Progress Report
on
the Status of
the European Green Crab in Oregon Estuaries in Early 2005

by

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

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. This has not happened. Some recruitment has occurred every year since 1998. Recruitment strength appears to be linked to winter temperatures: cold winters (2002) result in poor recruitment while warm winters (2003), in good recruitment. The 2003 year class was the most dominant one in the population in 2004 and early 2005. It appears that Coos, Yaquina, Netarts and Tillamook estuaries in Oregon and Willapa Bay, Washington harbor a small self-sustaining population of green crabs that is **not** dependent on a larval source from California.

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 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.

Introduction

The goal of this study is to estimate the current densities and predict the future status of the European green crab in Oregon estuaries and the Pacific Northwest. This is accomplished by:

- Estimating the size/age structure and density of the Oregon green crab population.
- Estimating the year-class strength of young-of-the-year green crabs.
- Comparing patterns in recruitment strength over time and correlating them to ocean conditions.

Sampling Methods for Green Crabs in Oregon

My sampling effort in the Spring of 2005 focused on four Oregon estuaries: Coos, Yaquina, Netarts and Tillamook. In each estuary, I sampled at least 3 different sites. For a more detailed description of sampling methods see previous status reports.

Results

Densities of Green Crabs in Oregon Estuaries

The relative abundances of green crabs trapped in Oregon estuaries in early 2005 are tabulated in Appendix 1 and summarized in Table 1. As can be seen from Appendix 1, Catch per Unit Effort (CPUE) is extremely variable, even within the same site. Thus, one must use caution in interpreting differences in CPUE between sites and over time. What can be concluded, however, is that catches have decreased an order of magnitude since 1999 (Table 1). While average CPUE in 1999 ranged from 0.4 to 0.7, that for 2002-2005 ranged from 0.03 to 0.3. It should also be noted that as densities deceased, I tended to focus more on productive "hot spots" rather than to consistently trap unproductive sites. I chose this strategy to obtain a sufficiently large sample size to assess population structure.

Table 1. Relative Green Crab abundances for study sites in Oregon estuaries from 1999 to 2005. Data for 1999 were complied from Hauck 2000 and Hunt and Behrens Yamada 2003.

Estuary	Number of crabs trapped (# trap-days)				
	1999	2002	2003	2004	Early 2005
Coos Bay	15 (39)	9 (180)	14 (203)	18 (137)	1 (35)
Yaquina	223 (323)	26 (168)	63 (1084)	12 (461)	10 (117)
Tillamook		2 (71)	6 (70)	4 (51)	0 (25)
Netarts		0 (44)	11 (44)	12 (39)	10 (31)
Total	238 (362)	37 (463)	94 (1431)	46 (688)	21 (208)

Estuary	Catch per trap per day				
	1999	2002	2003	2004	Early 2005
Coos Bay	0.38	0.05	0.07	0.13	0.03
Yaquina	0.69	0.15	0.06	0.03	0.08
Tillamook		0.03	0.09	0.08	0.00
Netarts		0.00	0.25	0.31	0.32
Total	0.657	0.080	0.066	0.067	0.10

Age Structure of Green Crabs in Oregon Estuaries

From previous mark and recapture studies and from shifts in size frequency distributions over time (Behrens Yamada et al. 2005,) I estimated the age of green crabs retrieved from Oregon estuaries in early 2005 (Appendix 2). I assigned crabs to three age classes based on their size and coloration (Appendix 2, Table 2). Crabs between 55 and 70 mm with green or yellow carapaces would represent the 2004-year class; those up to 85 mm, the 2003 year class. Larger crabs over 85 with hard red carapaces were categorized as 'older.

Table 2. Estimated age structure of *Carcinus maenas* retrieved from Oregon estuaries in early 2005.

Estuary	Year Class				
	2005	2004	2003	"older"	Total
Coos Bay				1	1
Yaquina		3	5	2	10

Tillamook Netarts		3	7		10
Total		6	12	3	21

Conclusions

In the spring of 2005, green crabs were still present in Oregon estuaries. Catches were on the same order of magnitude as in the previous three years, but an order of magnitude lower than in 1999. While recruits from 2004 were trapped, the most dominant cohort in Oregon estuaries remains to be the 2003 year class.

Acknowledgements

I am grateful Robbie Lamb, Dan Preston and Bob Piorkowski for helping sample in Yaquina Bay. I thank Bay Street Crab Company in Corvallis for continually supplying me with fresh bait, and the staff of North Bend Airport Security for driving us to our Pony Point study site.

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.

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.

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

Appendix 1. Relative abundance of crab species and sculpins (Numbers/trap/day) in Oregon estuaries during 2003. An asterisk beside trap number indicates that other traps were either opened or were stolen.

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

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)	*Canc produ*
Russell Point	03/24/05	Fish	Pools by bridge				0.33	0.33	
			Zoster marina						
Pony Point/Airport	03/24/05	Fish	*Zostera marina*	**0.1**			2.1		7.0
Charleston Boat Basin	03/23/05	Fish	*Zostera marina*				1.0		7.6
101/Roseburg Lumber Rd.	03/25/05	minnow	*Mid*						

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

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)
Johnson Slough		Fish	Below Bridge					
Sawyers Landing	4/10/05	Fish	Low					0.1
HMSC Pump	**4/14/0**	Fish	*Zostera*				0.92	

house	**5**		*marina*					
	5/15/05	Fish					0.46	0
	6/17/05	Fish		**0.33**	0.33	0.5	0.5	0
Sally's Bend C Fishing Platform	4/10/05	Fish	*Zostera marina*				0.4	0.2
	6/17/05	Fish			1.7		6.17	1.17
		Fish						
Oregon Coast Aquarium	**4/15/05**	Fish	subtidal				4.83	
	5/14/05	Fish		**0.4**	0.2		1.2	
	5/15/05	Fish		**0.2**			0.6	
	6/17/05	Fish		**0.2**	0.6		0.6	
Idaho Point	4/16/05	Fish	Low	**0.17**	0.08		1.0	
	5/15/05	Fish	Low	**0.1**			0.8	
	6/17/05	Fish	Low	**0.17**	0.17		2.83	
Sally's Bend A	5/17/05	Minnow	*Zostera japonica*		1.8			

Tillamook Bay

Mean CPUE (Catch/trap/day)

Site	Date	Trap Type	Zone	*Carcinus maenas*	*Hemigrapsus oregonensis*	*Hemigrapsus nudus*	*Cancer magister*	*Cancer magister* (Recruits)

Tillamook Spit A	05/27/05	Fish	*Zostera japonica*		0.2				
Tillamook Spit B	05/27/05	Fish	*Zostera japonica*		02				
Pitcher Point	05/27/05	Fish	*Zostera japonica*						
Hayes Oysters	05/27/05	Fish	*Low*				3.5		

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*
Intersection	*5/25/05*	Fish	pools	**1.67**	0.67	0.33			0.33
	5/27/05	Fish	Pools	**1.67**	2	0.66			0.33
RV Park	*5/26/06*	Fish	Low sand flat				1.7		7.6
Oyster Hatchery	*5/26/05*	Fish	Channel and mudflat		0.1		1.0		9.0
		Fish							
Whiskey Creek Salmon Hatchery	5/26/05	Fish	*Fucus*/mudflat		1.2	0.2			
		Minnow	*Fucus*/mudflat						

Appendix 2. *Carcinus maenas* catches and sightings in Oregon Estuaries in 2004. 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.

Bay	Site	Date	Sex	CW	Color	Year Class	Condition/ Comments
Coos Bay	Airport /Pony Pt	3/24/05	M	87	orange	Older	Good, dactyl on 1 worn
Yaquina	Idaho Pt	4/24/05	M	79.2	Orange	03	Missing #3, damaged dactyl tip
	Idaho Pt.	4/24/05	M	90.8	Orange	Older	barnacles
	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
	Aquarium mid flat	05/14.05	M	77.5	Yellow	03	Good
	Aquarium mud flat	05/14/05	M	69.4	Green	04	Good
	Idaho Pt.	5/15/05	F	92.2	Yellow-orange	Older	Good, tip of #6 propus worn
	HMSC pumphouse	6/17/05	M	88.8	Yellow-orange	03 or older	
	HMSC pumphouse	6/17/05	M	90	Yellow-orange	03 or older	
	Idaho Pt.	6/17/05	M	57.6	green	04	
	Aquarium mud flat	6/17/05	M	67.9	Green	04	
Netarts	Intersection of Netarts and Whiskey Creek Roads	05/26/05	M	90.1	Green	03	good
			M	94.6	Green-yellow	03	good
			M	71.8	Green-yellow	03	Missing 1 and 6
			M	67.5	Green	04	good
			M	77.6	Yellow-orange	03	
		05/27/05	M	86.65	Green	03	good
			M	79.4	Yellow-orange	03	good
			F	51.2	Green	04	Missing # 7
			F	55.1	Green	04	Good

			M	84.9	Yellow	03	good