Status of the European Green Crab in Oregon and Washington Estuaries in 2005

(January 9, 2006 version)

by

Sylvia Behrens Yamada,
Zoology Department,
Oregon State University
Corvallis, OR 97331-2914
541-737-5345; FAX: 541-737-0501;
yamadas@science.oregonstate.edu

and

Andrea Randall
PO Box 6
Chinook, Washington 98614
jaos_kemmer@hotmail.com

Report prepared for:

Stephen H. Phillips, Program Manager
Aquatic Nuisance Species Project
Pacific States Marine Fisheries Commission
205 SE Spokane Street, Suite 100
Portland, Oregon 97202
503-595-3100; Fax: 503 595-3232
stephen_phillips@psmfc.org
http://www.psmfc.org

Executive Summary

The recent invasion of Pacific Northwest estuaries by the European green crab, *Carcinus maenas*, caused much initial alarm. 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 as far north as Port Eliza 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 and recruitment of young green crabs have been much weaker in recent years.

It was hoped that green crabs would go extinct in the Pacific Northwest estuaries once the original colonists reached the end of their life span of 4-6 years and no new larvae arrived from California. This has not happened. Local recruitment has occurred most years since 1998. Recruitment strength is linked to winter temperatures: cold winters (2002) result in poor recruitment while warm winters (2003 and 2005), in good recruitment. As the 1998 year class dropped out of the population, it was replaced by the 2003 year class as the most dominant one. It was found it in the Coquille, Coos, Yaquina, Netarts Tillamook and Willapa Bay estuaries as well as on the northwest coast of Vancouver Island. Even though the 2003 year class was an order of magnitude less abundant than the 1998 one, it produced sufficient recruits in 2005 to maintain the Oregon and Washington satellite population.

There can be a substantial time lag between the discovery of an exotic species and its impact on the native community. For example, green crabs were documented to exist in New England in 1817, but it was not until the 1950's when this species expanded its range and increased in abundance sufficiently to impact the soft-shelled clam populations in Massachusetts, Maine and Nova Scotia. Even though green crab abundance in the Pacific Northwest is 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 in order to predict the next strong recruitment event of green crabs.

Efforts to educate the general public, including boaters and shellfish growers, not to transport non-native Aquatic Nuisance Species from one area to another should continue to prevent the 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 August 2004

Date	Talks / Activities	Location
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**
Sept. 27, 2005	***The invasive eelgrass, Zostera japonica in Oregon Estuaries***- Chana Dudoit	Pacific Coast Shellfish Growers Association/National Shellfish Association Conference **Hood River, Oregon**
August 22-25, 2005	***Growth and Persistence of the European Green crab in Pacific Northwest estuaries.***	Guest lecture and trapping exercise for Marine Biological Summer Camp, Hatfield Marine Science Center, **Newport, Oregon**
July 25, 2005	***Growth and Persistence of the European Green crab in Pacific Northwest estuaries.***	Guest lecture and field trip for Aquatic Biological Invasions Class (Bi 421/521), Oregon State University, Hatfield Marine Science Center**, Newport, Oregon**
July 10, 2005	***Growth and Persistence of the European Green crab in Pacific Northwest estuaries.***	Guest lecture and field trip for Biological Invasions Class (Bi 408/508), University of Oregon, Oregon Institute of Marine Biology, **Charleston, Oregon**

June 25, 2005	***Which crab eats more baby oysters, Native Dungeness or European Green crab?***	Poster and live crab display for Sea Fest, Hatfield Marine Science Center. **Newport. Oregon**
Feb 26, 2005	***Which crab eats more baby oysters, Native Dungeness or European Green crab?*** S. Yamada and Marsha Becklund	Poster and live crab display to celebrate the opening of the "Invasion of the Habitat Snatchers" exhibit at Hatfield Marine Science Center**.** **Newport. Oregon**
Feb 26, 2005	***Species identification of the invasive eelgrass, Zostera japonica***- Chana Dudoit	Poster and live display to celebrate the opening of the" Invasion of the Habitat Snatchers" exhibit at Hatfield marine Science Center. **Newport. Oregon**
Feb 26, 2005	***Spread of Zostera japonica in South Slough National estuarine Research Reserve*** – Susan Shrimpton and Jon Leischner	Poster to celebrate the opening of the "Invasion of the Habitat Snatchers" exhibit at Hatfield marine Science Center. **Newport. Oregon**
Feb, 17, 2005	***Non-Native Species in Oregon Estuaries***	American Fisheries Society, Oregon Chapter **Corvallis, Oregon**
Feb 12, 2005	***Status of the European Green Crab s invasion***	Marine Team (FW 499/599) OSU Fisheries and Wildlife Department , **Corvallis, Oregon**
Oct. 15, 2004	***European Green Crab Status in 2004***	Pacific Coast Shellfish Growers Association/National Shellfish Association Conference **Tacoma, Washington**
Aug. 3, 2004	***Invasive Species in Oregon Estuaries***, Presented talk and involved my students in green crab sampling.	Marine Ecology Class (Bi 474/574) Oregon Institute of Marine Biology, **Charleston, Oregon**

Introduction

European green crabs (*Carcinus maenas)* were first discovered on the east coast of North America in the early 1800's (Say 1817). They are native to 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 (McDonald et al. 2001, Jensen et al. 2002). Only the red rock crab appears 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 winter of 2003, good green crab recruitment occurred in estuaries from Coos Bay to the Little Espinosa inlet on the west coast of Vancouver Island. However, it is not know whether the 2003 cohort is abundant enough to maintain the Oregon and Washington green crab population.

Goals

The goal of this study is to estimate the current densities and age structure of green crabs in Oregon and Washington and to predict their future status in the Pacific Northwest. This is accomplished by:

- Setting traps and documenting the relative density (catch per unit effort) and size/age of green crab populations in select Oregon and Washington 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 obtaining data on green crab sightings.

- Estimating the year-class strength of young green crabs at the end of their first growing season.
- Comparing patterns in recruitment strength over time and correlating them to ocean conditions and winter surface water temperatures of estuaries.

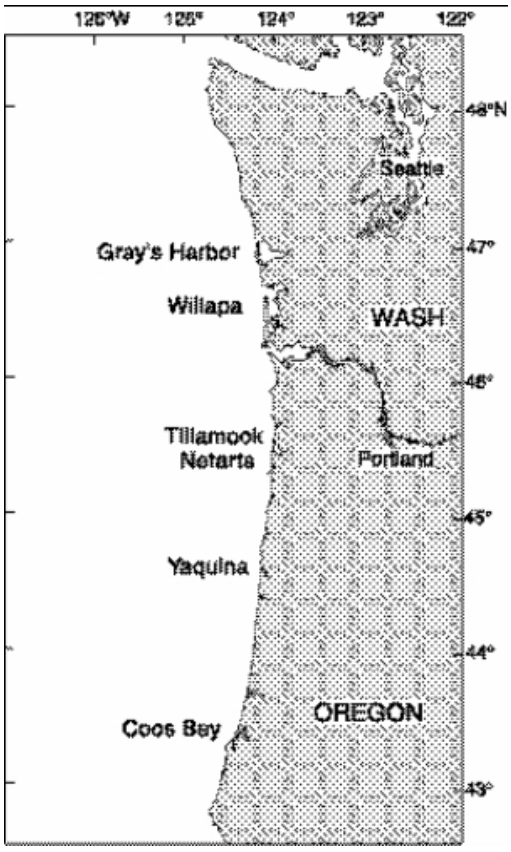

Figure 1. Map showing the major 6 study sites in Oregon and Washington.

Sampling Methods for Green Crabs

Our sampling effort in 2005 focused on four Oregon and two Washington estuaries: Coos, Yaquina, Netarts, Tillamook, Willapa Bay and Grays Harbor (Figure 1). Additional catch data for the Coquille estuary in southern Oregon was provided by Chana Dudoit and for Little Espinosa Inlet, on northern Vancouver Island in British Columbia, by Erik Hanson. The 6 main estuaries were sampled at least twice 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. Typically, we would trap young-of–the-year green crabs in the high and mid-intertidal with minnow and pit fall traps and larger adult crabs in the low intertidal and subtidal zones with folding 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 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 salmon backbones 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 high tide (6-24 hours, depending on tidal height and tidal cycle). Un-baited pit fall traps were used in the *Spartina* marsh at Stackpole in Willapa Bay and at Sally's Bend in Yaquina Bay. We retrieved the traps at low tide, identified all crabs 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 vernier

calipers. Native crabs and other by-catch were released while green crabs were removed from the ecosystem and destroyed.

Table 2. Relative Green Crab abundances for study sites in Oregon and Washington estuaries from 1999 to 2005. Data for Willapa Bay for 2004 were kindly supplied by P. Sean McDonald. Data for 1999 for Coos and Yaquina Bay were compiled from Hauck 2000 and Hunt and Behrens Yamada 2003; and that for Little Espinosa Inlet on the northwest coast of Vancouver Island, B.C. in 2005, by Erik Hanson. Note that in the last three years, green crabs have been most abundant in Netarts Bay, Oregon.

Estuary	*Number of crabs trapped (# trap-days)*				
	1999	*2002*	*2003*	*2004*	*2005*
Coquille					1 (22)
Coos Bay	15 (39)	9 (180)	14 (203)	18 (137)	9 (242)
Yaquina	223 (323)	26 (168)	63 (1084)	12 (461)	39 (290)
Netarts		0 (44)	11 (44)	12 (39)	52 (106)
Tillamook		2 (71)	6 (70)	4 (51)	12 (102)
Willapa		42 (99)	13 (409)	6 (195)	113 (449)
Grays Harbor					2 (94)
Little Espinosa BC					3 (59)
Total	238 (362)	79 (562)	109 (1810)	52 (883)	230 (1365)

Estuary	*Catch per 100 trap-days*				
	1999	*2002*	*2003*	*2004*	*2005*
Coquille					5
Coos Bay	38	5	7	13	4
Yaquina	69	15	6	3	13
Netarts		0	**25**	**31**	**49**
Tillamook		3	9	8	11
Willapa		42	3	3	25
Grays Harbor					2
Lt. Espinosa					5
Total	66	14	6	6	17

Results

Densities of Green Crabs in Oregon and Washington Estuaries

The relative abundances of green crabs trapped in Oregon and Washington estuaries in 2005 are tabulated in Appendix 2 and summarized in Table 2. As can be seen, catch per unit effort (CPUE) is extremely variable, even on consecutive days within the same site (Appendix 2). Thus, one must use caution in interpreting differences in CPUE. What can be concluded, however, is that catches from 2002-2004 were an order of magnitude lower than in 1999 (Table 2). While average catches for two Oregon estuaries in 1999 were 66 green crabs per 100 trap-days, those for 2002-2004 were only around 7. During spring and early summer of 2005, green crab catches were extremely low (Appendix 2, Figure 2). This pattern changed in mid-August when a strong cohort of new recruits entered our traps, raising the CPUE to 17 crabs per 100 trap-days.

Age Structure of Green Crabs in Oregon and Washington Estuaries

From previous growth studies (Behrens Yamada et al. 2005,) we estimated the age of green crabs retrieved from Oregon and Washington estuaries in 2005. We assigned crabs to age classes based on their size and coloration (Appendix 3, Table 3). Typically, crabs under 55 mm were assigned to the 2005-year class, those between 55 and 70 mm, to the 2004-year class and most larger crabs to the 2003-year class. Crabs over 85 which had not molted in a year (with hard red carapaces) were assumed to belong to the 2001-year class as recruitment failed in 2002. Prior to mid August 2005, the 2003 cohort was the dominant one in Pacific Northwest estuaries. By the end of the growing season, it was replaced by the 2005 cohort (Table 3, Figure 2).

Table 3. Estimated age structure of *Carcinus maenas* retrieved from Oregon and Washington estuaries in 2005. Asterisk indicates that additional crabs were caught by sports fishers or entered un-baited traps as part of a pheromone trial.

Estuary	Year Class				
	2005	2004	2003	2001	Total
Coquille			2		2*
Coos Bay	2	1	5	1	9
Yaquina	23	11	6	4	44*
Netarts	41	4	13		58*
Tillamook	10		2		12
Willapa	112		1		113
Grays Harbor	2				2
Total	190	16	29	5	240

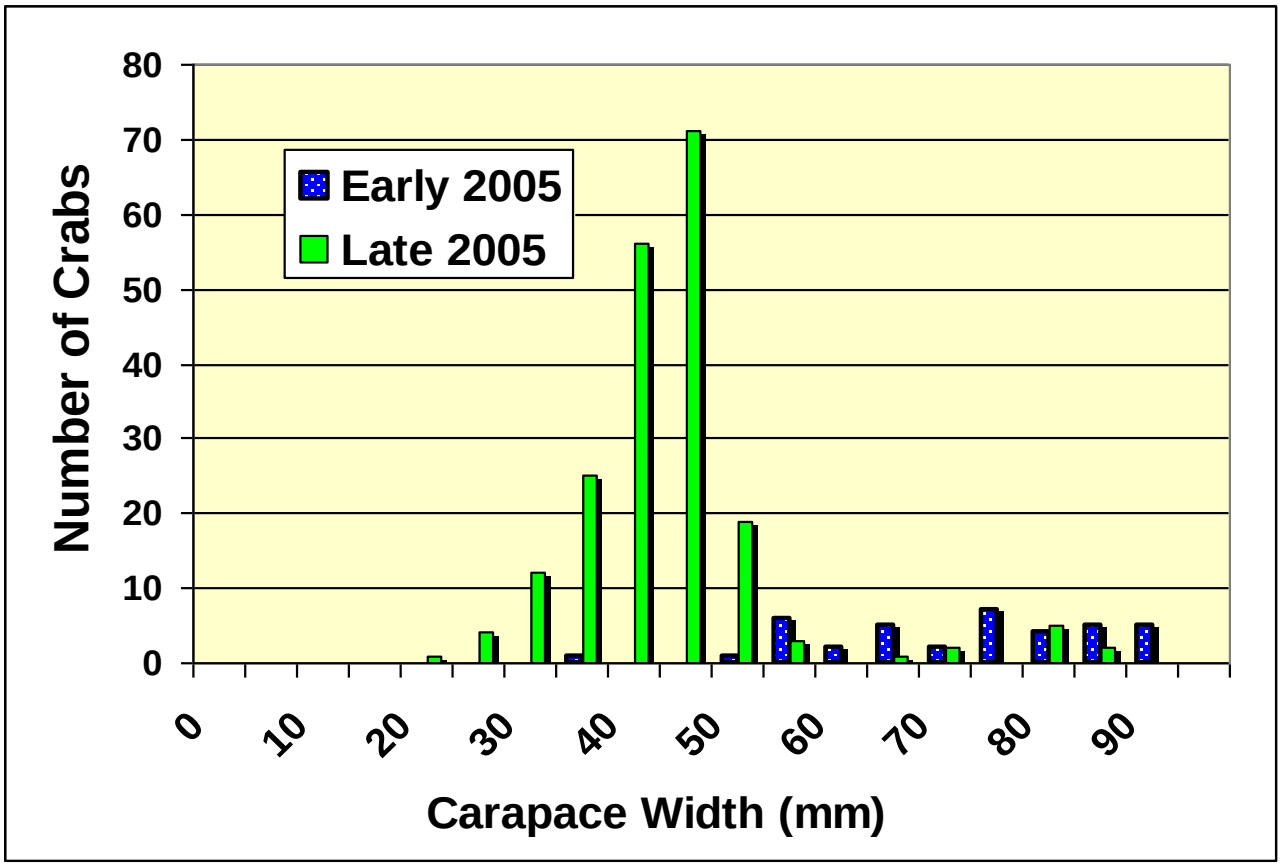

Figure 2. Size frequency distribution of green crabs recovered from Oregon and Washington estuaries form March to July (Early) and August to October (Late).

Recruitment over time

Periodic sampling of young crabs in 4 Oregon estuaries and systematic sampling in Willapa Bay, by the Washington Department of Fish and Wildlife (1998-June 2003) and by Andrea Randall (September 2003 and July-October 2005) indicate that recruitment occurred in NW estuaries from 1998 to 2005 (Table 4). We define recruitment as the time when a new cohort of green crabs enters our traps. 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 at the end of its first growing season. From 1999 to 2004 catches of green crab recruits decreased by an order of magnitude (Table 4).

In Maine and Europe, mild winters are 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 very poor or failed recruitment, and the mild winters of 2003 and 2005, by good recruitment (Table 4). When the last crabs of the 98-cohort died of senescence in the summer of 2003, the 2003 year class became the dominant one in Oregon and Washington estuaries. But since the 2003 cohort was less abundant than the 1998 one, it

was not know whether its females could produce enough larvae to adequately "seed" Pacific Northwest estuaries and keep the Oregon and Washington population from going extinct. That question was answered on August 18, 2005 when the 2005-cohort first appeared in our traps. Clearly, the 2005 year class is the strongest cohort since the major colonization event of 1998 (Table 3, Figure 2).

Discussion and Conclusion

Green crab range expansions along the North Eastern Pacific coast appear to be linked to El Niño events during the 1990's when pole-ward coastal currents during the winter months were strong enough to transport larvae from established populations in California to the Pacific Northwest (Behrens Yamada et al. 2005). For example, with a larval duration of 55 days at 12^{o}C and measured currents of up to 31 miles/day, larvae could theoretically be transported 1700 miles north-ward. This distance is greater than the 1080 miles between San Francisco Bay and Little Espinoza Inlet on Vancouver Island. During non-El Niño years, the potential transport distance would be less than 300 miles. Thus it would be possible for Coos Bay crabs to seed Yaquina Bay, Yaquina, to seed Tillamook, and Tillamook, to seed Willapa Bay and Grays Harbor. *During non-El Niño years it is probably unlikely that Oregon estuaries receive larvae from California or that Little Espinosa Inlet on Vancouver Island receives larvae from Willapa Bay.*

The abundance of green crabs in Oregon estuaries has decreased since the last strong El Niño of 1997/1998. Catches for 2002-2004 remained stable at around 7 green crabs per 100 traps. Even though coastal currents have not been favorable for larval transport from source populations in California, green crabs have persisted in Oregon and Washington estuaries. It appears that local reproduction and recruitment, especially following warm winters, have been high enough to keep this NW population from going extinct. In 2003 we saw good recruitment in estuaries from Oregon to the north-west coast of Vancouver Island. The 2003-year class was the most dominant one in the population until the summer of 2005 when it was dwarfed by the 2005-cohort, the strongest since 1998. *Since longevity of green crabs is around 6 years (Berrill 1982), it would require one good recruitment event every 5 years to keep the NW population of green crabs from going extinct.*

Monitoring and education efforts about avoiding the spread of Aquatic Nuisance Species should continue. There can be a substantial time lag between the discovery of an exotic species and its impact on the native community. For example, green crabs were documented to exist in New England in 1817 (Say 1817), but it was not until the 1950's when this species expanded its range and increased in abundance sufficiently to impact the soft-shelled clam populations in Massachusetts, Maine and Nova Scotia (Glude 1955, MacPhail,et al. 1955). Even though green crab abundance in the 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 of a non-indigenous marine species with planktonic larvae. The observed patterns could act as a model for predicting range expansion in other non-indigenous species.
2. to understand the role of ocean conditions on recruitment in order to predict the next strong recruitment event of green crabs.

Efforts to educate the general public, including boaters and shellfish growers, not to transport non-native Aquatic Nuisance Species from one area to another should continue. Right now, the green crab has not been found in the inland sea between Vancouver Island and the mainland, including Puget Sound and Hood Canal. These protected waters are not only ideal for growing shellfish but also are favorable habitats for green crabs. Once a satellite population were to become established in these protected waters, their larvae would be retained (rather than be lost to the open ocean) and could seed many other sites throughout this inland sea.

Table 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 and October. Catch per unit effort (CPUE) is reported as number of crabs per trap per day. N=number of young crabs sampled; SD=Standard Deviation; na=temperature data not available. Asterisk indicates that only 7 minnow traps were deployed that fall and that the one young crab entered a collapsible Fukui fish trap. Surface water temperatures for December-March for the Hatfield Marine Science Center 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. Note that larger mean sizes in 1998, 2003 and 2005 may be linked to warm surface water temperatures during the previous winter.

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		na	0		0			
2003	Coos		na	1		0.01	59.4		
2004	Coos		na	0		0			
2005	**Coos**		**na**	**2**		**0.05**	**45.0**		**44-46**
1998	Yaquina	0	10.9	201		5.0	46.9	5.0	32-60
1999	Yaquina	4	9.0	13	0.20		38.0	5.0	30-47
2000	Yaquina	3	9.5	14		0.31	37.5	5.0	30-45
2001	Yaquina	3	9.5	1		*	55		
2002	Yaquina	4	9.2	1		0.01	38.9		
2003	Yaquina	0	10.5	9		0.07	44.9	5.5	41-59
2004	Yaquina	3	9.9	4		0.07	35.3	5.1	32-43
2005	**Yaquina**	**2**	**10.3**	**21**	**0.75**	**0.14**	**41.0**	**8.4**	**28-46**
2002	Netarts		na	0		0.0			
2003	Netarts		na	6		0.15	49.4	3.7	45-55
2004	Netarts		na	0		0			
2005	**Netarts**		**na**	**25**		**0.92**	**42.9**	**5.3**	**30-53**
2002	Tillamook		na	0		0			
2003	Tillamook		na	5		0.17	50.0	3.1	46-55
2004	Tillamook		na	2		0.10	41.0		37-45
2005	**Tillamook**		**na**	**10**		**0.17**	**47.8**	**4.5**	**42-56**
1998	Willapa	3	8.9	47	0.778	0.74	45.9	4.0	37-55
1999	Willapa	4	7.6	3	0.023	0.0	38.2	7.5	32-47
2000	Willapa	4	8.0	9	0.046	0.03	43.4	12.0	19-58
2001	Willapa	5	8.0	7	0.046	0.02	51.3	2.7	48-56
2002	Willapa	4	7.6	0	0.0	0.0			
2003	Willapa	3	9.0	10	0.166		48.3	5.1	43-59
2004	Willapa	5	8.6	Not sampled					
2005	**Willapa**	**3**	**9.0**	**106**	**0.37**	**1.17**	**46.1**	**3.3**	**34-52**
2005	**Grays Harh.**			**2**		**0.03**	**47.3**		**44-50**

.

Acknowledgements

We are grateful to Chana Dudoit, Erik Hanson, Robbie Lamb, Holly Matteson, Jon Leischner, Dan Preston, Bob Piorkowski, Tandra Schmid and the following classes for helping with the trapping program.: Bi 408 of the University of Oregon, Bi 421 of Oregon State University and the Marine Biology Summer Camp at Hatfield Marine Science Center. Scott Groth of Oregon Department of Fish and Wildlife trapped in Coos Bay and reported on the green crab sighting from the Coquille estuary. P. Sean McDonald of the University of Washington shared his 2004 trapping data for Willapa Bay with us while Graham Gillespie of Fisheries and Oceans Canada and Erik Hanson of Portland State University provided data on crabs from British Columbia. Bruce Kaufman of the Washington Department of Fish and Wildlife provided us with historic trapping data for Willapa Bay. Surface water temperatures for the Hatfield Marine Science Center 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 Washington Department of Environment. We thank Bay Street Crab Company in Corvallis for supplying us with bait, and Gene Cossy and his staff of North Bend Airport Security for allowing us to sample at Pony Point.

Literature Cited

Behrens Yamada, S**,**. B.R. Dumbauld, A. Kalin, C. Hunt, , R. Figlar-Barnes and A. Randall 2005. Growth and persistence of a recent invader *Carcinus maenas* in estuaries of the Northeastern Pacific. Biological Invasions 7:309-321

Behrens Yamada, S. 2001. Global Invader: The European Green Crab. 123 pages. Oregon Sea Grant, Washington Sea Grant.

Behrens Yamada, S. and C. Hunt 2000. The arrival and spread of the European green crab, *Carcinus maenas,* in the Pacific Northwest. Dreissena! 11 (2): 1-7.

Behrens Yamada, S. and T. Davidson 2002. Status of the European Green Crab in Oregon Estuaries during the Summer of 2002.Report prepared for Pacific States Marine Fisheries Commission.

Berrill, M. 1982. The life cycle of the green crab Carcinus maenas at the northern end of its range. Journal of Crustacean Biology 2:31-39.

Beukema J.J. 1991. The abundance of shore crabs *Carcinus maenas* (L) on a tidal flat in the Wadden Sea after cold an mild winters. Journals of Experimental Marine Biology and Ecology 153:97-113.

Carlton , J.T. and A.N. Cohen 2003. Episodic global dispersal in shallow water marine organisms: The case history of the European shore crabs Carcinus maeans and C. aestuarii. J. of Biogeography 30(12):1809-1820.

Cohen, A.N., J.T. Carlton, and M.C. Fountain, 1995. Introduction, dispersal and potential impacts of the green crab *Carcinus maenas* in San Francisco Bay, California. *Marine Biology*. 122:225-237

Crothers, J.H. 1968. The biology of the shore crab *Carcinus maenas* (L.). 2. The life of the adult crab. Field Studies 2:597-614.

Hauck, L. 2000. Use of tethered prey for estimating the impact of the invasive European green crab. BS thesis, Biology Department, Oregon State University.

Hunt, C.E. and S. Behrens Yamada 2003. Biotic resistance experienced by an invasive crustacean in a temperate estuary. Biological Invasions 5 (1) 33-43. 1989-2000.

Jamieson, G.S., E.D. Grosholtz, D.A. Armstrong and R.W. Elner 1998. Potential ecological implications for the introduction of the European green crab, *Carcinus maenas*, (Linnaeus), to British Columbia, Canada and Washington, USA. Journal of Natural History 32:1587-1598.

Jensen, G.C., P.S. McDonald, and D.A. Armstrong. 2002. East meets west: competitive interactions between green crab, *Carcinus maenas* and *Hemigrapsus* spp. Marine Ecology Progress Series 225:251-262.

Lafferty, K. and A. Kuris 1996. Biological control of marine pests. Ecology 77: 1989-2000.

MacPhail, J.S., E.I. Lord and L..M. Dickie 1955. The green crab- a new clam enemy. Fisheries Research Board of Canada, Progress Report of the Atlantic Biological Station 63:3-11.

McDonald, P.S., G.C. Jensen and D.A. Armstrong 2001. The competitive and predatory impacts of the nonindigenous crab *Carcinus maenas* (L) on early benthic phase Dungeness crab *Cancer magister* Dana. Journal of Experimental Marine Biology and Ecology 258(1):39-54.

Say. T. 1817. An account of the crustacea of the United States. Journal of the Academy of Natural Sciences of Philadelphia 1:57-63.

Zeng, C., P. Abello, and E. Naylor 1999. Endogenous tidal and semilunar moulting rhythms in early juvenile shore crabs *Carcinus maenas*: implications for adaptations to a high intertidal habitat. Marine Ecology Progress Series 191: 257-266.

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.

COQUILLE						
Site	Date	Location Description	S ‰	Water Temp.	Air Temp.	Green Crabs Found?
Coquille Bridge	8/9/05	Rocky shore/sand and mud	25	16.6	20	no
	8/10/05		20	18.2	22.1	**Yes**
	8/11/05		30	15.7	21.7	no
Bandon Marsh	8/9/05	Muddy sediment	30	18	17	no
Bandon Boat Dock	8/10/05		30	15		no
COOS BAY						
Jordan Cove		***Range of values observed***	***11-34***	***14-22***	***14-22***	
	07/09/05		11	22	18	No
	9/02/05		5	17	17	**Yes**
	9/03/05		5	14	15	no
Russell Point		***Range of values observed***	***22-33***	***11-20***	***10.5-28***	
	03/04/05		22	11	10.5	no
	07/08/05		26	20	17	no
	07.09.05		29	17	17	no
	9/02/05		32	15	15	no
Trans Pacific Causeway		***Range of values observed***	***22-32***	***11-18***	***10.5-16***	
	03/25/05		22	11	10.5	no
	07/10/05		27	18	16	no
TransPacific	9/2/05	Under bridge and Scirpus marsh	32	16	13	no

Bridge						
Haynes Inlet Bridge	9/02/05	Rip-rap under bridge	32	17	12	no
Haynes Inlet	0/02/05	NW corner – soft mud	32	16	16	no
Charleston Boat Basin	3/23/055		16	11	11	no
C3arleston – Chucks Oysters	9/01/05	Marsh from bridge to Metcalf Marsh	34	17	16	no
Pony Point North Bend Airport	***Range of values observed***		***20-32***	***11-17***	***11.5-17***	
	03/24/05	Mudflat near rip rap, *Zostera marina*	20	11	11.5	**yes**
	07/07/05		17	18	17	**yes**
	07/08/05		25	17	14.5	**yes**
	09/03/05		32	16	16	no

YAQUINA BAY

Johnson Slough	***Range of values observed***		***23-32***	***15-20***	***16-22***	
	9/15/05	Below bridge, dry mudflat around creek, *Salicornia* patches	30	20	17.5	**yes**
Sawyers Landing		***Range of values observed***	***6-30***	***11-19***	***9-14***	
	04/10/05		6	11	9	no
Sally's Bend A	***Range of values observed***		***27-33***	***12-19***	***12-26***	

	5/17/05	At elbow near road entrance, mudflat, large *Scirpus* patches	22	16.5	15	no
	7/27/05					no
	9/14/05		33	19	19	**yes**
	9/15/05		32	18.5	20	no
	9/21/05		32	19.5	17	**yes**
Sally's Bend B	***Range of values observed***		***29-32***	***12-19***	***12-24***	
	9/14/05	Across from George St., *Scirpus* patches	32	19	19	no
Sally's Bend C	***Range of values observed***		***19-32***	***10-19***	***9-22***	
	04/10/05	Fishing platform	19	10.5	9	no
	5/17/05		22	16.5	15	no
	7/27/05					no
Hatfield Marine Science Center Pump house		***Range of values observed***	***22-34***	***11-21.5***	***12-23***	
	05/14/05	Rip rap/ boulders/sandy mudflat/ *Zostera marina*	22	15	18	no
	05/15/05		22	16	20	no
	6/17/05		24	15.5	15	**yes**
	7/15/05		28	21.5	19	**yes**
	7/26/05		34	17	18	no
	8/26/05		34	13	23	no
Oregon Coast Aquarium	***Range of values observed***		***19-34***	***9-25***	***8-23***	
	04/16/05	Tidal channel draining mudflat, along nature trail	19	12	12	no
	05/14/05		25	16.5	18.5	**yes**

	05/15/05					**yes**
	06/17/05		27.5	17	17	**yes**
	07/15/05		28	25	20	**yes**
	7/26/05		32	17	15	no
	8/23/05		32	15	20	**yes**
	8/24/05		32	15	15	**yes**
	8/25/05		34	15	21	no
	9/14/05		32	20	19	**yes**
	9/15/05		32	18.5	23	**yes**
Idaho Point		***Range of values observed***	***19-35***	***12-27.5***	***12-23***	
	04/16/05	Along rip-rap from point to floats	19	12	12	**yes**
	05/15/05		20	17.5	17.5	**yes**
	6/17/05		25	16	15	**yes**
	7/15/05		29	27.5	23	**yes**
	8/25/05		35	18	20	no
Neohla Pt.	8/26/05	Tidal reek near Spencer care center on Idaho Pt. Road	0	20	18	**yes**
	8/14/05		27	24.5	23	no

TILLAMOOK BAY

Tillamook Spit A	***Range of values observed***		***0-30***	***14-19***	***13-27***	
	5/27/05	mudflat- eelgrass zone below rip rap and in *Scirpus*	22	17	18	no
	8/19/05		25	21	16.2	**yes**
	9/18/05		26	16.2	18.0	**yes**
Tillamook Spit B	5/27/05		5	19	18.5	no
	9/18/05		30	15.5	17.5	**yes**
	9/19/05		30	15	16.5	no
Pitcher Point	5/26/05	South of Spit B – mudflat in Japanese eelgrass zone	24	17.5	21	no
	9/19/05		28	15.5	18	**yes**

Hayes oyster flat	5/26/05	Mudflat in native eelgrass zone	0	13	23	no
Bay City	9/19/05	Low level, on either side of causeway	22	13.6	14	no

NETARTS BAY

Whiskey Creek Salmon hatchery	***Range of values observed***		***0-34***	***13-20***	***14.5-21***	
	05/26/05	On mudflat and in creek	0	13.5	21	no
	9/18/05		32	13	14.5	**yes**
	9/19/05		32	18	16.5	**yes**
	10/05/05		27	13.5	14.5	**yes**
RV Park						
	05/26/05	Sand flat below riprap in native eelgrass zone	0-30	11-17.5	20-23	no
	8/18/05		34	16	16	no
Oyster Hatchery						
	05/26/05	Mudflat in native eelgrass zone	30	15.5	30	no
	8/18/05		32	13.5	16	no
Intersection of Whiskey Creek & Netarts Bay Roads	***Range of values observed***		***0-34***	***13.5-20***	***15s-23***	
	05/26/05	Pool below culvert draining Freshwater marsh	0	13.5	23	**yes**
	05/27/05		30	16.5	18.6	**yes**
	07/20/05		25	20.2	19.9	no
	8/18/05		30	15	15	**Yes**
	8/19/05		30	15	15	**Yes**
	9/18/05		34	14	16	no

WILLAPA BAY

Stackpole	07/07/05	Leadbetter Pt. Sate Park *Spartina* field	25.3	18.6	19.9	**yes**
	07/22/05	Leadbetter Pt. Sate Park *Spartina* field	24	22	17	no
	08/18/05	Leadbetter Pt. State Park Spartina field	28.1	16.9	16.2	**yes**
	09/20/05	Leadbetter Pt. Sate Park *Spartina* field	15.9	14.0	28.5	**yes**
	10/18/05	Leadbetter Pt. Sate Park *Spartina* field	14.0	13.0	26	**yes**
Nahcotta Lab	7/23/05	WDFW Office, Nahcotta, edge of Spartina and tideflat			18.1	no
Taylor Resources	08/18/05	Bay Ave./Sandridge Rd, edge of Spartina field	25.6	18.0	17.1	**yes**
	09/20/05	Bay Ave./Sandridge Rd, Spartina field	19.3	17.4	23.2	**yes**
Boat Ramp by Refuge	7/21/05	Highway 101. Either side of boat ramp used by old cable ferry	21	19	15.5	no
Pickerrell Creek	7/21/05	Highway 101. Near channel and on mudflat	3	16.5	18	no
Palix River	7/21/05	Off Bay Center Dike Road	25	15	13.5	no

GRAYS HARBOR

Grassy Island	7/22/05	marsh at end of Park Street across from Frank L Hotel	30	17	14.5	no
	10/06/05	Wildlife sanctuary, in front of Grassy Island	15	13	25	**yes**
	10/9/05		31	13	13	no
Brady's Oysters	7/22/05	Mouth of Elk River	24	17.5	15	no
	10/9/05		31	13	13	**yes**
Bay View Rd	7/22/05	Small channel, 1/2 mile from bridge, by catamaran	24	19	16	no

Appendix 2. Relative abundance of crab species and sculpins (Numbers/trap/day) in Oregon and Washington estuaries during 2003. An asterisk beside trap number indicates that other traps were either opened or were stolen.

Coquille Estuary **Mean CPUE (Catch/trap/day)**

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Coquille Bridge	*8/09/05*	Fish	Rocky shore/mudflat				6	0		0.25	4
	9/10/05	Fish		**0.25**			8.25	0		0.25	4
	8/11/05	Fish					8.33	0			4
Bandon Marsh	*8.08/05*	Fish	Muddy sediment				0	0			4
Bandon Boat Dock	*8/08/05*	Fish					3.33	0			6

Coos Bay

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Russell Point	03/24/05	Fish	Pools by bridge				0.33	0.33		0.17	5
	7/8/05	Fish	*Zoster marina*				7.4	0	0.2	2.4	5
	7/9/05	Fish					10.33	0		1.0	5
	9/02/05	Fish	*Pools*				5.4	0.6	0.2	1.6	5
	9/03/05	Fish					11.6	0.4	0.6	1.0	5
Pony Point/Airport	03/24/05	Fish	*Zostera marina*	**0.1**			2.1	0	7.0		10
	7/7/05	Fish		**0.27**			5.09	0.18	2.18	1.82	11
	7/8/05	Fish		**0.08**			8.67	0.33	1.75	2.08	12
	9/03/05	Fish					9.20	0.40		2.80	10
	7/7/05	Minnow		**0.22**			0.11	0.44		1.89	9

	7/8/05	minnow						0.44		1.44	9
	9/03/05	Minnow						0.2		0.5	10
Charleston OIMB	3/23/05	Fish	*Zostera marina*				1.0	0	7.6		10
Charleston – Chucks oysters	9/01/05	Minnow	*Scirpus*		0.1			0		0.5	20
Causeway over Haynes Inlet -S	07/10/05	Fish	*low*				6.14	1.14		1.86	7
North	7/10/05	Fish	*low*					5.7		1.1	10
South	3/25/05	minnow	*Mid*							2.4	10
North	7/10/05	minnow	*mid*		0.2			0.6		0.8	5
South	7/10/05	minnow	*mid*					0.4		0.6	5
Trans-Pacific Bridge	9/01/05	Fish	*Low*				6.6	0	3.0	1.0	5
	9/01/05	Minnow	*Scirpus*				0.2	0		0.4	4
Haynes Inlet Bridge	9/02/05	Fish	*Subtidal*				22.55	1.0			6
NW Haynes Inlet	9/01/05	Minnow	*Scirpus*					0		1.8	5
Jordan Cove	7.08/0	minnow	*High*				0.1	0		0.3	10
	7/09/05							0		0.1	10
	9/3/05	Minnow	*Scirpus*	**0.13**			0.2	0		1.13	15
	9/4/05	Minnow						0		0.75	16
	10/5/05	Minnow						0		0.83	6

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	9/16/05	Fish	Below Bridge					1.0		0.5	2
	9/16/05	Minnow	Marsh	**0.4**				0		0.7	10
Sawyers Landing	4/10/05	Fish	Low					0.1	1.9		10
Sally's Bend A	5/17/05	Minnow	*Zostera japonica*		1.8			0		1.6	5
	7/27/05	Minnow			0.7			0		0.7	10
	9/15/05	Minnow		**0.5**	0.1			0		2.0	10
	9/16/05	Minnow				0.1		0.2		0.6	20
	9/15/05	Pitfall		**1.0**	0.4			0.2			5
	9/21/05	Pitfall		**0.33**				2.33			3
Sally's Bend B	9.15.05	Minnow						0		2.2	5
Sally's Bend C Fishing Platform	4/10/05	Fish	*Zostera marina*				0.4	0.2	0.7	0.1	10
	6/17/05	Fish			1.7		6.17	1.17	0.33	2.33	6
	7/27/05	Fish					3.5	3	0.5	4.5	2
HMSC Pump house	**4/14/05**	Fish	*Zostera marina*				0.92	0	3.38	0.15	13
	5/15/05	Fish					0.46	0	4.31	0.23	13
	6/17/05	Fish		**0.33**	0.33	0.5	0.5	0	1.33	2.67	6
	7/15/05	Fish		**0.6**				0	1.8	4.2	5
	7/26/05	Fish			0.17		0.83	3		2.0	5
	8/26/05	Fish			0.17		2.0	1.0	0.83		6
	7/26/05	Minnow			0.67	0.5		1.0		1.0	6
Oregon Coast Aquarium	**4/15/05**	Fish	subtidal				4.83	0		0.17	6
	5/14/05	Fish		**0.4**	0.2		1.2	0		2.6	5
	5/15/05	Fish		**0.2**			0.6	0		2.8	5

	6/17/05	Fish		**0.2**	0.6		0.6	0		7.4	5
	7/15/05	Fish		**0.2**	1.2			0.8		7.4	5
	7/26/05	Fish			0.67		1.33	14.83		4.33	6
	7/27/05	Fish			2.5			8.5		2.5	2
	8/23/05	Fish			0.2			14.4		7.8	5
	8/24/05	Fish					0.2	8.6	0.2	5.6	5
	8/25/05	Fish						5.8		2.0	5
	7/26/05	Minnow			0.5			2		1	6
	8/23/05	minnow	Scirpus	**0.07**	0.07			4.21		0.5	14
	8/24/05	minnow		**0.09**	4.64			0	0.18	0.34	11
	8/25/05	minnow						0.73		0.36	11
	9/15/05	Minnow		**0.2**	1.0	0.3		4.6		0.6	10
	9/16/05	Minnow		**0.1**	0.1			2.5		0.2	10
Idaho Point	4/16/05	Fish	Low	**0.17**	0.08		1.0	0	2.58	0.08	12
	5/15/05	Fish	Low	**0.1**			0.8	0	1.0	3.3	10
	6/17/05	Fish	Low	**0.17**	0.17		2.83	0		1.17	6
	7/15/05	Fish	Low	**0.8**	0.2	0.2		0.2		5.2	5
	8/26/05	Fish	Loq				0.66	1.67		1.0	6
	6/26/05	Minnow	*Sand flat*		0.2		0.6	0		0.2	5
Neohla Point	8/26/05	Minnow	*Marsh and creek*	**0.2**	0.4			0		0.6	5
	9/15/05	Minnow			0.4			0		0.3	5

Tillamook Bay

Mean CPUE (Catch/trap/day)

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Bay City	9/20/05	Fish	*Low, both sides of causeway*		8.33	3		0		2	6
Tillamook Spit A	05/27/05	Fish	*Zostera japonica*		0.2			0		2	10
	8/19/05	Fish		**0.50**	0.75	0.25	1.0	0		3.50	4

	8/19/05	Minnow	*Scirpus*		0.9		0.1	0		3.4	10
	9/19/05	Minnow		**0.15**	0.62	0.23		0		1.54	13
Tillamook Spit B	05/27/05	Fish	*Zostera japonica*		02			0		2.8	5
	8/19/05	Fish			0.2		0.4	2.0		7.8	5
	8/19/05	Minnow	*Scirpus*		0.4			0.3		3.1	10
	9/19/05	Fish			0.5		1	0.5		3	2
	9/19/05	Minnow		**0.67**	0.17			0		1.0	6
	9/20/05	Minnow			0.38			0		0.75	8
Pitcher Point	05/27/05	Fish	*Zostera japonica*					0		2.5	5
	9/20/05	Minnow		**0.31**	0.69			0		0.92	13
Hayes Oysters	05/27/05	Fish	*Low*				3.5	0		4.0	5

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

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Intersection	5/25/05	Fish	pools	**1.67**	0.67	0.33		0	0.33	7	3
	5/27/05	Fish	Pools	**1.67**	2	0.66		0	0.33	4.7	3
	7/20/05	Fish	Pools		0.33		0.33	0		0.67	3
	7/21/05	Fish	Pools		0.33		8.33	0		0.67	3
	8/18/05	Fish	Pools	**0.75**			2.75	0.25	0.5	1.25	4
	8/19/05	Fish	Pools	**0.25**	0.75		8.0	0	1.0		4
	9/18/04	Fish	Pools		0.5		8.25	0.25	0.25	1.25	4
RV Park	5/26/06	Fish	Low sand flat				1.7	0	7.6	0.2	10
	8/18/05	Fish			0.17		2.17	0	7.0	0.33	6

Oyster Hatchery	*5/26/05*	Fish	Channel and mudflat		0.1		1.0	0	9.0	1.2	10
	8/18/05	Fish			0.33		3.33	0	0.67		6
Whiskey Creek Salmon Hatchery	5/26/05	Fish	*Fucus*/mudflat		1.2	0.2		0		1.2	5
	8/18/05	Fish		**0.67**			0.33	0		1.0	3
	10/05/05	Fish		**1.0**				0			2
	5/26/05	Minnow	*Fucus*/mudflat		1.2	0.2		0		1.2	5
	8/18/05	Minnow		**1.07**	0.6	1.2		0		0.8	15
	9/19/05	Minnow		**1.25**	0.5			0			8
	9/20/05	Minnow		**1.0**	0.38	0.13		0			8
	10/05/05	Minnow			0.33	2		0			6

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

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Stackpole	7/06/05	Pitfall	*Spartina*	0	0.06			15.9			16
	7/07/05	Pitfall		**0.06**	0.2			20.6			16
	7/08/05	Pitfall		0				19.0			16
	7/21/05	Pitfall		0	0.6			4.2			16
	7/22/05	Pitfall		0	0.8	0.06		3.8			16
	7/23/05	Pitfall		0	0.25			3.1	0.06		16
	08/18/05	Pitfall		**0.19**	0.6	0.06		1.19			16
	08/19/05	Pitfall		**0.12**	0.19	0.06	0.06	1.4			16
	08/20/05	Pitfall		**0.06**	0.12		0.06	1.9			16
	09/20/05	Pitfall		**0.56**		0.06	0.25	0.94			16
	09/21/05	Pitfall		**0.5**	0.125	0.06	0.06	1.19			16
	09/22/05	Pitfall		**0.44**	0.19			1.94		0.06	16
	10/18/05	Pitfall	*Spartina*	**0.44**	0.06		0.19	0.625			16
	10/19/05	Pitfall		**0.19**			0.125	1.31			16
	10/20/05	Pitfall		**0.06**		0.06	0.19	0.56			16

Stackpole N. of Pit	7/06/05	Minnow	*Spartina*	0	0.5			0.3		0.9	15
	7/07/05	Minnow		0	0.4			0.9		1.5	15
	7/08/05	Minnow		0		0.13		2.2		0.9	15
Stackpole S. of Pit	7/22/05	Minnow	Edge of Spartina	0	0.1			1.2		0.4	10
	7/23/05	Minnow	10 paces in	0				2.2		0.7	10
Stackpole WDFW monthly	08/18/05	Minnow	Edge of Spartina	0				0		1.2	5
	08/19/05	Minnow	10 paces in	0			0.2	0		0.6	5
	08/20/05	Minnow	15 paces in	0				0		0.2	5
Stackpole N. of Pit	09/20/05	Minnow	*Spartina*	**1.6**	0.3			0.2		0.6	10
	09/21/05	Minnow		**1.8**		0.2	0.1	0		0.8	10
	09/22/05	Minnow		**0.7**		0.1	0.1	0		0.3	10
Stackpole N. of Pits	10/18/05	Minnow	*Spartina*	**1.3**		0.1		0.4			10
	10/19/05	Minnow		**0.6**				0.3		0.1	10
	10/20/05	Minnow		**1.0**	0.3			0.5		0.1	10
Nahcotta Lab	7/23/05	Minnow	Edge of vegetation	0				0		3.7	10
Taylor Resources	08/18/05	Minnow	Edge of Spartina	0				1		2.6	5
	08/19/05	Minnow	10 paces in	0			0.2	3.2		0.6	5
	08/20/05	Minnow	15 paces in	**0.2**				1			5
	09/20/05	Minnow	*Spartina*	**0.2**				0.2		2.8	5
	09/21/05	Minnow		**0.2**				0		0.8	5
	09/22/05	Minnow						0.4		0.6	5
Long Is.Refuge	7/21/05	Fish	Old ferry ramp	0			15.8	1.6			5
		Minnow						0.2		1.8	5
Pickerrell Creek	7/21/05	Fish	Along creek bank	0			14	1		2.2	5
		Minnow	*Spartina*	0			0.4	0		1	5

Palix River	7/21/05	Minnow	*Spartina*				3.2	2.4			5
Bay Center	7/21/05	Fish	end of School Rd, in *Spartina* patches		1.75			0		3.5	4*

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

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Cancer productus*	Sculpin	Number Traps
Grassy Island Park Ave	7/22/05	Fish	*Creek*		0.2			0		3.2	5
	7/22/05	Minnow	*Scirpus*					0		0.8	5
Grassy Island Lila Street	10/06/05	Minnow	*Edge of native vegatation*	**0.1**				0		3.9	10
	10/09/05	Minnow			0.05			0		0.1	20
Brady's Oysters	7/23/05	Fish	*Low to mid*				9	3	4.86	0.28	7
	10/09/05	Fish					1.33	0.67	1.00	4.67	2
	7/23/05	Minnow	*Mid to high*				1.3	1.3		1.25	8
	10/09/05	Minnow	*Marsh*	**0.03**		0.13	0.03	0		0.53	30
Bay View Rd	7/23/05	Fish	*Creek*					0.33		1.33	3
		Minnow	*high*					0			2

Appendix 3. *Carcinus maenas* catches and sightings in Oregon and Washington Estuaries in 2005. 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
COQUILLE	Bandon crab dock	7/25//05	*F*	*78*	*Green-orange*	*03*	**Turned in by sports fisher*
		8/11/05	M	71.5	Yellow-green	03	Missing #1
COOS	Airport /Pony Pt	3/24/05	M	87	orange	Older	Good, dactyl on 1 worn
		7/7/05	M	85.73	Orange	03	
		7/7/05	M	82.06	Green	03	No dactyl on #6
		7/7/05	F	71.5	Yellow-orange	03	No 1, no 6
		7/7/05	M	63.37	Green	04	
		7/7/05	F	60.83	Orange-red	03	No #1
		7/8/05	M	82.4	Yellow-orange	03	No #1 puncture under side
	Jordan Cove	9/0/05	M	45.9	Yellow-green	05	
		9/02/05	F	44.0	Green	05	
YAQUINA	Johnson Creek	9/16/05	M	59.0	Green	04	
		9/16/05	M	45.2	Green	05	
		9/16/05	M	46	Green	05	
		9/16/05	M	42.5	Green-yellow	05	
	Sally's Bend A	9/15/05	M	41.45	Green	05	
		9/15/05	M	34.8	green	05	
		9/15/05	F	37.9	Green	05	
		9/15/05	M	42.7	green	05	
		9/15/05	F	27.8	Green	05	
		9/15/05	M	38.2	green	05	

		9/15/05	M	38.8	Green	05	
		9/15/05	M	29.5	green	05	
		9/16/05	M	32.41	Yellow-green	05	# 1 regenerating
		9/16/05	F	39.6	Green	05	# 1 regenerating
		9/21/05	*M*	*43.4*	*Yellow-orange*	*05*	**pheromone study*
		9/21/05	*F*	*37.2*	*green*	*05*	**pheromone study*
		9/21/05	M	87.6	Yellow-orange	03	Pitfall trap
		10/04/05	*M*	*38.2*	*Green*	*05*	** pheromone study*
		10/04/05	*M*	*37.5*	*Yellow-green*	*05*	** pheromone study*
	HMSC Pump House beach	6/17/05	M	88.8	Yellow-orange	03 or older	
		6/17/05	M	90	Yellow-orange	03 or older	
		7/15/05	F	66	Green	04	
		7/15/05	M	76.6	Yellow-green	03	
		7/15/05	M	83	Yellow-green	03	
	Hatfield Marine SC	4/14/05	*M*	*36.89*	*Green*	*04*	** Found by Marine Biology class*
	Aquarium mud flat	05/14/05	M	69.7	Orange	03	Missing # 2,3,4,7
		05/14.05	M	77.5	Yellow	03	Good
		05/14/05	M	69.4	Green	04	Good
		6/17/05	M	67.9	Green	04	
		7/15/05	F	59.5	Green	04	
		8/23/05	M	56	Green	04	
		8/24/05	M	33	Green	05	
		9/15/05	M	37.4	Green	05	
		9/15/05	F	38.6	Yellow-green	05	
		9/15/05	M	42.4	Yellow	05	
	Idaho Point	4/24/05	M	79.2	Orange	03	Missing #3, damaged dactyl tip
		4/24/05	M	90.8	Orange	01	barnacles

		5/15/05	F	92.2	Yellow-orange	01	Good, tip of #6 propus worn
		6/17/05	M	57.6	green	04	
		7/15/05	M	86	Yellow-green	03	
		7/15/05	F	59.4	Green	04	
		7/15/05	F	56.8	Green	04	
		7/15/05	F	57	Green/soft	04	
	Neohla Point	8/24/05	F	54.6	Green	04	
TILLAMOOK	Spit A	8/19/05	M	80.1	Yellow	03	Puncture in left gill chamber
		8/18/05	M	80.5	Yellow-orange	03	Missing # 1 propus tip
		9/18/05	F	51.3	Green	05	
		9/19/05	F	43.8	Yellow-orange	05	
	Spit B	9/18/05	M	45	Yellow	05	
		9/18/05	M	46.1	Yellow-green	05	
		9/19/05	M	50.6	Yellow	05	
		9/19/05	M	55.8	Yellow	05	
	Pitcher Point	9/19/05	M	52.2	Yellow-green	05	
		9/20/05	M	44	Yellow-green	05	
		9/20/05	F	47.2	Green	05	
		9/20/05	M	41.8	Yellow	05	
NETARTS	Intersection of Netarts and Whiskey Creek Roads	05/26/05	M	90.1	Green	03	good
		05/26/05	M	94.6	Green-yellow	03	good
		05/26/05	M	71.8	Green-yellow	03	Missing 1 and 6
		05/26/05	M	67.5	Green	04	good
		05/26/05	M	77.6	Yellow-orange	03	
		05/27/05	M	86.65	Green	03	good

		05/27/05	M	79.4	Yellow-orange	03	good
		05/27/05	F	51.2	Green	04	Missing # 7
		05/27/05	F	55.1	Green	04	Good
		05/27/05	M	84.9	Yellow	03	good
		8/17/05	M	85.8	Yellow-green	03	Missing # 8, and tip of propus
		8/17/05	M	82.8	Orange-red	03	Missing # 1 dactyl –puncture at base of #6; 4 mm barnacles
		8/17/05	M	74.8	Yellow-orange	03	
	Whiskey Creek Salmon hatchery	8/18/05	M	83.8	Orange	03	
		8/18/05	M	69.2	Yellow-green	04	
		8/18/05	M	42.8	Green	05	
		8/18/05	M	43.8	Green	05	
		8/18/05	M	40.9	Green	05	
		8/18/05	M	38.4	Green	05	
		8/18/05	F	20	green	05	
		8/18/05	M	38.5	Yellow-green	05	
		8/18/05	F	34.8	green	05	
		8/18/05	F	33.75	Green	05	
		8/18/05	F	32.2	Green	05	
		8/18/05	M	35.9	Green	05	
		8/18/05	M	34.75	Green	05	
		8/18/05	M	34.6	Green	05	
		8/18/05	M	33	Green	05	
		8/18/05	M	31.2	Green	05	
		8/18/05	M	30.4	Green	05	
		8/18/05	M	29.3	Green	05	
		8/19/05	M	82.8	orange	03	Missing #2 and dactyl on 6
		9/18/05	M	43.8	Yellow-green	05	
		9/18/05	M	45.5	Yellow-green	05	
		9/18/05	M	42.8	Yellow-green	05	

		9/18/05	*M*	*53.8*	Yellow-green	*05*	* *pheromone study No #1,4,9 puncture in gill chamber*
		9/18/05	M	36	green	05	
		9/18/05	*M*	*42.9*	green	*05*	* *pheromone study*
		9/18/05	M	35	green	05	
		9/18/05	F	36.9	green	05	
		9/18/05	M	29.8	green	05	
		9/18/05	*M*	*43.4*	green	*05*	* *pheromone study*
		9/19/05	M	46.3	yellow	05	
		9/19/05	M	41	Yellow	05	
		9/19/05	F	41	Yellow	05	
		9/19/05	M	44.2	Yellow-green	05	No # 6,7
		9/19/05	M	41.2	Yellow-green	05	
		9/19/05	F	48.2	Yellow-green	05	
		9/19/05	M	46.2	Yellow-green	05	
		9/20/05	M	42.6	Green	05	
		9/20/05	M	40	Green	05	
		9/20/05	M	43.2	Yellow-green	50	
		9/20/05/	F	38.9	Green	50	
		10/05/05	*M*	*43.8*	*Yellow-green*	*05*	* *pheromone study*
		10/05/05	*F*	*42.65*	*Yellow*	*05*	* *pheromone study*
		10/05/05	M	53	Yellow	05	
		10/05/05	F	50	green	05	
	Oyster Hatchery	11/10/2005	M	88.9	Orange	03	Found by Matt
WILLAPA	Stackpole	7/06/05	M	78.9	Yellow-green	2003	Rejuvenated 1
	Pitfall Traps	08/18/05	M	38.0	Green	2005	Good
		08/18/05	M	40.3	Green	2005	Good
		08/18/05	M	38.6	Yellow-green	2005	Good
		08/19/05	F	37.2	Green	2005	Good
		08/19/05	M	38.7	Green	2005	Good

		08/20/05	M	36.9	Yellow-green	2005	Good
		09/20/05	F	47.9	Green	2005	Good
		09/20/05	F	45.7	Green	2005	Missing #7 limb
		09/20/05	M	46.3	Yellow	2005	Good
		09/20/05	F	50.3	Green	2005	Missing #2, 4, 5 limbs
		09/20/05	M	43.7	Yellow	2005	Good
		09/20/05	F	48.0	Green-yellow	2005	Good
		09/20/05	M	46.0	Yellow-green	2005	Good
		09/20/05	M	48.1	Yellow-green	2005	Good
		09/20/05	M	48.8	Yellow-green	2005	Good
		09/21/05	F	41.0	Green	2005	Good
		09/21/05	F	50.8	Green	2005	Good
		09/21/05	F	49.6	Green	2005	Good
		09/21/05	F	46.3	Green	2005	Good
		09/21/05	M	41.6	Yellow	2005	Good
		09/21/05	M	50.1	Yellow	2005	Good
		09/21/05	M	45.1	Green-yellow	2005	Good
		09/21/05	M	42.5	Green-yellow	2005	Good
		09/22/05	M	43.5	Green-yellow	2005	Good
		09/22/05	M	50.7	Yellow	2005	Good
		09/22/05	M	42.6	Yellow	2005	Good
		09/22/05	M	39.0	Green-yellow	2005	Good
		09/22/05	M	45.5	Yellow	2005	Good
		09/22/05	M	43.2	Green-yellow	2005	Good
		09/22/05	M	48.0	Yellow	2005	Good
		10/18/05	F	34.7	Black-dead	2005	Must of got into pit when it was closed improperly. Missing #2,3,4,5,6 limbs
		10/18/05	M	44.5	Yellow	2005	Good
		10/18/05	M	47.4	Yellow	2005	Good
		10/18/05	F	48.9	Green	2005	Missing #1,6 limbs
		10/18/05	M	50.6	Yellow-orange	2005	Good

		10/18/05	M	45.1	Yellow-green	2005	Good
		10/18/05	F	49.0	Green	2005	Good
		10/19/05	M	45.0	Green-yellow	2005	Good
		10/19/05	M	42.0	Yellow	2005	Good
		10/19/05	M	44.6	Yellow		Missing #10
		10/20/05	F	48.0	Green		Good
	Stackpole – Minnow -N. of Pit	09/20/05	F	49.4	Green	2005	Good
		09/20/05	M	48.3	Yellow	2005	Good
		09/20/05	M	41.4	Yellow	2005	Good
		09/20/05	M	46.3	Yellow	2005	Good
		09/20/05	F	45.7	Green	2005	Good
		09/20/05	F	45.3	Green	2005	Good
		09/20/05	F	40.8	Green	2005	Good
		09/20/05	F	48.7	Green	2005	Good
		09/20/05	F	51.0	Green	2005	Good
		09/20/05	M	49.0	Yellow	2005	Good
		09/20/05	M	37.8	Yellow	2005	Missing #7 limb
		09/20/05	M	50.3	Yellow	2005	Good
		09/20/05	F	46.8	Green	2005	Good
		09/20/05	M	43.8	Yellow	2005	Good
		09/20/05	M	47.7	Yellow	2005	Good
		09/20/05	M	38.0	Yellow	2005	Good
		09/21/05	M	44.4	Yellow	2005	Good
		09/21/05	F	47.1	Green	2005	Good
		09/21/05	F	45.9	Green	2005	Good
		09/21/05	F	41.9	Green	2005	Good
		09/21/05	F	44.0	Green	2005	Good
		09/21/05	F	43.1	Green	2005	Good
		09/21/05	F	47.7	Green	2005	Good
		09/21/05	F	46.6	Green	2005	Good
		09/21/05	F	47.6	Green	2005	Rejuvenated #1 limb

		09/21/05	F	47.7	Green	2005	Good
		09/21/05	F	45.0	Green	2005	Good
		09/21/05	F	52.1	Green	2005	Good
		09/21/05	M	48.0	Yellow	2005	Good
		09/21/05	F	46.2	Green	2005	Good
		09/21/05	F	46.9	Green	2005	Good
		09/21/05	M	42.1	Yellow	2005	Good
		09/21/05	M	48.9	Yellow	2005	Good
		09/21/05	F	47.6	Green	2005	Good
		09/22/05	M	40.2	Yellow	2005	Good
		09/22/05	F	49.9	Green	2005	Good
		09/22/05	F	47.0	Green	2005	Good
		09/22/05	M	43.4	Green-yellow	2005	Good
		09/22/05	F	46.9	Green	2005	Rejuvenated #1 limb
		09/22/05	M	48.0	Green-yellow	2005	Good
		09/22/05	M	48.4	Yellow	2005	Good
		10/18/05	F	48.8	Green-yellow	2005	Good
		10/18/05	F	49.3	Green-yellow	2005	Good
		10/18/05	F	46.4	Green	2005	Good
		10/18/05	M	44.3	Yellow	2005	Good
		10/18/05	M	47.8	Yellow	2005	Good
		10/18/05	M	47.9	Yellow-orange	2005	Good
		10/18/05	M	46.1	Yellow	2005	Good
		10/18/05	M	50.9	Yellow	2005	Good
		10/18/05	F	44.8	Green	2005	Good
		10/18/05	F	39.6	Green	2005	Good
		10/18/05	M	49.3	Yellow	2005	Missing #6 limb
		10/18/05	M	48.7	Yellow	2005	Missing #10 limb
		10/18/05	M	46.9	Yellow-orange	2005	Missing #4 limb
		10/19/05	M	46.0	Yellow	2005	Good
		10/19/05	F	44.7	Green-yellow	2005	Good
		10/19/05	F	43.3	Green	2005	Good

		10/19/05	M	49.0	Yellow-orange	2005	Good
		10/19/05	F	43.8	Green-yellow	2005	Good
		10/19/05	M	50.0	Yellow	2005	Good
		10/19/05	F	48.3	Green	2005	Good
		10/19/05	F	43.5	Green-yellow	2005	Good
		10/19/05	F	46.6	Green	2005	Good
		10/19/05	M	41.8	Yellow-orange	2005	Good
		10/20/05	M	47.9	Yellow-green	2005	Good
		10/20/05	M	41.9	Yellow	2005	Good
		10/20/05	F	44.7	Green	2005	Good
		10/20/05	M	48.8	Yellow	2005	Good
	Taylor Resources	08/20/05	M	47.3	Yellow-green	2005	Good
		09/20/05	M	51.8	Yellow	2005	Good
		09/21/05	F	43.4	Green	2005	Good
Grays Harb	Grassy Is./Lila St.	10/06/05	M	44.1	Green-yellow	2005	Good
	Brady's Oysters	10/09/05	M	50.45	Yellow-green	2005	good