Preliminary Investigations of Crab Predation on Bay Scallops

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In the course of bay scallop aquaculture research conducted at the National Marine Fisheries Service Laboratory in Milford, CT, excess scallops were donated to Connecticut municipal shellfish commissions for free-planting in area waters. The practice of free-planting or tossing seed scallops (10 - 40 mm) directly into the water has come under scrutiny because of the observable decreasing return in the number of adults (>60 mm) caught by recreational fisherman in the towns that have such policies. Field studies of bay scallops have suggested a variety of causes for population fluctuations including habitat loss, genetic inbreeding depression, and predation. It is generally known that crab predation can be a major factor in survival and growth of bay scallops for reseeding or stock enhancement efforts, especially in sites devoid of eel grass which can serve as a refuge for small scallops.

To evaluate crab predation on scallops, an experimental study was conducted with green crabs (*Carcinus maenas*) in the laboratory. Six treatment aquaria with 10° C flowing seawater were established with a single crab and 10 scallops. A seventh aquarium, with 10 scallops and no crab to check for non-predator related mortality, was used as a control. Four separate trials were run with scallops in each of the following size classes: 10, 20, 30 and 40 mm shell height. Trials were duplicated with a second set of crabs and scallops. Observations were made at 1, 6, 20, and 48 hours for each study. Results indicated that larger-sized scallops had higher survival rates, indicating some degree of refuge from predation by green crabs. In addition, damage to scallop shells was manifested in a characteristic appearance which could be used in identifying mortality by crab predation in the field.

A smaller scale project involved a comparison of bay scallop predation by Asian shore crabs (*Hemigrapsus sanguinseus*) versus similar-sized green crabs. Six containers were set up for each crab species with fifteen scallops and one crab per container. The shell height of scallops ranged from 6-8 mm and the carapace width of crabs ranged from 18.0 to 25.3 mm. Observations were made after 48 hours when the experiment was terminated. The most notable difference was the amount of scallops eaten by the male and female crabs. Generally, male crabs ate all of the scallops in their containers, while the female crabs ate very few to none. This difference could be attributed to the larger size of the claw of the male crabs. There was a slight difference in the number of scallops eaten by the green crabs versus Asian shore crabs. These observations can be used for planning purposes when attempting to enhance or replenish scallop populations.

MATERIALS AND METHODS

Green crabs, *Carcinus maenas*, were caught by crab pot from the lab's Milford Harbor dock. Crabs with no apparent deformities were acclimated to 10ÊC in a holding aquarium in the lab. Bay scallops, *Argopecten irradians*, of appropriate sizes were taken from lab reared populations. Six treatment aquaria, 76 X 32 X 23 cm, with 10ÊC flowing seawater were set up for a single crab with 10 scallops of each size class. Size class intervals for scallops would be approximately 10, 20, 30, 40 mm. A seventh aquarium would be set up with 10 scallops and no crab as a control for non-crab related mortality, i.e. temperature shock or human handling effects.
Feeding trial commenced after a 2 day starvation period for the crabs to ensure hunger response. 10 scallops were then introduced to each aquarium and observed at 1,6 and 20 hour intervals. A 48 hour interval was added for the second run of the experiment. The number of scallops preyed within 20 and 48 hours were recorded. Predator behavior would be observed and documented.

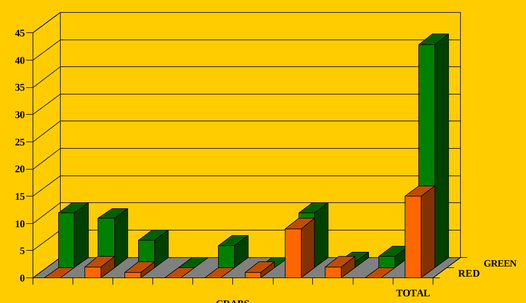
Green Crab Predation

Results of First Run

Average size of scallops

Crab #	Carapace width	Chela height	10 mm	20 mm	30 mm
A	71.3mm	22.8 mm	10	9	5
B	64.2 Red	18.2	0	2	1
C	68.5 Red	18.7	0	0	1
D	43.2	9.6	0	4	0
E	41.5	9.4	10	1	2
F	40.8 Red	9.4	9	2	0
Totals			29	16	9

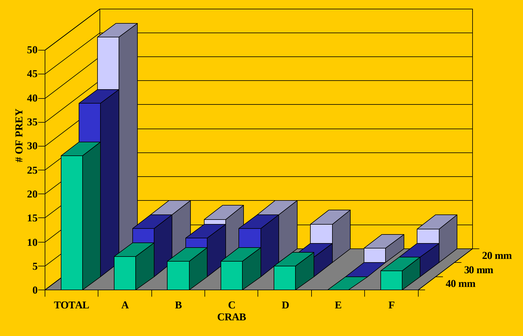
GREEN VS. RED VARIETY OF CRAB
Difference in amount of prey consumed



Results of Second Run

Crab #	Carapace width	Chela Heigth	20 mm 20 hrs	20 mm 48 hrs	30 mm 20hrs	30 mm 48 hrs	40 mm 20 hrs	40 mm 48 hrs
A	71.1mm	13.1 mm	9	10	6	10	5	7
B	64.1	16.7	6	9	1	8	5	6
C	60.1	19.6	8	10	3	10	5	6
D	57.8	13.5	4	8	2	4	4	5
E	56	9.8	2	3	0	0	0	0
F	55.1	11.7	3	7	0	4	3	4
Totals			32	47	12	36	22	28

SCALLOPS PER CRAB AT 48 HOURS



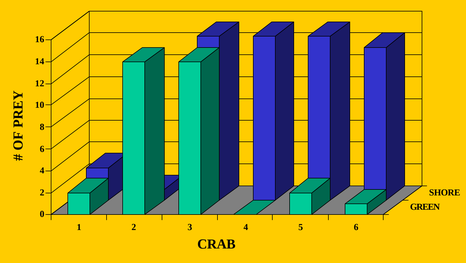
Green Crab

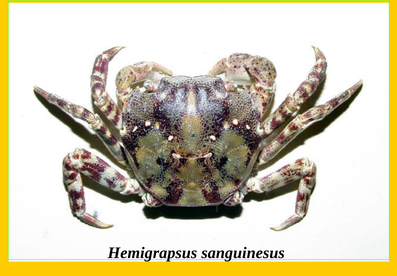
Crab #	Carapace width	M/F	Chela Length
1	24.1mm	F	13.1 mm
2	24.1	M	16.7
3	22.2	M	19.6
4	21.1	F	13.5
5	20.4	F	9.8
6	18.0	F	11.7

Asian Shore Crab

Carapace width	M/F	Chela Length
18.8 mm	F	11.5 mm
18.1	F	9.6
23.4	M	12.1
24.5	M	13.9
25.3	M	13.5
21.1	M	17.0

GREEN VS. ASIAN SHORE CRAB





Hemigrapsus sanguinesus

DISCUSSION

Predation by green crabs at 10° C can have a significant impact on scallop seeding and planting strategies that are commonplace in most towns that have a recreational harvest. Scallops are usually planted in late fall and decreased temperatures are associated with decreased mobility and therefore predator avoidance for the scallop.

Although some scallop mobility was observed at this temperature, observations confirmed that it was the crab's non-aggressiveness versus any avoidance on the scallops' part that contributed to scallop survival. Responses of the first experiment were not conclusive in that at times certain crabs would feed while others did not. Crab feeding responses overall did show a decrease in prey number with an increase in prey size over 20 hours which coincides with other studies. Reading of one other researcher (Tettlebach) did suggest allowing 48 hours for larger prey at this temperature which will be incorporated into the second run. Another unexpected result occurred when results for green variety of crabs was pooled versus red varieties. Greens (recently molted) accounted for 73% of all scallops preyed upon. The red varieties (late inter-molt) in some of the readings (Kaiser), are considered more aggressive and have better reproductive success supposedly because of harder, stronger shells. For the purpose of avoiding this variation in the experiment the second run was conducted with the green variety of the Green Crab.

The results for the second run did show that increasing the size of the prey would decrease the number of prey consumed. This could be for any or a combination of reasons. One explanation of results would be that a larger prey provided a larger meal and so less scallops were needed to satisfy the crab's appetite. Another explanation is that the size of the scallop and therefore the effort needed by the crab to get through the shell provides some protection for the prey, otherwise termed "size refuge". Clearly, since nearly 50% of the largest size scallops used in this experiment were consumed as prey it probably is not going to ease the concerns of aquaculturists that quite a few of the scallops that they try to seed area waters will end up on a crab's dinner plate.

An interesting result of the second run is brought to light by the fact that Milford Harbor green crabs normally never see, therefore feed on, a bay scallop. The 30 mm scallops were the first series introduced to these green crabs. At 20 hours, only 20% of the scallops were preyed upon. Whereas, when the 40 mm series were subsequently introduced to the same crabs, 37% were preyed upon in that 20 hour period. It would seem that the crabs needed some time to learn how to attack and break open the shell of the scallops. Once it did learn, it had no problem transferring that lesson onto a bigger animal with better and quicker results.

BIBLIOGRAPHY

Cunningham, P. N., and Hughes, R. N., (1984). Learning of predatory skills by shore crab *Carcinus Maenas* feeding on mussels and dogwhelks. Mar.Ecol. Prog. Ser. Vol 16: 21-26

Grosholz, E., Hedgecock, D. and Ruiz, G. (1997). Impact of recently introduced green crab on invertebrate and shore bird population. Internet www.bml.UCDavis.edu.

Jubb, C. A., Hughes, R. N. and T. ap Rheinallt (1983). Behaviorial mechanisms of size selection by crabs. *Carcinus maenas* feeding on mussels, *Mytilus edulis* J. Exp.Mar.Biol. Ecol 66: 81-87

Kaiser, M. J., Hughes, R. N. and Reid, D. G. (1990) Chelal morphometry, prey-size selection and aggressive competition in green and red forms of *Carcinus maenas*. J. Exp Mar.Biol. Eco. 140: 121-134

Lee, S. Y. (1993) Chela Height is an acceptable indicator of Chela strength in *Carcinus maenas*. Crustaceana Vol 65 No.1 pp 115-116.

Tettlebach, S. T. and Feng, S. Y. (1986) Intensity of crab predation on Northern Bay Scallops, *Argopectin irradians*: effects of prey size and predator assemblages on seasonal patterns. Journal of Shellfish Research - pp 112 - 143.

Washington Dept of Fish and Wildlife, WDFW Fact Sheet: Green Crabs(1997) Internet. www.Wa.gov

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