-80	Dec 1	Sept 15	Dec 1	Sept 15					

++ Season closed Dec 11 through Dec 21, 1991 due to domoic acid in crab viscera

*** Season opening north of Cape Falcon delayed due to soft shell crab

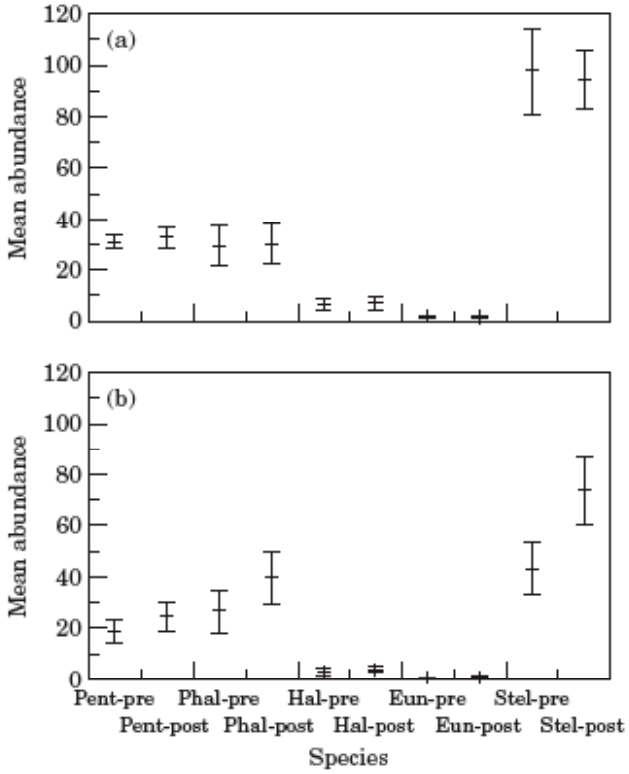
Source: Didier (2002).

2.1.2		
Effects of fishing operations and gear on habitat structure are known.		
SG 60	**SG 80**	**SG 100**
The nature of the fishery and the gear types used enable estimates about the probability of damage to habitat preferred by the target species, and the estimates are generally viewed as scientifically acceptable by those familiar with the fishery.	Impacts of the fishery on habitat structure within broad fishing areas are monitored and estimated to be within acceptable levels of impact for the size and complexity of the fishery and the type of habitats encountered.	Effects of the fishery (including deployment and retrieval of pots as well as lost pots) on habitat structure are monitored adequately to assess the potential for change and/or damage in fished areas compared to unfished areas of comparable habitat types.

Score: 80

The effects of fishing operations and gear on habitat structure are acceptable. The trap gear used in the fishery is considered static or passive since it is intended to remain stationary on the bottom until retrieved. Thus impacts for single fishing events are generally low and localized compared with the effects of mobile gear such as dredges and trawls whose fishing coverage can extend over considerable areas. Nevertheless, trap gear can move substantially during setting and retrieval, or when subjected to high currents and may dislodge sessile organisms or disturb biogenic structures on low relief, sandy bottoms (Eno et al. 2001; Valdemarsen and Suuronen 2001). Troffe et al. (2005) investigated the effects of prawn traps on sea whips (*Halipteris willemoesi*) in British Columbia, Canada, and found that gear can cause a significant level of damage to entangled individuals during retrieval. The authors expressed concern that larger, heavier pots used to fish Dungeness crab might produce greater impacts. However, the prawn traps used in the study by Eno et al. (2001) were connected via a bottom groundline, which increases dragging when gear is set and retrieved. Regulations governing the CA and OR Dungeness crab fisheries preclude the use of bottom groundlines. Instead, each pot possesses an individual line and buoy that is not linked to adjacent gear.

Figure 11 Mean abundance (+/-SE) of structure-forming species before (-pre) and after (-post) an experimental study of the effects of commercial crustacean traps.



A control plot where no trapping was done (a) and an experimental plot where traps were used (b) are shown. The species include: a bryozoan (*Pentapora foliacea*, Pent); an ascidian (*Phallusia* spp., Phal); two sponges (*Haliclona simulans*, Hal, and *Stelligera/Raspailia* spp., Stel); and a gorgonian (*Eunicella* spp., Eun). There was no significant difference in abundance of these species as a result of trap use.
Source: Eno et al. (2001).

The coastal Dungeness crab fishery is for the most part conducted in areas of low relief and low complexity. Most commercial fishing occurs in nearshore waters with silty sand to sand bottoms less than 40 m deep (PMFC 1978). Unconsolidated sedimentary habitats that occur in shallow coastal self waters are less affected by fishing than structurally complex habitats, such as seagrass meadows or biogenic reefs (Kaiser et al. 2001; Valdemarsen and Suuronen 2001). Moreover, these habitats tend to be more prone to natural disturbance, such as wave, surge, current and tidal forces that may disturb and/or redistribute material. Kaiser et al. (2001) suggests that benthic communities adapted to high levels of natural disturbance have shorter recovery trajectories than more structurally complex habitats, and may be less likely to experience long-term shifts in community structure or composition as a result of fishing than those in more stable habitats. Individual species in these habitats may also be more resilient. Eno et al. (2001) conducted experiments in Scotland in which they uprooted or smothered sea pens (*Penatula phosphorea, Virgularia mirabilis, Funiculina quadrangularis*) with shrimp creels. In all cases, the sea pens were able to fully recover from creel impacts. While not generally targeted by Dungeness crab fishers, hard benthos is less sensitive to traps than active/mobile gear. In southern England, rocky habitats (e.g., limestone, bedrock and coarse sediment) and their communities, including some species perceived as delicate, appeared relatively unaffected by the use of crab pots (**Figure 11**; Eno et al. 2001). Lowry (2007) studied bycatch rate and composition in spot prawn traps off the WA coast and found relatively little bycatch of most taxa except echinoderms (sea urchins) that were almost equalin biomass

to targeted prawn. However the pots of this commercial fishery have much smaller mesh size (2.2 cm) and are fished at deeper depth (150-250 m) over more complex substrate and so are not comparable to Dungeness gear and relative effects.

It should be noted that previous studies of fishing impacts have only examined the short-term effects of pots/traps on habitat structure and benthic communities. Whether or not there are cumulative impact of intensive fishing is not known, nor is the distribution of effort on the fishing ground (see indicator 2.1.1). Lost or dumped gear may also affect the quality of benthic habitats. Derelict gear may increase habitat complexity in unstructured habitats and provide refuges for some species much like artificial reefs (Valdemarsen and Suuronen 2001). Conversely, lost traps may drag along the bottom; several authors have noted incidental observations of damaged benthos in the vicinity of lost crustacean traps (Bullimore et al. 2001; Eno et al. 2001). In order to fully understand the effects of the Dungeness crab fishery on habitat structure, site-specific studies should be done that directly address relative fishing intensity and contribution of lost gear.

2.1.3		
Research is carried out on biodiversity and to identify communities and their structure in those habitats relevant to the fishery.		
SG 60	**SG 80**	**SG 100**
Species potentially interacting with the fishery are surmised based on general cumulative knowledge of species occurrence and associations from within the preferred habitat. Fishing impacts on biodiversity have been estimated based on gear and habitat associated with the target species.	The nature of fishing activities and gear type, coupled with a basic knowledge of community structure and biodiversity in the general area in which the fishery operates, allows an appropriate assessment of risks to habitat and biodiversity.	There is research being done on biodiversity and productivity in the area of the fishery. Preliminary estimates of biodiversity have been obtained to compare values in fished and unfished areas of similar habitat. Affects of the fishery on biodiversity have been quantified and are within acceptable limits.

Score 85

Bycatch of non-target species by the fishery is considered low and as such is not regularly monitored as in other fisheries (for more information see 2.1.4). Nonetheless, a direct impact on biodiversity through removal of non-target species is likely extremely low. In addition, since the fishing gear is passive, impacts on habitats are also believed to be minimal (see 2.1.2 and 2.1.4). That being said, there may be direct localized impacts in the area where traps are set, especially if the benthos is scoured when traps are drug during storms or high tidal currents. There may also be impacts on benthic communities if traps are lost and continue to "fish" or conversely if they become substrates for fouling species in an otherwise soft-bottom habitat. Adding artificial structure to soft-bottom benthic habitats has dramatic impacts on local species composition and abundance, with a shift towards species typically associated with rocky-reef habitats (Hueckel and Buckley 1987; Laufle and Pauley 1985; West et al. 1994). Lastly, there may be indirect impacts on benthic species composition, diversity, and abundance associated with the systematic removal of adult male Dungeness crab which exerts a strong predatory force on benthic species in soft-bottom habitats.

Despite regular surveys of rocky coastal habitats there is a paucity of data on soft-bottom habitats along the coast. The Coastal Biodiversity Survey (CBS) is designed to describe and measure communities living in the rocky intertidal along the west coast of North America. Although there are currently more than 90 sites ranging from Glacier Bay (AK) to Punta Abreojos (CA), none of these are located in soft-bottom habitats typical of the coastal fishery for Dungeness crab. Similarly, PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) conducts annual diver surveys to monitor the density and abundance of macroalgae and invertebrates at 32 sites in rocky intertidal and shallow subtidal habitats along the southern-central California and central Oregon coasts. Although they occasionally observe *Cancer* spp., few sites encompass soft-bottom benthic habitats targeted by the fishery (most are less than 35% sand). Published data on soft-bottom coastal habitats is often collected opportunistically; Gunderson et al. (1990) reviewed benthic information for the coast of Washington (**Table 3**) and found that soft-bottom habitats are dominated by infaunal bivalves and polychaetes, but the biomass and density of species was generally less than that observed in estuarine habitats where the fishery does not typically occur. There appear to be no published corollary studies for the coast of Oregon; most information collected on soft-bottom communities is from surveys conducted in intertidal or estuarine habitats. McConnaughey et al. (1994) used various data sets to characterize major sediment types along the WA-CA coast in an effort to describe extent of a "coastal landing strip" for Dungeness crab larvae in terms of suitable substrate. In 2003, Nelson et al. (2006) conducted surveys of coastal and estuarine soft-bottom communities from the Strait of Juan de Fuca to the Mexican border, some of which included subtidal soft-bottom habitats typical of Dungeness crab and the data could be analyzed for patterns in soft-bottom communities.

Dungeness crab represents only one of many species that compose the predatory guild of soft-bottom benthic habitats. If fishery removals are intense at small spatial scales it is possible that extraction of male biomass could affect community features. At the high end of landings for Oregon, over 10 million adult males may be taken off state waters and that the magnitude of biomass removal (8 million to 54 million pounds annually; PMFC 2004) could have marked effects on benthic communities. Considered collectively, coastal fisheries for benthic predatory species, including Dungeness crab, could impact patterns of diversity, production, and community composition of coastal soft-bottom benthic species, but without regular comprehensive surveys of these habitats it is difficult to assess what impact (individual or collective) fisheries are having on communities of these coastal habitats.

Table 3 Comparison of total infuanal density and biomass along the coast and in Gray's Harbor estuary. Also shown are data from epibenthic shrimp and copepods.

Method of Collection	Depth (m)	Major Taxa (Species Groups)	Density (No. m^{-2}) Mean or (Range)	Biomass[a] (g AFDW m^{-2}) Mean or (Range)	Source (Time of Year)
			COAST		
van Veen grab (0.2 m^2)	36	Total	2,036	1.40	Lie and Kisker 1970 (summer 1967–68)
Box corer (0.25 m^2)	15–46	Total	—	7.45	Pearson et al. 1987 (spring, fall 1984–85)
		Bivalvia (*Tellina* spp., *Siliqua* spp., *Mytilus* spp.)	—	1.38	Pearson et al. 1987 (spring, fall 1984–85)
		Polychaeta (*Owenia fusiformis*)	—	4.88	Pearson et al. 1987 (spring, fall 1984–85)
Trawl (3 m beam)		Crustacea (*Crangon alaskensis, Pandalus danae*)	—	0.02	Pearson et al. 1987 (spring, fall 1984–85)
Box corer (0.1 m^2)	36–44	Total	16,113	—	Miller et al. 1988 (summer, 1985)
		Polychaeta (*Owenia fusiformis*)	10,600	—	Miller et al. 1988 (summer, 1985)
		Cumacea	3,188	—	Miller et al. 1988 (summer, 1985)
		Amphipoda	744	—	Miller et al. 1988 (summer, 1985)
		Bivalvia	1,004	—	Miller et al. 1988 (summer, 1985)
			ESTUARY		
Pipe corer (13.2 cm^2)	Intertidal (0.0 to +2.1)	Total	(50,000–340,000)	(5.10–50.12)	Albright and Bouthillette 1982 (spring, summer 1980–81)
		Annelida (*Manayunkia* spp.)	(10,000–200,000)	(1.31–2.62)	Albright and Bouthillette 1982 (spring, summer 1980–81)
		Crustacea (*Corophium* spp.)	(1,000–85,000)	(1.52–12.07)	Albright and Bouthillette 1982 (spring, summer 1980–81)
		Bivalvia (*Macoma* spp., *Mya* sp.)	(100–1,700)	(0.51–3.53)	Albright and Bouthillette 1982 (spring, summer 1980–81)
van Veen (0.1 m^2)	4–12	Total	(10,000–45,000)	(0.32–3.81)	Albright and Bouthillette 1982 (spring, summer 1980–81)
		Annelida (*Glycinde* spp., *Magelona* spp., *Polydora* spp.)	(1,000–39,000)	(0.20–1.32)	Albright and Bouthillette 1982 (spring, summer 1980–81)
		Crustacea (*Corophium* spp.)	(1,000–39,000)	(0.21–3.04)	Albright and Bouthillette 1982 (spring, summer 1980–81)
		Bivalvia (*Macoma* spp.)	(10–200)	(0.09–1.23)	Albright and Bouthillette 1982 (spring, summer 1980–81)
Excavation (0.06 m^2)	Intertidal (+1.0 to +2.0)	Total	—	(3.12–10.64)	Smith et al. 1976 (spring, summer 1975)
		Polychaeta	—	(1.14–1.90)	Smith et al. 1976 (spring, summer 1975)
		Crustacea (Amphipoda, Cumacea)	—	(0.40–8.60)	Smith et al. 1976 (spring, summer 1975)
		Bivalvia	—	(0.88–3.20)	Smith et al. 1976 (spring, summer 1975)
Trawl (semi-balloon)	2–10	*Crangon* spp.	0.2 (outer estuary) 1.0 (inner estuary)	0.3 (outer estuary) 0.14 (inner estuary)	Hoeman 1982 (annual 1980–81)
Trawl (3 m beam)	2–12	*Crangon* spp.	—	(0.03–0.13)	Armstrong and Gunderson, unpublished data (spring, summer 1983–86)
Epibenthic pump	Intertidal (0.0 to +0.3)	Harpacticoida	7,100	0.01	Cordell and Simenstad 1981 (May 1980)

[a] Data of Lie and Kisker (1970), Pearson et al. (1987) used directly as AFDW. All other data converted from wet weight to AFDW by conversions of Lie (1969).

Source: Gunderson et al. (1990).

2.1.4		
Community information includes non-target species affected by the fishery.		
SG 60	**SG 80**	**SG 100**
Non-target species captured or injured by the fishery are poorly known from direct reporting but mangers can surmise likely composition based on combination of preferred habitat and gear-type.	Non-target species are known synoptically by virtue of anecdotal reports from the fishery directly, or as contained in other scientific or grey literature for similar preferred habitat, but are not quantified	There is comprehensive information on non-target species typically affected directly as by-catch or indirectly as a consequence of gear deployment/retrieval. This suite of non-target species is well described within the general framework of biodiversity and community studies including distribution and abundance (2.1.3).

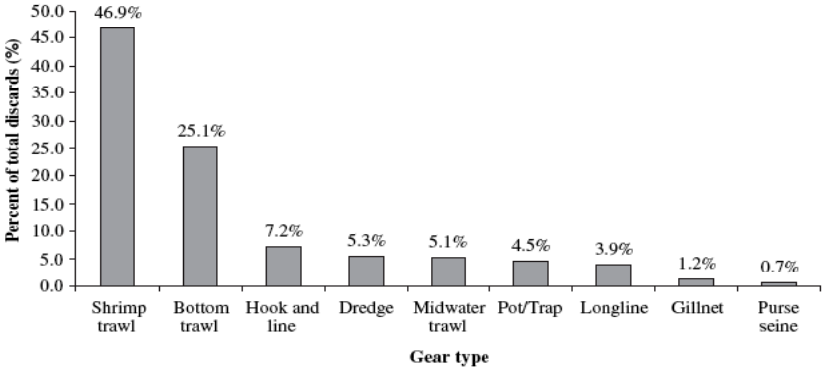
Score 80

Non-target species captured in the Oregon Dungeness crab fishery are known synoptically but are not quantified. Bycatch is perceived to be very low by managers; thus no effort is made to record information on non-target catch when it occurs and, to date, no consistent studies have been done that address non-target species in the Dungeness crab fishery. Anecdotal reports indicate that bycatch in the Oregon Dungeness crab fishery include some species of flatfish, groundfish, and octopus, but bycatch rates are low.

According to Harrington et al. (2005), pot/trap fisheries produce less bycatch than most fisheries (**Figure 12**). Bycatch is minimized by characteristics of the gear and the style of harvest. For instance, Valdemarsen and Suuronen (2001) point out that traps initiate selectivity through the use of bait that has the potential to attract the target species and/or repel unwanted organisms. Moreover, catch of non-target species is reduced by design elements, including mesh sizes and the size, shape, location(s) and design of pot entrances and escape openings (Valdemarsen and Suuronen 2001). In the Oregon Dungeness crab fishery, mesh size of pots and other gear features, such as escape rings, prevent undersized Dungeness crab from being captured and allow smaller organisms to pass through the pots unimpeded.

In general, trap fishing results in lower capture stress than other methods (Chopin and Arimoto 1995), which reduces the risk of injury and gear-related mortality, so non-target organisms may have a higher probability of survival if released (Valdemarsen and Suuronen 2001). However, actual fishing conditions may affect survival since barotrauma, thermal shock, and handling stress may increase mortality risk for released organisms (**Figure 13**; Davis 2002).

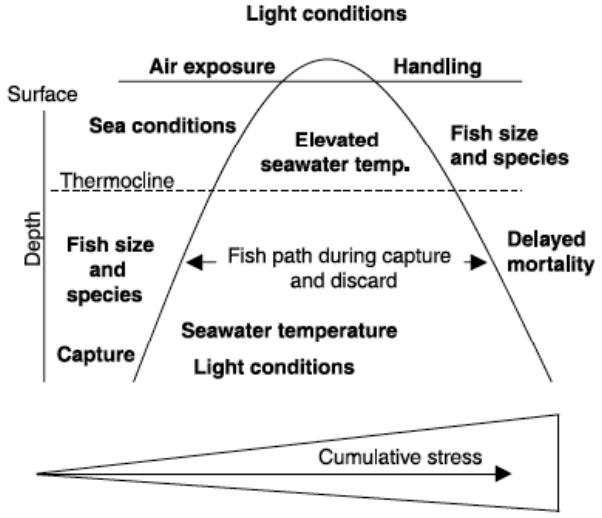
Figure 12 Percent of total USA discards (1.06 million tons) by gear type in 2002.



These estimates include published and grey literature sources that were summed by gear type and divided by total discards. *Source: Harrington et al. (2005).*

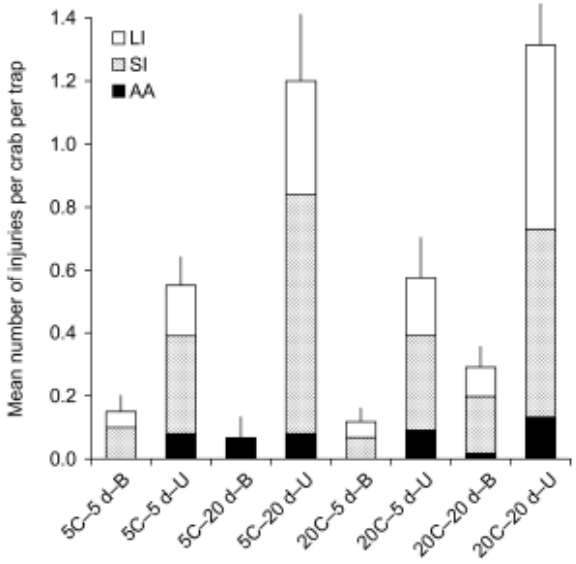
The largest component of bycatch in the Oregon Dungeness crab fishery consists of female and undersize male crabs. Mortality of discarded hardshell individuals is low (2% to 4%) but softshell (i.e., recently molted crabs)

Figure 13 A conceptual diagram of interacting factors in discard mortality of non-target organisms caught in fishing gear (e.g., trawls, traps, hook and line) deployed at depth.



The curved line indicates the path of non-target catch from capture at depth to the surface and subsequently at release. Some factors contributing to stress mortality are indicated in bold. Cumulative stress leading to mortality is indicated at the bottom of the diagram. The Oregon Dungeness crab fishery is conducted in relatively shallow coastal water compared to many fisheries so overall stress may be reduced. *Source: Davis (2002).*

Figure 14 Mean number (SE) of new injuries suffered per crab per trap in a field experiment.



Traps contained either 5 or 20 sublegal-sized Dungeness crab (5C or 20C) and were soaked for 5 or 20 d. The chelae of crab were either bound (B) or unbound (U). Damage consisted of three types: large injuries (LI), small injuries (SI), or autotomized appendages (AA). *Source: Barber & Cobb (2007).*

effective lifespan of a derelict trap.

mortality has been reported as high as 22% to 25% (Alverson et al. 1994). Managers use seasonal closures and pre-season softshell testing to reduce losses. Despite these measures, non-lethal damage may also reduce the fitness of released individuals. Barber and Cobb (2007) demonstrated that injuries among trapped crab increased significantly with trap soak time (**Figure 14**). In general, injured individuals experience reduced growth, delayed reproduction, lower mating success, and higher risk of mortality (Juanes and Smith 1995).

Ghost fishing occurs when pots are lost or abandoned but continue to fish. Annual percentage of commercial traps lost has been estimated at 10% (ODFW 2006) and 11% (Breen 1987) in some Dungeness crab fishing sectors. Derelict traps likely catch species not targeted by the fishery but crab constitute the majority of entrapped organisms (Laist 1997). Breen (1987) found that ten simulated lost traps captured 169 Dungeness crab in a year, about half of which died. Mortality may result from starvation, predation/cannibalism, or injuries associated with confinement (Breen 1987, 1990; Matsuoka et al. 2005). Thus the bodies of freshly killed organisms act as new bait in ghost fishing traps and may actually increase capture rate (Matsuoka et al. 2005). To address the issue, Dungeness crab fisheries have adopted regulations that require escape rings and time-release devices (e.g., biodegradable meshes or cord ties on trap doors) that allow crab to escape from derelict pots. Moreover, derelict gear removal programs have been undertaken in some areas (ODFW 2006).

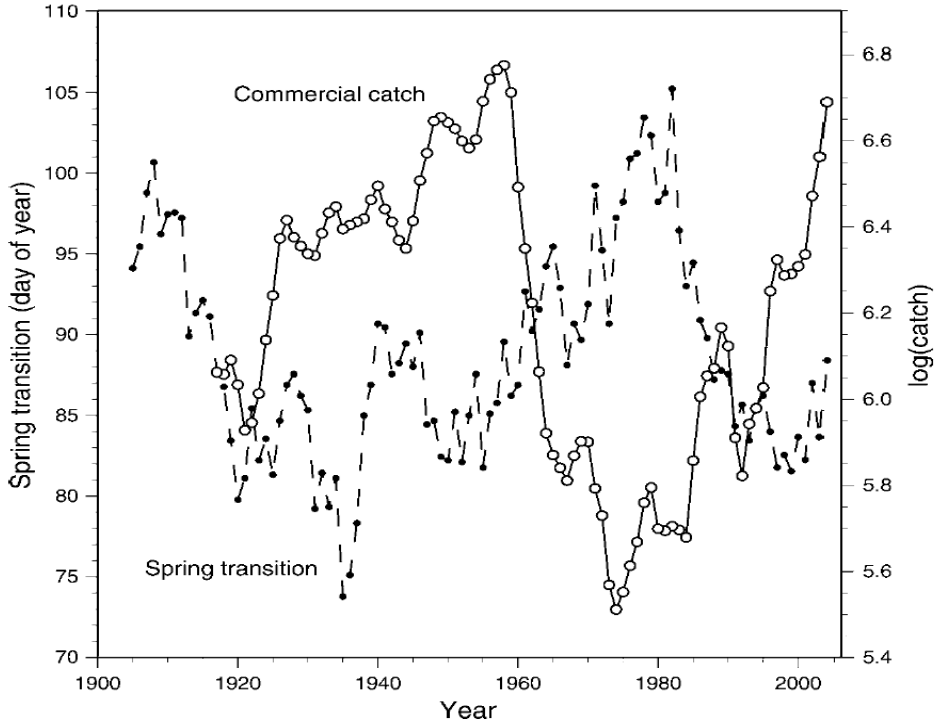
Despite producing low bycatch of non-target species and utilizing gear known to enhance survival of released organisms, the Oregon Dungeness crab fishery were scored at 80 because comprehensive bycatch data and ghost pot fishing impacts are not collected. Bycatch should be recorded and efforts should be taken to calculate mortality rates of non-target organisms. Work should also be done to determine the impact of ghost fishing on Dungeness crab and non-target organisms. According to Breen (1990), the following information is needed: 1) estimates of fishing effort and the trap loss rate, 2) an assumption about the proportion of derelict traps that continue to fish, 3) an estimate of mortality rate for each species captured, and 4) an estimate of the

2.1.5		
Ranges of natural variation in abundance and/or productivity of key species under different environmental regimes have been estimated such that effects of fishing might be identified against a backdrop of natural fluctuations.		
SG 60	**SG 80**	**SG 100**
Major states of large-scale environmental variation have been described at spatial scales that include that of the fishery. Research and monitoring programs on population abundance and distribution of key species are being developed.	Studies on variation in population abundance and distribution of key species (including non-target ones taken as by-catch), together with relevant environmental information are being collected in the area of the fishery. Research is being conducted on natural environmental variability in the fishery area.	Studies on the variation in population distribution and abundance of key species, together with collection of relevant environmental data have been conducted over the geographic range of the fishery. Research is underway to study environmental variation and its effects on marine communities in the area of the fishery.

Score 80

The commercial fishery for adult male *C. magister* along the west coast of North America began in San Francisco in 1848 (Dahlstrom and Wild 1983) and presently occurs in nearshore coastal shelf waters (< 40 m deep) from California to Alaska. Catch of non-target species are not regularly monitored by the fishery (see 2.1.4) since bycatch is generally believed to be minimal. Regular information on annual landings has been collected for the commercial crab fishery along the coast by Oregon Department of Fish and Game and California Department of Fish and Game. In Oregon and California the fishery is highly cyclic with decadal oscillations in crab landings (Fig 2.8 in indicator 2.1.1; Johnson et al. 1986; Methot 1989; Pauley et al. 1989). A Number of authors have explored factors that may influence the commercial fishery and have cited potential drivers (for a review see Hankin 1985) that include overfishing, variation in ocean circulation and upwelling that results in periodic pulse recruitment events (Wild et al. 1983; McConnaughey et al. 1992), and pre- and post-settlement density-dependent mortality (Botsford 1984; Eggleston and Armstrong 1995; Higgins et al. 1997). However, the predominate driver of crab populations is likely variation in oceanic transport that results in periodic high recruitment and settlement events. As is typical of invertebrate species with a long planktonic larval stage, Dungeness crab meta-population connectivity is based on variation in ocean circulation, upwelling, and temperature. McConnaughey et al. (1992; 1994) reviewed various hypotheses of ocean survival and found that intensity of northward geostrophic flow, rather than ekman transport (as previously suggested), was correlated with high recruitment events. Thus variation in recruitment appears to be driven by changes in ocean circulation, in particular the strength of the northward transport of larvae. More recent studies have also demonstrated a strong correlation between the timing of spring transitions (that drive coastal ocean currents), the abundance of megalope in light-trap collection boxes, and the magnitude of fishery returns 4 years later (**Figure 15**; Shanks and Roegner 2007). Thus cyclic peaks in catch are likely the result of a multi-year fishery on a single large year-class that periodically occurs as the result of ideal ocean circulation and favorable post-settlement conditions.

Figure 15 Date of the spring transition as determined from San Francisco sea level data.



(Solid circles, left-hand axis) plotted with the log-transformed commercial catch of *Cancer magister* (originally measured in metric tons) landed in San Francisco (open circles, right-hand axis). Both time series are smoothed with a 9-year running average, and the commercial catch data were lagged 4 years prior to smoothing. *Source: Shanks & Roegner (2007).*

2.1.6		
Trophic relationships of the target species within the community and resultant food webs are known including predator-prey associations with non-target species captured or injured by the fishery.		
SG 60	**SG 80**	**SG 100**
General information is available on common prey of the target species but no quantitative measures exist to gauge relative importance. Based on preferred habitat of the target species, common prey, and gear type, management can qualitatively gauge fishery impacts on the target and non-target components of the community.	General synoptic information is available to describe main prey taxa consumed by the target species, and coarse data are available on distribution and relative abundance of such prey taxa across different habitats in the fishery area.	Quantitative information is available on the position and importance of the target species within the food web of the biological community typical of its preferred habitat, including both dominant prey consumed by the target species, and what predators consume it at size/age legal in the fishery.

Score 80

Dungeness crab employs a wide-range of foraging strategies across their life-history and, although they are generally considered omnivorous predators, changes in their diet reflect distinct ontogentic shifts in their ecology. Thus the trophic role of *C. magister* varies over their ontogeny from vulnerable early life-history stages to less vulnerable later stages as benthic predators. Understanding their trophic role is

easiest by describing their ontogeny across 3 distinct stanzas: young of the year (YOY, 0+ yr), subadult (+1, +2, and +3 yr immature), and adult (> 3+ yr mature) crab.

Dungeness crab as prey: Due to their small size, larvae and newly settled crab are highly vulnerable to predation and are regular items in the diets of a variety of marine organisms including some not so obvious species such as gray whales in the north Pacific that consume megalopae (Darling et al. 1998). This last swimming stage is regularly found in large numbers in the stomachs of Chinook salmon along the coast of Oregon and California (25% of Chinook diet is *C. magister* megalopae; Hunt and Mulligan 1999) as well as other fish species such as tomcod (Haertel and Osterberg 1967), Pacific hake, sablefish, and Dover sole (Buckley et al. 1999). Early post-larval instars are common in the diets of larger conspecifics (Gotshall 1977; Stevens et al. 1982; Eggleston and Armstrong 1995; Visser 1997; Fernandez 1999) and a wide variety of marine predators including staghorn sculpin (Armstrong et al. 1995), Humboldt Bay copper rockfish (Sebastes caurinus; Prince and Gotshall 1976), white-winged scoters (Grosz and Yocom 1972), river otters (Larson 1984), *Pisaster brevispinus* in Bodega Bay (VanVeldhuizen 1978), and numerous other fish species (**Table 4**; Reilly 1983).

Table 4 of Post-larval, Young-of-the-year Dungeness crabs in fish stomachs from the Gulf of the Farallones.

	1975				1976				1977				1978			
Predator	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Acipenser medirostris	–	–	–	–	–	–	–	–	1	1	53	53.0	–	–	–	–
A. transmontanus	–	–	–	–	–	–	–	–	1	1	36	36.0	–	–	–	–
Damalichthys vacca	1	0	0	0.0	–	–	–	–	3	1	1	0.3	1	0	0	0.0
Genyonemus lineatus	5	0	0	0.0	6	1	1	0.2	28	7	20	0.7	16	1	2	0.1
Hexagrammos decagrammus	–	–	–	–	2	0	0	0.0	4	1	35	8.7	–	–	–	–
Lepidopsetta bilineata	–	–	–	–	2	0	0	0.0	5	5	60	12.0	3	0	0	0.0
Leptocottus armatus	4	0	0	0.0	–	–	–	–	17	7	9	0.5	11	2	2	0.2
Microgradus proximus	–	–	–	–	3	0	0	0.0	20	4	6	0.3	14	2	4	0.3
Mustelus henlei	–	–	–	–	–	–	–	–	6	3	7	1.2	2	0	0	0.0
Parophrys vetulus	7	0	0	0.0	10	0	0	0.0	23	6	75	3.3	14	0	0	0.0
Platichthys stellatus	12	1	6	0.5	10	0	0	0.0	31	15	840	27.1	28	1	1	0.04
Raja binoculata	9	0	0	0.0	9	0	0	0.0	17	8	91	5.4	9	2	2	0.2
Rhacochilus toxotes	2	1	2	1.0	–	–	–	–	1	0	0	0.0	–	–	–	–
TOTALS	40	2	8		42	1	1		157	59	1233		98	8	11	

•Includes data from Pt. Reyes-Bodega Bay area

Occurrence (A=Number of Stomachs Examined with Food; B=Number of Stomachs Containing Dungeness Crabs; C= Total Number of Dungeness Crabs in Stomachs; D= Average Number per Stomach). *Source: Reilly (1983).*

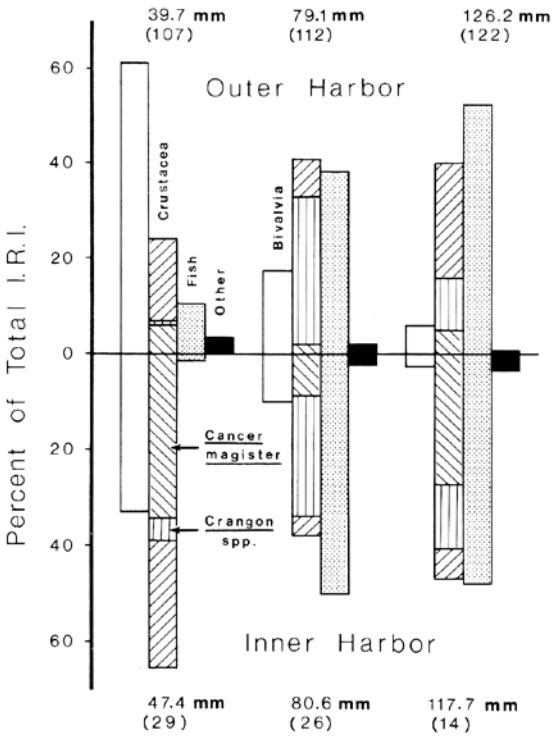
As subadults and adults, *C. magister* is far less vulnerable to many marine predators having achieved a size refuge from predation during their first and second years. That being said, there are a variety of organisms that are able consume larger crab. *C. magister* comprises 32% (by volume) of the fall diet of white sturgeon (*Acipenser transmontanus*) in San Pablo Bay (McKechnie and Fenner 1971), and there are some reports of adult crab (up to 114 mm CW) in the stomachs of large fishes such as cabezon in Oregon waters (Waldron 1958), and Pacific halibut, *Hippoglossus stenolepis*, off Alaska (Gray 1964). Additional predators of adult crab include wolf eel (*Anarrichthys occellatus*), lingcod (*Ophidon elongates*) and various rockfish (*Sebastes* spp.; Gray 1964). Although they are not considered primary diet items, large numbers of adult and subadult crab have been observed in the stomach of a great white shark off of Washington (LeMier 1951), and *C. magister* composes 11.6% to 23.3% (IRI) of the diet of leopard sharks in Humboldt Bay (CA) during spring and summer months (Ebert and Ebert 2005). *C. magister* have also been recorded in the diets of marine mammals such as sea otters (Morejohn et al. 1978). *C. magister* are most vulnerable during and immediately following molting and although crab attempt to reduce mortality

by molting in structured habitats, it is not difficult to imagine that any number of fish and mammalian predators might opportunistically consume soft-shelled crab.

Dungeness crab as predators: Newly settled crabs occupy highly productive complex habitats that serve as refugia for both themselves and their prey. Diet analyses of 0+ crab reveal that crabs will consume food items that range from small crustaceans and bivalves to macrophytes and benthic diatoms (Stevens et al. 1982; Jensen and Asplen 1998). Small crab (10-30 mm CW) also consume small bivalves such as *Transennella tantilla* (Asson Batres 1986) and *Mya arenaria* (Palacios et al. 2000). As is common among many crab species, cannibalism represents a large proportion of the diet of older instar crabs, especially in structured habitats where crab densities can be relatively high (Stevens et al. 1982; Visser 1997; Fernandez 1999). Growth rates are highest for crab that consume prey with high energetic content (Jensen and Asplen 1998), but in general consumption rates and subsequent growth are more reflective of physical conditions (temperature and salinity) than energetic resources (Gutermuth 1987; Gutermuth and Armstrong 1989).

In contrast to YOY crabs, subadult *C. magister* primarily consume fish, crustaceans (in particular several species of crangonid shrimp), and bivalves. Stevens et al. (1982; 1984) reported that crustaceans including *Crangon* spp. were the most important prey based on IRI values (**Figure 16**; index of relative importance) for 2+ yr crab in Grays Harbor (WA) and that 3+ crab primarily consumed fish, especially in an unstructured littoral habitat at high tide. Similarly, Holsman (2006) found that subadult crab consumed a preponderance of fish (primarily flatfish; Pleuronectidae), and to a lesser degree conspecifics (*C. magister*) and bivalves. Gotshall (1977) also found that fish were important in the diet of crabs <100 mm CW from Northern California, in contrast to crabs from Queen Charlotte Islands (BC) that primarily consumed crustaceans (Butler 1954). Crabs in estuaries also move into intertidal habitats during high tide to forage on polychaetes, amphipods and burrowing shrimp (Stevens et al. 1982; 1984) and feeding crabs appear to regularly use littoral habitats, especially unstructured areas during nighttime high tides (Holsman et al. 2006; Holsman 2006; Stevens et al. 1984). Many other crabs are known to have daily rhythms as well (Eggleston and Armstrong 1995), and nocturnal peaks in activity are common in the *Cancer* clade as a whole (see review by Novak 2004). The considerable biomass of subadult crabs in estuaries, coupled with their high energetic demand, suggest that *C. magister* may represent a substantial component of the marine food web and could exert multitrophic influences on the system (Holsman et al. 2003). Predation by *C. magister* may also limit the abundance of many intertidal and subtidal prey species in estuaries (Fernandez et al. 1993a; Fernandez et al. 1993b; Iribarne et al. 1995; Holsman et al. 2003; Holsman 2006).

Figure 16 Relative composition of diet of 3 size classes of crabs collected at outer harbor sites and inner harbor sites.



Mean carapace width (in mm) and number of crabs are shown above or below each bar. All prey items were grouped into 4 major categories: bivalves (open bars), crustaceans (hatched bars), fish (striped bars), or "others" (filled bars). Bar lengths are equivalent to percent of total IRI for each prey category.
Source: Stevens et al. (1982).

Although adult *C. magister* (>150 mm CW) in northern California consume a wide range of prey (at least 40 different food items; Gotshall 1977), crabs from Northern California to British Columbia are similar in that they primarily consume bivalves (Gotshall 1977; Butler 1954)

as well as crustaceans (isopods and amphipods) and fish (Mayer 1973; Stevens et al. 1982). Adult populations of *C. magister* are not likely limited by prey resources since adult crab are widely dispersed along the coast and they are generalist predators (Gotshall 1977). Cannibalism also occurs among adult crabs but is not believed to impact adult abundance (Stevens et al. 1982). Removal by the fishery of a large portion of adult male biomass may benefit both other stages of the species (females and sublegal males) that face less competition and have access to more prey, and other taxa (such as species of finfish) that overlap in diet with large Dungeness crab.

Impact of the fishery on trophic relationships: Trophic impacts of the fishery are not likely to result directly from bycatch or fishing gear impacts. The gear used in the Dungeness crab fishery is extremely selective; pots are fitted with 'escape rings' to release undersized male and female crabs and only legal-size males are retained. Moreover, bycatch is minimal and discards are lower in pot/trap fisheries than most other types (see Indicator 2.1.4). Since fishing effects are largely limited to one component of the Dungeness crab population (i.e., the extraction of legal-size male biomass), trophic impacts of the fishery should be less pervasive than in other fisheries and thus less difficult to estimate.

However, annual long-term removal of large numbers of adult *male C. magister* from benthic communities could potentially impact predator and prey dynamics of the species indirectly. Although *C. magister* are major predators in soft bottom environments, consuming a range of prey from bivalves to conspecifics (Butler 1954; Gotshall 1977; Stevens et al. 1982; Fernandez 1999), the direct and indirect impacts of Dungeness crab on benthic communities is poorly understood. Most studies to date have focused on the impact of settling 0+ crab on intertidal communities (Asson Batres 1986; Iribarne et al. 1994) or have suggested the role of *C. magister* in influencing the distribution of benthic prey and exerting density and trait mediated impacts on estuarine benthic species (Holsman 2006). However, no studies to date have examined the relative role of Dungeness crab in structuring benthic communities in different subtidal or intertidal habitats along the coast. Although structured and high relief habitats along the coast are sampled for benthic and epibenthic species abundance and distributions, little attention has been focused on a regular census of the unstructured soft-bottom benthic habitats utilized by *C. magister*. Biomass data for benthic species can be cobbled together from various published and unpublished studies (Albright and Bouthillette 1982, Gunderson et al. 1990, Williams 1994) but is not sufficient to compute abundance or biomass of benthic species consumed by Dungeness crab over wide regions of the coastal shelf. Thus, there is little opportunity at this time to extrapolate the trophic impacts of a fishery that systematically removes these important predators from top-down controlled benthic communities. Predation by other brachyuran species has been suggested to affect intertidal species; Hines et al (1990) found that *Callinectes sapidus* have a significant impact on benthic communities in Chesapeake Bay, and in Europe Jensen and Jensen (1985) documented declines in densities of cockle spat coinciding with the arrival of juvenile *Carcinus maenas* and *Cerastoderma edule* into the estuary. Numerous studies have suggested predation by *C. magister* as a mechanism limiting intertidal prey populations, (Asson Batres 1986; Posey 1986; Juanes and Hartwick 1990; Iribarne et al. 1995; Palacios et al. 2000) but few have explicitly examined this (but see Holsman 2006). Again, there are not similar data on crab prey of the coastal shelf over adequate spatial scales to extrapolate fishing impacts over broad areas.

While no studies have explicitly addressed the trophic impacts of the fishery, estimates might still be made based on existing information described above and characteristics of the fishery. Most studies of predator and prey interactions have explored direct impacts of a predator on faunal communities, but increasing attention has been directed towards additional indirect impacts of predators on community assemblages. Intermediate trophic predators or prey may alter foraging strategies in the presence of other competitive or predatory species and these behaviorally mediated interactions can have cascading effects on community assemblages and structure. Such trait-mediated interactions have yet to be explored in *C.*

magister and should be included in future investigations of *C. magister* fishery influences on soft bottom communities. The scale of overall survey work to produce such estimates does not occur on sand substrates for the coastal shelf off California through Oregon as is done in parts of the Gulf of Alaska and SE Bering Sea. In those systems very extensive data on myriad trophic interactions can be used to study effects of various fishery or natural shifts in community composition through programs like Ecopath of Ecosim.

2.2.1		
There is information on the presence and seasonal and temporal distribution and abundance of species protected, endangered or threatened (Listed) .		
SG 60	**SG 80**	**SG 100**
Based on a combination of gear-type, preferred habitat of the target species, coarse information on occurrence of Listed species, management can gauge if interactions based in the fishery are likely to threaten listed species.	There is synoptic data on occurrence of Listed species in the area of the fishery.	There is comprehensive information on distribution, abundance and seasonality of Listed species in the area of the fishery (as an element of 2.1.3).

Score 80

Two aspects of Dungeness crab fishery gear impacts on other species are bycatch and direct entanglement or possible behavioral modification of large migrating marine mammals. The Dungeness crab fishery is believed to have low rates of bycatch due to gear design that reduces capture of non-target species and undersized Dungeness crab (see 2.1.4). Most notable among migratory and resident Listed species off the Oregon coast are humpback whales (*Megaptera novaeangliae*). Whale population and seasonal timing of movement are well known and discussed in more detail below (PI 2.2.2 **Fig 17**, and NOAA Fishery website http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm#distribution).

2.2.2		
Studies of any adverse impacts of the fishery on Listed species have been done and incorporated into management strategies to avoid or minimize such impacts within acceptable minimum levels.		
SG 60	**SG 80**	**SG 100**

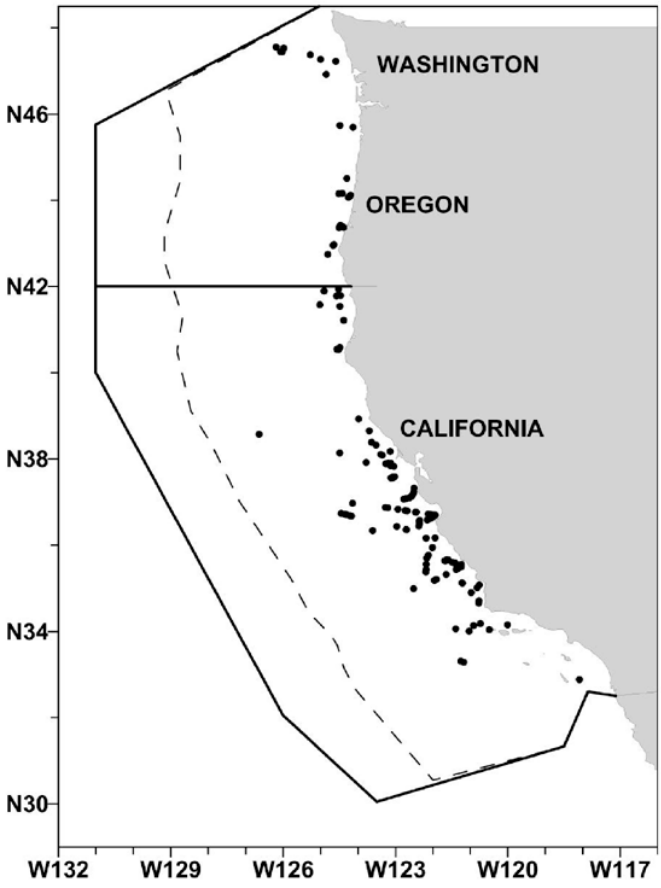
Based on a combination of gear-type, preferred habitat of the target species, and coarse knowledge of distribution of Listed species, management concludes there appear to be no ecological threats to populations of the species concerned. Specific fishery interactions with Listed species have been identified but there are limited management systems in place to reduce impacts.	Based on a combination of gear-type, preferred habitat of the target species, and known distribution of Listed species, critical fishery impacts on Listed species are estimated and evaluated within acceptable limits determined in a peer-reviewed scientific process that works to prevent important loss of geographic range, population structure, or reproductive success. Objectives and strategies are designed to adequately protect key aspects of the Listed populations within the fishery area.	Direct and indirect effects of fishing on any Listed species have been determined and are set within acceptable limits in accord with relevant statutes to prevent impacts at any time across the fishery area. Impacts on Listed species are regularly assessed and reported and compared between fished and unfished areas. Management objectives and strategies to detect and reduce impacts have been developed, tested and deployed across the fishery to adequately protect Listed populations.

Score 100

While several threatened or endangered species occur in the shallow coastal waters of Oregon, most are unlikely to interact with Dungeness crab fisheries. Many of the species in question would not be attracted to baited crab pots, nor would they be susceptible to the gear because of the size of meshes and trap openings used. The gear used in Dungeness crab fisheries is highly selective and bycatch of any type is extremely low (see indicator 2.1.4). That being said, there are a few reports of species being unintentionally captured or entangled in crab pot gear. The primary criterion for including a Listed species in the assessment of the present indicator is whether verified reports of interaction with Dungeness crab fisheries are available. Thus we believe the Oregon Dungeness crab fishery has very limited potential to interact with one threatened or endangered species, humpback whales (*Megaptera novaeangliae*).

Humpback whales (*Megaptera novaeangliae*) may occasionally become entangled in Dungeness crab fishing gear (NMFS, Southwest Region, unpublished data). These large whales are highly migratory; the eastern north Pacific stock remains in coastal waters of Central America and Mexico during winter/spring and then migrates to summer feeding grounds, which extend from California to southern British Columbia, in summer/fall (**Figure 17**; Steiger et al. 1991, Calambokidis et al. 1996). The whales feed extensively on krill and small, schooling fish, such as anchovies and herring. Listed under the Endangered Species Act in 1970, Braham (1991) estimated that North Pacific populations had been reduced to 13% of carrying capacity by whaling. While the eastern north Pacific stock was never independently assessed, it likely followed trends elsewhere. Currently the stock is rebounding; Calambokidis et al. (2004) estimated that the eastern north Pacific stock consisted of 1391 individuals in 2002/2003. The estimate was calculated using a Petersen mark-recapture method based on photos of whales on their summer feeding grounds from 1991 to 2003.

Figure 17 A composite of Humpback whale (Megaptera novaeangliae) sightings based on surveys conducted in California, Oregon, and Washington between 1991-2001.



The U.S. exclusive economic zone (dashed line) and the outer boundary of all surveys combined (solid line) are shown.
Source: Carretta et al. (2005).

Two additional species, bocaccio (*Sebastes paucispinus*) and cowcod (*Sebastes levis*), may also interact with Dungeness crab fisheries. Although we found no records describing these particular species as bycatch in crab pots, they fall into the broad category of groundfish, for which general anecdotal evidence does exist. The National Marine Fisheries Service has listed bocaccio and cowcod as "Species of Concern" because their populations have been dramatically overfished; bocaccio experienced a 97% decline in abundance between the early 1970's and the late 1990's (MacCall 2002) and cowcod may be at 4-7% of their unfished biomass (Butler et al. 2003). Bocaccio have a disjunct range, with a southern population centered off the California coast and a northern population extending from Washington State to British Columbia. Cowcod range from central Oregon to central Baja California but the species is most abundant in the southern California Bight (Butler et al. 2003). Adult bocaccio and cowcod prefer rocky habitats that are typically not targeted by the Oregon Dungeness crab fishery. However, juveniles of both species may utilize low relief, sandy bottoms characteristic of crab fishing grounds (Moser 1996).

2.2.3

Studies of any adverse impacts of the fishery on Listed species have been done and there is evidence that the fishery avoids or minimizes such impacts to within acceptable minimum levels.

SG 60	SG 80	SG 100
Based on a combination of gear-type, preferred habitat of the target species, and coarse knowledge of distribution of Listed species, management concludes there appear to be no ecological threats to populations of the species concerned. Specific fishery interactions are identified and recorded.	Based on a combination of gear-type, preferred habitat of the target species, and known distribution of Listed species, critical fishery impacts on Listed species are estimated to be within required limits. This is verified through a peer-reviewed, scientific process that works to prevent important loss of geographic range, population structure, or reproductive success of the listed species.	Direct and indirect effects of fishing on any Listed species have been determined and are within required limits. Impacts on Listed species are regularly assessed and reported and compared between fished and unfished areas.

Score 80

Baleen whales, unlike other marine mammals, sometimes become entangled in vertical lines used to mark traps, pots, or other demersal fishing gear (Read et al. 2006). Laist (1997) suggests that these whales become entangled or scarred by lines while the gear is being purposefully fished (as opposed to interactions with derelict gear). Whales may die from acute injuries incurred during entanglement or as a result of stress induced by an entanglement that may cause an imbalance in metabolic regulation (Angliss and Demaster 1998). These impacts have not been quantified for the eastern north Pacific stock of humpback whales but National Marine Fisheries Service has collected anecdotal reports in the vicinity of the CA Dungeness crab fishery. In 2001, a humpback whale was observed entangled in "pot gear" offshore of Point Bonita, California (NMFS, Southwest Region, unpublished data). In 2003, there were reports of at least five humpback whales entangled in crab pot and/or polypropylene lines in California (J. Cordero, NMFS, unpublished data).

Despite these observations, fewer whales become entangled off the west coast of the United States (California, Oregon, and Washington) than elsewhere. Relatively lower levels of entanglement may occur because: (1) whales migrate offshore of fishing grounds; and (2) whales may experience lower risk of entanglement during migratory swimming than when exhibiting feeding behaviors (NMFS 1991). It should also be noted that humpback whale migrations do not coincide with the majority of effort in Dungeness crab fisheries. While fishing effort is concentrated in the first six weeks of the season (Dewees et al. 2004), whales migrate to their northern feeding grounds in summer and fall (Steiger et al. 1991, Calambokidis et al. 1996). The eastern north Pacific stock of humpback whales is regularly surveyed, and population models could be constructed to determine acceptable bycatch limits.

As indicated previously (see Indicator 2.2.2), bocaccio (*Sebastes paucispinus*) and cowcod (*Sebastes levis*) could potentially interact with Dungeness crab fisheries. Like other groundfish, these species may be susceptible to capture in crab pots. Moreover, juveniles of both species utilize low relief, sandy bottoms characteristic of crab fishing grounds (Moser 1996). Nevertheless, there is no evidence that the fishery has any direct interaction with bocaccio or cowcod (PFMC 2004), and the incidental catch is negligible to the point that acceptable catch limits are not considered to be necessary. Some additional effort should be made to ensure that take of these species as bycatch remains low (see Indicator 2.1.4 for recommendations regarding bycatch).

2.3.1

There is sufficient information to assess if trends of decreasing non-target abundance are due primarily to the fishery and not natural variability.

SG 60	SG 80	SG 100
Non-target species as by-catch are known and limited data on frequency of occurrence are available. Gear and effort as direct deployment are known and there is a measure of lost gear and fishing life. Management can coarsely estimate capture, injury and mortality of key non-target species within the preferred habitat of target species based on effort and area. Those estimates can be compared to other population data of key non-target species to gauge relative impact of the fishery.	Non-target species of the fishery are known, by-catch information is available over time, and there is historical information enough on trends in population abundance of key species across environmental gradients to separate causes of reductions as due to natural forces or the fishery.	Direct and indirect effects of fishing on any Listed species have been determined and are within required limits. Impacts on Listed species are regularly assessed and reported.

Score: N/A

10.3 MSC Principle 3

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

Intent:

The intent of this principle is to ensure that there is an institutional and operational framework for implementing Principles 1 and 2, appropriate to the size and scale of the fishery.

Principle 3 evaluates the rules and procedures that are in place and how they are implemented to maintain a sustainable fishery and to ensure that the impact on the marine environment is minimized.

3.1.1		
The management system incorporates and applies an adaptive and precautionary exploited stock strategy.		
SG 60	**SG 80**	**SG 100**
There are basic attempts to control effort. The management system has identified the need for sustainability indicators to gauge how to set objectives in the fishery	The management system has sustainability indicators, including catch rates, and sets objectives related to these data. There are measures to control effort that have been shown to be effective.	The management system includes scientific assessment of stocks and sets precautionary long-term stock management objectives. The harvest strategy includes effective effort and/or output controls. Harvest strategies maintain stocks at productive levels and provide for the recovery of depleted stocks to specified levels within specified time frames. Stock assessments and harvest strategy evaluations have been properly peer reviewed and made available for stakeholder comment.

Score: 80

Oregon has adopted three effort and capacity control measures that promote fishery sustainability: limited entry, LE 200 (a reciprocal agreement with Washington to limit EEZ fishing off each state to the permitted vessels of that state) and a system of pot limits. In addition, the state restricts catch by size, sex and season. The combined effect of the suite of catch and effort controls meets the intent of the SG at the 80 level.

3.1.2		
The management system incorporates and applies an effective strategy to manage the ecological impacts of fishing.		
SG 60	**SG 80**	**SG 100**

Data on non-target species are irregularly collected, but no formal assessment has been conducted. A preliminary review of the impacts on habitats from fishing gear has been conducted. The management system periodically has used this data to discuss potential impacts in the fishery.	The management system regularly reviews the ecological impacts from fishing, but has no formal strategy. Data on non-target species are irregularly collected and assessed. Impacts on habitats from fishing gear have been assessed.	The management system has a strategy that takes into account all significant ecological impacts of the fishery, including non-target species and habitats.

Score: 85

Oregon's gear regulations are designed to minimize bycatch, the impact of bycatch, and ghost fishing of lost gear. Crab pots are required to have two escape rings to allow undersized crabs to exit at will. The lid closure of the pot must have a biodegradable component so that irretrievable gear will eventually release the trapped crabs and eliminate ghost fishing. Each pot must be fished independently rather than hooked together and attached to a surface buoy for identification and retrieval.

Bycatch rates of non-target species such as groundfish are low. Vessels fishing for Dungeness crab are exempt from using VMS and not subject to the Rockfish Conservation Areas (RCAs) because of the low rated of incidental catch in crab traps (PFMC 2005). The rebuilding plans for lingcod (*Ophiodon elongatus*) and canary rockfish (S*ebastes pinniger*), two overfished species under the West Coast Groundfish Fishery Management Plan, note that a 2002 sampling project north of Cape Mendocino found that lingcod were landed on .2% of Dungeness crab trips and canary rockfish were landed on <.05% of the Dungeness crab trips (PFMC 2003a;b)

Gear is placed on sandy bottom and is thought to have minimal impact on habitat through contact.

The fishery scored an 85 for this indicator because it has adopted a pot limit system that will reduce the impact of gear on benthic habitat through reducing the expansion of gear use. In addition, a project to collect derelict fishing gear, sponsored by the Oregon Fishermen's Cable Committee and the Oregon Dungeness Crab Commission and jointly funded by state and federal sources, has focused on the retrieval of crab traps (Oregon Department of Fish and Wildlife 2005; Oregon Fishermen's Cable Committee. 2006a;b;c).

3.1.3

The management system incorporates and applies an effective strategy to assess the socioeconomic potential and socioeconomic impacts of the fishery.

SG 60	SG 80	SG 100
Economic and social data are irregularly collected. The management system considers social and economic impacts of fishing, but has no formal strategy.	Economic and social data are regularly collected, and some assessment is conducted.	The management system has a strategy that takes into account all significant social and economic impacts of the fishery, including those on harvesters, processors and communities.

Score: 70

Landed catch and ex-vessel value are recorded through the fish ticket systems of the Oregon Department of Fish and Wildlife, and archived by the Pacific States Marine Fisheries Commission in the Pacific Fisheries Information (PacFIN) database. In Oregon, the volume and value of landed catch is reported annually in the Oregon Agricultural and Fishery Statistics (ODA 2006). In addition, annual fishery summaries have been jointly contracted by the Oregon Coastal Zone Management Association and the Oregon Department of Fish and Wildlife (cf Radtke and Davis 2004; 2005). In addition, fleet profiles and landings distributions were summarized to evaluate the impacts of various pot limits (Kaiser et al. 2002).

Aside from sale price, no additional economic data is regularly collected. Most economic social information is anecdotally provided at meetings and hearings or developed through occasional research projects. Notable exceptions are the research projects looking at economic options for the Dungeness crab fishery and the economic implications of management funded by CalCOFI and California Sea Grant (Dewees et al 2004; Hackett et al. 2003; 2004; Hankin et al 2005).

An overview of the Dungeness crab fishery done by the PSMFC in 2002 included some economic aspects of the fishery (Didier 2002). However, this report appears not to have been updated.

Social data are even less regularly collected through sporadic research projects. Community profiles designed to provide information for National Standard 8 (impacts of fishery management on communities) assessments of Fishery Management Plans done through the PFMC (PSMFC 2007; Norman et al. n.d.) provide some general fishing community information that is not specific to Dungeness crab. Most social information is provided anecdotally through public comment on pending regulations.

Condition 3.1.3: A plan for the regular collection and assessment of economic and social data on the Dungeness crab fishery should be developed. The data should support the assessment of the socio-economic potential of the fishery, the socio-economic impacts of the fishery and the socio-economic impacts on the fishery of implementing no-take marine reserves.

By the 1st annual surveillance, a synthesis of existing data shall be developed.
By the 2nd annual surveillance, a draft plan shall be developed.
By the 3rd annual surveillance, the data collection plan shall be implemented.

3.1.4		
The management system incorporates economic and social incentives that contribute to sustainable fishing.		
SG 60	**SG 80**	**SG 100**
The management system explicitly recognizes the importance of economic and social incentives for sustainable fishing but has no formal plan to incorporate them.	The management system is assessing the potential to use economic and social incentives such as market-based management tools or other incentives to promote sustainable fishing and has plans to include them.	The management system explicitly incorporates economic and social incentives such as market-based management tools or other incentives to promote sustainable fishing.

Score: 80

The fishery is moving in the direction of applying economic and social incentives to promote sustainable fishing. The fishery has a limited entry program that limits the number of vessels in the fishery but do not control effort. Oregon adopted a tiered pot limit program in 2006 that will reduce the amount of gear in

the water and place some controls on effort. However, the fishery continues to have a race for fish in which competitive incentives work against best fishing practices. Even with pot limits in place the persistence of the race to fish means that maximum economic benefits from the fishery are not being realized.

Greater economic benefits would be realized through management mechanism such as tradable pot certificates or other share-based systems that provided incentives to maximize value rather than volume. This would be possible through a pacing of landings that avoided price-depressing gluts and by innovative contracting and product development. An example of the deleterious effects of landings gluts took place in the California Dungeness crab fishery in 2004, when landed volumes were too large to be processed and were dumped by after they were unable to be unloaded (Chea 2004). Dewees et al (2004) and Hackett et al (2004) note several ways that the race for fish reduces the value generated by the fishery and assess a variety of alternative management options.

The management system is assessing the potential for using social and economic incentives and has plans to include them, but does not as yet explicitly incorporate them. The fishery receives a score of 80 for this indicator because of its pot limit program and its plan to consider tradable gear permits (ODFW 2006a).

3.1.5		
The fishery is free from significant subsidies, which promote over fishing or ecosystem degradation.		
SG 60	**SG 80**	**SG 100**
Direct subsidies exist and a plan for their elimination is in place. The subsidies that exist have not presently led to overfishing or ecosystem degradation.	There are no significant direct subsidies to the fishery that lead to overfishing or ecosystem degradation.	All aspects of the fishery are free from significant direct subsidies that promote overfishing or ecosystem degradation.

Score: 100

No significant direct subsidies exist in this fishery.

3.1.6.1		
The management system has a plan for research needed to support the harvest strategy.		
SG 60	**SG 80**	**SG 100**

Some limited research to support management is undertaken. Some research results are considered.	There is a research plan to support the management system. The research plan includes biological, ecological and economic elements. Resources are available for critical studies in support of management. Most research results are considered.	There is a research plan developed jointly by scientists and managers to support the management system. The research plan includes biological, ecological and economic elements. Resources are available to support research for the needs of management. Research results are made public and they are considered under the management system.

Score: 75

A limited amount of research to support management is conducted, and some of these research results are considered. However, the research is ad hoc and sporadic and is not part of a research plan, which would be a systematic framework targeted at providing biological, ecological and economic information to promote management objectives.

Condition 3.1.6.1: A strategic Research Plan for the Oregon Dungeness crab fishery should be developed to include

- biological, ecological and economic elements,
- a strategy for securing research funding support, and
- identified information gaps, needed research, and a strategy for filling information gaps.

The identification and synthesis of existing research should be completed by the time of the 1st annual surveillance audit.
The Plan shall be developed by the 2nd annual surveillance audit.
The Plan shall be implemented by the 3rd annual surveillance audit.
Evidence of procured research funding should be available by the end of the 5 year certification period

3.1.6.2

The management system has a plan for research needed to support the understanding of the ecological impacts of fishing.

SG 60	SG 80	SG 100
Some limited research to support ecosystem management is undertaken. Some research results are considered	There is a research plan to support the ecosystem. Resources are available for critical studies in support of ecosystem management. Most research results are considered.	There is a research plan developed jointly by scientists and managers to support ecosystem understanding and to determine where ecological impacts from fishing may be occurring. The effectiveness of the research plan has been assessed. Resources are available to support research for the needs of ecosystem management. Research results are made public and they are considered under the management system.

Score: 75

Limited research is conducted to understand the ecological impacts of fishing. Several of these projects are described under Principle 2. However, there is no research plan identifying needed ecological research or a strategy for securing resources for research funding.

Condition 3.1.6.2: Research on the ecological impacts of fishing should be included as part of the research plan to be developed under Condition 3.1.6.1.

3.2.1		
The fishery is managed and conducted in a manner that respects Indian treaty fishing rights, interstate agreements and congressional intent under the Magnuson Stevens Fishery Conservation and Management Act.		
SG 60	**SG 80**	**SG 100**
The management system appears to operate within applicable treaties, interstate agreements, and federal law, although no detailed examination of this has been made.	The management system does not employ or in any manner seek to operate within any exemption to otherwise applicable treaties, interstate agreements, or federal obligation.	All measures taken within the management system are in compliance with relevant treaty, interstate and federal obligations. The management system does not undertake unilateral exemption from any treaty, interstate or federal obligation pertaining to the fishery.

Score: 100

The Dungeness crab fishery is not exempt from any international agreement. Indian treaty fishing rights are not an issue for the Oregon fishery. Congressional intent for interstate coordination of management as specified by §302(e) of the MSFCMA (State Authority for Dungeness Crab Fishery Management) is being implemented through the tri-state MOU (Anon. 2005) and through meetings of the Tri-State Dungeness Crab Committee.

3.2.2		
The fishery is managed and conducted in a manner that complies with domestic law.		
SG 60	**SG 80**	**SG 100**
The management system appears from preliminary observations to operate within applicable domestic law and no noted violations have been identified that would jeopardize the management of fisheries resources.	The management system is known to be in compliance with the substantive and procedural aspects of applicable domestic law that pertain to any aspect of the fishery that affects sustainability.	The management system is consistently in compliance with all substantive and procedural aspects of applicable domestic law. No officer or agent of the management system, including its component entities, has at any time been found to be in contempt of any domestic court of jurisdiction on any matter related to performance of official duties on behalf of the management system.

Score: 100

The management system is consistently in compliance with all substantive and procedural aspects of applicable domestic law. There is no record of management being found in contempt of a court of jurisdiction. Coast-wide regulations and meat testing are collectively coordinated through the MOU (Anon 2005) signed by Oregon, California, and Washington. Congressional intent for interstate coordination of management as specified by §302(e) of the MSFCMA (State Authority for Dungeness Crab Fishery Management) is being implemented through the tri-state MOU (Anon. 2005) and through meetings of the Tri-State Dungeness Crab Committee. Each state has jurisdiction over its respective permit holders and permit conditions (such as gear, seasons, etc.) as well as control over conditions for making landings within a state.

3.3.1		
The management system involves all categories of stakeholders appropriately on a regular, integral, explicit basis.		
SG 60	**SG 80**	**SG 100**
The management system makes decisions after consulting some stakeholders.	The management system makes decisions after consulting all significant stakeholder groups.	The management system makes decisions that fully account and serve all stakeholders.

Score: 90

Mention is made in various documents of the Tri-State Dungeness Crab Committee as evidence of stakeholder involvement in the management process (cf. U.S. House of Representatives 1998a; Didier 2002). The committee is coordinating mechanism between the states of Washington, Oregon and California, and is advisory to the respective state governments (Fisher 1998). Committee members are one representative of the PSMFC (who chairs the committee) and three representatives of the Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, and California Department of Fish and Game. Each state member appoints an advisory group of 5 industry members (P. Burke 2007; D. Colpo 2007). The Committee meets on an irregular basis at the request of state members. Meetings are public. Brief meeting minutes are kept and are available to stakeholders on request (cf. PSMFC Tri-State Dungeness Crab Committee 2007). It would appear that the extent to which stakeholder interests are expressed through the Tri-State Committee process depends on the extent of communication between state membership and the fleet.

It is difficult to determine if the Oregon Fish and Wildlife Commission decisions have full accounting of all stakeholder interests at all times, but several pieces of information indicate that stakeholder perspectives are regularly sought and included in decision processes. The ODFW Marine Program has extensive interaction with members of the crab industry on an ongoing basis. In cooperation with the Oregon Dungeness Crab Commission it conducted a statewide stakeholder “crab summit” in 2005 (harvesters and processors) to address the issues of limited entry and pot limits (Burke 2005). Further information provided indicates extensive stakeholder consultation (both commercial and recreational) during meetings of the Oregon Fish and Wildlife Commission. At the March 2006 OFWC meeting 48 fishermen testified offering their views on proposed pot limits (OFWC 2006). The meeting was held in the Port of Newport to encourage high levels of industry participation.

The close interaction of the ODFW with Dungeness crab fishery stakeholders is exemplified by the process used in the development of pot limits. In response to a stakeholder (industry) expression of concern about the increasing amount of gear being fished in Oregon waters (cf Pazar et al. 2004, in addition to numerous other expressions) and the problems associated with the gear increase, a

stakeholder-involvement process was implemented to develop a program of limiting the number of pots. The schedule and meeting locations were publicized in advance (ODFW 2006 a;b;c).

July 2005: Fifty Crabbers and processors met for two days at a crab summit to discuss state jurisdiction to 200 miles and potential pot limit plans.
October 2005: The Oregon Fish and Wildlife Commission is presented with a summary of industry views and two potential pot-limit options.
July – December 2005: Stakeholder phone calls, personal visits, letters, and emails from were received by ODFW staff following the Crab Summit and the Commission meeting.
January 2006: Two draft proposals were mailed sent to all Oregon permit holders, processors and interested persons (>650 people).
February 2006. Two 2-hour teleconferences with ODFW staff for stakeholders who were at sea or in distant locations.
February 28, 2006: Deadline for written comments on the two draft crab pot proposals distributed in January.
March 2006 (OFWC Meeting in Newport) – Staff overview of the crab pot limitation development process for the Commission. The meeting was primarily to provide an additional opportunity for coastal public input. Public comments from 48 crab fishermen.
April 2006 (OFWC Meeting in Salem) – Staff briefings to the OFWC on public comments/input regarding the two draft options; Public testimony on the two options. Suggested amendments to the proposals based on public input and staff analysis provided to the OFWC.
May 2006: Final staff proposal/rule mailed to all recipients of the original draft proposals. Public comments/written comments received prior to May 15 was summarized by staff for the June OFWC presentation.
June 2006 (OFWC Meeting in Salem): Commission final action on the crab pot limitation proposed rule for implementation for the 2006-7 season (December 1, 2006). Public comment opportunity.
October 2006: pot limits and buoy tag programs took effect for the 2006-2007 season.

More recent evidence of information provision to Oregon stakeholders is an undated Oregon State Police/ODFW fact sheet on new regulations on unattended gear, and a November 6 2007 ODFW memo to Dungeness crab permit holders on several new rules adopted by the OFWC at its October meeting (ODFW n.d.; ODFW 2007).

3.3.2		
The management system provides for timely and fair resolution of disagreements.		
SG 60	**SG 80**	**SG 100**

Mechanisms for informal dispute resolution exist, and are used by some stakeholders.	The management system has mechanisms for both formal and informal resolution of disputes at all levels of, and for most issues arising within the system. The management system's dispute resolution procedures show evidence of being open to and used by at least some stakeholders. The resolution results are public.	The management system has established objective mechanisms for resolution of disputes at all levels of, and for all issues arising within the system. The management system's dispute resolution procedures show evidence of being open to and used by a variety of participants and stakeholders. The resolution results are public.

Score: 80

The Tri-State Dungeness Crab Committee exists to coordinate decisions among the three states and to provide a forum for negotiating interstate disagreements. The MOU provides a formal enabling mechanism for the coordination of interstate decisions (Fisher 1998; Anon. 2005).

Oregon has close coordination within state among managers and industry, and industry differences over management directions can be aired and resolved at meetings of the OFWC. The most relevant example of a forum for dispute resolution was the crab summit held in 2005 as a forum to discuss views on pot limits and other management options. These processes are public and show evidence of being open to and used by at least some stakeholders.

3.3.3

The management system presents managers with clear, relevant information, which is considered in decision-making.

SG 60	SG 80	SG 100
The management system's decision makers are provided with information under the management system and there is evidence that it is at least periodically considered.	The decision makers show evidence of regularly considering the information provided to them under the management system.	The management system regularly presents decision makers with analyzed alternatives for action. The management system shows evidence of a pattern of behavior by decision makers that reveals that they have found the information provided to them to be useful.

Score: 100

Examination of OFWC briefing books (available for each meeting at http://www.dfw.state.or.us/agency/commission/minutes/) reveals that the OFWC is regularly presented with analysis of agenda action items. Staff briefings include a background and description of the problem as well as an analysis of alternatives for action. While the OFWC may not always decide on the staff recommended option, it is clear from meeting minutes that the information is used to inform their decisions.

See as an example the ODFW staff briefing memo for the OFWC decision on Dungeness crab pot limits (ODFW 2006a). The briefing notes that it "presents staff progress on development of pot limit

implementation strategies and a brief discussion of process/next steps." The briefing documentation includes a description of the history of fishery management, description of the statutory context (state and federal) and legislated goals of Dungeness crab fishery management, applicable rules and procedures, description of the existing management approach and goals for the limited entry program enacted in 1995, biological and economic status of the fishery, background of the capacity problem, background of the gear loss problem, history of OFWC discussions of pot limits, description of public process (crab summit and public comments) to discuss pot limits, summary of summit findings, summary of public comments, description of public involvement, description of ODFW coordination with enforcement and industry in developing options, and future decision schedule, analysis of options, and staff-recommendations.

3.4.1

The management system restricts gear and practices to avoid by-catch, minimize mortality of by-catch, and reduce discard.

SG 60	SG 80	SG 100
A preliminary plan to avoid by-catch, minimize bycatch mortality, and reduce discards is in place.	Measures to avoid by-catch, minimize bycatch mortality, and reduce discards are in place.	Goals for bycatch, bycatch mortality and discards are specified. Measures to avoid by-catch, minimize bycatch mortality, and reduce discards are in place.

Score: 90

There is little formal monitoring of bycatch in Dungeness Crab fisheries. Some sampling of Dungeness crab landings has been done to establish bycatch rates of overfished species on rebuilding schedules. In addition fishery observers testing shell hardness to determine fishery opening date have anecdotally noted low bycatch levels.

Oregon's gear regulations are designed to minimize bycatch, the impact of bycatch, and ghost fishing of lost gear. Crab pots are required to have two escape rings to allow undersized crabs to exit at will. The lid closure of the pot must have a biodegradable component so that irretrievable gear will eventually release the trapped crabs and eliminate ghost fishing. Each pot must be fished independently rather than hooked together and attached to a surface buoy for identification and retrieval (Oregon Administrative Rules 635-005-0045 through 635-005-0060).

Bycatch rates of non-target species such as groundfish are low. Vessels fishing for Dungeness crab are exempt from using VMS and not subject to the Rockfish Conservation Areas (RCAs) because of the low rated of incidental catch in crab traps (PFMC 2005). The rebuilding plans for lingcod (*Ophiodon elongatus*) and canary rockfish (S*ebastes pinniger*), two overfished species under the West Coast Groundfish Fishery Management Plan, note that a 2002 sampling project north of Cape Mendocino found that lingcod were landed on .2% of Dungeness crab trips and canary rockfish were landed on <.05% of Dungeness crab trips (Pacific Fishery Management Council 2003a;b). Some octopus are caught in Dungeness Crab traps and are generally sold (Cascorbi 2004).

Gear is placed on sandy bottom and is thought to have minimal impact on habitat through contact.

Oregon scores 90 on this indicator because it has adopted a pot limit system that will reduce the amount of gear and therefore the bycatch potential of working gear and the ghost fishing potential of lost gear.

3.4.2		
The management system minimizes adverse impacts on the habitat.		
SG 60	**SG 80**	**SG 100**
The management system is working to identify critical habitats so they can be incorporated into an assessment of fishery related impacts.	The management system is gathering knowledge of sensitive habitats in the area of the fishery. As information concerning potential impacts on sensitive habitats is identified, there are mechanisms in place to assess whether the impacts are significant.	The management system requires efforts to identify and document any fishery related impacts on all habitats known to occur in the area of the fishery.

Score: 80

The habitat information collected through the Pacific Fishery Management Council process to meet the Magnuson Stevens Fishery Conservation and Management Act mandate to describe and identify "essential fish habitat" (EFH) (§303) applies indirectly to Dungeness crab habitat as crab share sandy bottom habitat with other species. However, as this provision applies only to species for managed under a federal FMP, documentation of Dungeness crab habitat is not done specifically through this process for the Oregon fishery.

In the 1970's the California Department of Fish and Game conducted the Dungeness Crab Environmental Project to determine environmental factors related to the decline in central California crab landings, including temperatures, salinities, toxicants, currents, upwelling, sea level, and river flows into the bays and ocean. The "critical stage" studies included distribution and relative abundance of larvae and juvenile crabs, crab predators, population genetic structure juvenile growth rates (Orcutt et al. 1975).

Other more recent habitat research has been conducted in both states. Rooper et al (2002) examine habitat use by juvenile Dungeness crabs in Oregon coastal estuaries. Two research programs monitor diversity, density, and abundance invertebrate communities in California and Oregon. The Coastal Biodiversity Survey measures communities living in the rocky intertidal, western coast of North America. PISCO monitors the density and abundance of invertebrates in the subtidal zone from southern-central California and central Oregon.

Direct impacts of crab gear on habitat are assumed to be small. However it is possible that if large quantities of gear are used to "reserve real estate" on the ocean floor during the early season, the cumulative impact of gear crowding on habitat might not be small.

The existence of ongoing intertidal and subtidal habitat monitoring programs in Oregon, while not implemented by the management system itself, do nevertheless provide a source of habitat information to management and to identify significant fishery impacts.

3.4.3		
The management system does not allow use of destructive fishing practices.		
SG 60	**SG 80**	**SG 100**

The management system prohibits the use explosives or toxic chemicals to kill or stun aquatic species.	The operational practices in the fishery attempt to minimize habitat impacts. There is evidence that the fishery does not use explosives or toxic chemicals to kill or stun aquatic species.	The management system prohibits fishery or operational practices that damage or destroy natural geologic, biologic, or chemical features or characteristics of the aquatic area in which the fishery occurs. There is a monitoring system in place to ensure such impacts do not occur. There are penalties for the use of destructive fishing practices.

Score: 100

State regulations concerning crab pots (see Oregon Administrative Rules, summarized in Didier 2002, Appendices B and C) specify operational practices in the fishery that attempt to minimize habitat impacts and penalties for their violation. The fishery does not use explosives or toxic chemicals. Operational practices requirements are enforced through on-shore and at-sea surveillance.

Shoreside enforcement of Oregon regulations is provided by the Fish & Game Enforcement Division of the Oregon State Police (OSP) in cooperation with the ODFW). At-sea enforcement is provided by the U.S. Coast Guard (USCG). Enforcement activities focus on gear and fishery violations (e.g. undersized crab, permit issues, closed-area harvesting), and involve significant dockside presence during times of peak landing activity. At-sea enforcement includes enforcement of season closure and gear removal regulations.

3.4.4

There is a process in place for rapid development of a recovery plan for Dungeness crab populations should significant depletion occur, as did the population near San Francisco in the late 1950s. Significant depletion can be defined as dropping below the LRP.

SG 60	SG 80	SG 100
In the event of significant declines, there is a process in place to develop a plan to recover depleted populations, and there is an appropriate trigger condition.	In the event of significant declines, there is a process in place to rapidly develop a plan to recover depleted populations within 20 years. The trigger for the process is tied to annual catch remaining at historically low levels for 10 years.	In the event of significant population declines, there is a process in place to rapidly develop a plan to recover depleted populations within 10 years and the trigger to implement the process is tied to annual monitoring of the LRP.

Score: 60

Condition 3.4.4: The definition of an LRP and plan for implementation of the management response required if the LRP is breached, as specified in the condition for 1.1.5, will meet the 80 scoring guidepost.

3.4.5		
The management system incorporates no-take zones where appropriate.		
SG 60	**SG 80**	**SG 100**
The management system has the capacity for establishing no-take zones.	The management system has considered the introduction of no-take zones.	The management system has completed a formal assessment to see if no take zones are appropriate for the fishery. If appropriate, no take zones are implemented.

Score: 80

For both states, fishing area set-asides are being considered or developed in processes that include but are not limited to fishery management.

In Oregon, the Ocean Policy Advisory Committee (OPAC), a multi-agency and stakeholder advisory committee to the governor, is developing a proposal for marine reserves. In addition, the ODFW has implemented a Nearshore Strategy for planning within the 30 fm. –shore zone. Under the strategy habitat protections and no-take zones would be considered.

3.4.6		
The management system minimizes operational waste.		
SG 60	**SG 80**	**SG 100**
The fishery management system encourages the minimization of operational wastes.	The fishery encourages minimization of operational wastes. There is evidence that operational wastes are minimized.	Management explicitly considers the effect of regulations on operational waste. There are monitoring and enforcement programs for operational waste.

Score: 90

Fleets are subject to federal enforcement of MARPOL, prohibiting at-sea disposal of waste. Similarly, state code of Oregon contains sections prohibiting at-sea disposal of waste (State of Oregon n.d.). Oregon's food fish management policy (ORS 506.109) specifies that one of the goals of food fish management must be to minimize waste. Oregon ports maintain dockside recycling facilities for free disposal of commercial fishery waste such as twine, oil and gear parts (Bryant 2007; Charleston Marine Complex 2007).

Waste of crabs as a result of fishery operations is addressed through the formal multi-state preseason quality testing of Dungeness crabs which was added to the state agencies' crab MOU in 1993 and subsequently amended in 1996. The provision includes a pre-season sampling and testing protocol to estimate whether the meat recovery percentage is adequate to produce a quality product (Didier 2002).

The OFWC gave explicit consideration to operational waste in its 2006 consideration of pot limits for Dungeness crab. As noted in the ODFW material prepared for the OFWC (ODFW 2006a;c), resource wastage (crab mortality) is inherent in the deployment of gear that is not tended, is lost or is used in the "race for real estate". Before pot limits were enacted crab pots were in some cases being used to block access to crab grounds in the valuable first weeks of the season when per-pot abundance of crab is the

highest. Crab pots used to block access could remain untended for weeks while "active" pots were tended by a vessel. Concentrations of gear near port entries and around concentrations of crab at sea posed barriers to traditional crab grounds for some vessels.

Oregon scores a 90 on this indicator as it has adopted a pot limit system that will reduce the potential of lost gear as a source of operational waste. In addition, a project to collect derelict fishing gear, sponsored by the Oregon Fishermen's Cable Committee and the Oregon Dungeness Crab Commission and jointly funded by state and federal sources, has focused on the retrieval of crab traps (Oregon Department of Fish and Wildlife 2005; Oregon Fishermen's Cable Committee. 2006a;b;c). However, monitoring and enforcement programs for operational waste are not a part of management, which prevents this indicator from being scored at 100.

3.5.1		
The management system enforces compliance in the fishery and has knowledge of the level of illegal fishing on the target species.		
SG 60	**SG 80**	**SG 100**
The management system has a compliance and enforcement system and there is general compliance with the system.	The management system has established a compliance and enforcement system and has demonstrated a consistent ability to enforce applicable rules. The level of illegal fishing is estimated.	The management system has established a comprehensive compliance and enforcement system. It contains procedures for effective compliance; monitoring, control, surveillance and enforcement, which ensure that management system controls are not violated and appropriate corrective actions, are taken. The level of illegal fishing is known.

Score: 100

Dungeness crab landed catch is monitored using fish tickets in Oregon, supplemented by shore-side sampling conducted by the respective state agencies.

Shoreside enforcement of Oregon regulations is provided by the Fish & Game Enforcement Division of the Oregon State Police (OSP) in cooperation with the Oregon Department of Fish & Wildlife (ODFW). At-sea enforcement is provided by the U.S. Coast Guard (USCG). Enforcement activities focus on gear and fishery violations (e.g. undersized crab, permit issues, closed-area harvesting), and involve significant dockside presence during times of peak landing activity. At-sea enforcement includes enforcement of season closure and gear removal regulations.

The Oregon Cooperative Enforcement Program sets annual enforcement priorities at a meeting of OSP and ODFW personnel (OSP 2005a;b). A cooperative enforcement plan (CEP) is prepared for each ODFW District (OSP 2005d;f). Monthly enforcement summaries are submitted to the Director of ODFW, citing the level of effort and number of violations detected in specific fishery areas. For example, the February 13 2006 summary report details of violations related to landing of undersized Dungeness crab (OSP 2006). An annual retrospective overview and projection for the year ahead is also prepared by OPS and submitted to the ODFW (OSP 2005e). The conditions for a score of 100 have been met.

3.6.1		
The management system provides for internal assessment and review.		
SG 60	**SG 80**	**SG 100**
The management system has an internal system for occasional evaluation of management performance in the case of special circumstances.	The management system has an internal system for evaluation of management performance.	The management system has an internal, continuing, system for evaluation of management performance.

Score: 80

Oregon has an internal continuing assessment and review of management performance through the Tri-State Committee and the Oregon Department of Fish and Wildlife. For example, the pre-season sampling and testing protocol for determining season opening date based on meat recovery rates resulted from discussions within the Tri-State Dungeness Crab committee. Annual reports by ODFW staff to the Fish and wildlife Commission provides season summaries and an identification of key issues to be addressed (ODFW 2008). The Commission also monitors in-season performance of the fishery and enacts regulations to control the pace of the fishery at the end of the season. It also uses trip limits and closed periods to limit mortality of soft-shell crabs. Occasional reports on contract to the ODFW include standard volume and price information on Dungeness crab as a component of all Oregon fisheries (cf. Radtke and Davis 2005). Oregon landings and revenues are also reported as part of the annual Oregon Agricultural and Fishery statistics (ODA 2006) and the annual report Fisheries of the United States (NMFS 20007.

However, a requirement in an appropriations bill of 2001 (P.L. 107-77) that the Pacific States Marine Fisheries Commission make a biennial report to Congress beginning in 2001 “on the health and management of the Dungeness Crab fishery located off the coasts of the States of Washington, Oregon, and California” appears to have resulted in only a single report (Didier 2002).

The PSMFC is required to submit to the Senate Committee on Commerce, Science, and Transportation and the House Committee on Resources a biennial report on the status and management of the fishery including:

- stock status and trends throughout its range;
- description of the research and scientific review processes used to determine stock status and trends; and
- measures implemented or planned to prevent or end overfishing.

This biennial report would provide a documented ongoing evaluation of management performance in the Dungeness crab fishery.

The 2006 revision of the Magnuson-Stevens Fishery Conservation and Management Act bill also extends state authority for managing the Dungeness crab fishery (under P.L. 105-384) through 2016 and revises state reporting requirements.

3.6.2		
The management system provides for external assessment and review.		
SG 60	**SG 80**	**SG 100**
The management system has a system for occasional external evaluation of management performance.	The management system has a system for a regular external evaluation of management performance.	The management system provides for an independent, expert review of management performance.

Score: 60

The management system would have a system for external evaluation of management performance if the biennial reports required under the Dungeness Crab Conservation and Management Act were being produced and submitted to Congress, but these reports have not been submitted since 2002.

Condition 3.6.2: As described in the Dungeness Crab Conservation and Management Act, biennial reporting shall be implemented on the status and management of the fishery including:

- stock status and trends throughout its range;
- description of the research and scientific review processes used to determine stock status and trends; and
- measures implemented or planned to prevent or end overfishing.

An updated report compliant with the specifications of the Act should be completed and submitted to Congress by the time of the 1st annual surveillance audit. In addition, a plan for the external review of the biennial reports to Congress and of management performance should be developed by the 1st annual surveillance audit and implemented by the time of the second annual surveillance audit. The plan should include a description of the primary data sources supporting the assessment, data management processes and funding.

3.6.3		
The management system identifies research needs and directs appropriate funding and other resources to these problems.		
SG 60	**SG 80**	**SG 100**
Resources for research are adequate to address at least some of the gaps in knowledge that are identified by the management system.	Resources for research are adequate to address critical gaps in knowledge that are identified by the management system.	Resources for research are adequate to address most gaps in knowledge that are identified by the management system.

Score: 70

A limited amount of research to support management is conducted, and some of these research results are considered. However, the research is not part of a research plan that identifies needed resources, so the adequacy of resources for research addressing critical knowledge gaps is unknown.

Condition 3.6.3: Actions to address Condition 3.1.6.1 and the research plan it describes will also address PI 3.6.3.

Progress toward achieving research funding will be assessed at each annual surveillance audit.

3.7.1		
Fishing operations are carried out in a manner that minimizes unintended impacts on the resource and the ecosystem.		
SG 60	**SG 80**	**SG 100**
The management system considers operational practices that would avoid damage to the resource or its ecosystem.	The management system explicitly includes operational practices that would avoid damage to the resource or its ecosystem.	The management system explicitly includes operational practices to avoid damage to the resource or its ecosystem. There is a monitoring system in place to measure such impacts.

Score: 80

Information presented above in the discussion sections of indicators 3.4.1 (bycatch), 3.4.2 (habitat impacts) 3.4.3 (destructive fishing practices), 3.4.5 (no—take areas) and 3.6.6 (operational waste) all address this indicator.

11. CERTIFICATION RECOMMENDATIONS AND PERFORMANCE SCORES:

The fishery achieved a normalized score of 80 or above on each of the three MSC Principles independently (Principle 1 – 83.9, Principle 2 – 84.6, and Principle 3 – 86.3). Although the evaluation team found the fishery in overall compliance (a normalized score of 80 on each MSC Principle), it also found the fishery's performance on 9 indicators to be below the established compliance mark (an un-weighted score of 80 for a single indicator). In these specific cases, the MSC requires that the Certification Body set 'Conditions for Continued Certification' that when met bring the level of compliance for the select indicator up to the 80-level score. **Table 5** below shows the overall results of the evaluation in terms of Principle 1, 2 and 3.

Table 5 Performance Indicator & Principle Scores

Principle	Wt	PI No.	Performance Indicator (PI)	Wt	Weight in Principle	Score	Contribution to Principle Score
One	0.433	1.1.1	Geographic Distribution Known	0.137	0.059	85	5.0
		1.1.2	All removals known	0.153	0.066	70	4.6
		1.1.3	Reproductive Capacity Monitored	0.241	0.104	80	8.3
		1.1.4	Productivity and abundance estimated	0.178	0.077	70	5.4
		1.1.5	Limit reference points	0.291	0.126	75	9.5
	0.567	1.3.1	Effects of fishery on age, sex and genetic structure do not impair reproductive capacity	1.000	0.567	90	51.0
Two	0.500	2.1.1	Types and Distribution of habitats relevant to fishery are known	0.156	0.078	85	6.6
		2.1.2	Gear effects on habitat are known	0.200	0.100	80	8.0
		2.1.3	Research on biodiversity and communities in habitats in fishery	0.167	0.084	85	7.1
		2.1.4	Non target species known in habitats	0.165	0.083	80	6.6
		2.1.5	Natural Variation in abundance for key species affected by fishery	0.154	0.077	80	6.2
		2.1.6	Trophic relations with target species are known	0.158	0.079	80	6.3
	0.500	2.2.1	There is information on the presence and seasonal and temporal distribution and abundance of species protected, endangered or threatened (Listed).	0.331	0.166	80	13.2
		2.2.2	Studies of any adverse impacts on Listed species has been incorporated into management strategies.	0.379	0.190	100	19.0
		2.2.3	There is evidence that the fishery avoids or minimizes adverse impacts on Listed species.	0.289	0.145	80	11.6
Three	0.197	3.1.1	Adaptive and Precautionary Stock Strategy	0.230	0.045	80	3.6
		3.1.2	Effective strategy to manage ecological impacts	0.154	0.030	85	2.6
		3.1.3	Effective strategy to manage socio-economic impacts	0.154	0.030	70	2.1
		3.1.4	Incorporates social and economic incentives to achieve sustainability	0.154	0.030	80	2.4
		3.1.5	Free from significant subsidies	0.154	0.030	100	3.0
		3.1.6.1	The management system has a plan for research needed to support the harvest strategy.	0.103	0.020	75	1.5
		3.1.6.2	Plan for research on ecological impacts	0.051	0.010	75	0.8
	0.125	3.2.1	Treaty rights and MSFCMA	0.500	0.063	100	6.3
		3.2.2	Complies with Domestic law	0.500	0.063	100	6.3
	0.104	3.3.1	Open consultations process with stakeholders	0.250	0.026	90	2.3
		3.3.2	Timely resolution of disagreements	0.375	0.039	80	3.1
		3.3.3	Management system present mangers with information	0.375	0.039	100	3.9
	0.156	3.4.1	Restrict gear impacts on bycatch	0.244	0.038	90	3.4

		3.4.2	Minimize adverse impact on habitat	0.213	0.033	80	2.7
		3.4.3	No destructive fishing practices	0.061	0.010	100	1.0
		3.4.4	Monitoring provisions	0.226	0.035	60	2.1
		3.4.5	Uses no-take zones where appropriate	0.128	0.020	80	1.6
		3.4.6	Minimize operational waste	0.128	0.020	90	1.8
	0.146	3.5.1	Enforces compliance and knows about illegal fishing	1.000	0.146	100	14.6
	0.140	3.6.1	Internal review	0.290	0.041	85	3.5
		3.6.2	External review	0.331	0.046	75	3.5
		3.6.3	Research needs and funding	0.379	0.053	70	3.7
	0.132	3.7.1	Minimize impacts on species and ecosystem	1.000	0.132	80	10.6

Overall weighted Principle-level scores	**Scores**
Principle 1 - Target species	83.9
Principle 2 - Ecosystem	84.6
Principle 3 - Management	86.3

12. CLIENT ACTION PLAN FOR MEETING CONDITIONS

The Client for this fishery assessment and certification has submitted an Action Plan for meeting all conditions and requirements under the MSC program.

ODCC Action Plan 1.1.2			
Conditional Requirement	How Meet	By Whom	When Completed
Present results of sampling Dungeness crab fishing to determine the rate at which females are caught, whether hard or soft shelled, and time to release. Present an estimate of the mortality rate of released female crabs. Review estimates of recreational catch, by-catch in the trawl fishery and the catch of undersized males. Where data are lacking, conduct the sampling/monitoring necessary for estimates. Present a crude (or better) estimate of recreational catch, by-catch in the trawl fishery and the catch of undersized males. By the 1st annual surveillance audit, Provide a list of the data available for each category requested and the planned approach.	A draft plan will be developed to access and analyze information about estimated levels of female crab captured and released in the commercial, recreational and trawl fisheries using a variety of existing methods/sources. Female and under-sized male crab harvest rates will be recorded during the pre-season (Oct-Nov) 'crab quality' testing conducted coast wide prior to the Dec. opener. In-season sampling will also be conducted in conjunction with commercial harvest activity. Data from on-going recreational crab fishery sampling will be incorporated into the review and reporting process, as will trawl by-catch information recorded by the NMFS trawl observer and trawl survey programs.	ODFW & ODCC* *work outside the scope of ODFW CMP will be carried out by the appropriate parties, under contract with the ODCC.	A list of available data will be compiled by the 1st annual surveillance (2011), along with a draft plan for accessing the information needed to satisfy the condition.
By the 2nd annual surveillance audit, provide a list of who will accomplish each requirement and any results available.			A list of who will be responsible for data collection & analysis will be available for review by the 2nd annual surveillance (2012), along with any preliminary results from the proposed sampling activity.
By the 3rd annual surveillance, provide all requested results; including data, analyses, and a description of sampling in place for future data.			Results of the data collection and sampling activity along with harvest estimates will be presented at the end of the 3rd annual surveillance (2013).

ODCC Action Plan 1.1.4			
Conditional Requirement	How Meet	By Whom	When Completed
By the 2nd Annual Surveillance, update analysis of both yield-per-recruit (YPR) and eggs-per-recruit (EPR) that evaluates the trade-off in yield involved in a policy of not fishing females by incorporating values for mortality of catch and release mortality of females, and growth of females. This analysis should include some evaluation of the effects of uncertainty on the conclusions regarding management policy. It should include the relevant conclusions in Methot (1989).	Data on catch and release female mortality will be collected and incorporated into the already established Yield-per-recruit (YPR) and Eggs-per-recruit (EPR) analyses.	Will be carried out by the appropriate parties, under contract with the ODCC.	Evidence that data is collected will be presented to CB by the first annual surveillance. That data will be incorporated into the Yield-per-recruit (YPR) and Eggs-per-recruit (EPR) analyses by the second annual surveillance audit.

ODCC Action Plan 1.1.5			
Conditional Requirement	How Meet	By Whom	When Completed
By the 1st annual surveillance develop a method for integrating a measure of CPUE (or other estimate of abundance) with the long-term data available from the catch series to formulate a Limit Reference Point.	A defensible method for establishing a LRP for the fishery, using the landings-based approach will be developed. Logbook data will be evaluated to determine whether CPUE information can be extrapolated and applied to LRP criteria.	ODFW CMP	Evidence of work related to condition will be presented at 1st annual surveillance (2011).
By the 2nd annual surveillance the Limit Reference Point and explicit management responses need to be formulated and in the process of being adopted by the ODF&W as regulatory instruments.	Specific responses to a breach of the LRP will be evaluated and developed through established public process which includes industry, agency and public input/review.		A LRP and draft management responses to a potential breach will presented at the 2nd annual surveillance (2012).
By the 3rd annual surveillance the Limit Reference Point and explicit management responses need to be adopted by ODF&W as a regulatory instrument.	Staff will present LRP options and specific mgmt. responses to be adopted into Oregon Administrative Rule (OAR) to Oregon Fish & Wildlife Commission (OF&WC).		A LRP and associated regulatory actions will be codified in crab fishery reg's* by the 3rd annual surveillance (2013). **contingent on OF&WC approval & adoption.*

ODCC Action Plan 3.1.3			
Conditional Requirement	How Meet	By Whom	When Completed
A plan for the regular collection and assessment of economic and social data on the Dungeness crab fishery should be developed. The data should support the assessment of the socio-economic potential of the fishery, the socio-economic impacts of the fishery and the socio-economic impacts on the fishery of implementing no-take marine reserves. By the 1st annual surveillance, a synthesis of existing data shall be developed.	Process will begin by assessing what data is currently available; what is currently being collected; and what is needed to both meet the 'condition' and provide an ongoing understanding of the 'socio-economic' aspects of the crab fishery. Potential information sources include biennial reports prepared by The Research Group, Corvallis, OR; Ecotrust 'fishing effort' mapping project; socio-economic studies being conducted in association with Marine Reserve implementation and Wave Energy evaluation.	ODFW CMP * Work outside scope of ODFW CMP will be carried out by the appropriate parties, under contract with the ODCC.	Evidence of work on available data/ needs assessment will be provided at the 1st annual surveillance (2011).
By the 2nd annual surveillance, a draft plan shall be developed.	A draft plan will be developed to incorporate this data within the framework of ODFW's CMP.		Draft plan for data collection and evaluation will be provided at the 2nd annual surveillance (2012)
By the 3rd annual surveillance, the data collection plan shall be implemented.	Information specific to the crab fishery will be collected and reviewed on a regular basis, and factored into the CMP's decision-making process.		Evidence of on-going socio-economic data collection will be presented at the 3rd annual surveillance (2013).

ODCC Action Plan 3.1.6.1			
Conditional Requirement	How Meet	By Whom	When Completed
A strategic Research Plan for the Oregon Dungeness crab fishery should be developed to include • biological, ecological and economic elements, • a strategy for securing research funding support, and • identified information gaps, needed research, and a strategy for filling information gaps. The identification and synthesis of existing research should be completed by the time of the 1st annual surveillance audit.	ODFW has recently procured funding for a permanent Dungeness Crab Management Program (CMP) w/one full-time staff member (job description attached as Appendix III) and research/monitoring funding. ODFW's intent is to develop the Program in a methodical fashion based on current and anticipated needs (i.e. biological, research, regulatory, economic), that continues to rely on active monitoring of harvest effort, regular interaction with harvesters, conservation-minded gear regulations and regular reviews of the fishery from a variety of perspectives. Part of that plan will include a management plan for research, which will address the issues raised in the condition.	Newly-hired CMP Manager *work outside the scope of the CMP will be conducted by the appropriate parties, under contract with the ODCC.	Existing research will be identified as framework of CMP proposed research plan is developed. Evidence of work will be presented at the 1st annual surveillance (2011).
The Plan shall be developed by the 2nd annual surveillance audit.			Evidence of plan development will be presented at the 2nd annual surveillance (2012).
The Plan shall be implemented by the 3rd annual surveillance audit.			Research plan will be incorporated into CMP by the 3rd annual surveillance (2013)
Evidence of procured research funding should be available by the end of the 5 year certification period.	Since ODFW has the program in its permanent budget, there is already dedicated funding for research. The current level of research funding may be augmented as opportunity and need arises. It should also be noted that the ODCC has and is committed to 'crab research' funding, with on-going commitments to 'stock-related' research as well as other projects designed to fill 'info gaps' in the crab fishery.		Evidence of ongoing research funding and the associated projects will be presented at each annual surveillance.

ODCC Action Plan 3.1.6.2			
Conditional Requirement	How Meet	By Whom	When Completed
Research on the ecological impacts of fishing should be included as part of the research plan to be developed under Condition 3.1.6.1.	Knowledge of known impacts of crab/pot fisheries will be summarized and considered in the preparation of the CMP research plan. Information generated by proposed Marine Reserve and Wave Energy-related research related to ecological impacts by or to the fishery will also be evaluated and included in this summary.	Newly-hired CMP Manager *work outside the scope of the CMP will be conducted by the appropriate parties, under contract with the ODCC.	See time frames given in response to condition 3.1.6.1

ODCC Action Plan 3.4.4			
Conditional Requirement	How Meet	By Whom	When Completed
The definition of an LRP and plan for implementation of the management response required if the LRP is breached, as specified in the condition for 1.1.5, will meet the 80 scoring guidepost.	See response to condition 1.1.5	See response to condition 1.1.5	See response to condition 1.1.5

ODCC Action Plan 3.6.2			
Conditional Requirement	How Meet	By Whom	When Completed
As described in the Dungeness Crab Conservation and Management Act, biennial reporting shall be implemented on the status and management of the fishery including: • stock status and trends throughout its range; • description of the research and scientific review processes used to determine stock status and trends; and • measures implemented or planned to prevent or end overfishing. An updated report compliant with the specifications of the Act should be completed and submitted to Congress by the time of the 1st annual surveillance audit.	Pacific States Marine Fisheries Commission (PSMFC) will use data collected through PacFIN and information from the Tri-State process to summarize landings/ stock status and current management of West Coast Dungeness crab fisheries. A report will be prepared and submitted to Congress in accordance with the DCCMA.	PSMFC *work outside the scope of PSMFC will be conducted by the appropriate parties, under contract with the ODCC.	Report will be available at the 1st annual surveillance (2011).
In addition, a plan for the external review of the biennial reports to Congress and of management performance should be developed by the 1st annual surveillance audit and implemented by the time of the second annual surveillance audit. The plan should include a description of the primary data sources supporting the assessment, data management processes and funding.	A process will be established to conduct an external review of the PSMFC reports, to include a description of the data and funding sources involved in the biennial reporting.	ODCC *work outside the scope of ODCC will be conducted by the appropriate parties, under contract.	A review plan will be developed by the 1st annual surveillance (2011) and implemented by the 2nd annual surveillance (2012).

ODCC Action Plan 3.6.3			
Conditional Requirement	How Meet	By Whom	When Completed
Actions to address Condition 3.1.6.1 and the research plan it describes will also address PI 3.6.3.	See 3.1.6.1	See 3.1.6.1	See 3.1.6.1

13. PEER REVIEW, PUBLIC COMMENT AND OBJECTIONS

A peer review has been conducted by two peer reviewers. Their comments and the response to the comments by the team can be found in Appendix III. As required, scientists nominated as peer reviewers for this report were posted on the MSC web site for stakeholder comment. Also, a public comment period was held, as well as a posting period for objections as required by the MSC.

14. MSC LOGO LICENSING RESPONSIBILITIES

As the "applicant" for certification of the fishery, the ODCC is the only entity that has the right to apply for a license to use the MSC logo. It is also the case that ODCC has the right to approve the use of the logo for other quota holders in the fishery at its discretion and by a means that is considered fair and equitable (based on MSC requirements). The MSC as the logo license owner has the sole right and responsibility to review and enforce its requirements with regard to the fair and equitable sharing of access to the fishery certificate. SCS as the certification body does not have any obligations to review, approve, or enforce the MSC requirements in this regard.

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APPENDIX I – CLIENT COMMENTS AND TEAM RESPONSE

May 7, 2010

To: Scientific Certification Systems, Inc. (SCS)
Attn: Jason Swecker, Dr. Sabine Daume
From: Nick Furman, ODCC

Re: Client response to 'Specific Conditions' outlined in Preliminary Draft Report – March 2010

Note: The following 'responses' were generated in consultation with the following individuals/agencies involved in various aspects of the Oregon Dungeness crab MSC certification process: Dr. Caren Braby (Oregon Department of Fish and Wildlife); Dr. Selina Heppell (Oregon State University) and Dr. Alan Shanks (Oregon Institute of Marine Biology). Responders to specific conditions are identified in ( ).

Condition 1.1.2: (ODCC/ODFW)

Much of the desired data about removals from this fishery are currently available for analysis and use. The recreational catch has been sampled by ODFW for multiple years and will continue in the future. Data from this program can be used to provide estimates of the 'sport' harvest of Dungeness crab on an annual basis. Data on Dungeness crab by-catch in the trawl fishery is available from NMFS's 'observer' program and can be accessed and reported on an annual basis.

The catch of females and undersized males in the fishery is not currently measured, but these numbers can be estimated through periodic sampling. Because ODFW will not be developing a 'sampling plan' for this under the new Dungeness Crab Management Program, periodic sampling, other than that done during pre-season testing*, can be addressed by ODCC. In-season harvest-rate sampling can be conducted during the trip-limited 'summer season' (2nd Monday in May through Aug. 14th) when pace slows making data collection realistic.

*Female harvest rates can be projected from landings generated in the annual pre-season 'crab quality' test fishery conducted by ODFW/ODCC to determine 'meat fill' rates for season-opening standards.

We recommend that the development of a sampling plan be completed by the 2nd annual surveillance with results available at the 3rd annual surveillance.

Team Response 1.1.2:
Client says that data are available for unspecified years, and they can be used to estimate recreational harvest. Plan for doing so not specified. Client says that data are available to estimate trawl b-ycatch for unspecified years. Plan for doing so not specified. Client says catch of females and undersized males is unknown. I do not understand sentence, "Because ODFW will not be developing a 'sampling plan' for this under the new Dungeness Crab Management Program, periodic sampling, other than that done during pre-season testing*, can be addressed by ODCC." They say that the harvest rate sampling can be done in the later part of the season after most of the catch has been taken or in the pre-season sampling. Both of these would still leave the bycatch early in the season highly uncertain.

Client recommends delaying all action on this condition by one year. No reason is given. They have most of the data, why not analyze it?

Condition 1.1.4: (Heppell)

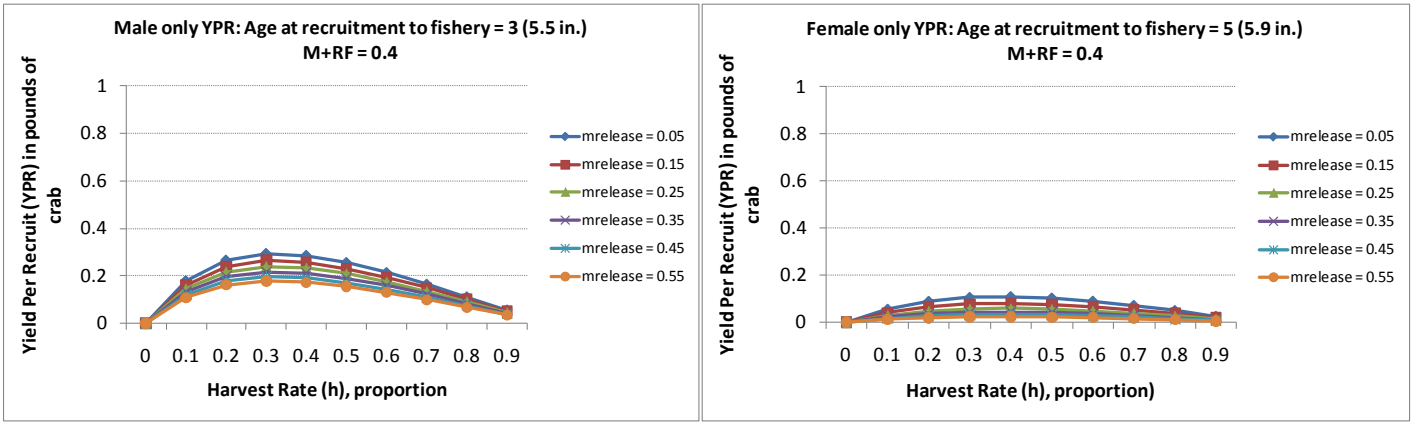
Yield-per-recruit (YPR) and Eggs-per-recruit (EPR) analyses under a range of harvest and release mortality scenarios were evaluated, using parameters from the literature. As stated in Methot (1989), "an accurate assessment of YPR cannot be made because of uncertainties in growth and natural mortality rate" (p. 213-214). The same can be said of EPR; however, like Methot and other researchers, we did examine a range of possible results and recommended focused research on growth and mortality of crabs in the Oregon fishery. These will be addressed in the research plans.

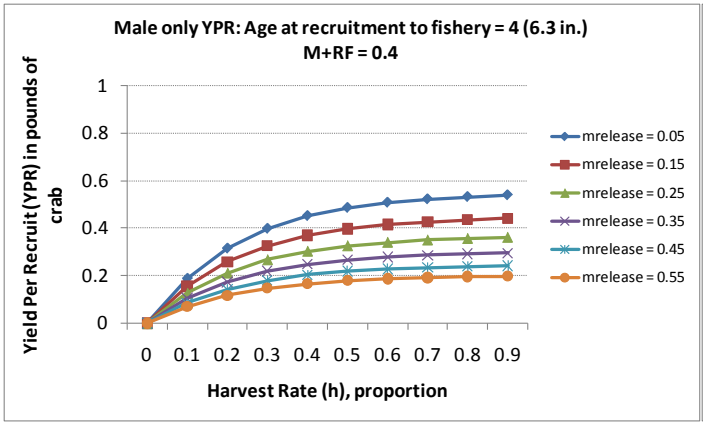
The issue of changes in YPR and EPR with female harvest was also addressed heuristically with our modeling exercise, which we have now expanded to include a broader range of potential mortality rates (harvest, release and natural) (Figure 1.1.4 A, B). Our stochastic model analyses shown in the February report support Methot's (1989) conclusion that "the large female harvest necessary to affect the stock's dynamics would be difficult to achieve" (p. 218) due to the large size that is the minimum for retention (the size limit for females would have to be much lower than for males because they do not grow as large) and the strong dependency of stock dynamics on abiotic factors.

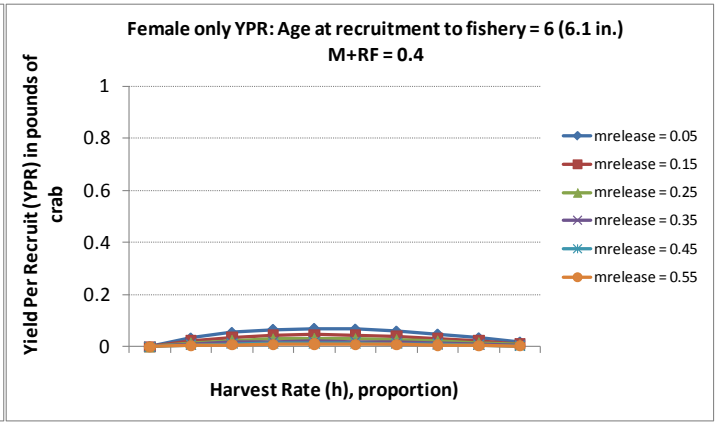
At present, there are no data on females in the Oregon fishery because females are not landed; thus, the number of females currently landed by the fishery is zero. There are no plans to alter the male-only restrictions for commercial or recreational fisheries.

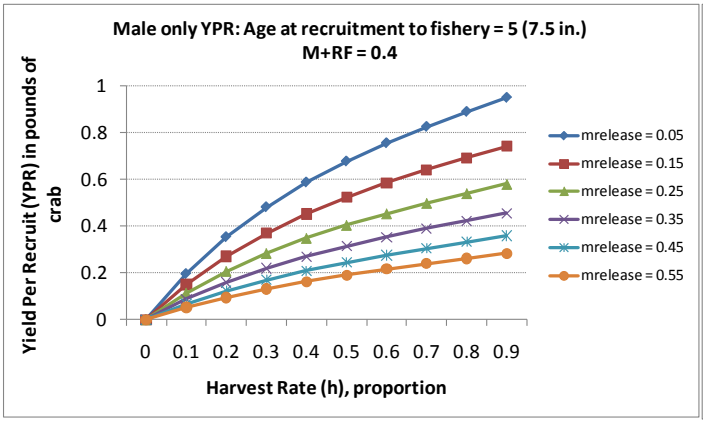
Improvements in data collection and a study of post-release mortality for females will allow a more refined evaluation of YPR and EPR for the Oregon Dungeness crab fishery. However, more precise values for these equilibrium-based assessment measures are unlikely to improve evaluations of stock status due to the highly variable recruitment rates observed. Development of reference points for management will be better focused on a pre-harvest evaluation of juveniles to identify low recruitment potential in upcoming seasons.

Figure 1.1.4. A. Yield-per-recruit calculations for Oregon Dungeness crab, based on 1 year-old recruits and literature values for size-at-age and weight at age (Table below). Figures are updates from the February report to better illustrate the effects of release mortality and minimum harvest size on YPR. Release mortality rate is instantaneous and added to the total non-fishery mortality (M = natural mortality, RF = recreational fishing mortality; the levels of these two rates are currently unknown). Calculations for M + RF = 0.2 show somewhat greater YPR values but indicate similar optimal harvest rates.




Male only YPR: Age at recruitment to fishery = 4 (6.3 in.)
M+RF = 0.4
Yield Per Recruit (YPR) in pounds of crab
1
0.8
0.6
0.4
0.2
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
Harvest Rate (h), proportion
mrelease = 0.05
mrelease = 0.15
mrelease = 0.25
mrelease = 0.35
mrelease = 0.45
mrelease = 0.55


Female only YPR: Age at recruitment to fishery = 6 (6.1 in.)
M+RF = 0.4
Yield Per Recruit (YPR) in pounds of crab
1
0.8
0.6
0.4
0.2
0
Harvest Rate (h), proportion)
mrelease = 0.05
mrelease = 0.15
mrelease = 0.25
mrelease = 0.35
mrelease = 0.45
mrelease = 0.55


Male only YPR: Age at recruitment to fishery = 5 (7.5 in.)
M+RF = 0.4
Yield Per Recruit (YPR) in pounds of crab
1
0.8
0.6
0.4
0.2
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
Harvest Rate (h), proportion
mrelease = 0.05
mrelease = 0.15
mrelease = 0.25
mrelease = 0.35
mrelease = 0.45
mrelease = 0.55

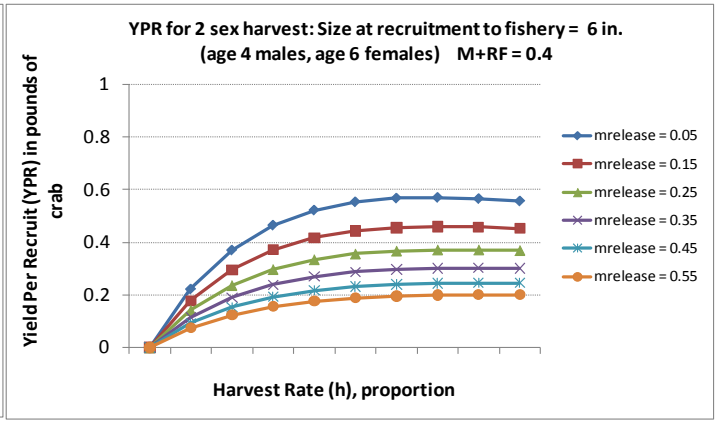

YPR for 2 sex harvest: Size at recruitment to fishery = 6 in.
(age 4 males, age 6 females) M+RF = 0.4
Yield Per Recruit (YPR) in pounds of crab
1
0.8
0.6
0.4
0.2
0
Harvest Rate (h), proportion
mrelease = 0.05
mrelease = 0.15
mrelease = 0.25
mrelease = 0.35
mrelease = 0.45
mrelease = 0.55

Figure 1.1.4.B. Eggs-per-recruit calculations for Oregon Dungeness crab, based on 1 year-old recruits and literature values for size-at-age and weight at age (Table below). Figures are updates from the February report to better illustrate the effects of release mortality and minimum harvest size on YPR. Release mortality rate is instantaneous and added to the total non-fishery mortality (M = natural mortality, RF = recreational fishing mortality; the levels of these two rates are currently unknown).

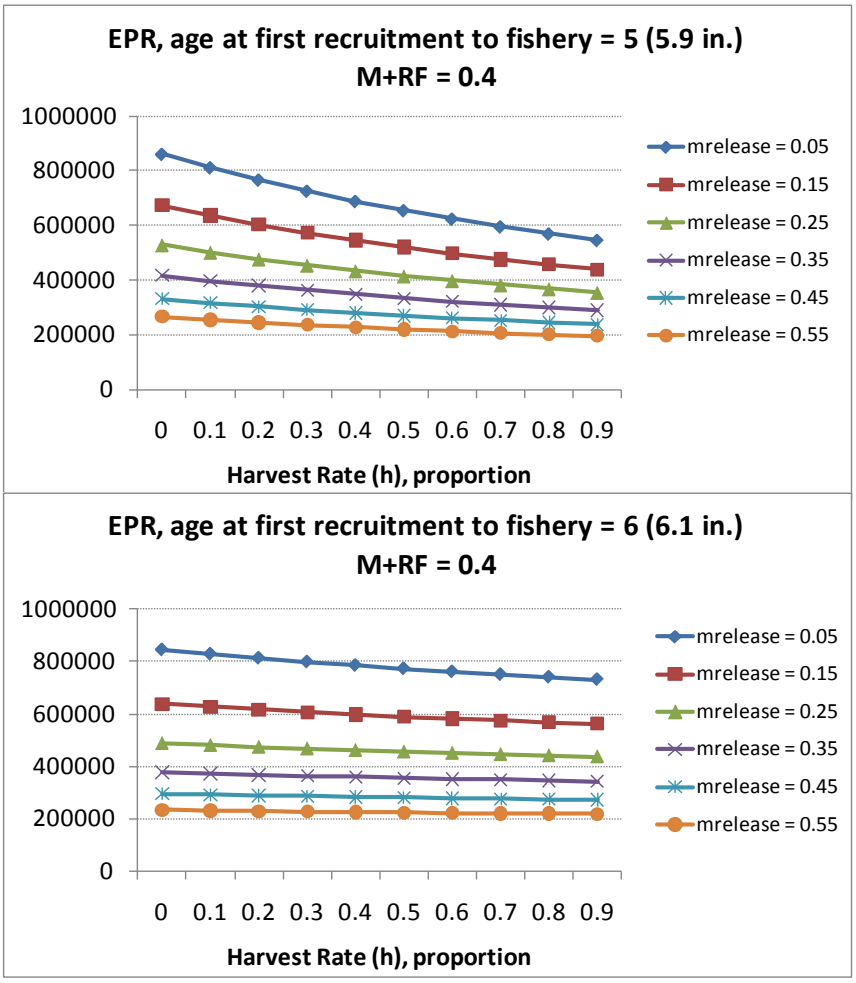


Table of parameters used to generate YPR and EPR curves.

Males								
age	1	2	3	4	5	6	7	8
length mm	60	120	140	160	190	200	205	210
wt grams	97.94	435.81	607.41	809.81	1172.5	1309.5	1381	1452.5
length (in)	2.36	4.72	5.51	6.30	7.48	7.87	8.07	8.27
weight (lbs)	0.22	0.96	1.34	1.79	2.59	2.89	3.04	3.20
maturity	0	1	1	1	1	1	1	1
Females								
length mm	60	110	130	140	150	155	157	159
wt grams	97.94	361.34	517.81	607.41	704.72	756.29	777.46	798.63

length (in)	2.36	4.33	5.12	5.51	5.91	6.10	6.18	6.26
weight (lbs)	0.21	0.80	1.14	1.34	1.55	1.67	1.71	1.76
Fecundity	0	162755	568070	729416	1202604	729416	442413	155410

Team Response 1.1.4:

Client says that the issue we asked them to address was addressed "heuristically" in their earlier report. It needs to be addressed directly. Client says that analysis has been expanded by adding release mortality. Client says that there are no plans to alter the male-only restrictions for commercial or recreational fisheries. This suggests they have no plans to evaluate the trade-offs involved in not catching females, as required by this condition.

In the last paragraph they note that the calculations specified in the condition "are unlikely to improve evaluations of stock status." This is further indication of a lack of interest in satisfying the condition.

My impression is that the client disagrees with the need for this condition, and has little interest in satisfying it. This indicates a fundamental disagreement with MSC Criterion 1.1, "The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity." The condition is requiring them to demonstrate that they are maintaining high productivity relative to all potential productivity. If they are not going to satisfy it, they should clearly state that, and this process can proceed without the unnecessary indirect debate.

The simple age-structured model they are using has all individuals at each age being the same size. This is a very crude approximation when describing a process in which the number of individuals greater than a certain size is a critical part of the dynamics. They have not related their growth model to size data as requested.

Conditions 1.1.5 and 3.4.4: (ODFW)

Using research conducted by Dr. Heppell, ODFW is confident that we will be able to develop a method for calculating and tracking LRP on an annual basis, based on landings. ODFW is also confident that we will be able to develop appropriate management responses to a breach of the LRP and have them adopted into Oregon Administrative Rule, through the Oregon Fish and Wildlife Commission. Because ODFW is just developing its Dungeness Crab Management Program (dedicated staff member has been hired as of 5/1/10), we suggest that reasonable deadlines for 1) developing the plan and 2) codification of the plan into rule would be for the 2nd and 3rd surveillances, respectively.

Team Response 1.1.5:

The sentence just prior to the statement of Condition 1.1.5 in the MSC Assessment Report for the Oregon Dungeness Crab Fishery is "The major shortcoming of the LRP condition is the fact that it is based on catch, rather than an index of abundance such as catch-per-unit-effort. As such it could be breached by management actions or market conditions alone, rather than a decline in abundance." In the first sentence of their response they state that they plan to develop an LRP based on landings. If that is to be their approach, they should explain how they will avoid the indicated problems with an index based on landings.

Condition 3.1.3: (ODFW)

ODFW currently produces these estimates in the form of biennial reports, prepared by an independent contractor. These reports are regularly produced and will satisfy the terms of this condition *(see attached document – OR Comm Fish Ec Impacts - The Research Group in Corvallis, OR*). This information is utilized in a variety of ways within the agency, and incorporated into the decision-making functions of administrative and Marine Region staff, as well as the members of the state Fish and Wildlife Commission.

Team Response 3.1.3:

This report provides useful information about the quantities, landed values and economic contribution (personal income) of all Oregon fisheries and of component fisheries. The information in this report could be used as the

basis for a specific report on the Dungeness crab fishery. However, to meet the terms of this condition a plan for the regular collection of economic and social data specific to the Dungeness crab fishery should be developed. It should be incorporated as part of the Dungeness crab research plan.

An obvious reason to have an ongoing data collection and analysis of economic and social issues of the Dungeness crab fishery is evident in the Section b. of the Dungeness Crab Program Manager position: in three separate places in this section on the purpose of the position the phrases "highly-charges and controversial public setting", "controversial setting", and "highly controversial and disputed" are used. There is also reference to crab management decisions having significant impacts on the economic vitality of Oregon's coastal communities and businesses. It states that the person in this position will "coordinate and conduct complex biological, physical and socio-economic analyses." All these provide for the necessity of having basic economic and social information routinely collected and available for analysis, and for having a plan for its collection.

Conditions 3.1.6.1 and 3.6.3: (ODFW/ODCC)
ODFW has recently procured funding for a permanent Dungeness Crab Management Program (1 full-time staff member <see attached job description> and research/monitoring funding), which will greatly increase the capacity of ODFW to be proactive in management. The staff person is newly hired (starts 5/1/10) and will be defining and developing the program over the next two years (2010-2012).

The plan is to develop the program in a methodical fashion based on current and anticipated needs (i.e. biological, research, regulatory, economic), that continues to rely on active monitoring of harvest effort, regular interaction with harvesters, conservation-minded gear regulations and regular reviews of the fishery from a variety of perspectives.

Part of that plan will include a management plan for research, which will address the issues raised in the condition. Because the program is new, we suggest that reasonable deadlines for 1) developing the plan and 2) implementation of the plan would be for the 2nd and 3rd surveillances, respectively. Since ODFW has the program in its permanent budget, there is already dedicated funding for research. The current level of research funding may be augmented as opportunity and need arises.

It should also be noted that the ODCC has and is committed to 'crab research' funding, with on-going commitments to 'stock-related' research being conducted by Dr. Alan Shanks/OIMB, as well as other projects designed to fill 'info gaps' in the crab fishery. The ODCC recently contributed funds to a 'tagging' study to determine crab movement as part of the baseline data being collected for proposed wave energy development along the Oregon coast. The ODCC recognizes the role of research in a well-managed fishery and will work with ODFW to see that meaningful projects are funded.

Team Response 3.1.6.1:
The Client notes the existence of the new Dungeness Crab Management Program and a newly hired (May 1 2010) Program Manager. Among the duties of the Program Manager is to develop a research plan. The conditions specify that the plan should be developed within the first year of certification and implemented in the second year. The Client proposes a more liberal timeline of developing a plan by the 2nd surveillance audit and implementing it by the 3rd.

The Assessment Team does not support the more relaxed timeline. Reasoning: The presence of a full time Program Manager should allow the development of a research plan within one year; indeed it is reasonable to expect that the development of such a plan with a complementary management plan would be the first task undertaken by a new program, to provide a context for the activities of that program. This is especially the case of dedicated funding for research is a component of the Program, as stated. Many of the listed duties of the Program Manager suggest that the existence of a research plan is a necessary condition for their performance. Working to see that meaningful projects are funded is not the same as having a strategic plan. The idea of a research plan is

to move research from a status of ad hoc and opportunistic to being integrated and strategic within the context of an overall framework.

Condition 3.1.6.2: (ODCC/ODFW)
Pot fisheries are known for their minimal ecological impact and the Oregon Dungeness crab fishery is no exception. There is abundant literature on the low-impacts of pot fisheries on habitat, in relation to actively fished gear. Crab pots have a small 'footprint' and rest lightly on sandy bottom. Movement can occur during stormy weather but gear is usually set in deep enough water during the worst periods to keep this to a minimum. The crab fishery does not occur in rocky areas, coral reefs or in/near kelp beds.

The Dungeness Crab pot fishery does have potential ecological impacts to habitat or to other species, through derelict (lost) gear. Derelict gear is an issue that is actively being addressed in the state. The ODCC has initiated a volunteer clean-up program, and ODFW has initiated funded clean-up programs to quantify the magnitude of the problem and determine solutions for industry-based management and minimization of derelict gear. Because of the status of our knowledge in this area, we suggest that there is sufficient evidence to simply summarize what is known about ecological impacts in the Research Plan, referred to in Condition 3.1.6.1. In addition, the ecological impacts from catching other species could be addressed by the periodic sampling described in our response to Conditions 1.1.2 and 2.2.1, above.

It should be noted that recent 'pot limit' regulations (2006) reduced the number of crab pots being employed in the Oregon fishery by some 50k-plus. 500 pots are the most any one vessel can fish, and many crabbers have permits allowing only 300 or 200 pots per vessel.

As Oregon moves forward with its 'marine reserve' program and its desire to be on the forefront of Wave Energy development, there will be many opportunities to study ecological impacts associated with these initiatives and related activities such as commercial fishing/crabbing. The M/R legislation requires that impacts *by* and *to* fisheries be considered in the development of the proposed reserves, and ODFW is at the center of the research being designed to fulfill these requirements. Study plans to look at ecological impacts are also part of the W/E permitting process, and crab fishery-related studies are planned in that arena as well. As one of state agencies involved in the 'settlement agreement' process, ODFW staff biologists will be reviewing the data at every turn.
Team Response 3.1.6.2:
The Client notes the existence of a literature on pot gear impacts, existing activities to retrieve derelict pot gear, regulatory reductions in #s of pots through pot limits, and research opportunities to be presented by the implementation of marine reserves and wave energy sites. This is the type of information that should be integrated into a Research Plan. A Research Plan can be thought of as an integrating framework for existing and needed information related to the Dungeness crab fishery.

Condition 3.4.4:
This condition is addressed in 1.1.5.
Team Response 3.4.4:
The described action seems reasonable as long as the research plan is developed in year 1.

Condition 3.6.2: (ODCC/ODFW)
Crab landings are available for public access and analysis through the PacFIN database, maintained by the Pacific States Marine Fisheries Commission (PSMFC). PSMFC maintains data for California, Oregon, Washington and Alaska. Dungeness crab also occur in Canadian waters, in the Province of British Columbia, and these data are tracked by Canadian authorities. For U.S. landings, PSMFC would be the likely entity to produce a report to Congress, which could be completed by the time of the first annual surveillance.

It should be noted that the fishery covered in this review for MSC certification is within Oregon waters and not the entire range of the specie. All management, research, and funding assumptions identified in this response apply only to the Oregon Dungeness crab fishery as such.

Team Response 3.6.2:

PSMFC is the responsible entity described in the Act to submit biennial reports. Submission of an updated report to Congress that is compliant with the specifications of the Act by the time of the first annual surveillance audit would meet the terms of this condition.

Condition 3.6.3:

This condition is addressed in 3.1.6.1.

Client Action Plan 3.6.3 (also addresses condition 3.1.6.1): (ODFW/ODCC)

ODFW has recently procured funding for a permanent Dungeness Crab Management Program (1 full-time staff member <see attached job description> and research/monitoring funding), which will greatly increase the capacity of ODFW to be proactive in management. The staff person is newly hired (starts 5/1/10) and will be defining and developing the program over the next two years (2010-2012).

The plan is to develop the program in a methodical fashion based on current and anticipated needs (i.e. biological, research, regulatory, economic), that continues to rely on active monitoring of harvest effort, regular interaction with harvesters, conservation-minded gear regulations and regular reviews of the fishery from a variety of perspectives.

Part of that plan will include a management plan for research, which will address the issues raised in the condition. Because the program is new, we suggest that reasonable deadlines for 1) developing the plan and 2) implementation of the plan would be for the 2nd and 3rd surveillances, respectively. Since ODFW has the program in its permanent budget, there is already dedicated funding for research. The current level of research funding may be augmented as opportunity and need arises.

It should also be noted that the ODCC has and is committed to 'crab research' funding, with on-going commitments to 'stock-related' research being conducted by Dr. Alan Shanks/OIMB, as well as other projects designed to fill 'info gaps' in the crab fishery. The ODCC recently contributed funds to a 'tagging' study to determine crab movement as part of the baseline data being collected for proposed wave energy development along the Oregon coast. The ODCC recognizes the role of research in a well-managed fishery and will work with ODFW to see that meaningful projects are funded.

Team Response 3.6.3 (same as for 3.1.6.1):

The Client notes the existence of the new Dungeness Crab Management Program and a newly hired (May 1 2010) Program Manager. Among the duties of the Program Manager is to develop a research plan. The conditions specify that the plan should be developed within the first year of certification and implemented in the second year. The Client proposes a more liberal timeline of developing a plan by the 2nd surveillance audit and implementing it by the 3rd.

The Assessment Team does not support the more relaxed timeline *[subsequent phone call with client an acceptable timeline was agreed upon]*. Reasoning: The presence of a full time Program Manager should allow the development of a research plan within one year; indeed it is reasonable to expect that the development of such a plan with a complementary management plan would be the first task undertaken by a new program, to provide a context for the activities of that program. This is especially the case of dedicated funding for research is a component of the Program, as stated. Many of the listed duties of the Program Manager suggest that the existence of a research plan is a necessary condition for their performance. Working to see that meaningful projects are funded is not the same as having a strategic plan. The idea of a research plan is to move research from a status of ad hoc and opportunistic to being integrated and strategic within the context of an overall framework.

APPENDIX II – PEER REVIEW COMMENTS

Peer Reviewer 1 - General Comments

Chapter 1: Introduction

This chapter is generally clear and provides adequate information.

The intent of the change in mission statement of the MSC in 2001 is confusing. The change seemed to remove objectives of social and economic performance. This implies that the scope of the assessment and review does not include, for example, management measures that may be inefficient, or social outcomes of the fishery. However the assessment includes conditions relating to social and economic data collection. Perhaps more detail of the principles or objectives of MSC under this mission may help.

Chapter 2: Summary (assessment process, recommendation, conditions)

The box detailing Special Condition 1.1.2 (quantification of total catch) doesn't seem clear. Current text suggests that discard mortality of females should be measured, plus total catch of undersize males. Is this correct? It seems odd as presumably the issue is measurement of total fishing mortality, which requires estimation of discard mortality of both females and undersize males.

Team Response: We need to know all removals, which is the goal of both statements.

Text for special condition 1.1.4 is not clear. It states "The dependence of productivity on abundance has been estimated and used to estimate potential TRPs and associated uncertainties"...and then goes onto prescribe YPR and EPR analyses. Suggest changing the text to "The dependence of **yield and egg production** on **harvest rate and size/sex exclusions** has been estimated and used to estimate potential TRPs and associated uncertainties".

Team Response: The problem with Dungeness crab is that the relationship between egg production and recruits is noisy and poorly known. To simplify the analysis, and add some clarity to results, we asked for just the per-recruit calculations. We have been unable to get a comparison using just those.

Text for special condition 1.1.4 states "...conduct an analysis of both yield-per-recruit (YPR) and eggs-per-recruit (EPR) that evaluates the trade-off in yield involved in a policy of not fishing females." But EPR analyses are unrelated to yield (except perhaps through a SRR). The key point here is presumably to conduct EPR and YPR analyses and evaluate if management could be adjusted to give better outcomes. However it's not clear if the objective here is simply to better manage egg production or whether it's also to increase yield or catch rate in the fishery.

Team Response: The reason for using per-recruit quantities is the same as in the previous paragraph. The objective is clearly stated, it is to evaluate the trade-off in yield involved in a policy of not fishing females. EPR here is a measure of replacement, hence an indication of sustainability. It can be compared to YPR under different management scenarios. With regard to the last sentence, the goal is to maximize catch while maintaining an adequate level of reproduction for the population to safely persist.

For condition 2.2.1 it's not clear why the required action includes actions to recover pots. We can guess it's to reduce bycatch but this isn't obvious. Also, the condition seems to imply that all bycatch should be recorded and all pot locations should be recorded. Does this mean location logging of all traps in the fleet (and 500 pots per vessel)? Does bycatch recording apply to all species or only TEPS? Does bycatch recording need to occur across the fleet or only a subsample?

Chapter 4: Management system

Under management history (4.1), it would be helpful to have a little more detail on the extent of controls on harvest rate of exploitable stock. Season and limited entry are listed but what about limits on trap numbers, setting times, vessel limits? Elsewhere there is mention of a "pot limit plan" (4.2) and also

periods of historical increase in pot numbers and management response so should be mentioned in this summary.

The type of effort data available could be listed in 4.5.4 ie. What is the capacity to track catch rate? The recent change in relation to logbook recording is important information that should be explained.

Chapter 6: MSC Principles

An introductory paragraph here would be helpful to clarify that these principles are applied to all fisheries assessed under MSC and that they provide the bounds of the assessment for this specific fishery. ie they were not developed for this assessment and are effectively fixed in this case but were used to guide the performance indicators in Section 8.

Chapter 9: Evaluation

Discussion of the rationale for the approach taken with Objective 1 seems logical and well presented.

The argument that harvesting still presents a risk of population cycling isn't clear "*In the case of Dungeness crab, modeling studies indicate that size selective harvest of males only does not lower the equilibrium population density, and the narrowing of the adult size distribution tends to make the population more susceptible to environmental variability (Botsford and Wickham 1978, Botsford 1986). Thus the cost of lower risk by not fishing female Dungeness crab is a greater propensity toward cyclic variability.*" This is basically an argument of authority – the process isn't explained. This seems important to put more detail into because otherwise the 100% SPR makes assessment of objective 1 a little pointless.

MSC Criterion 1.1 (p 28) states "*The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s)* ***and associated ecological community*** *relative to its potential productivity.*" This statement introduces the ecosystem into this criterion whereas the Principle 1 and all Performance Indicators relate to the species only.

In relation to the evaluation results for MSC Principle 2, my comments are minimal. As highlighted in the evaluation section, it is generally accepted within the scientific community that pots have relatively little physical impact on habitats during deployment and retrieval. In addition, as detailed in numerous scientific publications worldwide, bycatch from pot fisheries is low with only a few targeted species vulnerable to pots where fished. In relation to the Oregon fishery, mesh sizes and escape gap rings further help to reduce bycatch which justifies the overall scoring for this section. That said, condition 2.2.1 is warranted, particularly in relation to the provision of lost pot locations.

Peer Reviewer 2 - General Comments

My main comments concern the assessment team conclusions and scores provided under MSC Principles 1 and 3. As highlighted in the Scoring Rationale, management of the Oregon Dungeness crab fishery does not involve typical fishery management infrastructures typically in place within crustacean fisheries worldwide. Specifically, there is no annual stock assessment report and no LRP with which to advise management on explicit actions. I acknowledge the recommendations in Conditions 1.1.2, 1.1.5, 3.1.6.1, 3.4.4, and 3.6.2 and believe that if adhered to, the issues in relation to assessment and management can be addressed. However, despite these recommendations, I wish to highlight a number of areas where the SG given is questionable or where further clarification is required. I address these specifically below.

I have concerns in relation to the comments regarding the analyses of mandatory logbook data. In particular the comment "We presume ODFW will enter and evaluate all such data on an annual or biennial basis." [page 40] Clearly, if the status of the stock is to be assessed against a pre-defined LRP it is essential that financial and logistic provisions are put in place to ensure that logbook and research data are adequately collated and assessed. While I acknowledge the client comments on Page 95 that "*The ODCC recognizes the role of*

research in a well-managed fishery and will work with ODFW to see that meaningful projects are funded" I am concerned that there is no direct reference within the review for the provision of logbook data analyses.

Figure 1 (Page 16) needs to be updated to reflect the period expending to 2006 as per information provided in the text. If the data to 2006 is available, it should be graphically presented.

Peer Reviewer's Comments on Scores and Rationales

1.1.1 The geographic extent of the stock being fished is known, including the geographic extent beyond the managed fishery's boundaries and the enhancement of the managed-fishery population by larval and adult ingress from neighboring states, as well as the larval and adult egress to neighboring states.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

1.1.2 All removals from the Dungeness crab population are known, including the commercial and recreational catch, by-catch in the trawl fishery, and the catch and return of female Dungeness crabs and undersized males.	
Peer Reviewer 1	Scoring appropriate given the defined PI. The justification for this PI is not clear because the process of increased cyclic variability through altering the size structure isn't explained (as noted above). It is unclear why condition 1.1.2 separates undersize males and females – presumably estimation of total catch and discard mortality is required for both (as per YPR and EPR analyses by the Client).
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	In the best of all possible worlds, one would want to know the sizes and ages of all discards. However, one seldom does.

1.1.3 Reproductive capacity of the population is monitored to determine the effects of fishing on reproduction.	
Peer Reviewer 1	Scoring unclear. This PI is critical to the assumed maintenance of SPR independent of harvest rate on the exploited stock and thus that management is precautionary. Data collection to evaluate this criterion seems a little weak for such an important PI. First, female abundance is measured by CPUE and data seems to be collected as an irregular point estimate in research sampling (although mandatory log books are now in place). If correct, this seems inadequate because CPUE data from trap fisheries is notoriously variable with catchability varying through many factors unrelated to density. Second, the assumption that sperm limitation can be detected through mating success ignores the risk of reduced clutch size which can occur even with successful matings. There is a difference here between mating (which is measured in the existing research) and fertilisation (which is defined in the criteria). Given these points it's unclear whether either female abundance or fertilisation rate are truly measured every 5 years. A possible solution here is for the conditions to be more prescriptive in terms of CPUE data collection (eg minimum number of pots / days / areas sampled). Collecting female discard data in fishery logbooks would provide excellent coverage. Fertilisation success could perhaps be measured from ovigerous crabs (presence/absence and clutch weights) rather than spermathecae. Having made these points, I'd agree with the general conclusion of the panel that this issue appears low risk. This is because of aspects like the operational sex ratio being elevated by the ability of females to store sperm between clutches. Thus a high score is expected but more robust data collection seems appropriate.
Peer Reviewer 2	My issues in relation to this section are twofold. Firstly, I would question the criteria used to describe an SG of 80. Specifically, why is an estimate of female abundance every five years considered to be acceptable? I acknowledge that females are not taken within the fishery but factors other than fishing mortality may lead to declines in female abundance e.g. environmental factors acting on recruitment. As a result, I would suggest that female abundances need to be monitored annually.

	Secondly, this section highlights one of the main issues within the fishery i.e. the lack of a rigorous annual monitoring program to assess female crab abundance and levels of fertilization. As it stands, the estimates of female CPUE provided by Prof. Shanks cannot be put in context. For example, how do current catch rates compare with previous estimates of abundance? Are they within the long-term average or do they reflect historical lows for the fishery? Given the current low level of monitoring, I would suggest a lower score rating and a Condition that specifies the need for a scientifically rigorous sampling program to be implemented within the fishery.
Team Response	Both reviewer comments are judgments regarding the level of precaution we should seek. I do not disagree with them, we just chose lesser requirements. We should keep in mind that we were dealing with a management agency that was used to doing comparatively little in the way of annual management of this fishery.

1.1.4 The dependence of productivity on abundance has been estimated and used to estimate potential TRPs and associated uncertainties.	
Peer Reviewer 1	Scoring Appropriate. As noted above, the text for this section is not clear: (i) YPR provides a measure of yield in relation to harvest rate, not abundance (directly); (ii) the abbreviated title in Table 5 and repeated here is misleading because the criteria doesn't relate to estimation of abundance; (iii) EPR is not related to estimation of productivity (directly); (iv) examination of rules to increase yield from the fishery seems to fall outside the MSC mission as described in the introduction. Having said this, the proposed research is worthwhile and useful for the fishery (and fisheries in other States for that matter). The client shows that work on this is well advanced. The pathway of this research into an outcome for management isn't clear.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	I have addressed (i), (ii) and (iii) above. With regard to (iv) my understanding of MSC Criterion 1.1, "The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity", is that the reduction in productivity required to increase precaution in management is of interest to the MSC. With regard to the last sentence by Peer Reviewer 1, I think that knowing the trade-off between catch and sustainability is an essential part of management. It enables management bodies to select a degree of precaution.

1.1.5 A Limit Reference Point (LRP) has been established and its level is computed at appropriate time intervals to determine whether the stock is depleted.	
Peer Reviewer 1	Scoring Appropriate. The text associated with the scoring is logical and defensible. The text for condition 1.1.5 seems to require revision: (i) the comment "By the 2nd annual surveillance the Limit Reference Point condition (1.1.4)... need to be adopted" seems wrong. Condition 1.1.4 refers to a TRP not a LRP. (ii) the assessment noted that trends in catch are meaningless as a LRP yet condition 1.1.5 does not explicitly state that a LRP based on change in abundance (eg CPUE) should be developed. Comments by the client state their intent to use landing data (catch) for development of LRPs that can be monitored annually although logbook data is now also available and could presumably contribute to any LRP.

Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	(i) is correct, the text has been changed. With regard to (ii), I agree, the LRP needs to be based on an index of abundance such as CPUE. I point this out in response to the client's response to conditions.

1.2.1 A recovery plan has been implemented, and the population is making a timely recovery.	
Peer Reviewer 1	Scoring N/A. Classification as N/A is appropriate.
Peer Reviewer 2	Scoring N/A. Classification as N/A is appropriate.

1.3.1 The effects of the fishery on age, sex and genetic composition of the population have not impaired reproductive capacity.	
Peer Reviewer 1	Scoring appropriate. As noted for 1.1.3., the assumption that mating = fertilisation success has been brushed over. This assumption should probably be examined given the combined weights for 1.3.1 and 1.1.3 drive the outcome of the assessment for Principle 1. Put simply, the issue is whether a female is able to fertilise the whole clutch if she has mated with a small male that has already mated several times. This type of sperm limitation has been observed elsewhere. This is not a large risk but important nonetheless given the weighting.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	I do not disagree; this is a policy judgment regarding the level of precaution.

2.1.1 Nature and distribution of habitats relevant to the fishery are known.	
Peer Reviewer 1	Scoring appropriate (although could perhaps be scored higher). Information available on habitat usage is remarkably good.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

2.1.2 Effects of fishing operations and gear on habitat structure are known.	
Peer Reviewer 1	Scoring appropriate. Title of the PI refers to knowledge on gear impacts but the criteria relates to the scale of the impact. A different description of the PI would make this clearer – a suggestion is given ... Gear effects on habitat are known (and of acceptable impact?) Text supporting this PI concludes with a recommendation that lost gear be examined. This is covered partially in condition 2.2.1 and reference could be made to this.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	PR1's comment that the PI refers to scale of impacts rather than nature of impacts does not seem entirely the case since SG80 refers to "impacts of the fishery on habitat structure" as well as scale.

2.1.3 Research is carried out on biodiversity and to identify communities and their structure in those habitats relevant to the fishery.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

2.1.4 Community information includes non-target species affected by the fishery.

Peer Reviewer 1	Scoring appropriate. Text supporting this PI concludes with a recommendation that impacts of lost gear be examined. This is covered partially in condition 2.2.1 and reference could be made to this (and the similar need for 2.1.2)
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	A reference is no longer applicable as the condition for 2.2.1 is dropped based on a score of 80

2.1.5 Ranges of natural variation in abundance and/or productivity of key species under different environmental regimes have been estimated such that effects of fishing might be identified against a backdrop of natural fluctuations.	
Peer Reviewer 1	Scoring appropriate (although could perhaps be scored higher). Scoring for this PI is especially subjective. My impression is that the information available on environmental drivers of temporal variation is very well understood compared to most fisheries, hence a higher score may be appropriate.
Peer Reviewer 2	An SG of 80 here is questionable. While annual total catches are recorded, there is no information on catch-per-unit-effort as an indicator of abundance. Given that Figure 3 suggests that effort is increasing, this could be of concern in relation to catch rates. I would suggest a lower SG until adequate monitoring programs have been implemented.
Team Response	Each PR has a different impression of the SC score: one too low, one too high. The latter is of greater concern and the PR referes to Fig. 3 that suggests effort is increasing. The Client states in their response on the subject of pots that "It should be noted that recent 'pot limit' regulations (2006) reduced the number of crab pots being employed in the Oregon fishery by some 50k-plus. 500 pots are the most any one vessel can fish, and many crabbers have permits allowing only 300 or 200 pots per vessel." The Client also provided rationale for a LRP tagged to commercial landings and decline for four years below 80% of a 20 year mean. The Condition set for 1.1.5 is based on acceptance of the LRP criteria, but requires specific management responses within a regulatory instrument. In addition, the logbook fields require data on pounds landed per string of pots. Using an average weight per legal male, count could be estimated and from that a relative CPUE computed. Given these aspects relative to pot limits and criteria to define a LRP based on close monitoring of landings, we feel the score is appropriate.

2.1.6 Trophic relationships of the target species within the community and resultant food webs are known including predator-prey associations with non-target species captured or injured by the fishery.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible. The extensive information on prey and predator species could perhaps be used in qualitative loop analyses if there is insufficient data for EcoSim/ EcoPath.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

2.2.1 There is information on the presence and seasonal and temporal distribution and abundance of species protected, endangered or threatened (Listed).	
Peer Reviewer 1	Scoring appears too low. Score of 80 seems more appropriate based on knowledge of humpback whales. This section seems to have suffered from cut and paste errors. It's hard to make sense of. MSC Criterion 2.2 deals with listed species. The title of the PI 2.2.1 in the body of the text (p 53) seems appropriate but is different to the PI 2.2.1 title in the summary table 5. The text supporting PI 2.2.1 does not seem relevant to the title of the PI, for example, there

	is no discussion of listed species interactions. Likewise, condition 2.2.1 deals with recording pot location and recovery of lost pots, which seems unrelated to the criterion (apart from indirectly). Any condition arising from this PI should be more related to collecting information on humpback whales.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	PI titles in Table 5 have been changed in all cases noted by PR here and below. We agree with PR1 that there were cut-and-paste errors in the report provided to peer reviewers; the bycatch topic is covered in 2.1.4 and will be dropped from 2.2.1 with focus, instead, on Listed species….notably humpback whales. The score is raised to 80 and the Condition dropped.

2.2.2 Studies of any adverse impacts of the fishery on Listed species have been done and incorporated into management strategies to avoid or minimize such impacts within acceptable minimum levels.	
Peer Reviewer 1	Scoring appropriate. PI 2.2.2 in table 5 has the same title as PI 2.2.1 on p53? Assuming the correct PI here is "Studies of any adverse impacts of the fishery on Listed species have been done and incorporated into management…" then the assessment seems reasonable and the scoring appropriate.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	PI title clarified in Table 5

2.2.3 Studies of any adverse impacts of the fishery on Listed species have been done and there is evidence that the fishery avoids or minimizes such impacts to within acceptable minimum levels.	
Peer Reviewer 1	Scoring appears too high. The title of this PI on p56 is very similar to PI 2.2.2 on p55. They are different but should be re-worded if possible to make them clearer. The score of the assessment panel of 80 appears too high. To achieve this score the fishery needs to have "*fishery impacts on Listed species .. estimated to be within required limits. This is verified through a peer-reviewed, scientific process*". Although interactions seem trivial, the fishery can't claim to meet the PI to this level. Therefore a score of 60 seems more appropriate.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	We believe that the score is appropriate and the interactions trivial as noted by PR1. Lacking any evidence or report to date about direct observation of humpbacks entangled in Dungeness crab pots, we see no reason to impose a condition that would effectively amount to a literature review similar to the one done for PI 2.2.3. Should NOAA Fisheries learn of increased instance of whale-crab pot interactions in the future, the need for more directed study of this issue will be considered at surveillance audits.

3.1.1 The management system incorporates and applies an adaptive and precautionary exploited stock strategy.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible. Existing management systems appear to have limited adaptive capacity, hence a score of <100 is warranted until LRPs are in place.
Peer Reviewer 2	In order to achieve an SG of 85 here the criteria states "*The management system has sustainability indicators, including catch rates, and sets objectives related to these data*" – however, given that effort data are not collated, catch rate cannot be estimated. I would therefore question why limited entry, LE 200 and pot limits alone are deemed adequate to

	achieve the score attained given that there are numerous examples worldwide to suggest that these limits alone are not sufficient in controlling effort (and subsequent catch) within crustacean fisheries.
Team Response	The fishery employs a suite of measures to promote sustainability. It restricts catch by size, sex and season. In addition Oregon has adopted three access control measures. Reviewer 2 is correct that catch rates are not among the sustainability indicators; however the existence of other controls (sex, size, season and gear limits) do limit catch. The intent of the SG is met at the 80 level, but the absence of catch rates is problematic for a score above 80; as a result the score has been revised downward to 80.

3.1.2 The management system incorporates and applies an effective strategy to manage the ecological impacts of fishing.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.1.3 The management system incorporates and applies an effective strategy to assess the socioeconomic potential and socioeconomic impacts of the fishery.	
Peer Reviewer 1	Scoring appropriate. The intent of this PI seems to be to evaluate the gap between the potential and the current performance. Condition 3.1.3 is only a step toward this outcome – it involves data collection but no analysis of the performance gap or commitment to respond. The client notes that this data is collected but it's unclear whether the performance gap is evaluated in any way (eg comparing NPV of the fishery under current and potential management).
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	Condition 3.1.3 requires the development of a plan for the collection and assessment of economic and social data, which addresses the evaluation aspect in a non-specific way. PR 1 is correct in noting that the condition doesn't require the assessment of socioeconomic potential or impacts of the fishery and therefore only partly meets the intent of the SG. We have revised the wording of Condition 3.1.3 to include the use of the collected data to evaluate both the socioeconomic potential and socioeconomic impact of the fishery.

3.1.4 The management system incorporates economic and social incentives that contribute to sustainable fishing.	
Peer Reviewer 1	Scoring appears too high. This PI was scored 90 whereas the status of the fishery appears more in line with a score of 80. SG80: "*The management system is assessing the potential to use economic and social incentives such as market-based management tools or other incentives to promote sustainable fishing and has plans to include them*". In this case there appear to be no existing market based tools that reduce the race to fish; there are apparently plans to assess other options, but no evidence of plans to adopt economic and social incentives. Property rights of fishers appear weak so the economic incentive for sustainable fishing is also weak (ie they still compete for finite stock).
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	Upon reflection we agree with PR 1 that a score of 90 is too high. The supporting text indicates that the management system is assessing the potential for using social and economic incentives and has plans to include them, but does not as yet explicitly incorporate them. Accordingly, we have revised the score downward to 80.

3.1.5 The fishery is free from significant subsidies, which promote over fishing or ecosystem degradation.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.1.6.1 The management system has a plan for research needed to support the harvest strategy.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible. Condition 3.1.6.1 appears logical and helpful.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.1.6.2 The management system has a plan for research needed to support the understanding of the ecological impacts of fishing.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible. Condition 3.1.6.2 appears logical and helpful. The client notes that few research needs are likely to be identified through this process because ecological impacts of potting are minor. Nonetheless, including ecological issues within a larger research plan for condition 3.1.6.1 is logical and a useful formal process.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.2.1 The fishery is managed and conducted in a manner that respects Indian treaty fishing rights, interstate agreements and congressional intent under the Magnuson Stevens Fishery Conservation and Management Act.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.2.2 The fishery is managed and conducted in a manner that complies with domestic law.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.3.1 The management system involves all categories of stakeholders appropriately on a regular, integral, explicit basis.	
Peer Reviewer 1	Scoring appropriate. Note that SG100 for PI 3.1.6 discussed only researchers and managers, so implicitly excluded industry. Conditions 3.1.6.1 and 3.1.6.2 should perhaps be altered to include industry input to better meet PI 3.3.1.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	The membership composition and role of the Tri-State Dungeness Committee ensures that “managers” will include industry stakeholders, so industry input will be a component of 3.1.6.1 and 3.1.6.2.

3.3.2 The management system provides for timely and fair resolution of disagreements.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.3.3 The management system presents managers with clear, relevant information, which is considered in decision-making.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.4.1 The management system restricts gear and practices to avoid by-catch, minimize mortality of by-catch, and reduce discard.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.4.2 The management system minimizes adverse impacts on the habitat.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.4.3 The management system does not allow use of destructive fishing practices.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.4.4 There is a process in place for rapid development of a recovery plan for Dungeness crab populations should significant depletion occur, as did the population near San Francisco in the late 1950s. Significant depletion can be defined as dropping below the LRP.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible. Condition 3.4.4 appears appropriate.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.4.5 The management system incorporates no-take zones where appropriate.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible. Note that implementing no-take zones compounds the weak property rights of fishers mentioned for PI 3.1.4. The client notes the need and intent to consider impacts of these zones on fisheries which is positive.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	We agree that the impact of no-take zones on the fishery is worthy analysis, and we have modified wording to Condition 3.1.3 to include such analysis.

3.4.6 The management system minimizes operational waste.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.

3.5.1 The management system enforces compliance in the fishery and has knowledge of the level of illegal fishing on the target species.	
Peer Reviewer 1	Score of 90 appears too low. The fishery appears to be meeting the PI at the scoring guidepost of 100.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	A review of the text supporting the scoring of this indicator indicates that the elements of SG 100 have indeed been met. We agree that the score should be revised upward to 100.

3.6.1 The management system provides for internal assessment and review.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Given the infrequent level of reporting in relation to the Status and Management of the resource (i.e. the provision of just a single report by Didier 2002), an SG of 80 here is difficult to justify. Essential to the management of the fishery are timely, peer reviewed stock assessment reports that provide direct advice to management on the status of the resource. Therefore, while a system may be in place for internal assessment, its effectiveness in terms of ensuring adequate reporting needs to justified.
Team Response	The distinction being made by the team in this indicator is that the existing system described in the text comprises an internal evaluation of management performance, although not a continuing one (SG100) as evidenced by the discontinuities in the development and submission of the report required under P.L. 107-77.

3.6.2 The management system provides for external assessment and review.	
Peer Reviewer 1	Scoring unclear. The assessment panel's interpretation of this PI seems to be that regular stock status reports (ie Condition 3.6.2) would serve as external review. This seems to differ from the text in the scoring guideposts. Clearly the biennial reporting should be kept up to date, but in addition, this PI seems to require periodic external review of these reports AND management decision making.
Peer Reviewer 2	In relation to Condition 3.6.2, it is not clear if the biennial reporting on the status of the stock is connected to the logbook program described on Page 40. The assessment needs to specify where the financial and human resources described in Appendix 1 on Pages 94 and 95 are to be utilised. For example, if logbooks are to be the primary source of information in relation to the fishery, are adequate systems in place to ensure that the data are collated, analysed and interpreted in a manner to ensure timely delivery of stock status reports?
Team Response	PR 1's point is well taken regarding the need for condition 3.6.2 to specify not only submission of the Congressionally mandated report but also the external review of these reports and of management performance. We have added wording to this effect to Condition 3.6.2. Wording to reflect the concern of PR 2 about data sources and funding has also been added to the condition.

3.6.3 The management system identifies research needs and directs appropriate funding and other resources to these problems.	
Peer Reviewer 1	Scoring appropriate. Note that this PI requires management to direct resources to research needs. Thus Condition 3.1.6.1 only partially meets PI 3.6.3 because the condition only identifies funding sources – it remains unclear whether research needs will actually be resourced. Positively, the client has indicated their intent to go beyond the Condition "to see

	that meaningful projects are funded".
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.
Team Response	We agree with the comment of PR 1 and will continue to monitor progress in actual funded research, as indicated in Condition 3.6.3.

3.7.1 Fishing operations are carried out in a manner that minimizes unintended impacts on the resource and the ecosystem.	
Peer Reviewer 1	Scoring appropriate. Justification appears logical and defensible.
Peer Reviewer 2	Scoring appropriate. Justification appears logical and defensible.