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# The Effects of Different Fishing Methods on the Mortality of Eastern Oysters (*Crassostrea virginica*).


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## ABSTRACT

Sephton, T.W. and T. Landry. 1992. The effects of different fishing methods on the mortality of eastern oysters (*Crassostrea virginica*). Can. Tech. Rep. Fish. Aquat. Sci. 1862:v+10p.

The effects of two fishing methods on the post-harvesting mortality and recruitment of oysters were evaluated experimentally in a natural habitat. The three month experiment revealed that post-harvesting mortalities were significantly increased in hand picked areas while there were no significant differences between tonged and control areas. Spat survival was also shown to be significantly higher in areas that had been tonged compared to controls.

## RÉSUMÉ

Sephton, T.W. and T. Landry. 1992. The effects of different fishing methods on the mortality of eastern oysters (*Crassostrea virginica*). Can. Tech. Rep. Fish. Aquat. Sci. 1862:v+10p.

Les conséquences après-récolte sur la mortalité et le recrutement des huîtres ont été évaluées expérimentalement en milieu naturel, en utilisant deux méthodes de pêches. L'expérimentation, d'une durée de trois mois, a permis de démontrer que la mortalité après-récolte était significativement augmentée sur les sites récoltés manuellement, alors qu'il n'y avait pas de différence significative entre les sites récoltés au rateau et les sites contrôles. La survie du naissain était aussi significativement plus élevée sur les sites qui avait été récoltés au rateau comparativement aux sites contrôles.

## INTRODUCTION

The public fishing grounds and picking areas are the most important sources of legal size (hinge to bill length > 75mm) eastern oysters (*Crassostrea virginica* Gmelin) for the leasehold relay and market fisheries in Prince Edward Island and New Brunswick (Lavoie 1978, Hawkins and Rowell 1985). There is a general lack of long term data showing the changes in the abundance, biomass and distribution of oysters for most areas in the southern Gulf of St. Lawrence other than for the public fishing grounds of Bedeque Bay, Prince Edward Island (PEI) and Caraquet Bay, New Brunswick (NB) (Sephton and Bryan 1989). Bedeque Bay, PEI is one of the few areas where a spring relay fishery is practised in the Gulf of St. Lawrence and the tonging method of fishing is the only one authorised for collecting oysters from the public fishing areas, where shellfishermen harvest oysters by hand tonging from their dories. Oysters can also be collected to stock private leases, with special permission, from intertidal flats by hand picking during low tides, with shellfishermen walking and crawling over the flats. The effects of these two harvesting methods on natural mortality and population dynamics are not clear (Medcof 1961, Galtsoff 1964) and have been the subject of some controversy over the years among fisheries managers and shellfishermen. The objectives of the present study are to examine the effects of hand picking and tonging methods, on the mortality of intertidal oysters and the survival of oyster spat settling on the oyster cultch.

## MATERIALS AND METHODS

Two experiments were set up adjacent to one another in a sheltered cove in the North River, PEI (Fig.1) in early July of 1990 as shown in Figure 2. The area has a native population of oysters growing on the muddy substrate. There was a relatively dense cover of eel grass (*Zostera marina*) throughout the area.

### Experiment 1: Hand Picking

This experiment examined oyster mortality and the compared the effects of crawling and walking while hand picking oysters, and of tonging them from a dory. The null hypothesis was that walking and tonging had no effect on the survival of oysters remaining on the harvested area. All oysters were removed from the experimental area and the shells marked with a saw blade at the umbo. The test (tonging labelled "T" and picking labelled "W" in Fig.2) and control plots (2m X 5m each) were established and their position recorded on a map. They were delineated with labelled leadlines strung from anchored corner posts. Test and control plots were replicated (3 times each) at 2 adjacent locations for a total of 18 marked plots as shown in Figure 2. Marked oysters were spread uniformly over all plots at a density of 20-25 $m^{-2}$ (a total of ≈ 4000 oysters). Shellfishermen walked and crawled over the picking test plots during low tide at a speed simulating the normal searching and gathering behaviour of an experienced fisherman hand picking without actually handling the oysters, while tonging activities were simulated from a dory during high tide, on the tonging test plots. These simulations were consistent for all test replicates and were recorded using underwater video equipment.

The experiment was sampled in late September, 1990 about 3 months after the experiment started. A random $0.5m^2$ sample was collected from each plot by divers hand picking all material within the area of the quadrat. The $0.5m^2$ sample size was chosen to allow multiple sampling of each plot in the future without overly disturbing the plots. Oyster mortality (dead marked oysters with articulated shells) was estimated from the quantitative sampling of all test and control plots. The mortality data (percentage) were transformed using the arcsine square root transformation (Snedecor and Cochran 1967) and analyzed with a one-way ANOVA and the Duncan's multiple range test (SAS GLM procedure) (SAS 1989) to determine if there were significant ($p < 0.05$) differences within treatments and among paired comparisons.

Experiment 2: Tonging and Spat Settlement and Survival

This experiment examined the survival of oyster spat settling onto naturally occurring cultch that was disturbed and exposed by the tonging process. The null hypothesis was that there would be no difference in the spat settlement between the test and control plots. A series of test and control plots (2m x 5m each) were set up as described above and were replicated three times at 3 adjacent locations for a total of 18 marked plots as shown in Figure 2. All test (labelled "T" in Fig. 2) plots were tonged with oyster tongs from a dory to simulate oyster fishing while the controls were left undisturbed. All plots were equally susceptible to the settlement of oyster spat from local oyster populations.

In late September, 1990, benthic surface samples ($0.5m^2$) of all cultch (oysters and shells) were collected by divers hand picking all material from within the sample area. Samples were collected from 6 randomly selected test (of the 9 possible) and control (of the 9 possible) plots. All live oyster spat on all the shell cultch and oysters collected from each sample were identified and enumerated using a stereomicroscope. Live adult oysters were opened and all soft tissue removed from the valves prior to determining dry shell weights (washed and dried @ 60°C for 8 h.) of all oyster cultch.

Data on spat survival and settlement (number of live spat per weight of shell) were transformed with the $\log_{10}(n+1)$ transformation to normalize the data and analyzed with a one-way ANOVA (SAS GLM procedure) (SAS 1989) to compare spat abundance between control and test plots.

## RESULTS

Experiment 1: Hand Picking

A total of 283 marked oysters were recovered from the quantitative samples collected from the 3 experimental sites: 91 oysters from the 6 control plots, 107 oysters from the 6 tonging plots, and 85 oysters from the 6 walking plots (Table 1). Oyster mortalities in this experiment (I) ranged from 0% to 72%, with the highest mortality recorded from a picking plot where 8 of the 11 marked oysters collected were dead. The one-way ANOVA showed that the mortality levels were significantly ($F=6.89$; $df=2,15$; $p < 0.05$) different among the three (3) treatments (control, picking and tonging). A Duncan's multiple-range test revealed that the mortality levels observed from the picking plots, where walking and crawling activities were simulated, were significantly ($p < 0.05$)

higher then those from the tonging and control plots, which were not significantly different from one another. The average mortality level from the picking plots was 30.9%, while those from the tonging and control plots were 6.24% and 4.07%, respectively.

Experiment 2: Tonging and Spat Settlement and Survival

Spat were counted from a total of 2279 g of shell material which corresponded to approximately 75 oyster valves. Samples collected from the six (6) control plots had 962 g of cultch material (≈ 33 oyster valves), while those from the six (6) tonging plots had 1317 g (≈ 42 oyster valves). Spat counts varied from 0 to 55 per oyster valve and the highest count was recorded from a tonging plot sample where a total of 116 spat were enumerated from six (6) oyster valves. The control plots had an average spat density of 0.02 spat/g shell cultch with a range from 0/g to 0.033/g. The spat densities from the tonging plots ranged from 0.048/g shell cultch to 0.55/g with an average of 0.17/g shell cultch. A one-way ANOVA revealed that the spat settlement and survival densities from the tonging plots were significantly ($F=14.17$; $df=1,10$; $p < 0.05$) higher then those from the control plots.

## DISCUSSION

Increased mortalities and damage to the habitat are known to occur when mechanical or hydraulic oyster harvesters are used to harvest oysters (Klemanowicz and Steele 1984). The results from the present study clearly show that hand picking activities increases the mortality levels of those oysters remaining in the harvested area while tonging activities prior to the oyster spat settlement increases the spat settlement on oyster cultch (recruitment) without increasing the mortality levels. The differences in the quantity of cultch in the tonged and control plots (1317 g and 962 g, respectively) in experiment II, suggested that tonging had increased the quantities of cultch exposed thereby pre-disposing it to spat settlement and attachment. Many factors are known to influence the settlement of oyster spat onto various substrates such as chemical and environmental cues, the presence of conspecifics and predators and an interaction of environmental parameters as reviewed recently by Roegner and Mann (1990). It is generally believed that disturbing or working an oyster bed by tonging activities during a spring fishery significantly increases the availability of cultch to spatfall and potentially increasing the recruitment to the population (Lavoie and Bryan 1981) but had not actually been corroborated until the present study. Other stock enhancement techniques such as the planting of clam and oyster shell are commonly used to augment the natural cultch available in an area which usually increases the quantity of spat setting and eventual recruitment to the oyster population (Abbe 1988, Morales-Alamo and Mann 1990).

Oyster mortality caused by the mechanical damage of winter ice has always been a consideration when selecting an area for enhancement projects and private leases (Medcof 1961). Winter mortality caused by ice and freezing was an argument put forth by those who believed that oysters left in the intertidal zone and not fished for market or relaying were destined to certain death because of the ice. The argument followed that any detrimental effects of the hand picking would be negligible in comparison with those caused by the winter ice. The same would hold true for young of the year (spat) and juveniles. However, if any of the remaining oysters within the intertidal zone can survive, then our experiment clearly showed that tonging in these areas during high tides would significantly reduce post-harvesting mortality and increase the potential cultch for spatfall (recruitment) and survival of oyster spat, therefore contributing significantly to the local oyster population. Many oyster leases of different bottom types are located in intertidal areas, freezing solid some winters, with few reports of massive mortalities following spring thaw and are considered good grow out and production areas for the leasehold industry. A recent study of the effects of simulated ice rafting on sea-grass beds showed a rapid recovery of the benthic fauna (Schneider and Mann 1991) and further research is warranted to clarify the damage caused by winter ice on intertidal oyster populations.

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TABLE 1 Oyster mortality estimates from the control, tonging, and picking plots in the hand picking experiment (I). The total number recaptured are those marked oysters collected as part of the experiment. The picking plots are labelled "W" in Fig 2.

| | Treatment | Total N Recaptured | Mortality # Dead | Mortality Percentage |
|---|---|---|---|---|
| | Control | 21 | 1 | 4.76% |
| | Control | 16 | 2 | 12.50% |
| | Control | 12 | 0 | 0.00% |
| | Control | 14 | 1 | 7.17% |
| | Control | 9 | 0 | 0.00% |
| | Control | 19 | 0 | 0.00% |
| Total | Control | 91 | 4 | 4.07% |
| | Tonging | 15 | 2 | 13.33% |
| | Tonging | 12 | 1 | 8.33% |
| | Tonging | 15 | 0 | 0.00% |
| | Tonging | 12 | 0 | 0.00% |
| | Tonging | 15 | 0 | 0.00% |
| | Tonging | 38 | 6 | 15.79% |
| Total | Tonging | 107 | 9 | 6.24% |
| | Picking | 19 | 1 | 5.26% |
| | Picking | 6 | 1 | 16.67% |
| | Picking | 25 | 4 | 16.00% |
| | Picking | 11 | 4 | 36.36% |
| | Picking | 13 | 5 | 38.46% |
| | Picking | 11 | 8 | 72.73% |
| Total | Picking | 85 | 23 | 30.90% |

TABLE 2 Oyster spat densities from the control and tonging plots in the tonging and spat survival experiment (II).

| | Treatment | Total Wt Cultch (g) | Total Spat # | Spat Density(no/g) |
|---|---|---|---|---|
| | Control | 172.2 | 2 | 0.0116 |
| | Control | 109.6 | 2 | 0.0183 |
| | Control | 180.0 | 6 | 0.0333 |
| | Control | 195.5 | 0 | 0.0000 |
| | Control | 67.2 | 0 | 0.0000 |
| | Control | 237.9 | 7 | 0.0294 |
| Total | Control | 962.4 | 17 | 0.0177 |
| | Tonging | 231.0 | 15 | 0.0649 |
| | Tonging | 167.8 | 8 | 0.0477 |
| | Tonging | 212.7 | 116 | 0.5454 |
| | Tonging | 258.6 | 43 | 0.1663 |
| | Tonging | 270.0 | 41 | 0.1519 |
| | Tonging | 177.1 | 6 | 0.0339 |
| Total | Tonging | 1317.2 | 229 | 0.1739 |

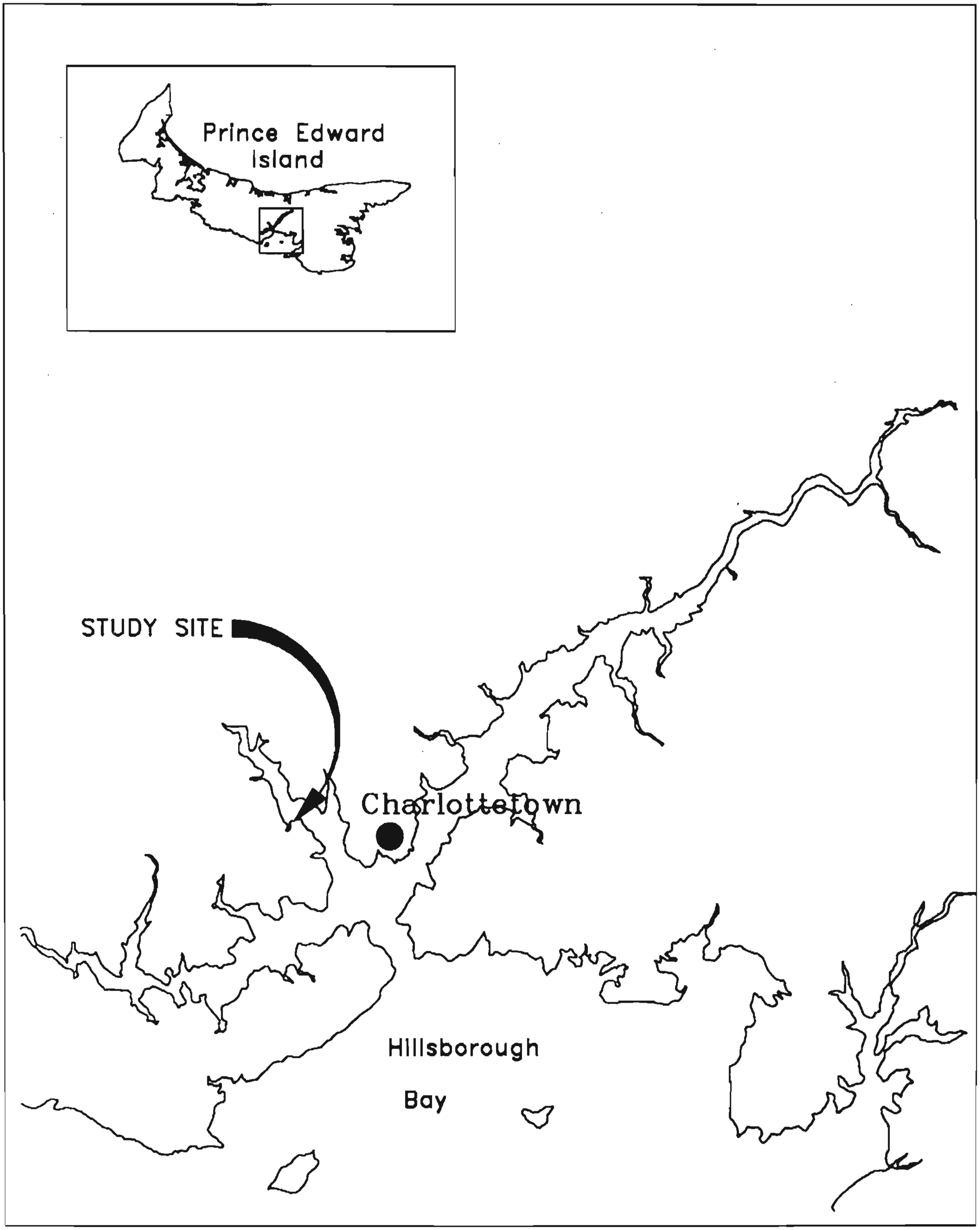


FIGURE 1 Location of study site in North River, Prince Edward Island.

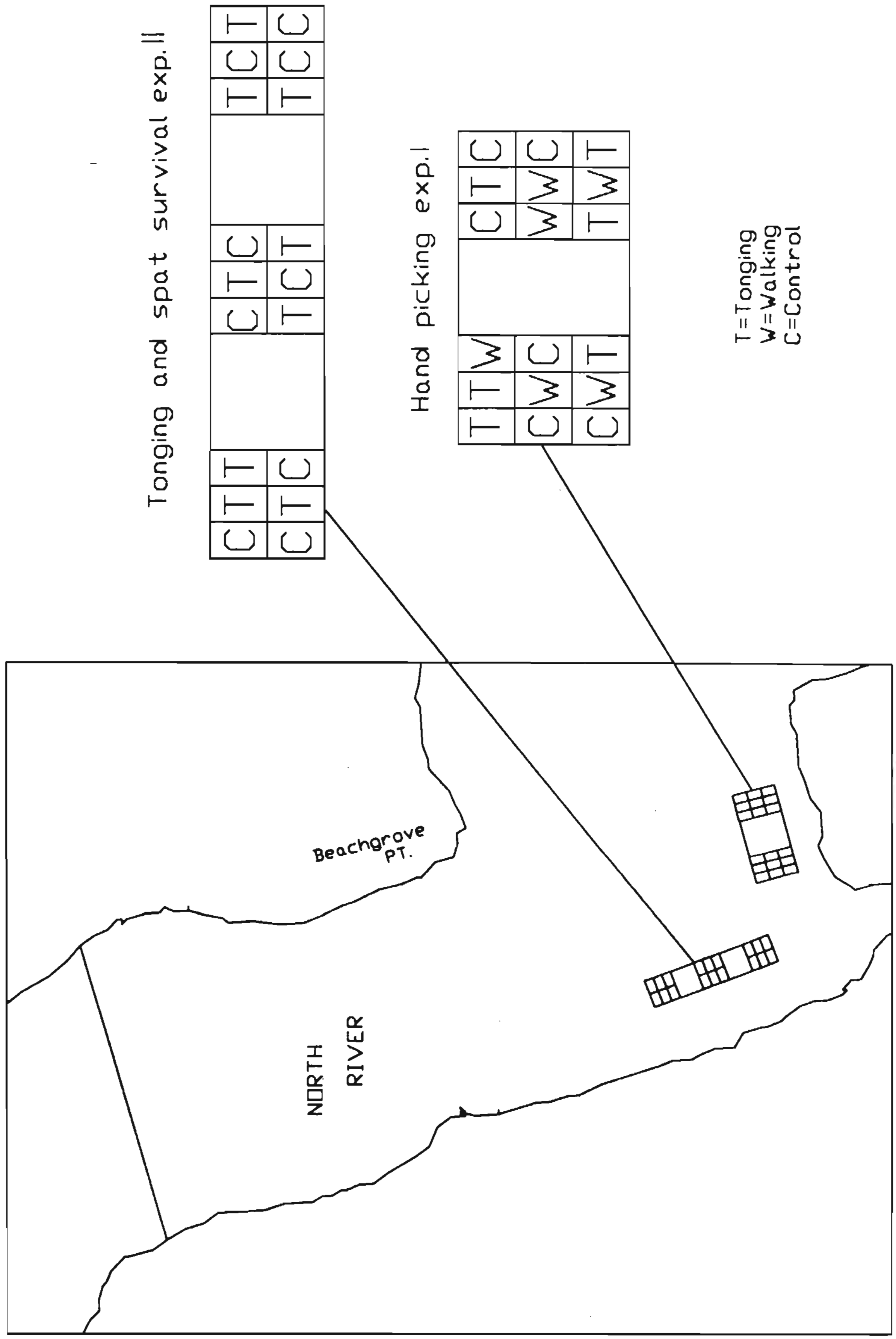


FIGURE 2 Diagram of the experimental plots used for the hand picking (I) and tonging and spat survival (II) experiments.