

Staff Report Developmental Fisheries Program

Summary of Staff Report

ODFW staff is providing a review of the Developmental Fishery Program for 1997 and asking the Commission to adopt regulation changes in the harvest program for some developmental fishery species and in the lottery system to issue permits.

Key elements and conclusions from the staff report are:

- One hundred and forty-five permits for the harvest of developmental fishery species have been issued in 1997, through September 30. Most landings of developmental fishery species have been as by-catch in other fisheries.
- ODFW staff completed a report of the survey for bay clams in Tillamook Bay, and collected biological information on several developmental species.
- The Developmental Fishery Board considered requests and recommends changes in the harvest programs for brine shrimp and prawns and in the lottery system to issue permits. The Board also considered requests but did not recommend changes in the harvest program for bay clams and to add Pacific rock crab to the developmental species list.
- The ODFW staff recommends changes in the harvest programs for brine shrimp and prawns and in the lottery system to issue permits.

Outline of Staff Report

- I. **Introduction** Page 4
- II. **Annual Report of Developmental Fisheries Activities** Page 4
 - Summarizes permits and landing activities of developmental fishery species.
 - Summarizes research and management activities of developmental fishery program.
- III. **Staff Analysis of Issues and Options - Recommendations** Page 8
 - Summarizes harvest programs and recent activities.
 - Summarizes conclusion of the evaluation of effects.

• *Issue 1.*
Waive renewal requirement for brine shrimp cyst harvest.

Option A: *(preferred)* Staff recommends the Commission waive the renewal requirements for harvest of brine shrimp cysts for this year.

Option B: No action

• *Issue 2.*
Change opening of brine shrimp cyst harvesting from January 1 to November 1.

Option A: *(preferred)* Adopt rules changing the opening of the brine shrimp cyst harvest season from January 1 to November 1.

Option B: No action.

• *Issue 3.*
Create separate permits for prawns and shrimp

Option A: *(preferred)* Adopt rules creating two separate permits for prawns and coonstripe/sidestripe shrimp with a new harvest program for shrimp.

Option B: No action.

• *Issue 4.*
Create preference system for unsuccessful lottery applicants

Option A: *(preferred)* Adopt rules creating a preference point system for unsuccessful lottery applicants.

Option B: No action.

• *Issue 5.*

Change wording to clarify intent for permit holders.

Option A: *(preferred)* Adopt rules changing wording to clarify intent as to who may be a permit holder.

Option B: No action.

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I. Introduction

The public hearing on November 14 is the annual review of the Developmental Fisheries Program. At the hearing, ODFW staff will: 1) describe the activities of the Developmental Fisheries Program in 1997; and 2) recommend changes to the harvest programs for developmental fisheries species and changes to the lottery system to issue permits.

II. Annual Report of Developmental Fisheries Activities

Permits

ODFW staff has issued 145 permits for the harvest of developmental fisheries species through September 30, 1997 (Table 1). Of the more than 100 permits issued in 1996, 16 met the landing requirements for renewal for 1997. The permits for three fisheries (bay clams, spot prawns, and brine shrimp) were issued through a lottery as there were more applicants than available permits by the filing deadline. All available permits were issued for nine fisheries or areas.

Landings

Landings of developmental fisheries species through September, 1997 are summarized in Table 2. As was the case in 1995 & 1996, the majority of the landings of developmental species were taken as by-catch in other fisheries. The landings of herring, smelt, and cockle clams are the result of the estuarine fisheries; none have been harvested from the ocean. The landing fees for species in all categories have generated approximately \$14,800 into the developmental fisheries fund in 1997, through September.

Research

BOX CRAB

Staff chartered a commercial crab vessel, F/V Alliance, out of Newport, to obtain distribution, abundance, sex and size composition, maturity, and fecundity data on box crab (see cruise report, Appendix A).

An average size and weight was determined for male and female crab. A conversion was created between different methods of measuring the crab to compare past data with more recent data.

A number of small sized male were sent to a researcher at the Oregon Institute of Marine Biology to determine size of maturity. All males examined contained spermatozoa indicating physical maturity (see report, Appendix B). Eggs were removed from a number of females to determine fecundity. Not all samples have been completed; fecundity estimates so far, range from 20,000 to 40,000.

A sample of crab was cooked and the meat picked out to determine meat yield. Average yield was 20.4% with leg meat accounting for almost 70 % of the total meat yield.

By-catch was very low. The most common species in the by-catch were hagfish and fragile sea urchins.

BRINE SHRIMP

Three trips have been made, to date, to Lake Abert to collect brine shrimp and water data. Through out the year, the lake has been at a high volume (282,000 to 315,000 acre ft) with a low salinity (32-42 ‰) due to heavy rains last winter. Average density ranges from 2,700 to 44,400 shrimp/m³ based on samples analyzed to date.

SNAILS

A sample of snails was obtained from a commercial harvester to collect growth data. The snails were tagged, measured, and placed in tanks in the laboratory. After two months, feeding 1-2 times a week, they were measured for a second time and we found significant growth in smaller snails with little growth observed in larger more mature snails. We will continue to feed them and monitor their growth.

COONSTRIPE SHRIMP

We have been working cooperatively with California Department of Fish and Game to collect data on coonstripe shrimp. They have sent us some of their market samples from off northern California to process, giving us access to data on the population of shrimp off southern Oregon/northern California.

MACKEREL

Finfish staff has been collecting size and age data on mackerel for several years from the bycatch in the whiting fishery. This year they began collecting stomach samples to determine the role of mackerels in salmon predation. They chartered a salmon troller in September to collect some at-sea data. So far, no salmon has been found in mackerel stomachs. We will attempt to obtain samples of Pacific mackerel for oil content analysis by the Astoria Seafoods Lab.

Board Activities

The Developmental Fishery Board considered requests to: wave the renewal requirements and change the opening date of the brine shrimp cyst fishery; and change the number of permits for prawns/shrimp. They also considered requests but did not make a recommendation to: change the renewal requirements for bay clams and issue the permits geographically; and add Pacific rock crab to the species list. The Board plans to review the criteria for permit renewal next spring.

Table 1. 1997 Developmental Fishery Permits (as of 9/30/97).

	Permits Allowed	Permits Issued	Renewals from 1996
Pacific hagfish	25	12	2
blue shark	10	4	
swordfish	10 other 20 longline	10* 2	3
northern anchovy & Pacific herring	15	4	
Pacific sardine & Pacific saury	15		
Pacific sandfish	10		
smelt	20		
Pacific pomfret	10		
slender sole	10		
box crab	25	25*	
Oregon hair crab & scarlet king crab & grooved tanner crab	10	10*	
spot shrimp & coonstriped shrimp	6 (3N/3S) trawl 10 (5N/5S) other	3* / 3* 5* / 5*	1 2
sidestripe shrimp			
cockle clams	5	1	
bay clams	11	11*	5
giant octopus	10	10*	
California market squid	30 (15N/15S) trawl	2 / 7	3
other squid spp.	30 (15N/15S) other	15* / 2	
fragile urchin	6 trawl 6 other		
sea cucumber	6 (3N/3S) trawl 10 (5N/5S) diver 10 (5N/5S) other	/ 1 1 / 5*	
marine snails	10	3	
brine shrimp adults	3	3*	
brine shrimp cysts	1	1*	
	total	145	16

* all available permits issued

N/S -- permits issued geographically by home port,
split at Heceta Head, 50% N, 50% S

Table 2. Landings of developmental fisheries species, by category, through September, 1997

Category A	Pounds	Category B	Pounds	Category C	Pounds
Pacific hagfish	24,172	salmon shark	-	spiny dogfish	12,408
blue shark	918	black hagfish	-	soupin shark	2,325
swordfish	1,394	Eelpouts	-	skate	1,618,444
northern anchovy	-	skilfish	-	American shad	149,099
Pacific herring	179,855	carp	-	Pacific cod	77,545
Pacific sardine	94	yellow perch	-	Pacific flatnose	-
Pacific saury	-	brown bullhead	-	Pacific grenadier	517,491
Pacific sandfish	-	northern squawfish	-	cabezon	38,332
smelt	27,109			sculpins	-
Pacific pomfret	-	euphausiids (krill)	-	kelp greenling	20,120
slender sole	-	Pacific sand crab	-	jack mackerel &	
		freshwater mussels	-	Pacific mackerel	4,368,374
box crab	49,763			greenstriped rockfish	
Oregon hair crab	-			redstripe rockfish	
scarlet king crab	-			shortbelly rockfish	
grooved tanner crab	615			sharpchin rockfish	
spot shrimp	55,865			splitnose rockfish	
coonstriped shrimp	-			Pacific sanddab	405,028
sidestripe shrimp	-			butter sole	3,961
butter clams	7,026			English sole	1,027,531
cockle clams	39,190			rex sole	614,346
gaper clams	759			rock sole	26,960
littleneck clams	7,771			sand sole	170,448
softshell clams	540			lemon sole	6,211
giant octopus	37,173			spotted ratfish	37
California market squid	202,748			wolf-eel	3,519
other squid spp.	-			walleye pollock	-
fragile urchin	-				
sea cucumber	7,442			red rock crab	1,624
marine snails	669			purple sea urchins	140
brine shrimp	5,000			crayfish	47,340

III. Staff Analysis of Issues and Options - Recommendations

The following discusses staff recommendations. The full text of proposed rule changes is attached beginning on Page 13.

Background of Commercial Brine Shrimp Fishery

HARVEST PROGRAM

In November 1996, the Fish and Wildlife Commission approved a total of four permits for the harvest of brine shrimp; one for harvest of cysts and three for harvest of adults. The season for cyst harvest was set at January 1 through March 31. The season for adult harvest was set at May 1 through August 31. The renew requirements for each fishery was set at a total of 5,000 pounds.

PERMIT AND HARVEST ACTIVITIES

A total of 19 and 7 applications were received for cyst and adult permits, respectively. A lottery was held on 1-8 to issue the permits. On January 30, we received a letter from the cyst permit holder returning the permit. The first person the alternate list was contacted and another permit issued on February 7.

There was no harvest of cysts this year due to an early hatch of cysts. One adult harvester was active this summer, making sufficient landings to renew his permit.

• *Issue I.*

Waive renewal requirement for brine shrimp cyst harvest.

On February 7th of this year, the cyst harvester made a trip to Lake Abert to assess conditions of the lake and the viability of cysts. His sampling showed a low salinity of the lake and no viable cysts; all cysts collected were empty shells indicating hatching had already occurred. A second trip was made on February 28, along with staff from ODFW and the Bureau of Land Management. Additional sampling showed the same conditions; low salinity and empty cysts. The observed stages of brine shrimp nauplii indicate they hatched approximately one month earlier.

Because there were no cyst available for harvesting, the Board and staff recommend the renewal requirements for cyst harvesting be waived for this year.

Option A: (*preferred*): Staff recommends the Commission waive the renewal requirements for harvest of brine shrimp cysts for this year.

Option B: No action

• *Issue 2.*

*Change opening of brine shrimp cyst harvesting
from January 1 to November 1.*

The water conditions (water level, salinity, etc) of Lake Abert can vary considerably from year to year. For example, records of lake volume from 1926 through 1990 show levels from 0 to over 463,000 acre ft., with a 65 year average of 197,500 acre ft. The water conditions not only affect the size of the population of brine shrimp, but also the timing of hatching in the late winter or early spring.

According to cyst harvesters, the cyst are in the best condition for harvesting well in advance of hatching. Cysts that are approaching hatchout are metabolically active, the shells are weakened, and the embryos have a limited shelf life and are less stable.

According to bird census data from ODFW and BLM, the peak bird observations at Lake Abert is over by October.

The permit holder has requested and the Board and staff recommend changing the opening of the brine shrimp cyst harvest season from January 1 to November 1, beginning in 1998 to increase the chance of obtaining quality cysts.

Option A: (*preferred*): Adopt rules changing the opening of the brine shrimp cyst harvest season from January 1 to November 1.

Option B: No action

Background of Commercial Prawn Fishery

HARVEST PROGRAM

Spot prawns, coonstripe shrimp, and sidestripe shrimp were placed on the developmental species list under one permit in 1995. Six permits are available for the use of trawl gear and ten are available for other gear (pots). The permits are issued geographically, 50 % north and south of Heceta Head. The renewal requirements are 5 landings of at least 100 pounds each.

PERMIT AND HARVEST ACTIVITIES

All available prawn/shrimp permits have been issued each year; usually through a lottery (Table 3). However, there have been few vessels meeting renewal requirements. The majority of prawn landings have been with trawl gear and all the shrimp landings have been with pot gear.

Table 3. Permits renewed and issued, applications received, by north/south geographic distribution, and pounds landed, by gear, for spot prawns, coonstripe, and sidestripe shrimp, 1995-1997(through September).

	1995		1996		1997	
	trawl	pot	trawl	pot	trawl	pot
renewals from previous year	-	-	0/1	0/1	1/0	0/2
lottery applications	7/0	7/9	2/1	3/6	0	8/11
permits issued (* through lottery)	3*/3	5*/5*	3/3	5/5*	3/3	5*/5*
total pounds landed						
spot prawn	8,874	3,982	6,493	1,438	20,639	2,482
coon/side stripe shrimp	-	1,223	-	1,536	-	-

• *Issue 3.*

Create separate permits for prawns and shrimp

All available prawn/shrimp permits have been issued each year; usually through a lottery (Table 3). However, there have been few vessels meeting renewal requirements and a lot of interest from other people in obtaining a permit. Most of the landings of prawns have been with trawl gear and in deeper waters and all landings of shrimp have been with pot gear in shallower waters. The Board feels there is enough separation between the two fisheries and enough interest to create separate permits.

The Board and staff recommend removing coonstripe and sidestripe shrimp from the permit with spot prawn, leaving the harvest program for spot prawns unchanged. The new harvest program for coonstripe and sidestripe shrimp would be: 10 permits for pot gear only; permits not issued geographically; renewal requirements of 5 landings of at least 100 pounds each (round weight).

Option A: (*preferred*) Adopt rules creating two separate permits for prawns and coonstripe/sidestripe shrimp with a new harvest program for shrimp.

Option B: No action.

Background of Permit and Lottery System

Permits are issued to individual vessels, except when hand harvest methods are used; the permit holder is the owner of the vessel. Permit holders have until December 31 of each year to make landings to qualify for renewal and submit an application to renew their permit for the next year. Applications for new permits are due by February 1 of each year. If more applications are received than available permits, a lottery is conducted to issue the permits. Otherwise, permits are issued on a first come-first serve basis throughout the rest of the year until all available permits are issued. Applicants who are unsuccessful in the lottery are placed on a waiting list for any permits turned in during the year.

• Issue 4. *Create preference system for unsuccessful lottery applicants*

Few people are meeting the renewal requirement each year (Table 4) which creates a lot of turnover in the permits, however, it also means, many people are not using their permits during the year. The Board would like to find a way to provide incentives for using permits or turning them in if they are not used, especially for those species where there is a high demand for the permits.

The Board is recommending creating a preference point system for lottery applicants similar to the preference point system for hunting tags where a person would receive a preference point for the next year's lottery if they were unsuccessful in obtaining a permit in this year's lottery. If a person does get a permit in the lottery and does not make the landings to renew the permit, they may have less of a chance of getting a permit the next year because they did not get a preference point. in effect, penalizing them for not using the permit.

The Board also plans to review other issues regarding renewal requirements next year.

Table 4. Annual permit activity.

	1995	1996	1997
permits issued	159	113	140
renewed from previous year	-	9	16

Option A: (*preferred*) Adopt rules creating a preference point system for unsuccessful lottery applicants.

Option B: No action.

• Issue 5.

Change wording to clarify intent for permit holders.

OAR 635-006-0910(4) states: ... The permit holder is the **owner** (emphasis added) of the vessel or the individual person when hand harvest methods are used.

It has always been the intention of the Board to allow someone who is leasing a vessel to be able to obtain a permit. Because of that intention, the words "or controlled by" were included OAR 635-006-0910(5): Transfer of permits: Permits for Developmental Fisheries Species are not transferable to another person or entity; provided however that permits may be transferred to another vessel **owned or controlled by** (emphasis added) the permit holder up to two times annually.

The Board would like to clarify their intention by adding the words "or controller" to 635-006-0910(4) to read: The permit holder is the **owner or controller** (emphasis added) of the vessel or the individual person when hand harvest methods are used.

Option A: (*preferred*) Adopt rules changing wording to clarifier intent as to who may be a permit holder.

Option B: No action.



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Developmental Fisheries Species List

635-006-0850 (1) The Developmental Fisheries Species List, Category "A," is as follows:

(a) FISH

(A) Pacific hagfish (*Eptatretus stouti*) fishery has a qualifying and annual renewal requirement of five landings. There are 25 permits for harvest of which there are no trawl permits;

(B) Blue shark (*Prionace glauca*) fishery has a qualifying and annual renewal requirement of either five landings consisting of at least 500 pounds each landing or one landing consisting of at least 5000 pounds. There are 10 permits for harvest of which there are no high seas drift net permits and no large mesh gill net permits. No permit is needed for hand lines or hand harvest. Experimental gear permits may be required;

(C) Swordfish (*Xiphias gladius*) fishery has a qualifying and annual renewal requirement of either five landings consisting of at least 500 pounds each landing or one landing consisting of at least 5000 pounds. There are 20 permits for harvest by floating longline and 10 permits for harvest by other gear. Specially adapted drift/gill net may be permitted. Experimental gear permits may be required. Five single-delivery permits will be issued to those who applied by annual filing date, but did not receive a Developmental Fishery Permit. Gill net gear must conform to California gear restrictions;

(D) Northern anchovy (*Engraulis mordax*) and Pacific herring (*Clupea pallasii*) fishery has a qualifying and annual renewal requirement of either five landings consisting of at least 500 pounds each landing or one landing consisting of at least 5000 pounds. There are 15 permits for ocean harvest. Specially adapted small mesh drift/gill net may be permitted. No permit is needed for hand lines or hand harvest. Experimental gear permits may be required;

(E) Pacific sardine (*Sardinops sagax*) and Pacific saury (*Cololabis saira*) fishery has a qualifying and annual renewal requirement of either five landings consisting of at least 500 pounds each landing or one landing consisting of at least 5000 pounds. There are 15 permits for ocean harvest. Specially adapted small mesh drift/gill net may be permitted. Experimental gear permits may be required;

(F) Pacific sandfish (*Trichodon trichodon*) fishery has a qualifying and annual renewal requirement of five landings. There are 10 permits for harvest of which there are no dredging permits and no trawl permits, however, limited numbers of experimental gear permits may be issued for trawl harvest. Permits are area specific. Experimental gear permits may be required. No permit is needed for hand lines or hand harvest;

(G) Eulachon (*Thaleichthys pacificus*), whitebait smelt (*Allosmerus elongatus*), night smelt (*Spirinchus starksi*), longfin smelt (*Spirinchus thaleichthys*) and surf smelt (*Hypomesus pretiosus*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 20 permits for ocean harvest of which there are no trawl permits, however, limited numbers of experimental gear permits may be issued for trawl harvest. Specially adapted small mesh drift/gill net may be permitted. No permit is needed for hand lines or hand harvest. Experimental gear permits may be required;

(H) Pacific pomfret (*Brama japonica*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 10 permits for harvest. Experimental gear permits may be required;

(I) Slender sole (*Eopsetta exilis*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 10 permits for harvest. Experimental gear permits may be required.

(b) INVERTEBRATES

(A) Box crab (*Lopholithodes foraminatus*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 25 permits for harvest with pots only;



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(B) Grooved tanner crab (*Chionoecetes tanneri*), Oregon hair crab (*Paralomis multispina*) and scarlet king crab (*Lithodes couesi*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 10 permits for harvest with pots only;

(C) Spot prawn (*Pandalus platyceros*), [coonstripe shrimp (*Pandalus danae*), and sidestripe shrimp (*Pandalopsis dispar*)] fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds (round weight) each landing. There are six permits for harvest by trawl gear and 10 permits for harvest by other gear. Permits are area specific. Experimental gear permits may be required. Permits are issued geographically, split at Heceta Head with 50 percent issued north and 50 percent issued south of Heceta Head;

(D) Coonstripe shrimp (*Pandalus danae*), and sidestripe shrimp (*Pandalopsis dispar*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds (round weight) each landing. There 10 permits for harvest by pot gear;

[(D)](E) Ocean cockle clams (*Clinocardium nuttallii*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are five permits for ocean harvest only. No permit is needed for hand lines or hand harvest. Experimental gear permits may be required;

[(E)](F) Bay clams including cockle clams (*Clinocardium nuttallii*), butter clams (*Saxidomus giganteus*), gaper clams (*Tresus capax, nuttallii*), native littleneck clams (*Protothaca staminea*), and softshell clams (*Mya arenaria*) fishery has no qualifying and annual renewal requirements for intertidal hand harvest, an unlimited number of permits, and a \$25 permit fee. There are 11 permits (individual or vessel) for subtidal dive harvest, effective March 18, 1997-December 31, 1997, and 10 permits thereafter. Qualifying requirements are either five landings consisting of at least 200 pounds each landing or an annual total of 2500 pounds for one calendar year during the qualifying period of January 1, 1990 through October 16, 1995. Annual renewal requirements are either five landings consisting of at least 100 pounds each landing or an annual total of 2500 pounds;

[(F)](G) Giant octopus (*Octopus dofleini*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 10 permits for harvest using octopus pots only;

[(G)](H) California market squid (*Loligo opalescens*) and other squid (several species) fishery has a qualifying and annual renewal requirement of either five landings consisting of at least 500 pounds each landing or one landing consisting of at least 5000 pounds. There are 30 permits for harvest using trawl gear and 30 permits for harvest using other gear types. Experimental gear permits may be required. Permits are issued geographically, split at Heceta Head with 50 percent issued north and 50 percent issued south of Heceta Head;

[(H)](I) Fragile urchin (*Allocentrotus fragilis*) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 500 pounds each landing. There are six permits for harvest using trawl gear and six permits for harvest using other gear. Experimental gear permits may be required. Permits are issued geographically, split at Heceta Head with 50 percent issued north and 50 percent issued south of Heceta Head;

[(I)](J) Sea cucumber (*Parastichopus* spp.) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are six permits for harvest using trawl gear, 10 permits for harvest by diver, and 10 permits for harvest by other gear. Experimental gear permits may be required. Permits are issued geographically, split at Heceta Head with 50 percent issued north and 50 percent issued south of Heceta Head;

[(J)](K) Marine snails (various species) fishery has a qualifying and annual renewal requirement of five landings consisting of at least 100 pounds each landing. There are 10 permits for subtidal harvest only;

[(K)](L) Brine shrimp (*Artemia* spp.) fishery has a qualifying and annual renewal requirement of at least 5000 pounds landed. There are three permits to harvest adults and one



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permit to harvest eggs. Applicants for the egg permit must have prior experience harvesting brine shrimp.

(2) The Developmental Fisheries Species List, Category "B," is as follows:

(a) FISH

- (A) Salmon shark (*Lamna ditropis*);
- (B) Carp (*Cyprinus carpio*);
- (C) Black hagfish (*Eptatretus deani*);
- (D) Yellow perch (*Perca flavescens*);
- (E) Eelpouts (family Zoarcidae);
- (F) Brown bullhead (*Ameiurus nebulosus*);
- (G) Skilfish (*Erilepis zonifer*);
- (H) Northern squawfish (*Ptychocheilus oregonensis*).

(b) INVERTEBRATES

- (A) Euphausids (krill) (family Euphausiidae);
- (B) Pacific sand crab (*Emerita analoga*);
- (C) Freshwater mussels (families Margaritifera, Anodonta, Gonidea, and Corbicula).

(3) The Developmental Fisheries Species List, Category "C," is as follows:

(a) FISH

- (A) Spiny dogfish (*Squalus acanthias*);
- (B) Soupfin shark (*Galeorhinus zyopterus*);
- (C) Skate (family Rajidae);
- (D) American shad (*Alosa sapidissima*);
- (E) Pacific cod (*Gadus macrocephalus*);
- (F) Pacific flatnose (*Antimora microlepis*);
- (G) Pacific grenadier (*Coryphaenoides acrolepis*);
- (H) Cabezon (*Scorpaenichthys marmoratus*);
- (I) Sculpins (family Cottidae);
- (J) Kelp greenling (*Hexagrammos decagrammus*);
- (K) Jack mackerel (*Trachurus symmetricus*);
- (L) Chub (Pacific) mackerel (*Scomber japonicus*);
- (M) Greenstriped rockfish (*Sebastes elongatus*);
- (N) Redstripe rockfish (*Sebastes proriger*);
- (O) Shortbelly rockfish (*Sebastes jordani*);
- (P) Sharpchin rockfish (*Sebastes zacentrus*);
- (Q) Splitnose rockfish (*Sebastes diploproa*);
- (R) Pacific sanddab (*Citharichthys sordidus*);
- (S) Butter sole (*Pleuronectes isolepis*);
- (T) English sole (*Pleuronectes vetulus*);
- (U) Rex sole (*Errex zechirus*);
- (V) Rock sole (*Pleuronectes bilineatus*);
- (W) Sand sole (*Psettichthys melanostictus*);
- (X) Curlfin (lemon) sole (*Pleuronichthys decurrens*);
- (Y) Spotted ratfish (*Hydrolagus colliei*);
- (Z) Wolf-eel (*Anarrhichthys ocellatus*);
- (AA) Walleye pollock (*Theragra chalcogramma*).

(b) INVERTEBRATES

- (A) Red rock crab (*Cancer productus*);
- (B) Purple sea urchins (*Strongylocentrotus purpuratus*);
- (C) Crayfish (*Pacifastacus leniusculus*).



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Procedures for Issuance, Transfer and Renewal of Developmental Fisheries Species Permits

635-006-0910 (1) Applications:

(a) An applicant for a permit must submit a complete application in writing accompanied by an annual fee of up to \$75. The application shall include the species of fish to be taken, the method of gear proposed to be used, and the area from which the Developmental Fisheries Species are to be taken, and other information as the Department may require;

(b) Complete applications must be received postmarked or date-stamped by January 1 of the year of issue for new species added to the developmental fishery list in OAR 635-006-0850, and thereafter by the annual filing date of February 1 of the year of issue;

(c) An application shall be considered complete if it is legible, has all information requested on the form, and is accompanied by the required fee in full. Any application which is not complete shall be returned and, unless it is thereafter resubmitted and deemed complete by the filing date, the individual shall not be considered to have applied in a timely manner.

(2) Number of permits allowed:

(a) An individual shall not submit more than one application, per permittee, for each developmental fishery species category;

(b) No permittee who holds a valid developmental fisheries permit may apply for any additional permits for the same species category. A valid developmental fisheries permit is a permit which is neither at issue in a pending Permit Review Board proceedings nor before a court of law;

(c) If a permittee, who holds a permit at issue either before the Permit Review Board or a court of law, is awarded another permit for the same species category through the lottery and thereafter prevails before the Permit Review Board in court, the permittee shall immediately surrender one of the permits to any Department office, so that only one valid permit per species category is held.

(3) Issuance of permits:

(a) If the number of applicants received by the filing date is less than the number of permits available, all applicants who have submitted complete applications shall be issued a permit within 14 days of the filing date.

(A) Any remaining permits shall be issued on a first-come, first-served basis, within 14 days of receipt of each completed application, until a maximum number of permits is issued. Priority shall be based on postmark or date-stamped date;

(B) The names of applicants who did not receive a permit shall be placed on an alternates list, in the order they are received, until the next annual filing date. Applicants whose names are placed on the alternates list shall be refunded their permit fee minus a \$10 application fee. Permits which become available before the end of the year shall be made available to the alternates list, in the order listed. The applicant shall be notified of an available permit and shall resubmit a complete application and permit fee within 30 day of the date the notification is mailed. The permit shall be issued within 14 days of receipt of the resubmitted application and fee. If an alternate fails to apply, he shall forfeit the permit and the permit shall then be made available to the next name on the alternate list.

(b) If the number of applications received by the filing date is greater than the number of permits available, the Department shall determine first how many applications there are **[from applicants who have made Oregon landings equal to the minimum annual renewal requirements of the species applied for in any one year either within the period January 1, 1978, through December 31, 1994] with preference points as accrued under OAR 635-006-xxxx**, except for new species that have qualification restrictions set forth in OAR 635-006-0850. Evidence of landings must be supplied by the applicant and submitted with the application.



OREGON ADMINISTRATIVE RULES

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(A) If the number of these applicants does not exceed the number of permits, they shall be given all available permits and any remaining applicants shall be placed in a lottery;

(B) If the number of applicants who have **made landings** preference points exceeds the number of permits, then these applicants only shall be placed in a lottery, and **[the names of these applicants shall be drawn to obtain the available permits]** grouped by the number of preference points they have accrued for each permit category. Applicants with the highest number of preference points for each permit category will be drawn first. Applicants having the next highest number of preference points per permit category will be drawn next. This permit issuance process will continue through descending numbers of preference points until all the available permits have been issued, unless all qualified applicants with preference points have been issued permits prior to that point. Permits shall be issued within 14 days of the lottery;

(C) In addition, remaining applicants (who **have not made landings** do not have preference points) shall be placed in a lottery and their names shall be drawn;

(D) The Department then shall prepare an alternates list, in which applicants who **made landings** have preference points are listed first (in the order drawn), and thereafter remaining applicants are listed, in the order in which they were drawn. All applicants whose names are placed on the alternates list shall be refunded their permit fee minus a \$10 application fee. Any permits available before the end of the year shall be made available to the first name on the alternate list. The applicant shall be notified of an available permit and shall resubmit a complete application and permit fee within 30 day of the date the notification is mailed. The permit shall be issued within 14 days of receipt of the resubmitted application and fee. If an alternate fails to apply for the lottery permit within 30 days, he shall forfeit the permit and the permit shall then be made available to the next name on the alternate list.

(c) Permits may be made available before the end of the year by a permittee voluntarily turning in a permit.

(4) Persons to whom permits are issued: Permits shall be issued to either a vessel or an individual person when hand harvest methods are used. The permit holder is the owner or controller of the vessel or the individual person when hand harvest methods are used.

(5) Transfer of permits: Permits for Developmental Fisheries Species are not transferable to another person or entity; provided however that permits may be transferred to another vessel owned or controlled by the permit holder up to two times annually.

(a) To transfer a permit, a permittee shall first apply on a form provided by the Department and shall include a \$25 transfer fee;

(b) No transfer shall be considered effective until the permittee has received approval from the Department and an updated permit.

(6) Renewal of permits:

(a) Permits may be renewed by submission, to the Department, of the appropriate fee and a complete application date-stamped or postmarked before January 1 of the year for which renewal is sought;

(b) An application for renewal shall be considered complete if it is legible and has all information requested on the form and is accompanied by the required fee in full. Any application which is not complete shall be returned, and unless it is thereafter resubmitted and deemed complete before January 1, the individual shall not be considered to have applied for renewal in a timely manner;

(c) It is the responsibility of the permit holder to ensure an application is complete and is filed in a timely manner. Failure of the Department to return an application for incompleteness or of an individual to receive a returned application shall not be grounds for treating the application as having been filed in a timely and complete manner;



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(d) In addition to timely and complete filing to renew a permit, a permittee must annually lawfully land the required pounds and/or landings listed in OAR 635-006-0850. However, if a permittee obtained a permit later than July 1 of the prior year, the permittee shall not be required to make the annual landing requirement by the following January. Instead, at the next renewal thereafter, the permittee shall be required to demonstrate the annual landing requirement was fulfilled during the first full year in which the permit was held.

(7) Authority of the Director: Consistent with OAR 635-006-0810 through 635-006-0950, the Director is authorized to issue Developmental Fisheries Permits under the authority of ORS 506.460.

Preference Point System

635-006-xxxx (1) Valid applicants who did not receive a permit during the lottery shall receive one preference point applicable to subsequent permit lotteries for the permit category for which points were accrued, except as excluded in 635-006-xxxx(4).

(2) Applicants shall accrue no more than one preference point per permit category per year.

(3) Applicants successful in obtaining a permit shall have zero preference points when they next apply for a new permit in that permit category.

(4) Applicants will forfeit preference points accumulated for a permit category when they do not apply for that permit category for two consecutive years.

(5) Department records are final to determine accrued preference points for permits applicants.

(6) Each applicant's preference point accrual record will be linked to his or her social security number or tax ID number and/or vessel document number. Preference point applicants shall use the same social security number or tax ID number and/or vessel document number each time they apply for a permit.

(7) Applicants will receive no preference points when their application is not received by the appropriate application date.

APPENDIX A. Box crab research - Cruise report

OREGON DEPARTMENT OF FISH AND WILDLIFE
CRUISE REPORT
F/V ALLIANCE
APRIL 18-19, 24-26, 1997

- OBJECTIVES:** The purpose of this chartered cruise was to obtain distribution, abundance, sex and size composition, maturity, and fecundity data on box crab.
- VESSEL:** The F/V Alliance, owned by Bob Spelbrink out of Newport, was chartered.
- LOCATION:** Sampling was done in four areas in 66 to 85 fm off Stonewall Banks and Heceta Banks (15-60 miles SW of Newport, OR).
- OPERATION:** We utilized standard Dungeness crab pots, singly or on longline gear. We also covered four commercial crab pots with burlap to retain all sizes of species that entered them. Most gear was set in the afternoon and retrieved the next morning for an average of 15 hour soak times. Except, one string was set in the morning and retrieved in the afternoon for a 6.5 hour soak, and two strings were left in the water for 6.5 days due to adverse weather.

Data on size (three different measurements), weight, and sex were collected from individual crab. Females of various sizes were retained to determine fecundity. Males of various sizes were retained to determine size of maturity. A number of "market size" crab were retained and cooked to determine meat yield.

- RESULTS:** CPUE: Box crab were found in all depths, but not all areas. The average catch of box crab for a string of gear ranged from 0 to 64 crab per pot, with the highest numbers from the string with the longest soak time (6.5 days). Counting only the pots with overnight soak times, the peak average catch for a string was 17 crab/pot. The highest average catch per pot per hour of soak time was from the string with the shortest soak time, (1.7 crab/pot/hr, 6.5 hr soak).

SIZE: There has been no "standard" method for measuring the size of box crab. Some data collected during the fishery in the early 1980's used the carapace width including the spines (CWWS), other data since has used carapace width without the spines (CWOS). Data collected in other areas have used carapace length (CL). For our future size data, we will be using carapace length. We collected

all three measurements from 200 crab and calculated an equation to convert from CWWS and CWOS to CL.

A total of 509 crab were measured for carapace length. The crab ranged in length from 67 mm to 144 mm with an average of 103 mm. Males ranged in length from 69 mm to 144 mm with an average of 106 mm. Sixty-two percent of the males were of "market size" (≥ 105 mm). Females ranged in length from 67 mm to 113 mm with an average of 94 mm.

WEIGHT: Individual weights were taken from 200 crab ranging in length from 67 to 135 mm. Individual weights ranged from 12 gm to 102 grams with an overall average of 43.7 gm. Males ranged in weight from 12 to 102 gm with an overall average of 49.6 gm. Females ranged in weight from 13 to 48 gm with an overall average of 32.6 gm. Average weight of "market size" males (≥ 105 mm CL) was 64.8 gm.

SIZE OF MATURITY - MALES: Approximately 50 males ranging in sizes from 69 mm to 133 mm, carapace length, were sent to Jeff Goddard at the Oregon Institute of Marine Biology in Charleston to determine minimum size of maturity. All crab were found to contain spermatozoa indicating physical maturity.

SIZE OF MATURITY - FEMALES: We used the presence or absence of eggs to indicate the size of maturity of females. The smallest female with eggs, or which appeared to have recently shed eggs, was 78 mm. The largest female with no sign of having eggs was 83 mm. It appears the minimum size of physical maturity is in the 78 to 83 mm range.

FECUNDITY: Twenty-one females with eggs, ranging in size from 68 to 107 mm CL, were retained to determine fecundity (number of eggs). Four samples have been analyzed to date, with counts ranging from 20,100 to 48,000 eggs per female.

SEX RATIO: Sex ratio varied from string to string, with a range of 100 % males to 58 % females. The overall average ratio was 65 % males and 34 % females.

MEAT YIELD: Twenty-eight crab were retained to determine recovery rate of meat. The crab were cooked and the meat was picketed out, keeping the leg and body meat separate.

The crab ranged from 95 mm to 127 mm in carapace length, with an average of 112 mm. Whole, live weight ranged from 377 to 915 gm,

with an average of 618 gm. Total yield ranged from 12.5 to 27.0 %, with an average of 20.4 %. Leg meat accounted for almost 70 % of the total meat yield.

BY-CATCH: The amount of by-catch was low. The most common species in the by-catch was 49 hagfish from 6 pots. The next highest by-catch was 18 sea urchins from two pots, nine Dungeness crab from four pots, and seven flatfish from five pots. We also saw two seastars from two pots and one octopus, sculpin, rockfish, and ratfish, each from one pot.

SNAIL FISH: Eggs of a snail fish (*Careproctus* sp.) have been found in the gill cavity of box crab in California and British Columbia. Crab retained for the meat yield study were bled and cleaned prior to cooking in order to look for any snail fish eggs found under the carapace. Of the 28 crab from the meat yield study, plus 15 other crab examined, six were found to contain snail fish eggs.

ACKNOWLEDGMENTS:

We thank Bob Spelbrink and the crew of the F/V Alliance for the use of the vessel and all their hard work and expertise.

We also thank Jeff Goddard for his patience and analysis of box crab gonads.

ODFW PERSONNEL:

Jean McCrae
Vicki Hoover

APPENDIX B. Box crab research - Maturity study report

Size at maturity in box crabs, *Lopholithodes foraminatus*, from
Oregon

Report prepared for the Oregon Department of Fish and Wildlife

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August 1997

INTRODUCTION

Knowledge of size at sexual maturity is essential for setting meaningful size limits and maintaining adequate brood stock in fisheries. In many crustaceans sexual maturity can be divided into physiological or gonadal maturity, which is indicated by the presence of mature gametes, and functional maturity, which is attained when physiologically mature individuals are competent and likely to mate (Lawton & Lavalli, 1995). An adolescent period may separate the onset of these two conditions (Lawton & Lavalli, 1995). From a fisheries standpoint, size at functional maturity, which is similar to age at first reproduction, is clearly the more important of the two parameters.

In many brachyuran and anomuran crabs the onset of functional maturity in males is correlated with an increase in the size of the chelae relative to the rest of the body (Hartnoll, 1969, 1978). This allometric shift presumably enhances the male's ability to grasp and compete for females prior to copulation and has been used as an indicator of "morphometric maturity" (e.g., Conan & Comeau, 1986; Lovrich & Vinuesa, 1993). In females the presence of external eggs is a clear indication of functional maturity, but "because individuals not carrying eggs may also be mature, the proportion of ovigerous [females] in a population... is an equivocal index of maturity" (Lawton & Lavalli, 1995).

The purpose of this study was to determine size at maturity in *Lopholithodes foraminatus*, an anomuran crab currently under consideration for commercial harvest. Observations focused on males, and secondarily on females. There are no published accounts of reproduction in this species.

METHODS

Box crabs of widely varying sizes were collected off the central Oregon coast in late April 1997 and delivered to the Oregon Institute of Marine Biology (OIMB) by Jean McCrae of the Oregon Department of Fish and Wildlife (ODFW). Crabs were held alive at OIMB in a 1600 liter tank with flow-through seawater. To determine size at maturity I examined the following after icing and pithing each crab:

Gonadal maturity

Freshly killed crabs were banded and the gonads located in the posterior part of the cephalothorax. Exploratory dissection revealed that in males the tubular testes/vas deferens

(hereafter, testes) is milky white in color and enters the 5th pair of pereopods (legs) where it terminates in a genital pore located on the distal end of the coxa. The male genital pore is surrounded by a distinct, tapering group of straight to gently curving setae. The setose tips of the 5th pair of pereopods can bend back to reach the genital pore setae and are apparently used to transfer spermatozoa to the females. In females the ovaries are bright orange to red-orange in color. A small portion of the gonad from either the middle of the testes or the main mass of the ovary was removed, gently macerated and squashed on a microscope slide, and examined using bright field and phase contrast microscopy for the presence of mature gametes. The abdomens of female specimens were also examined for the presence of extruded eggs/embryos.

Chela allometry and morphology of the 5th pair of pereopods

Length and height of both chelae and length and width of the carapace were measured to the nearest 0.1 mm using vernier calipers (Figure 1). Following Lovrich & Vinuesa (1993), I examined the relationship between chela height and carapace length for changes in the level of chela allometry. I also made qualitative observations of the 5th pair of male pereopods, which as revealed above, are used for transferring spermatozoa to the females.

Mating marks and other external indications of mating activity

Butler (1960: 643), working on dungeness crabs, *Cancer magister*, noted that "close contact during the pre-mating embrace produces marks or an abrasion at several places on the exoskeletons of both male and female crabs." I therefore examined the exoskeletons of the box crabs for possible mating marks and other indications of reproductive activity.

RESULTS

Gametes and gonadal maturity

Forty-five crabs (33 males and 12 females), ranging in carapace length from 62.0 to 130.0 mm, were examined (Table 1). Each of these possessed mature spermatozoa or well developed oocytes, indicating gonadal maturity. Spermatozoa were obvious as refractile, multistellate cells possessing 3 to 5 slender, pointed rays and were clustered in rounded sac-like structures. These sacs, in turn, were connected to a cord-like structure secondarily looped and packed into the

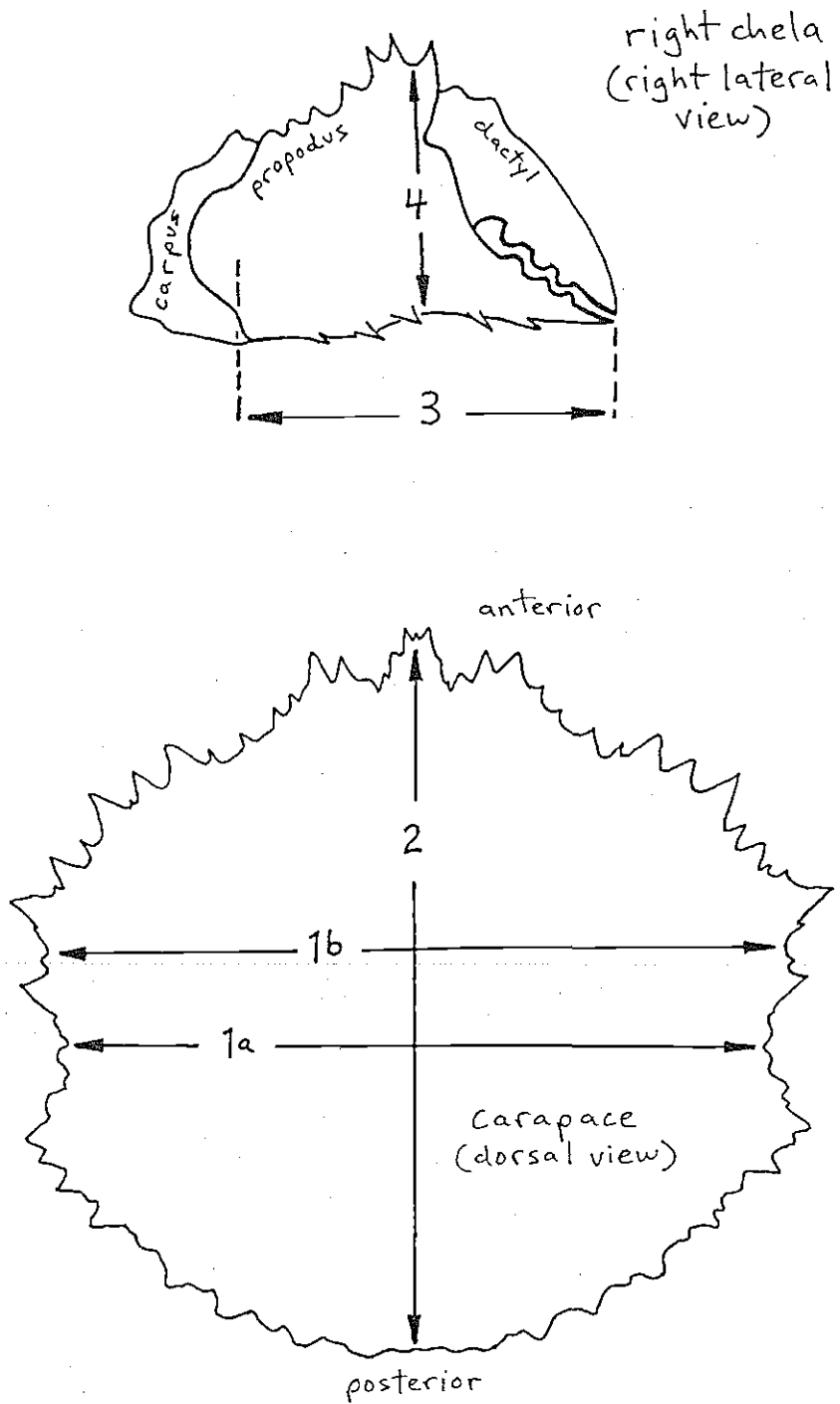


Figure 1. Measurements taken on box crabs, *Lopholithodes foraminatus*: 1a, carapace width a; 1b, carapace width b; 2, carapace length; 3, chela length; 4, chela height.

Table 1. Carapace and cheliped dimensions of box crabs, *Lopholithodes foraminatus* from Oregon. Measurements in mm. Dimensions measured are defined in Figure 1. Blanks mean measurements were not obtained.

Crab	Carapace			Chelipeds			
	width		length	Right		Left	
	a	b		length	height	length	height
males							
1	135.8	151.2	125		46.6		34.1
2	81.2	86.7	74.4	33.2	22.9	27	16
3	75.5	84.2	72.5	28.2	20.4	23.9	14.8
4	98	104.9	89.5	41.4	29.2	34.9	22.5
5	71.1	79.7	69	29.4	20.4	24.9	15.2
6	82.4	90.7	77.8	34.2	23.7	29.3	13.2
7	79.4	85.3	74.2	31.6	22.6	26.9	16.5
8	74.5	78.9	70	29.4	20.9	25.3	15.3
9	76.2	84.8	72.2	29.1	20.6	23.7	14.7
10	67	69.7	62	25.4	18.3	22.1	13.8
11	93.2	102.7	86.6	39.6	27.5	33.5	20.8
12	78.2	85.3	74.2	33.1	22.5	27.7	16.6
13	87.9	102.1	88.1	41.3	27.9	35.3	20.7
14	84.8	93.6	80.5	34.7	23.9	29.7	17.5
15	85.4	92	80.8	35.8	24.2	30.4	18.6
16	145.3	165.3	130	68.4	47.2	57.6	34.7
17	133.9	146.5	122.8	60.1	42.6	50.3	32.1
18	109.6	123.8	101.3	47.9	36.1	39.4	25.5
19	91.4	100.2	84.4	37.9	26.5	31.4	19.1
20	104.2	116.1	96.8	44.9	31.1	38.5	24.1
21	97	105.2	90.1	38.5	27.3	32.6	21.2
22	104.2	113.2	95.8	45.3	32.1	37.7	24.3
23	85.8	94.7	80.2	35.9	24.8	30.7	18.8
24	120.7	138.7	111	54.5	37.8	46.3	28
25	97.6	109.3	93.1	45.5	30.7	39.8	22.1
26	114.7	128.5	105	51.1	35.3	43.9	25.8
27	112.4	122.3	102.5	48.7	33	40.3	24.4
28	109.3	111.1	101.8	48.5	33.3	40.5	24.4
29	87.3	94.5	81.1	35.8	26	30.9	19.6
30	96.6	106.1	89.3	38.9	27.6	33.4	20.2
31	100	110.7	94.9	44.6	31.1	37.6	22.7
32	79.5	88.1	75.7	33.7	23.3	29.2	17.3
33	86.7	92.7	81.3	35.5	25.1	29.1	18.8
females							
1	102.5	108.1	95.7				
2	67.3	72.6	66.7				
3	82.9	90.2	76.7				
4	87.4	93.8	82.8	33.8	22.3	24.2	16.5
5	86.4	90.8	80.6	33.5	22.6	28.9	16.6
6	84.8	91.2	79.4	32	20.8	27.2	16.2
7	88.5	93.2	82.2	34.6	22.9	29.4	17.6
8	79.2	85.8	74.4	32	22.3	27.7	16.6
9	112.8	121.4	108.8	46.3	29.5	39.3	21.5
10	86	92.3	81.8	31.5	22.1	23.3	16.4
11	87.6	93.3	82.4	33.8	23	28.4	17.2
12	82.5	86.9	76	32.4	21.3	26.9	16

testes. Sections of this cord, with the attached sacs-like structures, appear to constitute spermatophores in this species. The main body of each spermatozoan measured approximately 4.5 μm in diameter, with rays up to 8 μm long. No qualitative differences were observed in the testes of small versus large crabs.

Two females (numbers 1 and 4 in Table 1), with carapace lengths of 95.7 and 82.8 mm were ovigerous, and in early May zoea larvae hatched from at least one other captive female.

Chela allometry and morphology of the 5th pair of pereopods

Dimensions of the chelae and carapace are given for males and females in Table 1. The relationship between height of the right chela and length of the carapace in males is shown in Figure 2. The relationship between these two variables is virtually linear, with a constant slope, indicating no change in the level of allometry for these variables in the sample examined.

No gross morphological differences were observed in the 5th pereopods of large versus small males.

Mating marks and other indications of reproductive activity

No marks that might be attributed to mating activity were found on the exoskeletons of any crabs. However, microscopic examination of the setae surrounding the male genital pore suggested that larger individuals had a higher proportion of broken or abraded setae than smaller individuals. I examined this further by qualitatively scoring the genital pore setae on 16 pairs of 5th pereopods as either: worn (the tips of most setae broken or abraded), intact (the tips mostly intact and finely pointed), or intermediate (both worn and broken setae present, either on the same leg or on different members of a pair). The results of this examination are given in Table 2.

Crabs with worn genital pore setae had a mean carapace length of 106.4 mm (S.D. = 23.4 mm, $n = 6$) and were significantly longer than both those with intact setae (mean carapace length = 72.7 mm [S.D. = 3.5 mm, $n = 5$]; $t = -3.478$, $p = 0.018$) and those with intermediate condition setae (mean carapace length = 77.6 mm [S.D. = 11.4 mm, $n = 5$]; $t = 2.657$, $p = 0.033$). There was no significant difference in mean carapace length between crabs with intermediate and intact setae ($t = -0.9228$, $p = 0.398$).

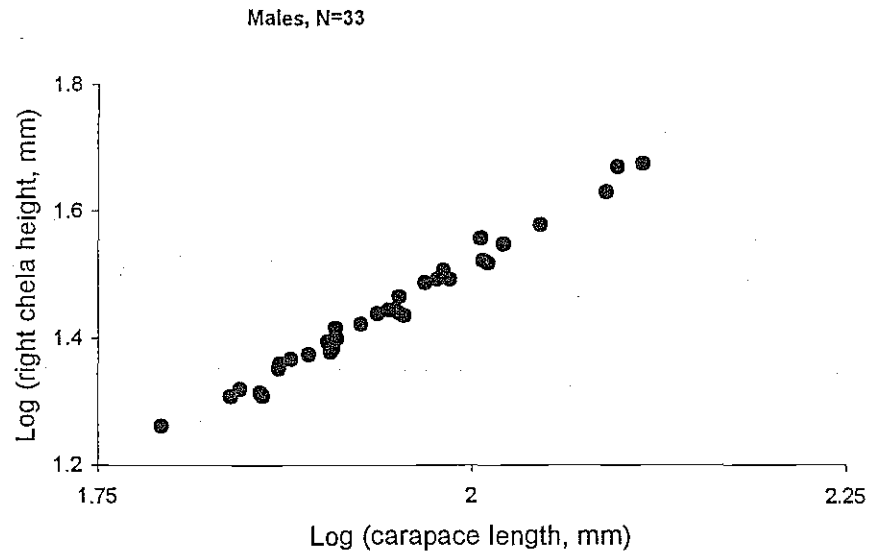


Figure 2. Log chela height plotted against log carapace length for male box crabs, *Lopholithodes foraminatus*. $y = 1.3314x - 1.1424$, $R^2 = 0.985$. Data from Table 1.

Table 2. Carapace length and condition of the setae surrounding the genital pores in 16 male box crabs. Crab numbers correspond to those in Table 1.

Condition of setae: Intact = tips of most setae finely pointed and intact; worn = most tips broken or abraded; intermediate = many intact and worn tips.

Male crab #	Carapace length (mm)	Condition of genital pore setae
2	74.4	intact
5	69	intact
6	77.8	intact
8	70	intact
9	72.2	intact
4	89.5	intermediate
7	74.2	intermediate
10	62	intermediate
12	74.2	intermediate
13	88.1	intermediate
1	125	worn
3	72.5	worn
11	86.6	worn
16	130	worn
17	122.8	worn
18	101.3	worn

DISCUSSION

Gonadal maturity

Each crab examined possessed mature gametes, indicating that box crabs are gonadally mature upon reaching a carapace length of 75 to 70 mm or less in males and about 80 to 75 mm or less in females. Two males with a carapace length less than 70 mm were examined (Table 1); both had mature spermatozoa. The non-motile, multistellate spermatozoa observed in these crabs are typical of many decapod crustaceans (Felgenhauer & Abele, 1991).

Functional maturity

No morphometric or morphological changes which might indicate functional maturity were observed in either the chelae or 5th pair of pereopods of males. Although the sample size in the chela allometry measurements was small, I suspect that other functional constraints have precluded an allometric shift in the size of the chela relative to the rest of the body. Box crabs are named for their ability to fold their legs and chelae against the body to form a tight-fitting whole difficult to pry open. This is likely a defense against predators. Moreover, when the legs are folded against the body, curved indentations on the carpus of the 1st and 2nd pereopods combine to form conspicuous holes leading into a chamber formed by the pereopods. Although the function of these openings is unknown, the necessity of a tight fit of the box crab's legs and chelae against its body may have precluded the allometric increases in the size of the chelae observed in other types of crabs.

Allometry of either testes weight (e.g., Brown & Powell, 1972) or length of the 5th pair of pereopods may prove more useful than chela allometry in determining size at functional maturity in male box crabs.

The two ovigerous females observed in this study indicate that at least some female box crabs are functionally mature at under 100 mm carapace length.

No mating marks were observed on the exoskeletons of the crabs. However, the setae surrounding the genital pores of males were broken and worn in large crabs compared to small crabs (Table 2). During mating, spermatophores are presumably picked up from the genital pore setae by the setae on the dactyls of the 5th pereopods (see section 2.1); damage to the genital pore setae may therefore reflect increased brushing associated with mating activity. Alternatively, worn setae in larger crabs could result from similar rates of wear in small and large crabs

combined with a longer intermolt period in larger crabs. Given that worn setae were observed in some relatively small crabs (Table 2), the latter hypothesis seems unlikely. Assuming that worn setae result from increased mating activity, the data in Table 2 suggest that mating has commenced in crabs with a carapace length of about 80 mm, but can begin at smaller sizes (as evidenced by the size of the smallest crabs with setae of worn or intermediate condition). Genital pore setae from more crabs should be observed to further evaluate this finding, and direct observations of mating behavior are needed to verify the cause of the damage to these setae.

CONCLUSIONS

Males box crabs are physiologically (gonadally) mature at a carapace length of 75 to 70 mm or less, and based on limited evidence from observations of the setae surrounding their genital pores, appear to be functionally mature at about 80 mm carapace length, with some males mating at even smaller sizes. Further study of the genital pore setae is needed to strengthen these findings concerning size at functional maturity; examination of testes weights and allometry of the 5th pair of pereopods may corroborate them.

Female box crabs are gonadally mature at a carapace length of 80 to 75 mm or less and at least a few are functionally mature at a carapace length of less than 100 mm.

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