Status of the
European Green Crab in Oregon and Washington Estuaries

Final Report

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by

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Executive Summary

Following the last El Niño of 1997-98, a strong cohort of young green crabs appeared in estuaries along the coasts of Oregon, Washington, and on the west coast of Vancouver Island, British Columbia. Unusually strong northward-moving coastal currents (up to 50 km/day from September 1997 to April 1998) must have transported green crab larvae from more established source populations in California to the Northwest. Coastal transport events have been much weaker in recent years.

It was hoped that green crabs would go extinct in the Pacific Northwest once the original colonists reached the end of their life span of 6 years and no new larvae arrived from California. From 2002 to 2004 green crab catches in Oregon and Washington were only around 7 crabs per 100 traps. However, this population size appears to be large enough to keep the population from going extinct. Local recruitment has occurred in Oregon and Washington estuaries and inlets on the west coast of Vancouver Island. Good recruitment in 2003, 2005 and 2006 is linked to warm winters and shore-ward transport in late winter/early spring when larvae are believed to be settling out from the plankton. *The 2005 and 2006 year-classes are now the dominant cohorts in the Pacific Northwest, thus assuring a larval source until 2012 when the last of these crabs will die of old age.*

Even though green crab abundance in the Pacific Northwest is still low when compared to Europe, eastern North America, Tasmania and California, it is imperative to continue monitoring efforts for two reasons:

1) to elucidate the process of range expansion and population persistence of this model non-indigenous marine species with planktonic larvae and

2) to understand the role of ocean conditions on recruitment strength in order to predict the next strong recruitment event of green crabs.

Outreach efforts to educate the general public, including boaters and shellfish growers, not to transport non-native Aquatic Nuisance Species (ANS) from one area to another should continue. Such efforts could delay the spread and establishment of the green crab in the inland sea between Vancouver Island and the mainland, including Puget Sound and Hood Canal.

Professional and Outreach Activities since Fall 2005

Date	Talks / Activities	Location
Oct. 3, 2006	***European Green Crab Status in 2006***	Pacific Coast Shellfish Growers Association/National Shellfish Association. Hilton Conference Center **Vancouver, Washington**
Oct 3, 2006	***Sex Pheromones: A new tool for controlling a global invader?***	
Sept. 7, 2006	***Assisted Oregon Public Broadcasting crew film green crab story for Oregon Field Guide.***	**Tillamook Bay and Netarts Bay, Oregon**
July 18-19, 2006	***Growth and Persistence of the European Green crab in Pacific Northwest estuaries.*** Guest lecture and field trip for Aquatic Biological Invasions (Bi 421/521)	Hatfield Marine Science Center, **Newport, Oregon**
July 8-9 2006	***Native American use of Shellfish.*** Presentation and trapping exercise for Making a Living in the Estuary (Anthro 407)	Hatfield Marine Science Center, **Newport, Oregon**
May 22- June 6	***Worked with three Marine Biology (Bi 450) students testing responses of male green crabs to female pheromone***	**Yaquina Bay, and Netarts Bay, Oregon**
May 14-16	***Trapped for green crabs with Fisheries and Oceans, Canada biologists***	**Barkley Sound, British Columbia**
April 10, 2006	***Green Crab Biology and Invasion History***. Presentation for Marine Biology Class (Bi 450)	Hatfield Marine Science Center, **Newport, Oregon**
Dec. 14, 2005	***Trapping demonstration for participants of Green Crab Technical Meeting***	Sally's Bend and Hatfield Marine Science Center, **Newport, Oregon**
Dec. 13, 2005	***Green Crab Species Overview and Status in the Pacific NW.***	Green Crab Technical Meeting Pacific States Marine Fisheries Commission **Portland, Oregon**
Dec. 6, 2005	***Green crab Species Overview and Status in the Pacific NW.***	Menge-Lubchenco Lab Lunch Oregon State University, **Corvallis, Oregon**
Nov. 8, 2005	***Persistence of the European green crab in the Pacific NW.***	100th Meridian- Columbia River Basin Group. **Portland, Oregon**
Oct. 5, 2005	***Persistence of the European green crab in the Pacific NW.***	Oregon Invasive Species Council - talk and field trip to retrieve trapped crabs . **Tillamook, Oregon**
Sept. 27, 2005	***European Green Crab Status in 2005***	Pacific Coast Shellfish Growers Association/National Shellfish Association Conference **Hood River, Oregon**

Introduction

European green crabs (*Carcinus maenas)* were first discovered on the east coast of North America in the early 1800's (Say 1817). These natives of Europe and Northern Africa and were introduced into North America via shipping. Green crabs arrived in California prior to 1990, and by 2000, had dispersed as far north as Port Eliza on the northern coast of Vancouver Island, British Columbia. The potential range of green crab includes Southeast Alaska (Behrens Yamada 2001, Carlton 2003).

The green crab is a voracious predator that feeds on many types of organisms, including commercially valuable bivalve mollusks (e.g., clams, oysters, and mussels), polychaetes, and small crustaceans (Cohen et al. 1995). It also competes with native juvenile Dungeness crabs and shore crabs for food and shelter (McDonald et al. 2001, Jensen et al. 2002). One native species, the red rock crab, has been shown to offer biotic resistance to this invader, but only in the cooler and more saline lower parts of estuaries (Hunt and Behrens Yamada 2003). Scientists, managers and shellfish growers are concerned that increases in the abundance and distribution of this efficient predator and competitor could permanently alter native communities and threaten commercial species such as juvenile Dungeness crab, juvenile flatfish and bivalves (Lafferty and Kuris 1996, Jamieson et al. 1998).

On the West Coast, the northward range expansion of green crabs during the 1990's appears to be linked to favorable ocean conditions for larval transport during El Niño events (Behrens Yamada et al. 2005). Warm temperatures and strong northward moving coastal currents (>50 km/day) during the 1997/1998 El Niño were correlated with the appearance of a strong cohort of young green crabs in NW estuaries in the summer of 1998 (Behrens Yamada and Hunt 2000, Behrens Yamada et al. 2005). With the loss of this strong cohort to senescence and the absence of favorable currents to transport larvae from California in recent years, it was hoped that green crabs in Northwest estuaries would go extinct. This has not happened. Some localized recruitment has occurred in some estuaries every year. Following the warm winters of 2003 and 2005, good green crab recruitment occurred in estuaries from Coos Bay to Kyuquot Sound, BC on the northern west coast of Vancouver Island.

Goals

The goal of this study is to document the present and predict the future status of the European green crab in the Pacific Northwest. This is accomplished by:

- Estimating the size/age structure and relative density of green crabs in Oregon and Washington estuaries by using baited traps.
- Estimating year-class strength of young-of-the-year green crabs at the end of their first growing season by setting minnow and pit-fall traps in the high intertidal zone.

- Comparing patterns in recruitment strength over time and correlating them to ocean conditions and winter surface temperatures of estuaries.
- Collaborating with scientists from Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife and Fisheries and Oceans Canada as well as with shellfish growers in order to compile all existing green crab data for the Pacific Northwest.

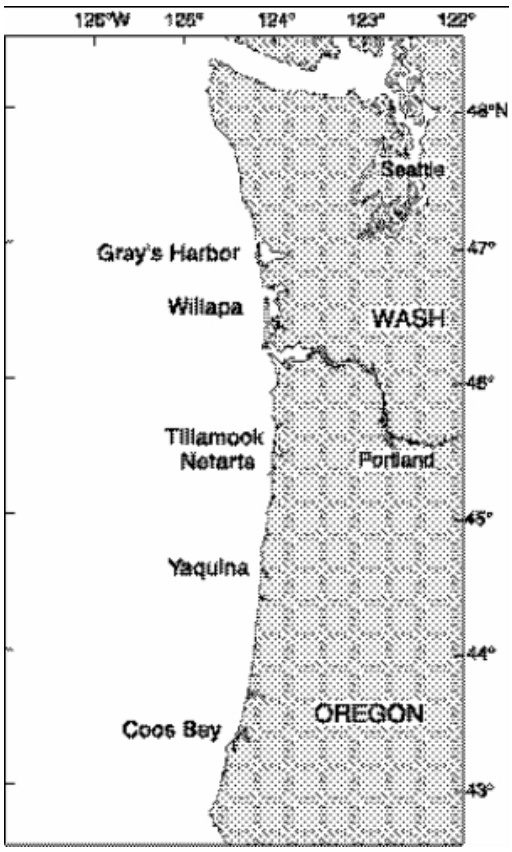

Figure 1. Map showing the major 6 study sites in Oregon and Washington.

Sampling Methods for Green Crabs

Our sampling effort in 2006 focused on four Oregon and two Washington estuaries: Coos, Yaquina, Netarts, Tillamook, Willapa Bay and Grays Harbor (Figure 1). These estuaries were sampled at least three times during the 2005-trapping season (Appendix 2). In each estuary, we selected study sites within various habitat types and tidal levels. Since green crabs are rare and patchily distributed, we did not choose our sites randomly. Instead, we preferentially sampled sites that have harbored green crabs in the past such as tidal marshes, gradually sloping mudflats and tidal channels where salinities remain above 15 ‰ and water temperatures range between

12^{o}-22^{o} C in the summer (Behrens Yamada and Davidson 2002). Green crabs are noticeably absent from the cooler, more saline mouths of estuaries, which are dominated by the larger and more aggressive red rock crab, *Cancer productus* (Hunt and Behrens Yamada 2003).

Since *C. maenas* larvae settle high on the shore (Zeng et al. 1999), and crabs move into deeper water as they age (Crothers 1968), we adapted our collecting methods and locations to effectively sample all age classes of *C. maenas.* Since traps differ in their sampling efficiency for different sizes of crabs, we used three trap types (Table 1). Folding fish traps, with their wide slit-like openings, work well for adult crabs larger than 40 mm carapace width (CW); while minnow traps with their small mesh size (0.5 cm) retain young-of–the-year green crabs. Green crabs start entering these baited traps when they are around 20-30 mm CW. Pitfall traps are water-filled 5-gallon buckets buried into the sediment so that their rims are flush with the surface of the sediment. Thus they trap actively foraging crabs of any size. Pitfall traps were only used at the Stackpole site in Willapa Bay where green crabs have been continually sampled since 1998. Typically, we would trap young-of–the-year green crabs in the high intertidal with minnow and pit fall traps and larger adult crabs in the mid to low intertidal and subtidal zones with folding fish traps (Appendix 2).

Table 1. Types of traps used for sampling *C. maenas* in Oregon and Washington estuaries. Size selectivity is given in carapace width (CW).

Trap Type	Description	Dimensions	Tidal Height	Size Selectivity (CW)
Folding Fukui Fish Trap	Plastic mesh (2 cm) with two slit openings (45 cm)	63 x 46 x 23 cm	Subtidal to lower intertidal	Large >40 mm
Minnow/ Crayfish	Wire mesh (0.5 cm) cylinder with two openings expanded to 5 cm	21 cm diameter 37 cm long	Medium to high	Medium-large 20-70 mm
Pit fall	Water-filled 5-gallon bucket embedded into the sediment	31 cm diameter 37 cm high	High	All sizes

On gravel shores, we added rocks to the minnow and fish traps to weigh them down and to provide shelter for the crabs. On soft sediment, we pinned the minnow traps down with thin metal stakes. We cut fish carcasses into sections and placed them into egg-shaped commercial bait containers (15 x 8 mm). Holes (0.5 cm) in the sides and lids of the containers allow bait odors to diffuse. One bait container with fresh bait was placed in a trap and left for one tidal cycle (typically 24 hours). We retrieved the traps at low tide, identified all crabs and other by-catch to species and noted the sex, carapace widths (CW) and molt stage of all green crabs (Appendix 3). Green crabs were measured between the tips of their fifth anterio-lateral spines using digital calipers. Native crabs and other by-catch were released while green crabs were removed from the ecosystem and destroyed.

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Table 2. Relative Green Crab abundances (# per 100 trap-days) for study sites in Oregon and Washington estuaries. Data for Grays Harbor 2002 and Willapa Bay 2002-2003 were kindly supplied by Washington Department of Fish and Wildlife and those for Willapa Bay 2004, by P. Sean McDonald. Note that in the last four years, green crabs have been most abundant in Netarts Bay, Oregon.

Estuary	Number of crabs trapped divided by (# trap-days)				
	2002	2003	2004	2005	2006
Coos Bay	9 (180)	14 (203)	18 (137)	9 (242)	22 (273)
Yaquina	26 (168)	63 (1084)	12 (461)	39 (290)	48 (211)
Netarts	0 (44)	11 (44)	12 (39)	52 (106)	47 (82)
Tillamook	2 (71)	6 (70)	4 (51)	12 (102)	41 (147)
Willapa	57 (1640)	13 (409)	6 (195)	113 (449)	19 (245)
Grays Harbor	5 (1203)	--	--	2 (94)	3 (175)
Total	99 (3306)	107 (1810)	52 (883)	228 (1283)	180 (1133)

Estuary	Catch per 100 trap-days				
	2002	2003	2004	2005	2006
Coos Bay	5	7	13	4	8
Yaquina	**15**	6	3	13	23
Netarts	0	**25**	**31**	**49**	**57**
Tillamook	3	9	8	11	28
Willapa	3.5	3	3	25	8
Grays Harbor	0.4	--	--	2	2
Total	3	6	6	18	16

Table 3. Green crab annual catch and sighting data for estuaries and inlets in the Pacific Northwest. Note that catches in Oregon and Washington were high in 1998, right after the 1997/98 El Nino. The last colonists that had arrived during that event died of old-age in the summer of 2004. However, local recruitment in recent years (especially in 2003, 2005 and 2006) was high enough to keep the Oregon and Washington population of green crabs from going extinct. Asterisk indicates that fewer than 50 traps were deployed. "P" indicates that green crabs were present.

Bruce Kauffman of Washington Department of Fish and Wildlife helped calculate catch data for Willapa Bay and Grays Harbor from 1998 to 2003. Data for the west coast of Vancouver Island were kindly provided by Fisheries and Oceans Canada scientists (Gillespie et al. 2006). Additional catch and sighting data were provided Hauck 2000 and Hunt and Behrens Yamada 2000 and by individuals including Neil Richmond, Erin Richmond, John Schafer, Todd Miller, Chris Hunt, Ron Figlar-Barnes, Marsha Becklund, Ashlie Gilmore, Tim Davidson, TJ Hesse, John Faudkar, Jessie Hayes, Erik Hanson and Sean McDonald,

Number of Green Crab per 100 trap-days										
Estuary/ Site	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Kyuquot Sound, BC						P			P	53
Esperanza Inlet BC					P	P	P		5	46
Nootka Sound BC				P						3
Clayoqout Sound. BC				P						20
Barkley Sound. BC			P						P	172
Esquimalt BC			P							
Grays Hbr, WA		28	3	3	1	0.4			2	2
Willapa, WA		35	43	4	3	3.5	3	3	25	8
Tillamook, OR	P	128	P	P	2*	3	9	8	11	28
Netarts, OR	P	139			6*	0	25	31	49	57
Yaquina, OR	P	192	69	63	57	15	6	3	13	23
Alsea Bay, OR		P				P	P			
Winchester Bay OR		P								
Coos Bay, OR	0.2	65	38	P	63*	5	7	13	4	8
Coquille, OR		P							5*	

Results

Densities in Pacific Northwest

The relative abundances of green crabs trapped in Oregon and Washington estuaries in 2006 are tabulated in Appendix 2 and summarized in Tables 2 and 3. As can be seen from Appendix 2, catch per unit effort (CPUE) is extremely variable. Many factors contribute to this variability, including water temperature, bait type, trap type, tide level, phase in the tidal cycle and the patchy distribution pattern, molt phase, and hunger level of the crabs. Sampling bias also plays a role. For example, when green crabs were rare in Oregon, we focused on known "hot spots" to at least catch a few crabs for age class analysis. One thus must use caution in interpreting differences in CPUE between sites and over time. Minor differences in CPUE are not significant but difference on an order of magnitude would be.

What can be concluded, however, is that catches in Oregon have decreased an order of magnitude since 1998 colonization event (Table 3). While average CPUE per 100 traps ranged from 65 to 192 in 1998, it dropped to 0-15 by 2002. Average catches in both Oregon and Washington averaged less than 7 crabs per 100 traps for 2002, 2003 and 2004. Averages catches in the last two years have roughly doubled due to good recruitment in 2005 and 2006.

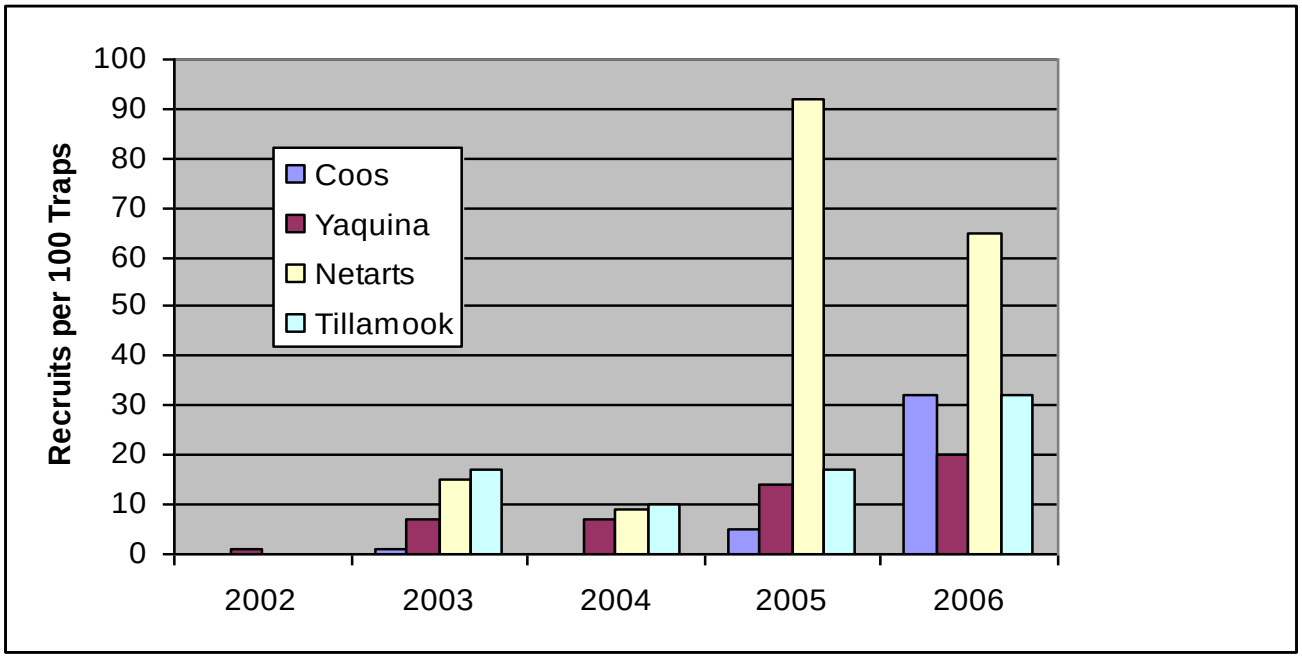
The most interesting development this year has been the extensive sampling program for non-native species around Vancouver Island by Fisheries and Oceans Canada. (Gillespie et al. 2006). While no green crabs were trapped in the 19 stations in the inland sea (Johnstone Strait, Desolation Sound and Discovery Passage), all 5 inlets sampled on the west coast of Vancouver Island yielded green crabs (Table 3). Densities were comparable, to those measured in Oregon and Washington over the last two years. However, catches in Barkley Sound averaged 172 per 100 traps, with one station, Pipestem Inlet yielding 228. These densities are as high as those measured in Oregon right after the 1997/98 El Niño (Table 3)

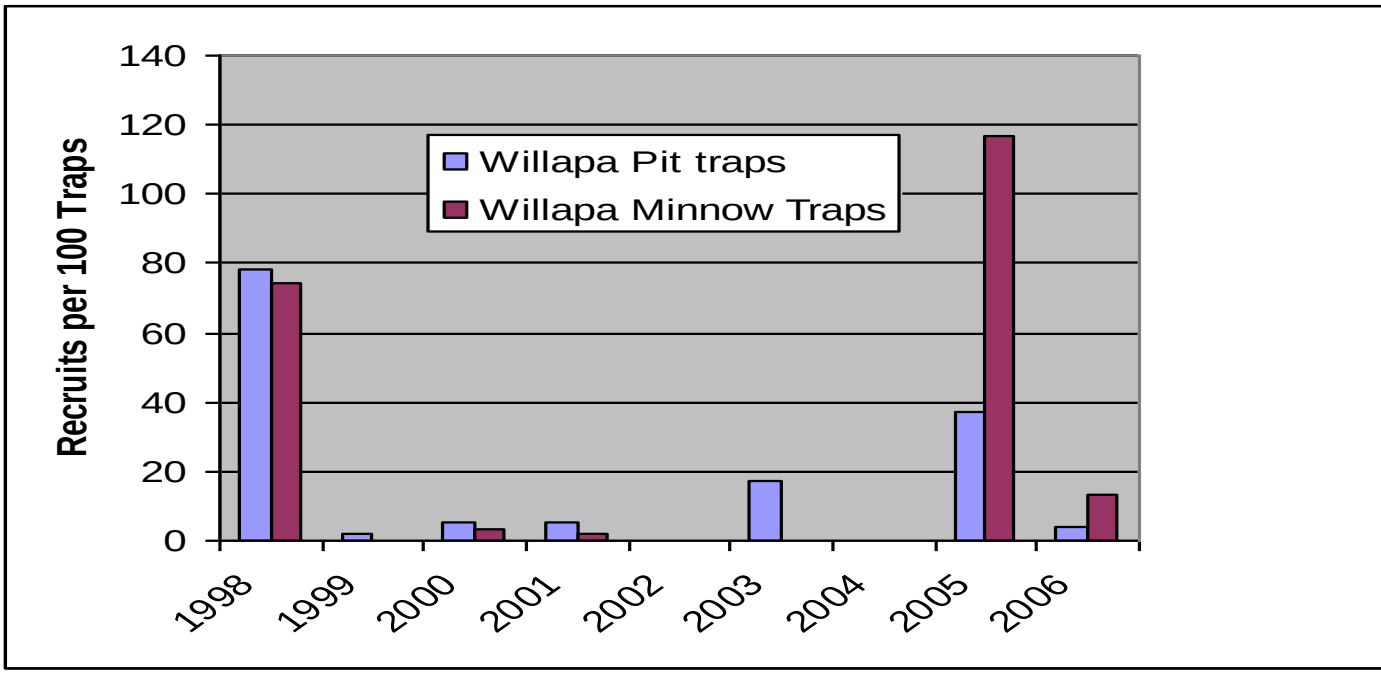
Recruitment

Sampling of young crabs in four Oregon estuaries since 2002 and at Stackpole in Willapa Bay, by the Washington Department of Fish and Wildlife and Andrea Randall since 1998, indicates that recruitment occurred in NW estuaries most years (Figure 2; Appendix 4). We define recruitment as the time when a new cohort of green crabs first enters our traps in late summer. Recruitment densities and sizes were measured around September, at the end of their growing season. The new cohort of green crabs following the 1997/1998 El Niño ranged in abundance from 0.74 crabs to 5.0 crabs per trap-day and ranged in carapace width from 32-60 mm in September 1998. In subsequent years catches of recruits decreased by an order of magnitude (Figure 2; Appendix 4).

Mild winters in Maine and Europe are typically followed by good green crab recruitment and growth (Berrill 1982, Beukema 1991). This trend also appears to hold for the Pacific Northwest. The cold winter of 2002 was followed by no recruitment in Washington and only one recruit being found in Oregon. The mild winters of 2003 and 2005 saw good recruitment in Oregon, Washington and British Columbia (Figure 2; Appendix 4; Gillespie et al. 2006).

Figure 2. Recruitment strength of young-of-the-year green crabs in four Oregon estuaries and in Willapa Bay, Washington. Willapa Bay was not sampled in 2004. For average sizes of recruits, see Appendix 4.





Since green crabs live up to 6 years, one good recruitment event is needed at least once every 5 years to keep the population from going extinct. When the last crabs of the 98-cohort died of senescence in the summer of 2004, the 2003 year class became the dominant one in Oregon and Washington estuaries. Even though the 2003 cohort was less abundant than the 1998 one, it produced enough larvae in 2005 to adequately "seed" Pacific Northwest estuaries and keep the Oregon and Washington population from going extinct. In Willapa Bay, the 2005 recruitment event was the strongest since 1998 (Figure 2; Appendix 4). While recruitment in Oregon estuaries was good in 2006, Washington estuaries showed a decline. The loss of nursery habitat in Willapa Bay due to the *Spartina* eradication program may have contributed to low recruitment.

Age Structure of Green Crabs in Oregon and Washington Estuaries

From previous mark and recapture studies and from shifts in size frequency distributions over time (Behrens Yamada et al. 2005,) we estimated the age of green crabs retrieved from Oregon and Washington estuaries in 2006. We assigned crabs to age classes based on their size and coloration (Table 4; Appendix 3). For example, during the summer crabs between 50 and 70 mm, with green or yellow carapaces would represent the 2005 year class. Larger crabs, most likely belonged to the 2003 year class as recruitment was poor in 2002 and 2004. Over 80% of the green crabs in Oregon and Washington estuaries belong to the 2005 and 2006 year classes. These young crabs comprise the majority of the breeding population, and would be able to seed Oregon and Washington estuaries until 2012.

Table 4. Estimated age structure of *Carcinus maenas* retrieved from Oregon and Washington estuaries in the 2006. Total crabs include trapped crabs recorded in Table 1, those caught in pheromone trials, crabs and molts found on the shore and in sports catches. "P" indicates that the 2004 year class was represented in Yaquina Bay in previous years, but could not be distinguished from the 2003 cohort.

Estuary	Year Class				
	2006	2005	2004	2003	Total
Coos Bay	18	1		5	24
Yaquina	18	18	P	29	65
Netarts	26	30		3	59
Tillamook	35	9		2	46
Willapa	6	25		1	32
Grays Harbor	1	1			2
Total	104	84		40	228

Conclusions

In 2006, we found green crabs, including 2006 recruits, in all six Oregon and Washington estuaries. Catches were highest for Netarts (65/100 traps) at the center, and lowest for Grays Harbor and Coos Bay, toward the edge of the range sampled. Recruitment in Oregon estuaries was good in 2006 (between 20 and 65 per 100 traps) but much poorer in Willapa and Grays Harbor. The 2005 and 2006 cohorts are now the dominant year classes in Oregon and Washington estuaries, comprising 82% of the population. Given that the longevity of green crabs is 6 years; these strong cohorts will provide a larval source until 2012. From 2002 to 2004 green crab catches in Oregon and Washington averaged less than 7 crabs per 100 traps. This population density appears to be large enough to keep the population from going extinct. These observations together with the recent confirmation of viable green crab populations on the west coast of Vancouver Island suggest that this species is very likely to persist in the Pacific Northwest.

Even though green crab abundance in the Pacific Northwest is below a level at which ecological impact can be measured (10 per trap; Grosholtz, personal communication) and much lower than in Europe, eastern North America, Tasmania and California, it is imperative to continue monitoring efforts for two reasons:

3) to elucidate the process of range expansion and population persistence of this model non-indigenous marine species with planktonic larvae and

4) to understand the role of ocean conditions on recruitment strength in order to predict the next strong recruitment event of green crabs.

Outreach efforts to educate the general public, including boaters and shellfish growers, not to transport non-native Aquatic Nuisance Species (ANS) from one area to another should continue. Such efforts could delay the spread of ANS in general, and could prevent the establishment of the green crab in the inland sea between Vancouver Island and the mainland, including Puget Sound and Hood Canal. Once green crabs get established in the inland sea, they would spread very quickly as many suitable habitats, devoid of larger crabs and other predators, exist in shallow, warm bays and near freshwater outfall. Other non-native species such as the Japanese oyster, the manila clam and the purple varnish clam spread throughout the inland sea in couple of decades as larvae are retained and not carried out to sea as may be the case the coastal estuaries of Oregon and Washington.

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Pony Point. Bruce Kauffman of Washington Department of Fish and Wildlife and Scott Groth of Oregon Department of Fish and Wildlife provided additional data. We thank the staff and faculty of the Oregon Institute of Marine Biology for their hospitality while sampling in Coos Bay. We are especially thankful for Graham Gillespie, Tom Therriault, Antan Phillips, Dennis Rutherford, Debbie Paltzat, Susan Bower and Jason Dunham of Fisheries and Oceans Canada for sharing their data on the recent non-native species survey around Vancouver Island.

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Appendix 1. Physical data for *Carcinus maenas* sampling sites in Oregon and Washington estuaries. Range of values observed includes sampling times from 2002 to 2005.

Site	Date	Location Description	S ‰	Water Temp.	Air Temp.	Green Crabs Found?
COOS BAY						
Jordan Cove		***Range of values observed***	***5-34***	***14-22***	***14-24***	
	4/4/06		20		14.5	no
	5/16/06		29	14.5		no
	5/17/06		28	14.4		no
	9/10/06		34	19.4	23.5	**yes**
	9/11/06		32	17	17	**yes**
Russell Point		***Range of values observed***	***22-33***	***11-20***	***10.5-28***	
	4/4/06		20	10.5	9.5	no
	5/16/06		27	14.9		no
	5/17/06		28	15		no
	5/18/06		29	14.8		no
	6/28/06		27	16.7		no
	6/29/06		27	15.5		no
Trans Pacific Br. N 43° 26.222' W 124° 14.155'	9/13/06		32	17	16.4	**yes**
Trans Pacific Ln.		***Range of values observed***	***22-33***	***11-18***	***10.5-16***	
N 43° 26.571'	6/7/06		26	18.6	15	no
W 124° 13.388'	9/13/06		33	16.4	15.3	no
Haynes Inlet	9/13/06					**yes**
N 43° 27.003' W 124° 13.478'						

Glasgow	9/13/06					no
N 43° 26.941'						
W 124° 19.476'						
Kentuck inlet A	9/13/06		28	19.1	19	**yes**
N 43° 25.299'						
W 124° 11.522'						
Kentuck Inlet B	9/13/06		28	19.1	19	no
N 43° 25.201'						
W 124° 13.229'						
Chaleston, Metcalf Marsh	9/13/06		34	12.7	14.8	no
Charleston Boat Basin	6/7/06		30	17.7	19.3	no
Pony Point	***Range of values observed***		***17-32***	***11-17***	***11.5-18***	
N. Bend Airport	4/4/06	Mudflat near rip rap, *Zostera marina*	20	10.8	11.0	**yes**
N 43° 25.403'	6/10/06		24	15	14.2	no
W 124° 14.369'	7/5/06		27	18.7	17.7	no
	9/11/06		33	18.2	17	**yes**
Ferry Road Park	7/4.06		28	18	17.6	no
N 43° 25.185'						
W 124° 13.0851'						

YAQUINA BAY

Johnson Slough	***Range of values observed***		***23-32***	***15-20***	***16-22***	
N 44° 34.692'	4/25/06	Below bridge/along creek bank , *Salicornia* patches	10	13.4	13.2	no
W123° 59.333'	8/23/06		30	21.5	19.8	**yes**

	9/26/06		30	14.7	17.2	**yes**
Sally's Bend A	***Range of values observed***		***22-33***	***12-19***	***12-26***	
N 44° 37.699'	4/28/06	*Scirpus* patches	20	14.9	13.3	no
W124° 01.482'	6/14/06			15.9		
	8/16/06		33	17.2	22.3	no
	8/23/06		31	18	20	**yes**
	9/20/06		32	16.8	15	**yes**
Sally's Bend B	***Range of values observed***		***29-33***	***12-19***	***12-24***	
N 44° 37.640'	8/16/06	*Scirpus* patches	33	17.2	22.3	**yes**
W124° 00.790'	8/23/06		31	18	20	**yes**
	9/20/06		32	16.8	15	**yes**
Sally's Bend D		*Scirpus* patches				
N 44° 37.561'	9/21/06		32	16.8	17	**yes**
W124° 00.537'						
Sally's Bend C	***Range of values observed***		***19-32***	***10-19***	***9-22***	
N 44° 37.419'	4/28/06	Eel grass from gate to Fishing platform	21	14.9	13.6	no
W124° 01.463'	6/14/06		26	15.9	16.5	no
	6/23/06		31	21	19.0	**yes**
Hatfield Marine		***Range of values observed***	***22-34***	***11-21.5***	***12-23***	
Science Center	6/14/06	Rip rap/ boulders/sandy mudflat/ *Zostera marina*	32	15.3	16.5	**yes**
Pump house	7/9/06		30	16.5	22.3	**yes**
N 44° 37.408'	7/18/06		34	16.8	21	**yes**
W124° 02.576'						
Oregon Coast	***Range of values observed***		***19-34***	***9-25***	***8-23***	
Aquarium	4/28/06	Tidal channel draining mudflat, along nature trail	24-27	15	16.5	**yes**
N 44° 37.108'	8/16/06		32	18.5	22.5	no

W124° 02.165'	9/19/06			14		no
Idaho Point		***Range of values observed***	***19-35***	***12-27.5***	***12-23***	
N 44° 36.818'	6/15/06		30	16.7	17.8	**yes**
W 124° 01.582'						
Neohla Pt.	6/15/06	Tidal reek near Spencer care center on Idaho Pt. Road		16		**yes**
N 44° 36.751'						
W 124° 02.517'	9/19/06			14		**yes**

TILLAMOOK BAY

Tillamook Spit A	***Range of values observed***		***0-30***	***13-19***	***13-27***	
N 45° 30.843'	4/25/06	mudflat- eelgrass zone below rip rap and in *Scirpus*	11	12.7	17.4	**yes**
W 123° 56.738'	7/27/06		30	21.0	18.6	**yes**
	9/06/06		31	18	19.2	**yes**
Tillamook Spit B						
N 45° 30.456'	7/26/06		30	21.5	16.5	no
W 123° 56.615'	9/06/06		31	18	19.2	**yes**
Pitcher Point	9/06/06	South of Spit B – mudflat in Japanese eelgrass zone	31	18	19.2	**yes**
N 45° 30.365'						
W 123° 56.508'						
Hayes Oyster	7/26/06	Mudflat in native eelgrass zone	8	21.0	20.1	no
N 45° 29.445'	9/05/06	High zone in *Carex* vegetation	26	15.9	14.3	no
W 123° 55.010'						
Old Mill Marina	7/26/06		34	13.8	29.8	no

NETARTS BAY

Boat Ramp N 45° 25.832' W 123° 56.827'	9/7/06	Low to mid-tidal rocks and mud flat	34	14.4	18	**yes**
Whiskey Creek Salmon hatchery N 45° 24.-----' W 123° 56.-----'		***Range of values observed***	***0-34***	***13-20***	***14.5-21***	
	4/25/06	On mudflat and in creek		13.7		**yes**
	7/26/06		34	22.0	21.0	**yes**
	9/06/06		31	16	17	**yes**
Intersection of Whiskey Creek & Netarts Bay Roads N 45° 24.865' W 123° 56.064'		***Range of values observed***	***0-34***	***13.5-20***	***15s-23***	
	4/25/06	Pool below culvert draining Freshwater marsh	33	13.7	17.5	**yes**
	7/26/06		32	19.4	18.8	**yes**
	9/06/06		34	16.5	18	**yes**

WILLAPA BAY

Stackpole Leadbetter Pt. Sate Park N 46° 35.848' W 124° 02.195'		***Range of Values observed***	***14-28***	***11-19***	***9-28***	
	4/1/06	Shellbags onTide flats outside spartina field	23	11	10	**yes**
	4/17/06	Shellbags	23	11	9	**yes**
	4/28/06	Shellbags	23	13	11	**yes**
	5/16/06	Shellbags	23	19	18	no
	5/31/06	Shellbags	26	20	16	no
	5/31/06	Pit traps in Spartina field	25	16	18	**yes**
	7/25/06		30	Thermometer broke		**yes**
	9/06/06	Pitfall traps	32	15	15	**yes**
	10/24/06		30	12	10	**yes**
Parcel A	7/13/06	Edge of Spartina	No	Data	taken	no

Taylor Resources N 46° 29.519' W 124° 01.814'	***7/11/06***	***Bay Ave./Sandridge Rd, edge of Spartina field***	25	18.8	17.5	**yes**
Boat Ramp by Refuge N 46° 24.750' W 123° 54.258'	7/12/06	Mile 24, Highway 101. Either side of boat ramp used by old cable ferry	21	19.7	15.4	no
Pickerrell Creek N 46° 32.930 W 123° 53.765'	7/12/06	Mile 37.5, Highway 101. Near channel and on mudflat	1	15.3	15	no
Bay Center N 46° 37.782' W 123° 57.562'	7/12/06	*Spartina* patches on sand flat	30	21.9	18.7	no

GRAYS HARBOR

Lila St. Refuge	6/26/06	Private wildlife sanctuary, in front of Grassy Island	30	21	26	no
N 46° 52.480'	7/13/06	Upper tideland	24	16	16	no
W 124° 05.904'	9/22.06		30	14	13	**yes**
	10/26/06		25	11	9	no
Brady's Oysters	6/26/06	Mouth of Elk River	25	20	24	no
N 46° 51.723'	7/13/06		24	16.7	16.7	no
W 124° 04.333'	9/22/06		28	13	14	no
	10/26/06		26	10	9	**yes**
Bay View Road	9/22/06	Upper tideland, native vegetation	25	14	13	no

Appendix 2. Relative abundance of crab species and sculpins (Numbers/trap/day) in Oregon and Washington estuaries during 2006. An asterisk beside trap number indicates that other traps were either opened or were stolen.

Coos Bay

Site		Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Russell Point	4/4/06	Fish	Pools by bridge				0.5	0		0.33	6
	4/5/06	Fish	*Zoster marina*				1.82	0		0.2	6
	5/16/06	Fish					5.67	0		0.5	6
	5/17/06	Fish					5.5	0		1.17	6
	5/18/06	Fish					11.33	0	0.17	0.67	6
	6/28/06	Fish					11.33	0	0.17	1	6
	6/29/06	Fish	*Pools*				7.1	0	0.1	0.1	10
	6/29/06	Fish					10	0		0.25	4
Pony Point/Airport	4/4/06	Fish	*Zostera marina*	**0.2**	0	0.3	0.3	0.2	0	0	10
	6/8/06	Fish					4.63	0		0.09	11
	7/5/06	Fish					1.2	0		0.6	10
	9/12/06	Fish		**0.1**			5.5	0	0.1	0.4	10
	4/4/06	Minnow			0	0	0.4	0	0	0	10
	6/8/06	minnow						0			10
	7/5/06	Minnow						0.4		0.3	10
	9/12/06	Minnow		**0.2**	0.2		0.1	0.1		0.7	10
Ferry Road	7/5/06	Fish					2.4	0	1.1	1.2	10
Haynes Inlet	9/13/06	Minnow		**0.5**				0		0.25	4
Glasgow	9/13/06	Minnow						0		0.4	5
Kentuck A	9/13/06	Minnow		**0.6**			0.4	0			5

Kentuck B	9/13/06	Minnow					0.6	0		0.2	5
Charleston Boat Basin	6/8/06	Fish	*Zostera marina*				0.6	0		0.3	10
Medcalf Marsh	9/13/06	Minnow		0	0	0	0	0	0	0	5
Trans-Pacific Ln.	6/8/06	Fish	*Low*				4.9	0		2.6	10
	9/13/06	Fish			0.4		0.2	0		0.2	5
	6/8/06	Minnow	*Scirpus*				0.7	0		2.3	10
	9/13/06	Minnow									
Trans Pacific Br.	9/13/06	Minnow		**0.2**				0		0.2	5
Jordan Cove	04/04/06	minnow	*Scirpus*		0	0	0	0	0	1.1	10
	04/5/06	Minnow						0		0.4	10
	5/16/06	Minnow	*Scirpus*				0.1	0		0.5	10
	5/17/06	Minnow					0.75	0		0.75	8
	9/11/06	Minnow		**0.9**				0			10
	9/12/06	Minnow		**0.2**				0		0.2	20

Yaquina Bay

Mean CPUE (Catch/trap/day)

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpins	Number Traps
Johnson Slough	4/28/06	Fish	Below Bridge				7.0	0.5		0.5	2
	8/24/06	Fish		**0.5**			3.5	0		0.5	2
	9/26/06	Fish		**1.25**			3.5	0		1.0	4
	4/28/06	Minnow	Marsh			1.67	0.33	0		0.67	3
	8/24/06	Minnow						0		1.0	8
	9/26/06	Minnow		**0.07**				0		0.53	15

Sally's Bend A	04/28/06	Minnow	*Scirpus*		0.67			0		0.57	3
	6/15/06	Minnow			1.5			0		5.1	10
	8/17/06	Minnow			0.33			0			9
	8/24/06	Minnow		**0.1**	0.2			0		0.8	10
	9/20/06	Minnow		**0.2**	0.2			0		0.3	20
Sally's Bend B	8/17/06	Minnow	*Scipus*	**0.33**	1.0			0		1.0	6
	8/24/06	Minnow		**0.5**	0.75			0		2.23	8
	9/20/06	Minnow		**0.17**	0.17			0		0.17	6
Sally's Bend C Fishing Platform	04/28/06	Fish	*Zostera marina*				1.0	0	5.5		2
	6/15/06	Fish			0.8		5.4	0		9.8	5
	6/23/06	Fish		**0.1**	0.5		2.3	0		3.7	10
Sally's Bend D	9/21/06	Minnow	*Scirpus*	**0.53**	0.13			0		1.33	15
HMSC Pump house	**6/15/06**	Fish	*Zostera marina*	**0.4**	0.1		2.0	0	0.9	3.5	10
	6/16/06	Fish		**0.4**			0.6	0		1	5
	7/9/06	Fish		**0.2**	.2		0.4	0	0.2	7.7	10
	7/18/06	Fish		**0.33**	0.44		0.67	0	0.11	3.55	9
Oregon Coast Aquarium	**4/28/06**	Fish	subtidal	**0.5**			3.5	3.5		0.5	2
	4/28/06	Minnow	*Scirpus*				2	0.66		1.33	3
	8/17/06	Minnow			0.6			0.1			10
	9/20/06	Minnow						0.1		1.5	10
Idaho Point	6/16/06	Fish	Low	**1.2**			1.0	0			5
Neohla Point	6/16.06	Fish	*Marsh and creek*	**1.0**				0		3.75	4
	6/20/06	minnow		**0.2**	0.2			0		1.0	5

Tillamook Bay **Mean CPUE (Catch/trap/day)**

Site		Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Tillamook Spit A	4/26/06	Fish	*Scirpus*	**0.125**				0		0.125	8
	7/26-27	Fish		**0.33**	4.83		0.25	0	0.08	3.83	12
	9/06/06	Fish		**0.82**			1.0	1.0		1.35	11
	9/07/06	Fish		**0.73**	1.0			0.18		1.17	11
	4/26/06	Minnow	*Scirpus*		0.125			0		0.25	8
	9/06/06	Minnow		**0.4**	0.8			0.2		1.8	5
	9/07/06	Minnow		**0.07**	0.33		0.07	0.93		1.43	15
Tillamook Spit B	4/25/06	Fish	*Zostera japonica*					0			1
	7/26-27	Fish			0.8		0.3	9.7		4.7	10
	4/25/06	Minnow	*Scirpus*					0			6
	9/06/06	Minnow		**0.5**	2			1.0		0.9	10
	9/07/06	Minnow		**0.2**				4.5		0.4	10
Pitcher Point	9/06/06	Minnow	*Scirpus*	**0.7**				0		1.4	10
	9/07/07	Minnow		**0.2**				0.1		3.4	10
Hayes Oysters	7/26/06	Fish	*Low, eelgrass*				0.52	0.01		0.14	10
	9/6/06	Minnow	*High vegetation*					0.1		2.7	10
Bay City/Old Mill	7/26/06	Fish	*Subtidal/docks*				8	0		11.75	4

Netarts Bay **Mean CPUE (Catch/trap/day)**

Site		Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps

Boat Ramp	9/07/06	Fish		**0.2**	0.4		8.8	0	1.0	1.2	5
Intersection	04/26/06	Fish	pools	**2.67**	1		3.33	0			3
	06/26/06	Fish		**0.25**	0.5	0.25	0.77	0		4	4
	9/06/06	Fish		**0.75**			8.0	0	0.25	6.5	4
	9/07/06	Fish		**0.75**			4	0		1.75	4
Whiskey Creek Salmon Hatchery	04.26/06	Fish	*Fucus*/mudflat	**0.67**	1.0			0			3
	07/26/06	Fish		**0.5**	0.75	0.5		0		0.25	4
	9/06/06	Fish		**1.5**	3.77		0.75	0		0.75	4
	9/07/06	Fish		**0.5**	0.5		0.75	0.25		1.5	4
	04/26/06	Minnow	*Fucus*/mudflat	**0.08**	0.33	0.33		0			12
	07/26/06	Minnow		**0.2**	2.4	1.3		0		0.6	10
	07/27/06	Minnow	*Zeroed in on hotspot*	**0.6**	1.8			0			5
	9/06/06	Minnow		**0.8**	0.2	0.1		0		1.0	10
	9/07/06	Minnow		**0.5**	0.2	0.2	0.1	0		0.1	10

Willapa Bay **Mean CPUE (Catch/trap/day)**

Site		Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Stackpole	5/31/06	Pit-fall	*Spartina*	**0.12**	0.88	0	0	0	0	0	17
	6/1/06	Pit-fall		**0.06**	1.0		0.06	0			17
	7/25/06	Pit-fall			0.7			3.9			17
	7/26/06	Pit-fall			0.29			8.4			17
	7/27/06	Pit-fall		**0.6**	0.35	0.12		12.2			17
	9/06/06	Pit-fall			0.12		0.6	5.76			17
	9/07/06	Pit-fall		**0.12**	0.17	0.12	0.58	7.47			17
	10/24/06	Pit-fall	*one trap lost lid for>30 d	**0.06***	0.06*		2.23*	0.29*			17
	5/31/06	Minnow		**0.1**	0.4	0.1	0	0	0	0.3	10
	6/1/06	Minnow		**0**	0.7	0.1	0	0	0	0.7	10
	7/27/06	Minnow		**0.1**	0.4		0.8	0.2		1.9	10
	9/06/06	Minnow		**0.1**	0.2		0.2	1.3		1.3	10
	9/07/06	minnow			0.2		0.7	0.9		1.5	10

	10/24/06	Minnow		**0.3**	0.2		0.5	0		0.3	10
Taylors Resources	7/12/06	Minnow	Spartina edge	**0.2**			0.6	0		2.8	10
Nacotta Lab	7/13/06	Minnow	Spartina edge				0.3	0		1.5	10
Long Is.Refuge	7/12/06	Fish	Old ferry ramp				17.8	0		1.2	5
		Minnow					3.5	0			5
Pickerrell Creek	7/12/06	Fish	Along creek bank				37.4	0		1.6	5
		Minnow					2.2	0		0.2	5
Bay Center	7/12/06	Minnow	end of School Rd, in *Spartina* patches		0.22		0.89	0.33		0.33	9

Grays Harbor **Mean CPUE (Catch/trap/day)**

Site		Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Lila Street-refuge	6/26/06	Fish	Native vegetation					*0*		0.6	5
		Minnow						*0*		4.9	10
	7/13/06	Minnow						0		0.6	15
	7/14/06	Minnow						0		0.3	20
	9/22/06	Minnow		0.06	0.06			0		0.33	15
	10/26/06	Minnow						0		0.5	10
Brady's Oysters	6/26/06	Fish	*Low to mid*				2.4	0		1.3	5
	7/13/06	Fish					2.95	0.05		4.64	20
	7/14/06	Fish					3.5	0.2	0.7	1.3	20
	6/26/06	Minnow	Native vegetation		0.2			0		5.2	10
	7/13/06	Minnow						0.2		1.0	10

	7/14/06	Minnow			0.1			0.5		0.4	10
	9/22/06	Minnow						0		0.9	10
	10/26/06	Minnow		0.2				0		1.6	10
Bay View Road	9/22/06	Minnow	Upper tideland					0.2			5

Appendix 3. *Carcinus maenas* Catches and Sightings from Oregon and Washington Estuaries in 2006. Year Classes are estimates based on crab size, carapace coloration, hardness and presence of large barnacles. Crabs that are green have molted recently, while red crabs have not molted for a long time, in some case well over a year. Missing limbs are numbered in sequence: 1= Right claw; 5= last leg on right side, 6= left claw, 10=last leg on left side.

Estuary	Site	Date	Sex	CW	Color	Year Class	Condition/Comments
COOS	Airport /Pony Pt	4/4/06	M	83.4	Yellow green	2003	Good
			M	79.0	orange	2003	Good
		9/12/06	M	80.34	Orange	2003	Large barnacles
			M	86.52	Orange	2003	No # 6.,4
			F	73.16	Yellow-green	2003	No # 4
	Jordan Cove	9/10/06	M	37.50	Green	***2006***	Good
			M	42.57	Yellow-green	***2006***	Good
			M	38.78	Green	***2006***	Good
			M	38.2	Yellow-green	***2006***	Good
			M	44.36	Yellow-green	***2006***	Good
			M	41.57	Yellow-green	***2006***	Good
			M	49.50	Yellow-green	***2006***	Good
			F	44.04	Yellow-green	***2006***	Good
		9/11/06	M	52.2	Yellow-green	***2006***	Good
		9/12/06	M	45.08	Yellow-green	***2006***	Good
			M	45.11	Yellow-green	***2006***	No #2
	Pooled sites:	9/13/06	M	56.34	Yellow	2005/2006	
	Trans Pacific Br.		M	40.36	Yellow	***2006***	
	Hayes, Kentuck A		M	36.24	Yellow	***2006***	
			M	47.47	Yellow	***2006***	
			F	46.08	Green	***2006***	
			M	46.65	Yellow	***2006***	
	Boat Basin	6/5/06	?	23		***2006***	Scott Groth; Molt; crab is now 30 mm
	North Spit	7/10/06	M	40	Green	***2006***	Scott Growth; good

	Joe Ney Slough Hanson Landing	12/6/06	F	88.55		***2003***	Tom Gaskill; Missing 3 legs
YAQUINA	Johnson Creek	8/24/06	M	64.4	Yellow	2005	Good, #6 regenerating
		9/26/06	M	73.41	Yellow	2005	No # 1
			M	76.93	Orange	2003	Barnacles on back
			M	92.48	Yellow-orange	2003	No # 8
			M	74.23	Yellow	2005	good
			M	79.27	Yellow	2005	Both claws regenerating
			F	54.70	Green	2005/2006	good
	Sally's Bend A	8/24/06	M	35.92	Yellow-green	***2006***	Good
		9/20/06	M	35.52	Green	***2006***	Good
			M	38.06	Yellow-green	***2006***	Good
			F	35.14	Green	***2006***	Good
			M	33.84	Green	***2006***	Good
	Sally's Bend B	8/17/06	M	44.48	Green	***2006***	Good
			M	40.15	Green	***2006***	Good
		8/24/06/	M	38.72	Green	***2006***	Good
			F	36.36	Green	***2006***	Good
			M	48.10	Yellow-green	***2006***	Good
			M	54.74	Yellow-orange	2005	Good
	Sally's Bend C	6/23/06	M	54.4	Yellow green	2005	No #1, 2, 5 6; cracked carapace
			M	49.6	Orange yellow	2005	Good
	Sally's Bend D	9/21/06	M	51.19	Green	***2006***	Good
			M	48.13	Yellow-green	***2006***	Good
			F	44.91	Yellow-green	***2006***	Good
			M	45.84	Yellow	***2006***	Good
			F	45.77	Green	***2006***	Good
			F	47.77	Yellow green	***2006***	Good
			M	46.08	Yellow	***2006***	Good
			M	50.99	yellow	***2006***	Good
	HMSC Pump	5/30/06	?	73.2		2003	Molt ; crab is now over 80 mm

	dock beach						
		6/14/06	M	73.6	Orange	2003	good
			F	80.5	Orange	2003	No # 5; tips on propal tip worn
			M	91.0	Orange	2003	No # 6, 7, 8, 10
			M	87.9	Yellow	2003	Propal tip on #6 worn
		6/15/06	M	81.8	Yellow orange	2003	Small barnacles; no # 3; worn propal tip
			M	87.7	Yellow orange	2003	8 mm barnacles, no 1, 3, 7
		07/08/06	M	89.1	Yellow	2003	No # 3; dactyl half gone
			M	47.9	Green	2005	good
		07/18/06	M	88	Orange	2003	No # 5, 9
			M	83.8	Orange	2003	No # 3, 7
			M	92	Orange	2003	good
		07/19/06	M	73.8	Yellow-orange	2003	Non 1, 3, 5, 10 no claw on 6
	Aquarium mud flat	4/29/06	M	54.9	Yellow green	2005	Good
		6/6/06	M	62	Yellow green	2005	Good
		6/14/06	M	62.8	Yellow	2005	good
	Idaho Point	6/16/06	M	89.5	Yellow	2003	Good
			M	92.0	Yellow	2003	Good
			M	86.8	Yellow orange	2003	No # 1; 10 regenerating
			M	76.9	Yellow green	2003	Good
			M	67.0	Yellow green	2005	Good
			F	60.6	Green	2005	Good
		6/23/06	M	89.4	Orange	2003	With barnacles/ good
		7/19/06	M	83.6	Yellow	2003	good
			M	71.8	Yellow	2003	good
			M	84.9	Yellow-orange	2003	No # 8
			M	90.4	Yellow-orange	2003	good
			M	81.5	Yellow-orange	2003	No # 1
		7/20/06	M	89	Yellow	2003	good
			M	79.4	Yellow-orange	2003	No # 1
		9/19/06	M	61.45	Yellow-orange	2005	No # 1,6,7

		9/20/06	M	81.08	Yellow-orange	2003	Good
			M	72.50	Yellow	2005	Good
		9/21/06	M	93.5	Yellow-orange	2003	Good; caught by David Trystman
	Neohla Point/ Spencer Point	06/15/06	M	63.7	Yellow green	2005	Good; # 6 regenerating
			M	64.1	Orange	2005	good
			M	83.55	Yellow orange	2003	Good
			M	58.05	Green	2005	Good
		9/21/06	M	55.41	Yellow	2005/2006	Good
TILLAMOOK	Spit A	4/26/06	M	48.5	Yellow orange	2005	Missing # 4, 6, 7, 8, 9
		7/25/06	M	67.7	Yellow-green	2005	Good
			M	72.7	Yellow-orange	2003	Good
			M	63.6	Yellow-orange	2005	Good
		7/27/06	M	70	Yellow	2005	Good
		9/05/06	M	65.2	Yellow	2005	Good
			M	41.8	Yellow-green	***2006***	Good
			M	41.5	Green	***2006***	Good
			M	41.4	Green	***2006***	Good
			F	39.8	Green	***2006***	Good
			M	41.4	Green	***2006***	Good
			M	81.3	Orange	2003	# 1 regenerating,; 2, 7 missing
			M	72.5	Yellow-orange	2005	Good
			M	69.4	Yellow-orange	2005	Good
			M	66.9	Yellow-orange	2005	Good
	Spit B	9/05/06	M	37.1	Green	***2006***	Good
	Pitcher Point	9/05/06	M	51.4	Yellow-green	***2006***	Good
	Spit/ pooled sites	9/06/06	M	58.4	Yellow	2005	Good
			M	49.3	Yellow-green	***2006***	Good
			M	40.8	Yellow-green	***2006***	Good
			M	42.6	Green	***2006***	Good
			F	39.7	Green	***2006***	Good

			F	40.9	Green	***2006***	Good
			F	37.8	green	***2006***	Good
			M	37.2	Yellow-green	***2006***	Good
			M	36.5	Yellow	***2006***	Good
			M	43.7	Yellow-green	***2006***	Good
			M	41.8	Green	***2006***	Good
			M	42.3	Green	***2006***	Good
			F	41.4	Yellow-green	***2006***	Good
	Spit/ pooled sites	9/7/06	F	39.1	Green	***2006***	Good
			F	31.0	Green	***2006***	Good
			M	34.4	Yellow	***2006***	Good
			M	48.23	Yellow-green	***2006***	Good
			M	40.55	Green	***2006***	Good
			F	44.29	Green	***2006***	Good
			F	45.46	Green	***2006***	Good
			F	42.72	Green	***2006***	Good
			M	34.95	Yellow-green	***2006***	Good
			F	38.73	Yellow-green	***2006***	Good
			F	40.15	Yellow-green	***2006***	Good
			F	33.65	green	***2006***	Good
			?			***2006***	Escaped
			?			***2006***	Escaped
			?			***2006***	Escaped
			?			***2006***	Escaped
NETARTS	Intersection of Netarts and Whiskey Creek Roads	4/25/06	M	63	Yellow green	2005	Missing # 2
			M	61	Yellow green	2005	Missing 1 and 6
			M	60.3	Yellow green	2005	Good
		4/26/06	M	41.0	Yellow green	2005	Good

			M	54.5	Yellow green	2005	Good
			M	44,6	Yellow green	2005	Good
			M	63.5	Yellow green	2005	Good
			M	82.2	Red orange	2003	Good
		5/25/06	M	55	Yellow orange	2005	Missing # 1, 2, 3, 6
			M	49.9	Yellow	2005	Missing # 1
		5/26/06	M	72.4	Yellow	2003	# 6 regenerating
			M	61.2	Yellow	2005	Good
			M	57.6	Yellow green	2005	Good
		07/26/06	F	67.9	Green	2005	Good
		07/27/06	F	55.2	Green	2005	Good
			M	61.9	Yellow	2005	Good
			M	61.5	Yellow	2005	Good
		9/05/06	M	69	Yellow-green	2005	Good
			M	68.6	Yellow-orange	2005	Good
		9/07/06	M	66.72	Yellow	2005	Good
			M	70.40	Yellow-orange	2005	Good
	Whiskey Creek Salmon hatchery	4/25/06	M	56.2	Yellow green	2005	Good
			F	45.3	Yellow orange	2005	Missing #1 (right claw)
		4/26/06	M	56.8	Yellow green	2005	Good
		5/25/06	M	58.0	Yellow green	2005	Good
		5/29/06	F	36	Yellow green	2005	Good
		7/26/06	M	72.5	Yellow	2005	Good
			F	53.0	Yellow-green	2005	Good
			M	27.2	Green	***2006***	Good
			M	24.7	Green	***2006***	Good
			F	26.6	Green	***2006***	Good
		7/27/06	M	30.4	Green	***2006***	Good
			F	24.8	Green	***2006***	Good
			M	65.5	Green	2005	Good
		9/05/06	M	49.6	Yellow-green	***2006***	Good

			F	42.6	Yellow-green	***2006***	Good
			M	47.0	Yellow-green	***2006***	Good
			F	34.4	Green	***2006***	Good
			F	41.8	Green	***2006***	Good
		9/06/06	F	39.4	Green	***2006***	Good
			M	34.0	Yellow-green	***2006***	Good
			F	30.5	Green	***2006***	Good
			F	38.9	Green	***2006***	Good
			M	41.4	Yellow-green	***2006***	Good
			M	36.8	Green	***2006***	Good
			F	37.0	Yellow-green	***2006***	Good
			F	34.2	Green	***2006***	Good
			M	36.2	Yellow-green	***2006***	Good
		9/07/06	F	38.31	Green	***2006***	Good
			F	38,27	Green	***2006***	Good
			F	37.41	Yellow-green	***2006***	Good
			M	47.62	Yellow-green	***2006***	Good
			F	36.19	Green	***2006***	Good
			F	40	Green	***2006***	Good
			M	28.64	Yellow-green	***2006***	Good
	Boat Basin	9/07/06	?	~65		2005	escaped
	South end of Bay, oyster plots	Early May	F	74.86	Orange	2003	Carrying eggs, Matt Bunell
	Oyster hatchery	~July 12	M	74.43	Yellow-green	2005	Good, Mark Witwer
		~July 12	M	69.36	Yellow-orange	2005	Good, Mark Witwer
WILLAPA	Stackpole	4/1/06	M	49.0	orange	2005	Good
		4/1/06	F	48.0	Orange	2005	Weggs, Shell bags
		4/1/06	M	50.8	Orange	2005	Missing 2, shell bags
		4/1/06	M	47.4	Yellow/orange	2005	Missing 3 and 6, shell bags
		4/1/06	M	45.1	Orange	2005	Good, shell bags
		4/1/06	M	45.0	Orange	2005	Missing 8, shell bags

		4/1/06	M	44.7	orange	2005	Missing 8, shell bags
		4/17/06	M	45.5	orange	2005	Missing 1, shell bags
		4/28/06	M	48.2	Yellow/orange	2005	Good, shell bags
		5/31/06	M	57.0	Green/yellow	2005	Good, Pit trap
		5/31/06	M	43.2	Green/yellow	2005	Good, Pit trap
		5/31/06	M	57.8	Yellow	2005	Good, Crayfish trap
		6/1/06	M	50.4	Green/yellow	2005	Good, pit trap
		7/27/06	M	61.4	Orange	2005	Missing leg #1, Pit trap
		7/27/06	M	59.9	Orange	2005	Good , Minnow trap
		9/06/06	M	61.0	Yellow	2005	Good
		9/06/06	F	35.4	Green	***2006***	Good
		9/06/06	M	39.0	Green	***2006***	Good
		10/24/06	M	45.3	Yellow	***2006***	Good
		10/24/06	F	49.0	Green	***2006***	Good
		10/24/06	F	40.1	Green-yellow	***2006***	Good
		10/24/06	F	46.1	green	***2006***	Missing # 6,7,8,9; trap fished for > 30 days
	Stony Pt	April	M	52.0	Orange	2005	Missing 1, brought in by Ekone
		April	F	53.0	Orange	2005	Weggs, brought in by Ekone
		April	M	44.0	Orange	2005	Missing 1 and 6, Ekone
		April	M	44.0	Orange	2005	Missing 8, brought in by Ekone
		April	M	47.0	orange	2005	Missing 3, brought in by Ekone
	Parcel A, WDFW	5/15/06	M	63.0	Yellow	2005	WDFW moving shell bags
		5/16/06	M	49.0	Orange	2005	WDFW moving Shell bags
	Taylor Resources	7/12/06	M	61.1	Yellow-orange	2005	Good
		7/12/06	M	65.0	Yellow	2005	Good
	Bay Cnt. Mariculture	11/07/06	F	80		2003	Dick Wilson,, missing a few legs
Grays Harb	Wildlife Sanctuary	9/22/06	M	60.0	orange	2005	good
	Brady's Oysters	10/26/06	M	56.5	Orange	2005	Missing limb# 7
		10/26/06	M	49.0	Green	***2006***	Missing limb #1 and 2

Appendix 4. Relative abundance (CPUE) and size of young-of-the-year *Carcinus maenas* at the end of their first growing season in Oregon and Washington estuaries. Crabs were typically caught in September. Catch per unit effort (CPUE) is reported as number of crabs per trap per day. N=number of young crabs sampled; SD=Standard Deviation, Water temperatures for December-March for the Hatfield Marine Science Center Pump Dock in Yaquina Bay were provided by David Specht of the Newport EPA; those for Willapa Bay, by Jan Newton and Judah Goldberg of the DOE.

Year Class	Estuary	# Months <10°C	Mean Winter Temp. °C	N	CPUE Pitfall traps	CPUE Minnow traps	Mean Carapace Width (mm)	SD	Range
2002	Coos			0		0			
2003				1		0.01	59.4		
2004				0		0			
2005				2		0.05	45.0		44-46
2006				17		**0.32**	43.5	4.6	36-52
1998	Yaquina	0	10.9	201		**5.0**	46.9	5.0	32-60
1999		4	9.0	13	0.20		38.0	5.0	30-47
2000		3	9.5	14		**0.31**	37.5	5.0	30-45
2001		3	9.5	Not sampled					
2002		4	9.2	1		0.01	38.9		
2003		0	10.5	9		0.07	44.9	5.5	41-59
2004		3	9.9	4		0.07	35.3	5.1	32-43
2005		2	10.3	21	0.75	0.14	41.0	8.4	28-46
2006		3	9.8	18		**0.20**	42.6	5.9	34-51
2002	Netarts			0		0.0			
2003				6		0.15	49.4	3.7	45-55
2004				0		0			
2005				25		**0.92**	42.9	5.3	30-53
2006				21		**0.65**	38.6	5.3	29-50
2002	Tillamook			0		0			
2003				5		0.17	50.0	3.1	46-55
2004				2		0.10	41.0		37-45
2005				10		0.17	47.8	4.5	42-56
2006				31		**0.32**	40.7	4.4	31-51
1998	Willapa	3	8.9	47	**0.778**	**0.74**	45.9	4.0	37-55
1999		4	7.6	3	0.023	0.0	38.2	7.5	32-47
2000		4	8.0	9	0.046	0.03	43.4	12.0	19-58
2001		5	8.0	7	0.046	0.02	51.3	2.7	48-56
2002		4	7.6	0	0.0	0.0			
2003		3	9.0	10	0.167	0.0	48.3	5.1	43-59
2004		5	8.6	Not sampled					
2005		3	9.0	106	**0.37**	**1.17**	46.1	3.3	34-52
2006				5	0.04	0.13	42.5	5.1	35-49

1998	Grays Harbor			3		1.00	45.3	5.0	40-50
1999				24		0.024	37.4	7.7	34-51
2000				3		0.01	41.3	6.5	35-48
2001				1		0.01	47.9		
2002				0		0			
2003					Not Sampled				
2004					Not Sampled				
2005				2		0.03	47.3		44-50
2006				1		0.02	49.0		