

Interactions of the Crayfish *Orconectes propinquus* with Benthic
Invertebrates in Tenderfoot Creek, Michigan.

BIOS 569 - Practicum in Aquatic Biology

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1993

ABSTRACT

This study focused on the relationship between adult *Orconectes propinquus* crayfish and the benthic macroinvertebrates of Tenderfoot Creek, located within the University of Notre Dame Environmental Research Center (UNDERC) in Gogebic County, Michigan. *O. propinquus* was the only crayfish species found in the riffle area of Tenderfoot Creek. Enclosure experiments demonstrated that crayfish increased the total number of invertebrate larvae found in stream drift and decreased the total number of invertebrate larvae found within the cobble substrate. The direct effect of the crayfish, i.e. consumption of macroinvertebrates, was not the sole effect of the crayfish on the invertebrate community. The adult crayfish also reduced the number of benthic invertebrates indirectly by dislodging invertebrates into the drift. During an experiment in which young-of-the-year crayfish were the only food source, adult crayfish were shown to feed upon the YOY at night, although the presence of cover for the YOY reduced the rate of cannibalism. Other evidence also suggests strong intraspecific interactions. In enclosures with adult crayfish, the number of young was much lower than in enclosures without adult crayfish. YOY were found in the stream at greater numbers in shallow and rocky areas, possibly providing protection from fish and larger crayfish. Young were also found in rock crevices of deeper waters where adult crayfish may not be able to forage.

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INTRODUCTION:

Crayfish are opportunistic omnivores with complex roles as a herbivores, predators, and detritivores within lake and stream systems. Examination of stomach contents has revealed that crayfish consume a wide variety of food items, including diatoms and other algae, midge larvae, mayfly nymphs, other crayfish, plant detritus, fish remains, rotifers, and copepods (Capelli 1980). Predation by dense crayfish populations has been shown to significantly alter macrophytes (Chambers 1990) and prey populations (Lorman and Magnuson 1978).

Several hundred species of crayfish are known. The species of crayfish that inhabits the riffle area of Tenderfoot Creek in Northern Michigan is *Orconectes propinquus* (Girard), sometimes known as the blue crayfish. Stomach analysis on *O. propinquus* in lakes has revealed the presence of midge larvae, mayfly nymphs, and other crayfish (Capelli 1980). In the presence of *Orconectes virilus*, *O. propinquus*, and *O. rusticus* the abundance of snail populations greatly declines (Hanson 1990, Weber 1990). Mayflies were found exclusively in some crayfish stomachs in September and November (Capelli 1980). Capelli also found clear seasonal differences in the consumption of some food items in lakes, especially the consumption of other crayfish. In late June, 60% of stomachs from individual crayfish contained crayfish parts but in August only 15 to 20% contained crayfish parts. In experiments run during late September and mid-November the percentage dropped to near 0 (Capelli 1980). During July, Capelli found intact young-of-the-year (YOY) within the crayfish stomachs, but the cannibalism on YOY did not continue after August. Studies have shown that all non-molting crayfish in Trout Lake, Wisconsin, (8 mm carapace length or larger) could usually avoid predation if adequate shelter was available (Capelli 1975). The YOY are usually at least 8 mm by August.

I describe here the impact of *O. propinquus* on benthic invertebrates and YOY crayfish within a riffle area of Tenderfoot Creek, Gogebic County, Michigan.

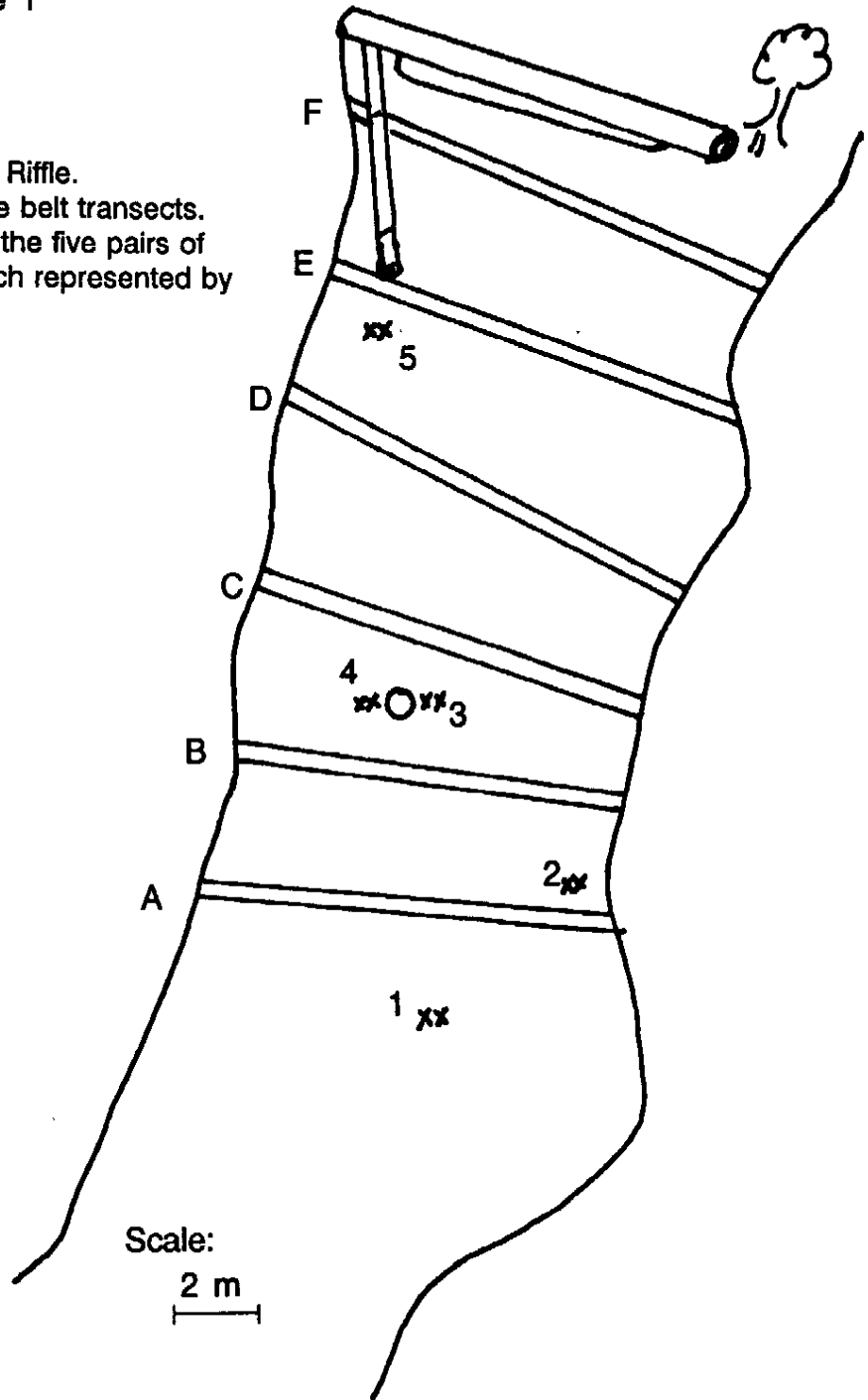
MATERIALS AND METHODS:

Site Description:

A 32.2 m long riffle area of Tenderfoot Creek, Michigan, was the principle site of my experiments (Fig. 1). The depth of the stream riffle from upstream to downstream ranged from 0.02 m to 0.36

Figure 1

Fig. 1: Stream Riffle.
Letters label the belt transects.
Numbers label the five pairs of enclosures, each represented by an 'x'.



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m ($\bar{x} = 0.23 \pm 0.07$ m) (L.M. Bongiovi, personal communication). On July 20, the current velocity was 0.40 m/s. At the upstream end of the riffle the streambed consisted of small cobble. Further downstream, the substrate was larger and the water was deeper due to a natural log dam. The six transects (labeled A-F in Figure 1) were surveyed for crayfish. Transect A was 0.5 x 9.5 m. Transect B was 0.5 x 6.5 m. Transect C was 0.5 x 4.7 m. Transect D was 0.5 x 8.6 m. Transect E was 0.5 x 9.7 m. Transect F was 0.5 x 7.9 m. The locations of the ten enclosures used in experiment 1a and 1b are indicated by 'x' marks. Enclosure pair 1 was placed among large rocks where crayfish were often sighted at a water depth of approximately 0.2 m. The stream depth varied throughout the summer. Enclosure pair 2 was located in a sandy-bottomed region of the riffle at a water depth of approximately 0.3 m, where few crayfish were sighted. Enclosure pairs 3 and 4 were placed on either side of a grass-covered rock in a portion of the stream just deep enough to cover the enclosures, approximately 0.1 m. Enclosure pair 5 was placed in a sandy-bottomed region of the riffle, comparable to the region of enclosure pair 2 at a water depth of approximately 0.3 m.

Natural boundaries delineated the experimental riffle area. A bend in the river accompanied by fallen logs separated the riffle area from the upstream portion. The downstream border was defined by four large logs and a tree growing close to the bank. The riffle continued downstream from the logs, but was shallow with fairly uniform small cobble.

Observational Study: Estimate of Crayfish Density

Two transects (1 x 13.8 m, and 1 x 11.2 m) in a downstream portion of the riffle were sampled on June 5. Neither of these two transects were used in the population density estimate due to location.

Six belt transects, perpendicular to stream flow were surveyed for crayfish by snorkeling and visual inspection in order to determine an average crayfish density of the riffle area (Fig. 1). The six principle transects (approximately 0.5 x 8 m) were studied between June 17-24. The transects were marked by flags close to shore at four corners. I began at one side of the stream and my partner began at the other. We turned over every rock within the width of the transect as we moved across the stream and met in the middle. We visually inspected the stream bed for crayfish, counting the number of crayfish within the transect and observing the crayfish habitat and behavior.

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Experiment 1: Crayfish Effect on Invertebrate, Drift and Benthic Abundance

Ten cylindrical, clear butarate enclosures (23 cm long, 10 cm in diameter) were assembled (Fig. 2). Lab matting (mesh size = 8 x 14 mm) was attached to both ends with hose clamps which prevented 2+ and 3+ crayfish from entering or exiting the enclosure but allowed movement of insects, fish fry, drift materials, young-of-the-year, and 1+ crayfish. On the downstream end of the enclosure a tapered net (20 cm in length, 500 micron netting) was attached to the enclosure with another hose clamp and sealed at the downstream end with a plastic clip. Water flowed freely through the enclosure and net. The enclosures were filled with stream cobble to a depth of 5 cm for a bottom surface area of approximately 0.023 m². Stream cobble (placed in a large container and agitated to remove invertebrates) was preferable to dry quarry gravel due to the length of time needed for colonization by algae and invertebrates in previous experiments near this location. The algae-covered stream cobble provided food and habitat for invertebrates that colonized the enclosures over a two-week period. The ten enclosures were arranged in pairs and distributed evenly across the width of the stream and anchored by nearby rocks. In two separate experiments (1a and 1b), one 3+ crayfish was placed in one random enclosure of every pair. In the first experiment the crayfish used were all males because all 3+ females found were berried. Crayfish used had carapace lengths ranging from 29.2 mm to 31.4 mm (average = 31.0 mm, SD = 1.9 mm, n = 5). The second experiment also used all male crayfish with carapace lengths ranging from 31.6 mm to 35.2 mm (x = 32.5 mm, SD = 2.7 mm, n = 5). The crayfish were left in the enclosures for 72 hours. I sampled drift nets every 12 hours for 48 hours. The contents of the entire enclosures (substrate and invertebrates) were collected after 72 hours for analysis.

Experiment 2: Predation on YOY by Adult Crayfish.

Three buckets (bottom surface area = 0.05 m², height = 0.35 m) were placed in the channel, filled to stream height (about 10 cm) with stream water, and covered with lab matting. Inside each of the three buckets was placed ten young-of-the-year crayfish collected from the same area. One adult male crayfish (CL = 35 mm) was placed in the first bucket. In the second bucket two adult males (CL = 25 mm and CL = 33 mm) were placed. In the third bucket one adult female (CL = 38.5 mm) was placed. All three buckets were left overnight. Twelve hours later, the adult crayfish were released and the young-of-the-year were re-counted.

Figure 2.

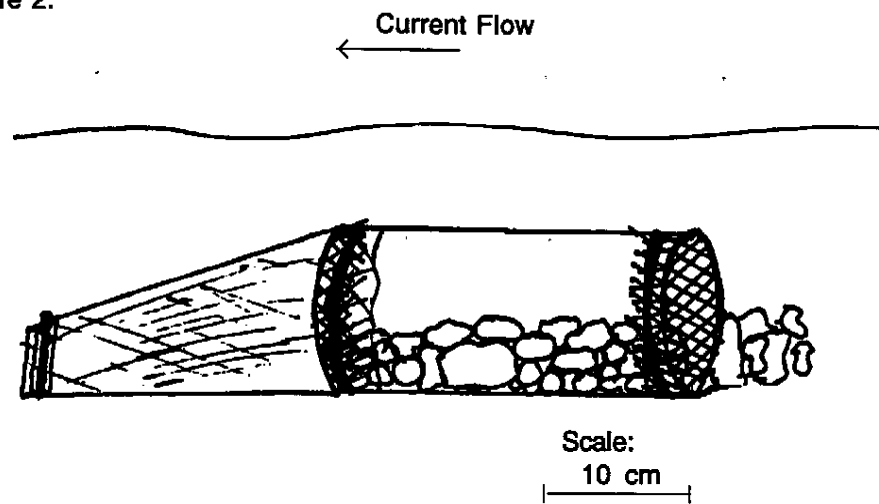


Fig. 2: Experimental apparatus used to examine the influence of crayfish on stream drift

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The next evening the experiment was conducted again, but with washed, algae-free gravel from the gravel pit lining the bucket bottom (5 cm deep) which provided cover for the YOY. New crayfish were collected for the experiment. In the first bucket one adult male (CL = 36 mm) was placed. In the second bucket, one adult female (CL = 32 mm) and one adult male (CL = 26 mm) were placed. In the third bucket one female (CL = 32 mm) was placed. In each of the three buckets ten YOY were placed. After twelve hours the adult crayfish were released and the YOY were re-counted.

Experiment 3: Crayfish Habitat Preference

In cooperation with Alisha Eisert and Dr. Martin Berg, on July 19, a downstream portion of Tenderfoot Creek was marked off into six paired regions. Each region was 3 m long and 1.5 m wide in a uniform, cobble-bottomed portion of the stream. To one randomly selected side of each pair, large bundles of sticks were added and tied in place by string attached to anchoring bricks in order to increase heterogeneity of the stream bottom. In a counting technique designed by Alisha Eisert and Lisa Bongiovi, two divers snorkeled through each plot and independently counted the crayfish, while visually estimating the age and location of the crayfish.

RESULTS:

Observational Study:

On June 5, we counted 9 crayfish in a 1 m x 13.8 m area and 27 crayfish in a 1 m x 11.2 m area downstream from the experimental riffle area. The average density of crayfish in the transects perpendicular to stream flow was 1.6 ± 1.0 crayfish/m².

Within the 32.3-m-long experimental riffle, six 0.5-m-wide transects, perpendicular to stream flow, were surveyed for crayfish density. The transects in the experimental riffle were searched between June 17 and June 24. Over the eight days the average crayfish density increased. The crayfish may have become more active and more easily detected as the stream got warmer, or our powers of observation simply may have improved throughout the week. The density of crayfish counted on June 17 was 1.47 crayfish/m². The average density of crayfish counted on June 18 was 2.42 ± 0.5 crayfish/m². The density of crayfish counted on June 21 was 2.33 crayfish/m². The average density of crayfish on June 24 was 5.1 ± 0.1 crayfish/m². The average crayfish density for the experimental riffle area was 3.04 ± 1.9 crayfish/m². Transect locations are shown

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in Figure 1.

Young-of-the-year were first observed on June 5 as dark purple-colored eggs attached in a mass at the base of the tails of 3+ females. All berried females that were found were partially buried in the sand or hidden beneath large rocks. By June 17, the eggs were transparent, and small (approximately 1 mm) fully formed crayfish could be seen inside the eggs. The eggs were still attached to the underside of the females' tails, and the females were still in protected locations. On June 25, the first YOY were seen clinging to algae and in rock crevices, and were still approximately 1 mm in total length. By July 20, the YOY had grown to a carapace length of 7.1 ± 1.9 mm ($n = 6$) and could be found in all regions of the streambed. The YOYs were found in the greatest numbers in shallow water (10 cm or less) among small gravel substrate.

EXPERIMENT 1: Crayfish Effect on Invertebrate Drift and Benthic Abundance

The drift samples contained a wide variety of materials including plant material, fish fry, and invertebrates. The most common invertebrates were Trichoptera (Hydropsychidae and Rhyacophilidae), Coleoptera, Elmidae, Ephemeroptera (Baetidae), Diptera (Simuliidae), and Amphipoda (*Hyalella*). Other less common invertebrates included midges, leeches, stoneflies, various caddisflies, various beetles, spiders, and emerging adults of various aquatic insects (Appendix A).

The total number of drifting invertebrates collected for the four intervals in experiment I, part a (Fig. 3) and part b (Fig. 4), was significantly greater for drift samples taken from enclosures containing crayfish (ANOVA, $p = 0.001$). In three of the individual eight twelve-hour collections, the total invertebrate drift per sample was significantly greater in drift from enclosures with adult crayfish. The presence of an adult crayfish significantly decreased the total number of macroinvertebrates within the stream drift over the total 48 hours (ANOVA, $p = 0.003$) (Fig. 5). There was no significant change in the number of invertebrates collected in the stream drift for the daytime or nighttime (ANOVA, $p = 0.7$) indicating that the crayfish influence upon the invertebrate community was independent of time.

The presence of crayfish also negatively affected the total number of benthic invertebrates found inside the enclosures at the conclusion of both experiment 1 a and 1 b (Fig. 6), but was not statistically significant (ANOVA, $p = 0.075$).

Figure 3. Experiment 1a
DRIFT ANALYSIS OF INVERTEBRATES

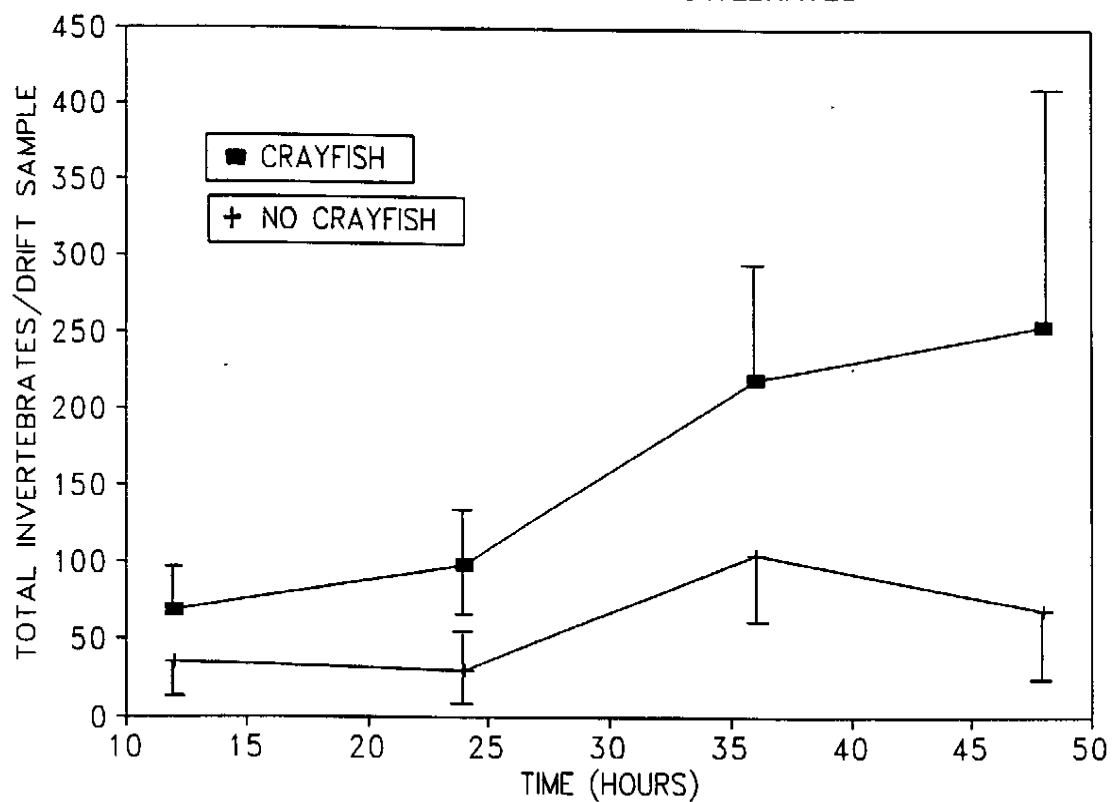


Fig. 3: Total invertebrates per drift sample versus time for experiment 1A, in June. Error bars represent standard error.

Figure 4. Experiment 1b
DRIFT ANALYSIS OF INVERTEBRATES

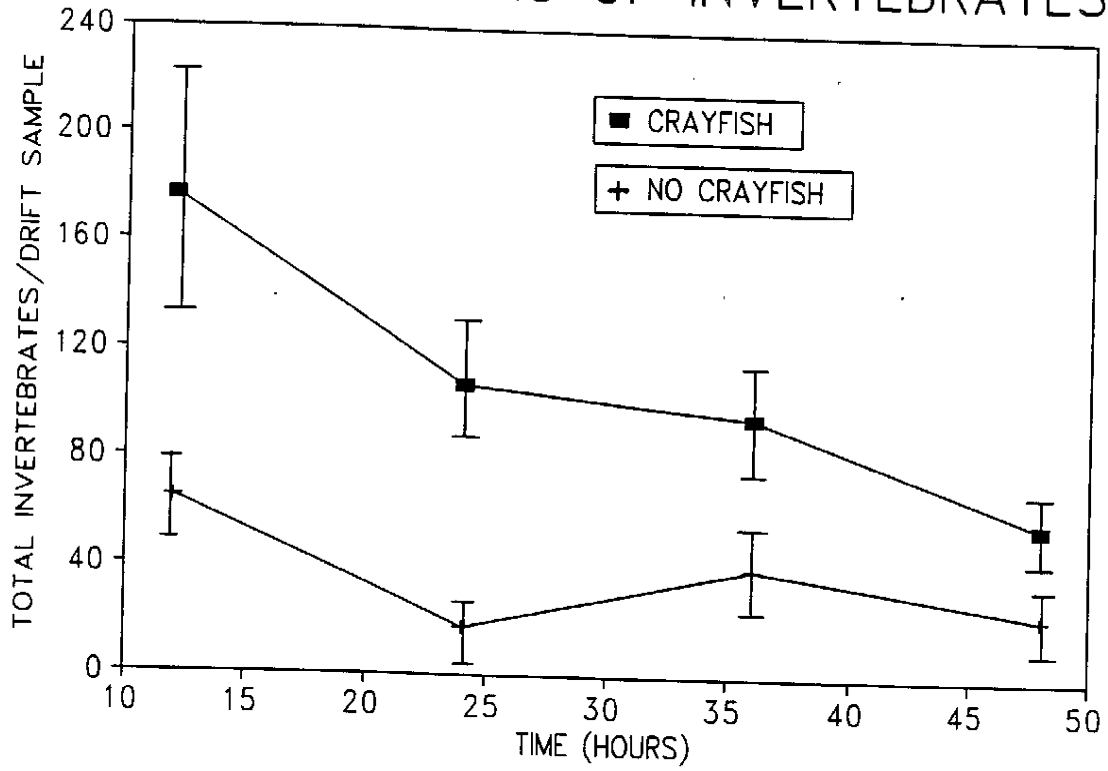


Fig. 4: Total invertebrates per drift sample versus time for experiment 1B, in July. Error bars represent standard error.

Figure 5.
DRIFT ANALYSIS OF INVERTEBRATES

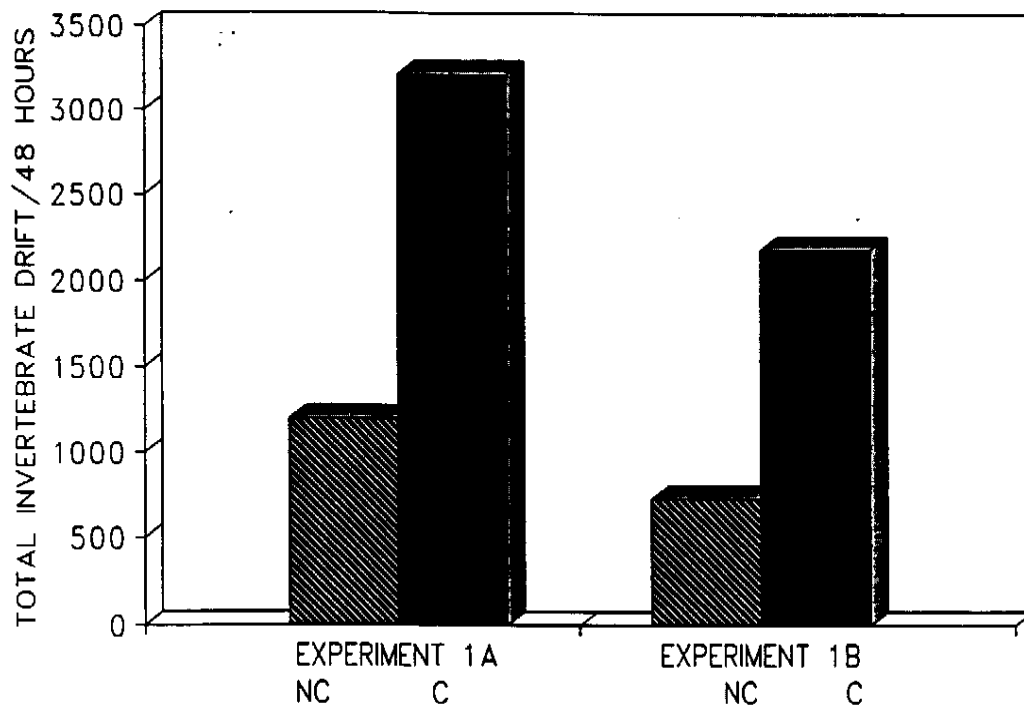


Fig. 5: Total invertebrates in the combined drift samples for the two experiments 1A and 1B collected over 48 hours.

Figure 6. Experiment 1
INVERTEBRATES IN BENTHIC SAMPLE

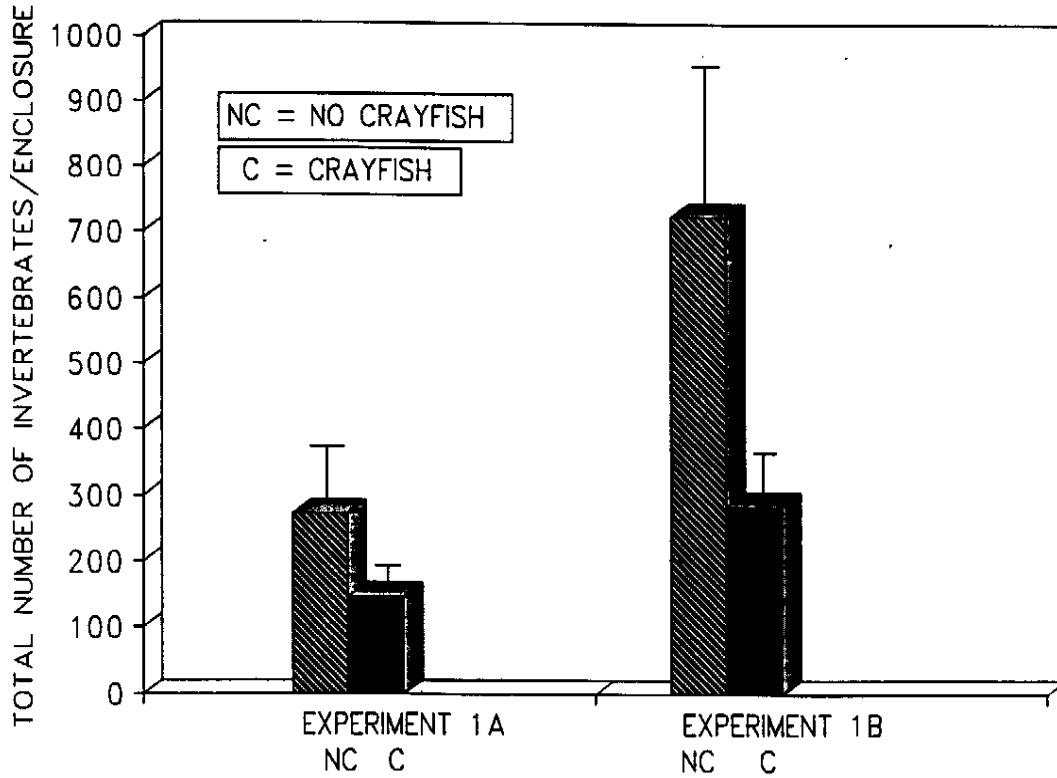


Fig. 6: Average number of invertebrates in each benthic sample at the completion of experiments 1A and 1B. Error bars represent standard error.

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Experiment 1a indicated that *O. propinquus* males had a negative impact on the total macroinvertebrate community in the enclosures. During experiment 1b the YOY were found inside the enclosures. The presence of adult crayfish negatively affected the number of YOY in the enclosures (Fig. 7), but was not statistically significant (ANOVA, $p = 0.4$).

EXPERIMENT 2: Predation on YOY by Adult Crayfish.

Adult crayfish consumed their young, but substrate cover reduced predation rates. In the buckets without cover, each adult crayfish consumed an average of 2.3 ± 0.7 young overnight. In the bucket with clean gravel as substrate each adult crayfish consumed an average of 0.5 ± 1.5 young overnight (fig. 8). However, ANOVA indicated that this difference was not statistically significant ($p = 0.057$). In the experiment without cover, the female crayfish consumed as many YOY as their male counterparts.

EXPERIMENT 3: Crayfish Habitat Preference

Crayfish significantly preferred (ANOVA, $p = 0.03$) the heterogeneous (woody) habitat to the homogeneous (cleared) streambed (Fig. 9). All habitats were covered with a low turf of macrophytes (*Ceratophyllum*, *Potamogeton*, *Myriophyllum*, and various grasses) and had some gravel. Three crayfish were found in the areas without stick bundles: a 1+ under plants, a 3+ next to cobble, a 2+ in thick grass. Crayfish found in areas with stick bundles were usually found within or under the bundles. Larger crayfish were sometimes found nestled in large holes within the anchoring bricks. Three of the 28 crayfish found in stick bundle regions were YOY. All three YOY were found under stick bundles. The remainder of the crayfish found under or inside of the bundles were mostly 2+ and 3+ crayfish of both sexes.

DISCUSSION:

Experiment 1:

The presence of an adult *O. propinquus* crayfish increased the number of macroinvertebrates in the drift and decreased the number of macroinvertebrates found in the substrate of the experimental enclosures. Crayfish are known to be "enthusiastic feeders" (Lodge 1985) and may have disturbed invertebrates, dislodging them into the water column and causing them to drift downstream. If the crayfish consume and dislodge invertebrates, their impact upon the

Figure 7. Experiment 1B
YOUNG-OF-THE-YEAR IN ENCLOSURES

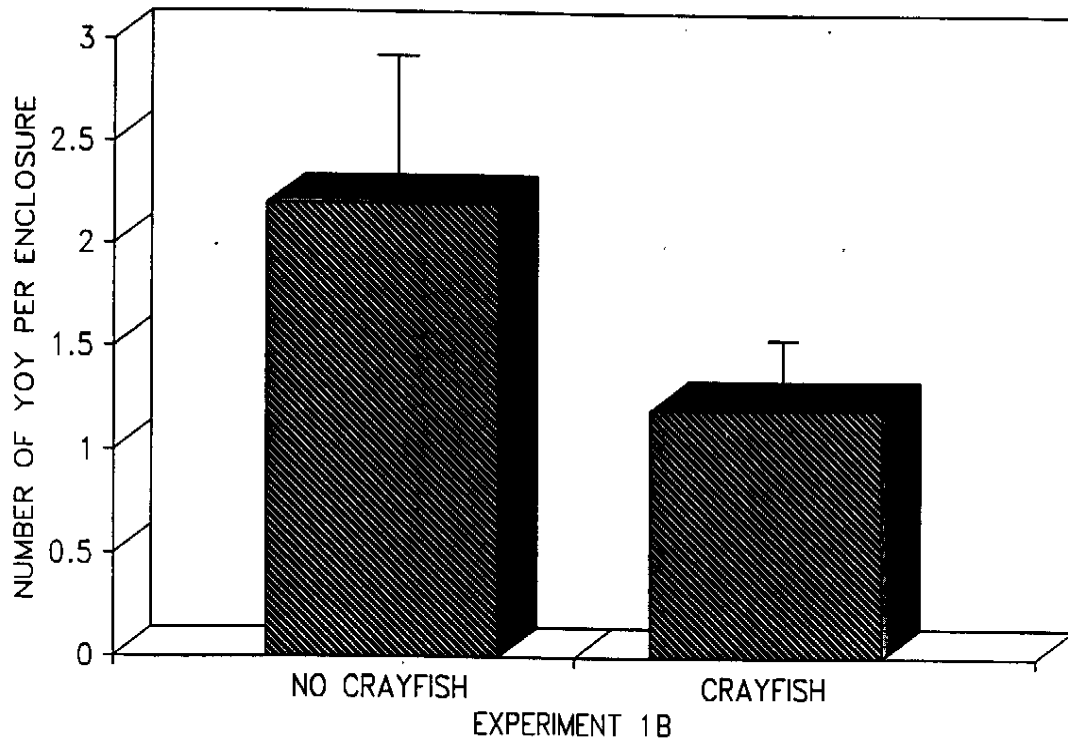


Fig. 7: Number of young-of-the-year per enclosure in enclosures containing an adult crayfish and in enclosures not containing an adult crayfish. Error bars represent standard error.

Figure 8.
CRAYFISH CONSUMPTION OF YOUNG

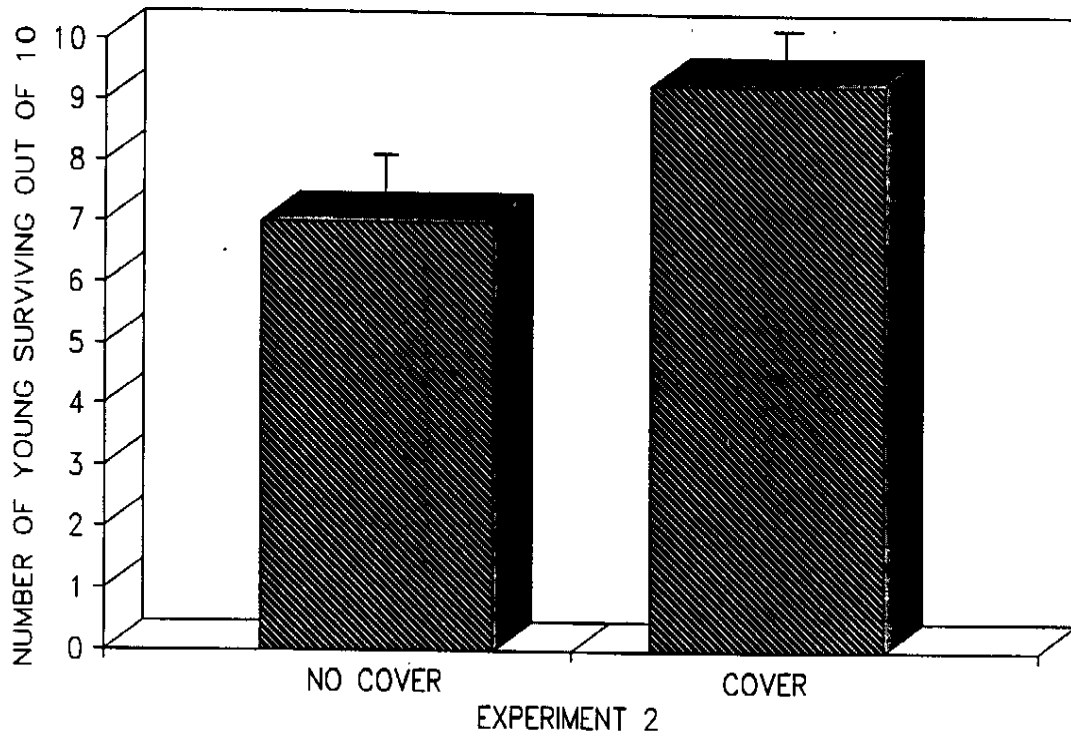


Fig. 8: Average number of young-of-the-year surviving out of 10, for the buckets containing cover and the buckets not containing cover. Error bars represent standard error.

Figure 9. Experiment 3
HABITAT PREFERENCE IN CRAYFISH

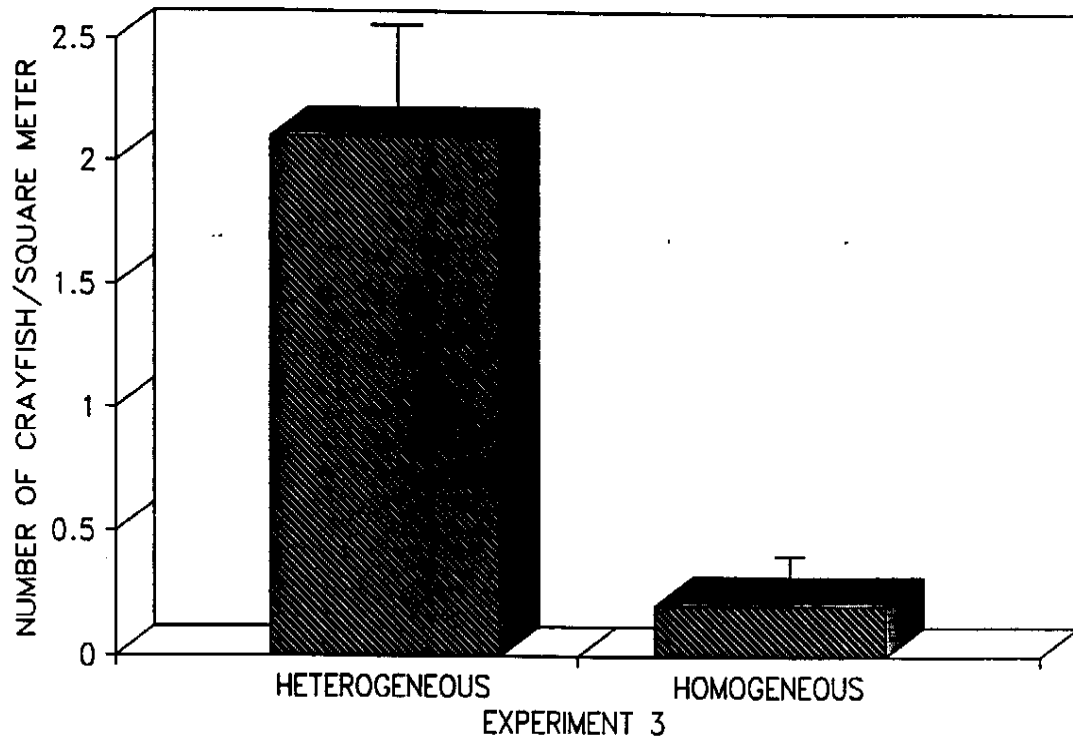


Figure 9: Average number of crayfish per m² in heterogeneous regions and homogeneous regions of the stream. Error bars represent standard error.

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invertebrate community is both direct and indirect. Dislodging the invertebrates may make them easier prey for fish or other predators, indirectly causing a decrease in the community. A number of studies examining crayfish stomach contents have indicated that crayfish consume large numbers of invertebrates. These studies have shown that invertebrates comprise a large portion of the crayfish diet (see review by Magnuson, et al. 1975). Experiment 1a indicated that *O. propinquus* males had a significant negative impact on the total macroinvertebrate community in the enclosures, in contrast to Hanson's conclusion that *O. virilis* male crayfish had little apparent effect on the abundance of non-molluscan invertebrates in lakes (Hanson 1990). The *O. propinquus* crayfish in Tenderfoot Creek caused both a direct and an indirect reduction in the invertebrate community.

Many studies have concluded that larger YOY feed primarily upon amphipods under natural conditions, but that adult crayfish feed primarily on plant material and detritus with small amounts of animal material such as snails (see review by Hanson, et al. 1990). The presence of YOY in the second experiment may have reduced the total number of invertebrates in the substrate and drift within the enclosures. The number of YOY crayfish entering and exiting the enclosures could not be controlled due to the large mesh size of the lab matting, but should have been similar for all replicates. If younger crayfish do consume more macroinvertebrates than older crayfish, my experiment may have underestimated the total effect of *O. propinquus* upon the riffle by using only 3+ individuals within the enclosures.

Experiment 2:

The YOY consumed in this experiment support Capelli's (1980) observation of YOY in adult crayfish stomachs in lakes at a depth of 1 m. The average carapace length for YOY found within the enclosures from experiment 1 was 7.1 ± 1.9 mm (n= 6). Capelli observed that crayfish of carapace length 8 mm are able to escape predation in the presence of cobble. The crayfish within the riffle area of Tenderfoot Creek demonstrated behavior comparable to the lake crayfish in Trout Lake at 1 m that Capelli observed (Capelli 1980).

The number of YOY found inside the enclosures from experiments 1a and 1b support the possibility of cannibalism. Fewer YOY were found inside enclosures with adult crayfish than were found inside enclosures without adult crayfish. Whether this is an indication of predation on the YOY by the adults or merely a result of

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overcrowding cannot be determined. The adult crayfish were never directly observed feeding upon the YOY and the presence of an adult crayfish did not significantly affect the number of YOY inside the enclosures.

My bucket experiment indicated that adult male crayfish ate YOY at the same rate as female adult crayfish under the experimental conditions. In another study, male crayfish preyed little on YOY in comparison with female crayfish (Hanson 1990).

Unfortunately, the change in treatment from one adult crayfish per bucket to two adult crayfish per bucket confounded the results. Interactions between the two adult crayfish (in bucket 2 of both cover and no cover trials) may have interfered with their feeding effort over the evening. In experiments with *O. rusticus* crayfish, aggression was related to available shelter (Capelli 1984). Food, even in excess did not reduce aggressive interactions to the same extent as did shelter. Since no cover was provided for the adult crayfish in bucket 2, experiment 2a (no cover), interactions between the two males and the effect these interactions may have had on feeding behavior cannot be determined. The gravel, which appeared to serve as shelter for the YOYs (by a decrease in number consumed), may have been insufficient shelter for the adults in bucket 2, experiment 2b, allowing for disruptive interactions between the male and female adults.

The only food source present for the adult crayfish was YOY. It is possible that under this food restriction, cannibalism was increased over cannibalism that actually occurs under normal stream conditions where other invertebrates or vegetation may be a preferred food source. This creates opportunities for further study of crayfish food preferences, including YOY.

Experiment 3:

The crayfish demonstrated a clear preference for heterogeneous habitat in this experiment (ANOVA, $p = 0.03$). The areas with sticks bundles and anchoring bricks had over eight times the crayfish density of the regular smooth bottom of the stream. In an artificial substrate experiment performed in the laboratory, Sacramento River crayfish (*Pacifastacus leniusculus*) demonstrated a preference for larger mixed rock over small gravel (Klosterman 1983). *O. propinquus* demonstrated a distinct preference for the larger, complex structures of sticks and bricks, over the small, simple gravel and grasses available in all six areas. This finding across species is not surprising. Crayfish in tanks have been observed occupying shelters, and remaining in them, even throughout

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the nighttime foraging period. Crayfish engage in aggressive behavior with other crayfish if shelters are not available (Capelli 1984). The stick bundles may have provided shelter from known predators of young crayfish, such as large fish (Lorman 1978), and may protect newly molted adults from predators and cannibalism. The stick bundles were well covered with vegetation and algae, perhaps serving as a food source for the crayfish and habitat for invertebrates, which may provide additional food for the crayfish.

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Acknowledgements

I would like to thank Dr. Lamberti for his patient assistance both in the field and in Galvin. I would like to thank Pat Charlebois for her resourcefulness. I would also like to thank the entire 1993 summer class, Scattered Hail, for helping to make this project a reality, especially, Lisa Bongiovi and Alisha Eisert for the field assistance and Brian Foy for the lab work. I would like to thank Dr. Berg for sharing his teaching genius both as a field resource and as a statistical wizard. A special thanks goes to Mr. and Mrs. Bernard J. Hank for providing this opportunity through their generous financial support. A final thanks goes to the loons in Tenderfoot Lake and the *hyla versicolor* - for the music.

Appendix A

Crayfish experiment with *O. propinquus* at Tenderfoot Creek. Experiment I = trial in Jun
 HYDROP=HYDROPSYCHIDAE; RHYACO = RHYACOPHILIDAE; SIMULI= SIMULIIDA
 OTHER INCLUDES LEECHES, BIVALVES, LARGE STONFLIES, AND OTHER INVERT

Experiment I								
order	BAGS	REP	TYPE	HOUR	DATE	TIME	HYDROP	RHYACO
1	A		1 NC		12 6/19	AM	4	0
2	B		2 NC		12 6/19	AM	0	0
3	C		3 NC		12 6/19	AM	2	0
4	D		4 NC		12 6/19	AM	0	0
5	E		5 NC		12 6/19	AM	0	0
6	A		1 NC		24 6/19	PM	2	0
7	B		2 NC		24 6/19	PM	4	0
8	C		3 NC		24 6/19	PM	0	0
9	D		4 NC		24 6/19	PM	0	0
10	E		5 NC		24 6/19	PM	0	0
11	A		1 NC		36 6/20	AM	0	0
12	B		2 NC		36 6/20	AM	0	0
13	C		3 NC		36 6/20	AM	4	0
14	D		4 NC		36 6/20	AM	0	0
15	E		5 NC		36 6/20	AM	0	0
16	A		1 NC		48 6/20	PM	0	0
17	B		2 NC		48 6/20	PM	0	0
18	C		3 NC		48 6/20	PM	24	0
19	D		4 NC		48 6/20	PM	0	0
20	E		5 NC		48 6/20	PM	0	0
21	A		1 C		12 6/19	AM	0	0
22	B		2 C		12 6/19	AM	0	0
23	C		3 C		12 6/19	AM	2	0
24	D		4 C		12 6/19	AM	0	1
25	E		5 C		12 6/19	AM	0	0
26	A		1 C		24 6/19	PM	0	0
27	B		2 C		24 6/19	PM	0	0
28	C		3 C		24 6/19	PM	2	0
29	D		4 C		24 6/19	PM	0	0
30	E		5 C		24 6/19	PM	0	0
31	A		1 C		36 6/20	AM	8	0
32	B		2 C		36 6/20	AM	0	0
33	C		3 C		36 6/20	AM	8	0
34	D		4 C		36 6/20	AM	8	8
35	E		5 C		36 6/20	AM	8	0
36	A		1 C		48 6/20	PM	0	0
37	B		2 C		48 6/20	PM	0	0
38	C		3 C		48 6/20	PM	16	0
39	D		4 C		48 6/20	PM	0	0
40	E		5 C		48 6/20	PM	0	0

e; Expreiment II = trial in July; c = experimental (crayfish present); nc = control (no crayfish in enclosure).
 E; CHIR NOMIDAE; BAETDAE = BAETADAE ; HYALEL = HY LA; CHAOBO = CHAOBOROU S
 EBRATES WHICH WERE FOUND IN VERY SMALL QUANTITIES.

SIMULI	CHIR	ELMIDAE	BAETDAE	HYALEL	CHAOBO	OTHER	SUM F-M	TOTAL S
12	24	0	0	20	8	4	68	72
12	32	0	8	4	0	13	56	69
4	4	0	2	1	0	0	13	13
4	8	0	6	0	0	0	18	18
4	1	0	2	0	0	0	7	7
4	6	0	6	0	0	2	18	20
4	12	2	0	0	0	0	22	22
36	40	0	6	0	0	0	82	82
4	8	0	7	0	0	0	19	19
4	1	0	2	0	0	0	7	7
0	64	32	0	0	16	24	112	136
20	28	0	8	4	0	8	60	68
64	60	0	5	4	0	0	137	137
56	36	0	16	8	8	8	124	132
0	24	4	4	8	4	8	44	52
4	36	0	0	0	0	0	40	40
8	20	0	8	0	0	0	36	36
64	56	8	16	0	0	24	168	192
28	16	0	8	0	0	4	52	56
4	12	0	0	0	0	4	16	20
12	28	0	0	0	12	2	52	54
4	44	0	4	4	0	8	56	64
76	64	0	10	10	0	6	162	168
4	8	0	1	4	0	0	18	18
4	36	0	0	0	0	0	40	40
72	36	0	16	0	0	0	124	124
4	6	4	0	0	0	0	14	14
76	64	0	10	0	0	6	152	158
72	28	0	14	0	0	2	114	116
32	32	0	16	0	0	0	80	80
96	88	32	24	8	16	18	272	290
8	64	16	0	8	4	16	100	116
184	88	0	48	0	0	0	328	328
120	104	0	40	8	16	8	304	312
16	24	0	0	4	0	2	52	54
24	112	8	32	0	0	0	176	176
0	36	0	8	0	0	0	44	44
576	176	8	56	32	0	8	864	872
58	30	0	12	0	0	4	100	104
28	24	0	20	0	0	5	72	77

EXPERIMENT II

41	A	1	NC	12	7/17	AM	36	4
42	B	2	NC		7/17	AM	16	0
43	C	3	NC		7/17	AM	50	0
44	D	4	NC		7/17	AM	28	2
45	E	5	NC		7/17	AM	11	2
46	A	1	NC	24	7/17	PM	1	0
47	B	2	NC		7/17	PM	6	1
48	C	3	NC		7/17	PM	12	0
49	D	4	NC		7/17	PM	5	0
50	E	5	NC		7/17	PM	3	2
51	A	1	NC	36	7/19	AM	4	2
52	B	2	NC		7/19	AM	10	0
53	C	3	NC		7/19	AM	10	0
54	D	4	NC		7/19	AM	4	0
55	E	5	NC		7/19	AM	4	0
56	A	1	NC	48	7/19	PM	3	0
57	B	2	NC		7/19	PM	12	0
58	C	3	NC		7/19	PM	0	2
59	D	4	NC		7/19	PM	0	0
60	E	5	NC		7/19	PM	0	1
61	A	1	C		7/17	AM	164	0
62	B	2	C		7/17	AM	164	0
63	C	3	C		7/17	AM	140	0
64	D	4	C		7/17	AM	52	4
65	E	5	C		7/17	AM	8	0
66	A	1	C		7/17	PM	12	20
67	B	2	C		7/17	PM	108	0
68	C	3	C		7/17	PM	52	0
69	D	4	C		7/17	PM	40	0
70	E	5	C		7/17	PM	12	0
71	A	1	C		7/19	AM	56	8
72	B	2	C		7/19	AM	46	2
73	C	3	C		7/19	AM	50	4
74	D	4	C		7/19	AM	14	0

4	12	0	20	8	0	1	84	85
6	12	0	10	2	0	10	46	56
22	22	2	2	2	0	5	100	105
16	10	0	2	0	0	4	58	62
0	0	0	1	1	0	1	15	16
3	2	0	4	0	0	0	10	10
5	3	0	11	0	0	1	26	27
2	8	0	4	0	0	0	26	26
5	3	0	4	0	0	0	17	17
0	0	0	2	0	0	0	7	7
4	10	0	4	0	0	1	24	25
14	26	0	6	12	0	2	68	70
14	6	0	6	0	0	2	36	38
6	16	0	2	0	0	0	28	28
6	10	0	16	0	1	1	37	38
4	1	0	2	0	0	0	10	10
12	0	28	2	0	0	0	54	54
2	10	0	4	0	0	0	18	18
4	8	0	6	0	0	0	18	18
3	6	0	5	0	0	0	15	15
8	72	0	24	0	0	0	268	268
4	36	0	40	40	0	1	284	285
32	18	0	6	0	0	4	196	200
12	16	0	20	16	0	0	120	120
0	0	0	4	0	0	0	12	12
4	40	0	36	0	0	1	112	113
4	40	0	20	0	0	0	172	172
32	28	0	8	0	0	0	120	120
4	24	0	40	0	0	0	108	108
0	4	0	8	0	0	0	24	24
12	20	0	28	24	0	3	148	151
16	14	4	32	4	0	0	118	118
0	16	0	30	0	0	5	100	105
8	8	0	18	8	0	1	56	57