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Comparison of the relationship between lobster catch rates and temperature between a spring (LFA 24) and a fall (LFA 25) lobster fishery in the Gulf of St. Lawrence.

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ABSTRACT

The relationship between the mean daily temperature (MDT) and daily catch per unit effort (CPUE) for lobster was study in two different lobster fishing areas (LFA) in the southern Gulf of St. Lawrence. Data were collected in 8 different study sites representing a spring (LFA 24; Alberton, Malpeque, Tracadie Bay and North Lake) and a fall (LFA 25; Pointe-Sapin, Cap Lumière, Robichaud and Pugwash) fishery. Lobster landings and number of trap hauls were available through a volunteer program by fishers and bottom temperatures were measured from moored thermistors. The analysis showed that their was no relationship between the MDT during the 24 hr prior to trap being hauled and CPUE for all the study sites in LFA 25, and that a good relationship between the MDT and CPUE was observed for only 2 out of the 4 sites in LFA 24. The total absence of a relationship in LFA 25 was attributed to the high water temperature recorded during the entire fall lobster fishing season.

RÉSUMÉ

La relation entre la température quotidienne moyenne (TQM) et la prise par unité d'effort (PUE) quotidienne pour le homard a été étudiée dans deux différentes zones de pêche du homard (ZPH) dans le sud du golfe du Saint-Laurent. Les données ont été récoltées dans 8 différents sites d'étude représentatifs d'une pêcherie du printemps (ZPH 24; Alberton, Malpeque, Tracadie Bay et North Lake) et d'automne (ZPH 25; Pointe-Sapin, Cap Lumière, Robichaud et Pugwash). Les débarquements de homards et le nombre de casiers levés ont été obtenus par un programme volontaire de pêcheurs repères et les températures du fond ont été enregistrées par des thermographes à des stations fixes. Les analyses ont démontrées qu'il n'y avait aucune relation entre la TQM de la période de 24 h précédant la levée du casier et la PUE pour tous les sites d'étude dans le ZPH 25. Une bonne relation entre la TQM et la PUE a été observée pour seulement 2 des 4 sites d'étude dans le ZPH 24. L'absence totale d'une relation dans le ZPH 25 était attribuable à la température élevée observée toute au long de la saison de pêche en automne.

Introduction

The lobster fishery in the southern Gulf of St. Lawrence is managed within 5 Lobster Fishing Areas (LFA). These fisheries are regulated by a minimal legal size, fishing season, prohibition on ovigerous females landings and trap limits (Lanteigne et al. 1994, Lanteigne and Mallet 1995), which differ for each LFA (Table 1).

Table 1. Fishing season dates, minimum legal sizes and trap limits for each Lobster Fishing Area (LFA) in the southern Gulf of St. Lawrence.

LFA	SEASON	LEGAL SIZE	TRAP LIMITS
23	MAY-JUNE	66.7 mm	375
24	MAY-JUNE	63.5 mm	300
25	10 AUG.-10 OCT.	66.7 mm	250
26A	MAY-JUNE	65.1 mm	300
26B	MAY-JUNE	70.0 mm	300

Landings in the Gulf of St. Lawrence have reached historical highs from the mid to the late 1980's (Lanteigne et al. 1994, Lanteigne and Mallet 1995). Since 1985, different trends have been observed in LFA 24 and 25 (Fig. 1). Considering sub-areas within each LFA, increasing trends were observed in LFA 24, while a rather stable trend and a decreasing trend were observed in the western and central portion of LFA 25, respectively (Fig. 1).

Comeau and Drinkwater (1997) showed a relationship between wind, mean daily water temperature (MDT) and catch per unit effort (CPUE) for the Baie des Chaleurs in LFA 23. However, they could not establish a relationship between MDT and CPUE for fishing grounds located in the Gulf of St. Lawrence (LFA 23). The positive correlation indicated by Comeau and Drinkwater (1997) corroborate McLeese and Wilder (1958) findings on the activity and catchability of lobster in relation to temperature. According to fishers in LFA 24 and 25 wind will affect their daily landings in some sub-areas. In the entire LFA 24 and sub-area in LFA 25 west, southerly winds will produce a decrease in landings, while northerly winds produce good landings. In contrast, wind will not significantly affect landings in sub-area LFA 25 central.

The purpose of this paper is to investigate the relationship between MDT and daily CPUE for LFA 24 and 25 where different landings trends have been observed.

Materials and Methods

The study sites are located in LFA 24 and 25 (Fig. 2). LFA 24 encompasses fishing grounds in Northern Prince Edward Island (PEI) from North Cape to East Point. LFA 25 encompasses fishing grounds in Western and part of Central Northumberland Strait from the Escuminac Point to Pugwash on the New Brunswick-Nova Scotia (NB-NS) side, and from North Cape to Victoria on the PEI side. Sub-areas within each LFA were grouped based on statistical districts (SD): LFA 24 west (SD 92 & 93), LFA 24 central (SD 95 & 96), LFA 24 east (SD 88), LFA 25 west (SD 75, 76, 77 & 82) and LFA 25 central (SD 45, 78, 80 & 83).

Data on catches and trap hauls for each study site were obtained from a voluntary fisher's logbook program (Index-Fisher Program) initiated in 1993 by the Lobster Group from the Department of Fisheries and Oceans (DFO) in Moncton (Lanteigne et al. 1994). From these data,

daily CPUE was calculated. As lobster catchability is influenced by soak time (Krouse 1989), only catch and effort data with one (1) soak day were used.

Temperature data were collected under the Coastal Water Temperature Monitoring Program (CWTM) designed and managed by the Lobster Group (DFO) in Moncton (Lanteigne et al. 1996). In 1995 and 1996, temperature loggers (model; Vemco Minilog) located in LFA 24 and 25 (Fig. 2) were attached to a mooring with a surface buoy and deployed at a depth of 20 m. The only exception was the temperature logger in Malpeque which was attached to a complete sub-surface setup. All loggers used were programmed to record temperature and time every 2 h.

The daily CPUE and the mean daily temperature (MDT) were used to investigate the relationship of catchability and temperature. To better reflect the average temperature experienced during a fishing period (being the time between the setting and hauling of the traps), the MDT for comparison with the CPUE on day i was calculated by averaging temperatures over a 24-h period beginning at 8:00 am the previous day since most traps are hauled and redeployed during the early morning. To remove seasonal trends, first differences of the CPUE and MDT were taken, i.e.

$$\Delta \text{ CPUE} = \text{CPUE } (t_{i+1}) - \text{CPUE } (t_i)$$
$$\Delta \text{ MDT} = \text{MDT } (t_{i+1}) - \text{MDT } (t_i)$$

where Δ represents the first difference. The dependence of CPUE and MDT was then tested using the binomial test (Conover 1980).

Results

Lobster catchability depends on a series of environmental, physiological and behavioral factors along with mechanical characteristics of the trap (Krouse 1989). Lobsters have a hard exoskeleton and growth is accomplished through molting, i.e. replacing their entire carapace with a larger one. Because of the soft carapace condition following molting, lobsters will seek shelter shortly before molting in order to protect themselves against predators. The molting season in the Gulf of St. Lawrence normally starts at the end of June and continues all summer until the end of August.

Most of the spring fisheries in the Gulf of St. Lawrence are characterized by an offshore-inshore movement of the traps over the entire fishing ground. The fishing strategies or patterns in LFA 24 and 25 are quite different. In LFA 24, fishers used small (32 in. on length with one parlor) traditional wooden traps attached on strings of 6 to 15 in SD 92 and on strings of 5 to 10 in the rest of the LFA. At the beginning of the season, lobster traps are concentrated offshore at depths of 20 to 30 m followed by a gradual inshore movement until the end of the fishing season, at which time traps are observed close to shore. Few traps are located at depths greater than 15 m by June. These seasonal changes in the placement of traps corresponds to the inshore migration of lobsters during the spring. The catch composition in LFA 24 is characterized by the smallest size lobster landed in Eastern Canada (Robichaud et al. 1996a), mainly due to the regulation on legal size.

In LFA 25, different fishing strategies are encountered between the western and central portion of the Northumberland Strait, and between the PEI and the NB-NS side. The fishing pattern of an offshore-inshore movement observed in the SD 75, 76 and 82 is similar to the one observed in the spring fishery in LFA 24. For the remaining SD, fishers undertake less directed movements as they cover the entire fishing grounds over the whole season. On the PEI side, all fishers used large (4 ft. of length with 2 parlors) wooden traps fished singly or attached on strings

of 2 to 3 traps. On the NB-NS side, fishers used large wire traps in SD 75, 76 and 45 (Pugwash area) and large wooden traps in SD 77, 78 and 80. Traps are attached on strings of 5 to 6 in SD 75 and 76, and as single traps in the other SD. The hoop ring of the entrances are larger in the SD 80, 45 and on the entire PEI side. In the remaining SD on the NB side, the hoop rings are of the same size as LFA 24, i.e. approximately 5.5 inches diameter. The catch composition is primarily canner size lobster (80 % of lobster between 66.7 to 81 mm carapace length) in LFA 25 west, compared to a ratio of 1:1 between canner and market size lobster in LFA 25 central (Robichaud et al. 1996b). Landings per fisher is higher in LFA 25 west than in LFA 25 central. As the fishing season progresses and the CPUE decreases, fishers in LFA 25 central will adopt a trap hauling rotation, i.e. they will either fish every 2 to 3 days or alternate from hauling half the traps one day and the other half the next day. In either scenario, soak time is 2 to 3 days, and the CPUE data cannot be used to investigate the variability between MDT and CPUE.

Prior to statistical analysis and data transformation to investigate daily variability, all trends need to be identified and those not related to this study be removed for each LFA. As it was observed by Comeau and Drinkwater (1997) in LFA 23, seasonal trends were observed for the MDT and CPUE data in LFA 24 (Fig. 3). A positive trend was observed for temperature as the cold water (± 2 °C) observed in early May gradually warming to ± 14 °C at the end of the lobster fishery season in June (Fig. 3). In contrast, the CPUE showed a negative trend with a high CPUE (± 1.5 lb./trap haul) in May decreasing (± 0.5 lb./trap haul) to the end of the fishing season (Fig. 3). The positive trend for temperature was independent of fishing activities and can be considered as the independent variable. However, the CPUE calculated from daily landings and traps hauled will be affected by catchability and the availability of the resource. The relatively large biomass of lobster available to fishers at the beginning of the season depletes with the season as fishers explore and harvest every possible fishing grounds. In order to remove this negative effect of cumulative fishing mortality, the analyses were limited to the early part of the season. A preliminary assessment of the landings indicated that in all study sites up to 66 % of the landings were caught in the first 4 weeks of the season, and the following weeks corresponded with the steady drop of CPUE. Furthermore, catchability in mid to late-June is negatively affected by molting. Thus, only temperature and CPUE data for the first 4 weeks of the fishing season were considered.

For LFA 25, the trends observed for MDT and CPUE are quite different than the ones observed in LFA 24. There is no trend in MDT over time (Fig. 3). The warm temperatures experienced in the summer persisted for the entire fishing season with little variation. For the CPUE, a large drop is observed in the first days of the season (Fig. 3). A steady downward trend is then observed as the season progresses and CPUE decreased to less than 1 lb./trap haul (Fig. 3). To remove the large drop in CPUE, the first four days of fishing were eliminated.

The MDT observed in LFA 24 are colder than the ones observed in LFA 25 (Fig. 4). These differences in the temperature regimes were expected as the LFA 24 is a spring season with a warming trend in contrast to a fall season with rather stable condition in LFA 25. Less variations in the MDT were also observed in LFA 25 (Fig. 4). Temperature in the sub-area LFA 25 west is colder than the one observed in the sub-area LFA 25 central (Fig. 4).

On the scattergram of MDT versus CPUE, coordinates of the paired variables located in the upper right (+/+) or the lower left (-/-) quadrats indicate a good correlation between the two variables (Figs 5, 6), suggesting a similar trend. Based on the binomial test, 2 sites over 4 in LFA 24 (North Lake in 1995 and Alberton in 1996) and all studied sites in LFA 25 showed that the MDT and CPUE are independent (Table 2).

Table 2. The binomial test for the mean daily temperature (MDT) and catch per unit effort (CPUE) for all study sites in LFA 24 and 25. Variables (MDT and CPUE) are independent if $p > 0.05$. The statistical district of each study site is indicated in parenthesis.

SITE	YEAR	
	1995	1996
LFA 24		
ALBERTON (92)		p = 0.2266
MALPEQUE (93)		p = 0.0032[1]
TRACADIE BAY (96)	p = 0.0195[1]	
NORTH LAKE (88)	p = 0.3633	
LFA 25		
POINTE-SAPIN (75)	p = 0.0717	
CAP LUMIÈRE (76)	p = 0.2120	
ROBICHAUD (78)		p = 0.1509
PUGWASH (45)	p = 0.1719	p = 0.2905

[1] indicate the sites where a good correlation between MDT and CPUE were observed.

Discussion

In the spring lobster fishery, a positive relationship between MDT and CPUE was observed in half of the sites studied. In both years, the study site located closer to central PEI (Tracadie Bay and Malpeque) showed a relationship. Comeau and Drinkwater (1997) demonstrated that the relationship between MDT and CPUE is related to wind in the Baie des Chaleurs fishery. Hence, it is possible that water temperature at the sites that showed a relationship is wind driven with alongshore winds producing a classical Ekman response. That Ekman response might be less pronounce at both ends of PEI and could explain the lack of relationship.

No relationship was found between MDT and CPUE in LFA 25. Absence of a relationship between MDT and CPUE in LFA 25 had to be expected as temperatures observed during the fall lobster fishing season have little variation and are well within the "preferred" temperatures for a high lobster activity and catchability (McLeese and Wilder 1958).

In future work, emphasis should be made on the relationship between CPUE and MDT at a given site over time. This could be used to investigate the relation between inter-annual temperature fluctuation and landings.

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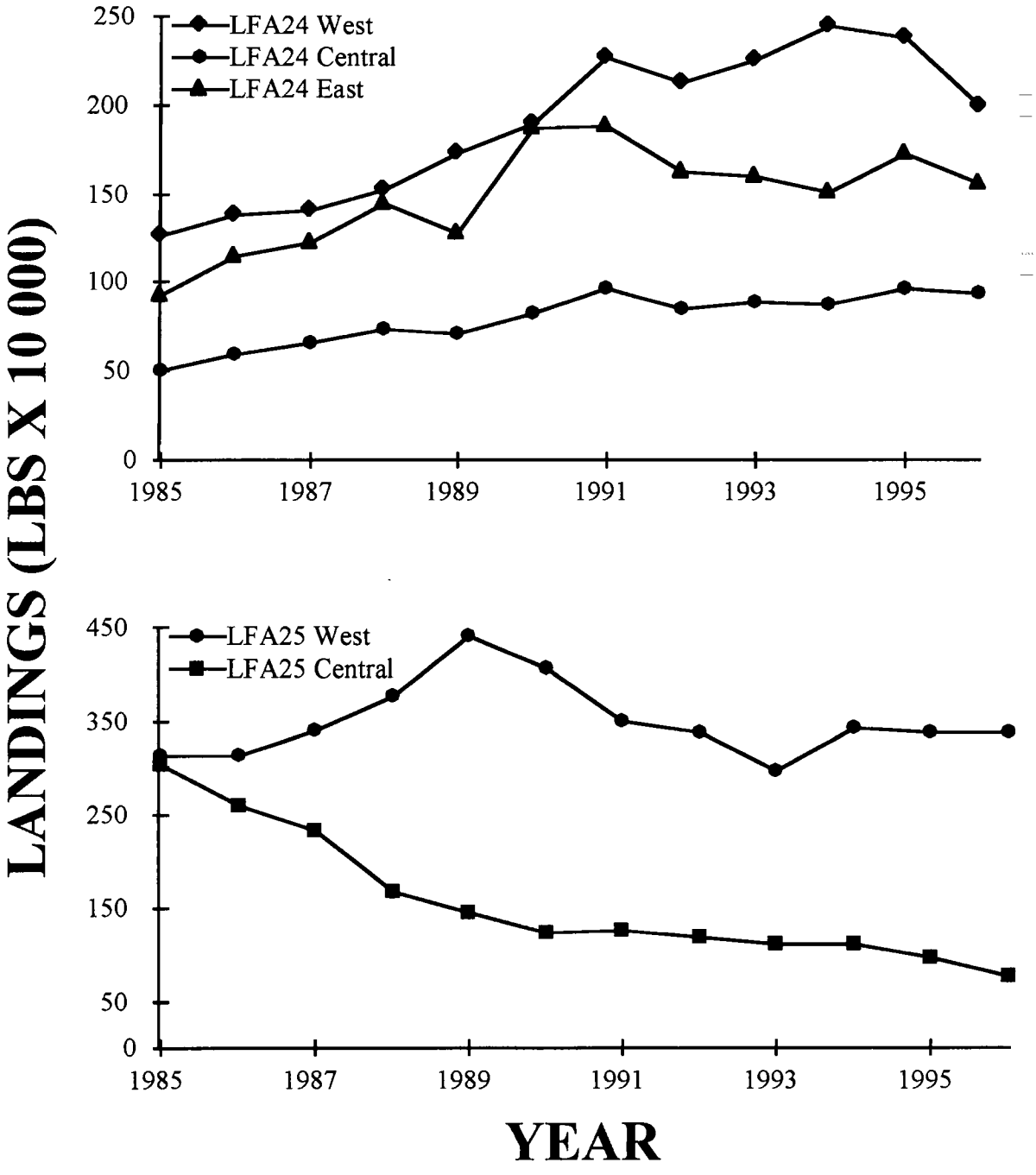

Figure 1. Landings in Lobster Fishing Areas 24 and 25, 1985 to 1996.

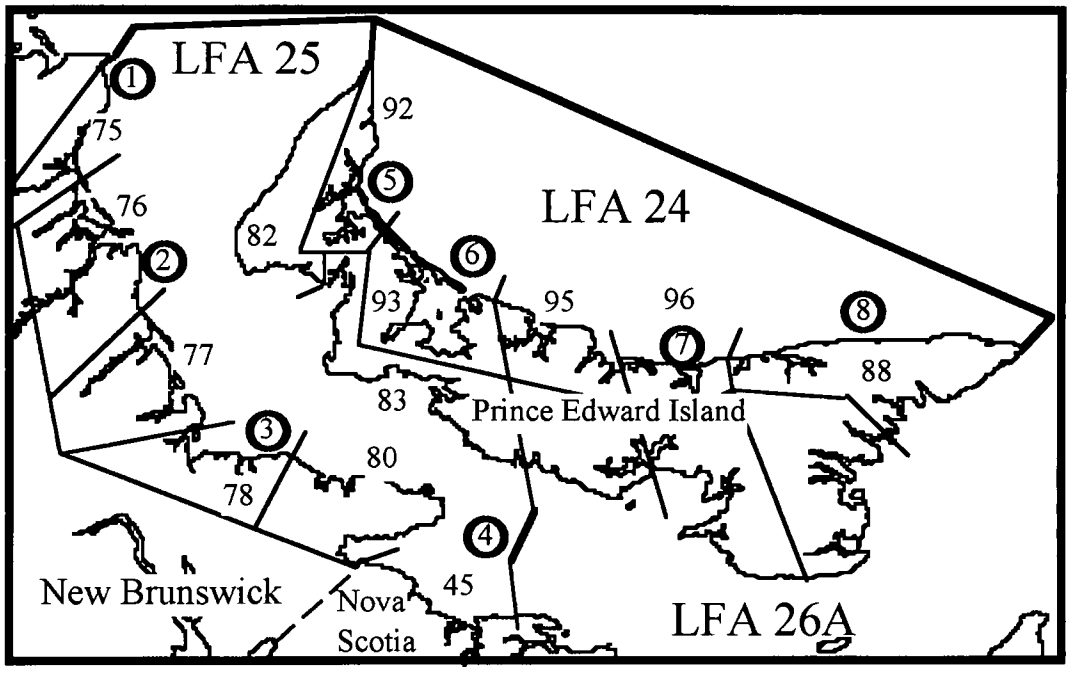

Figure 2. Map of study sites including the Lobster Fishing Areas (LFA) and statistical districts in the southern Gulf of St. Lawrence: 1) Pointe-Sapin (1995), 2) Cap-Lumière (1995), 3) Robichaud (1996), 4) Pugwash (1995 - 96), 5) Alberton (1996), 6) Malpeque (1996), 7) Tracadie Bay (1995), and 8) North Lake (1995).

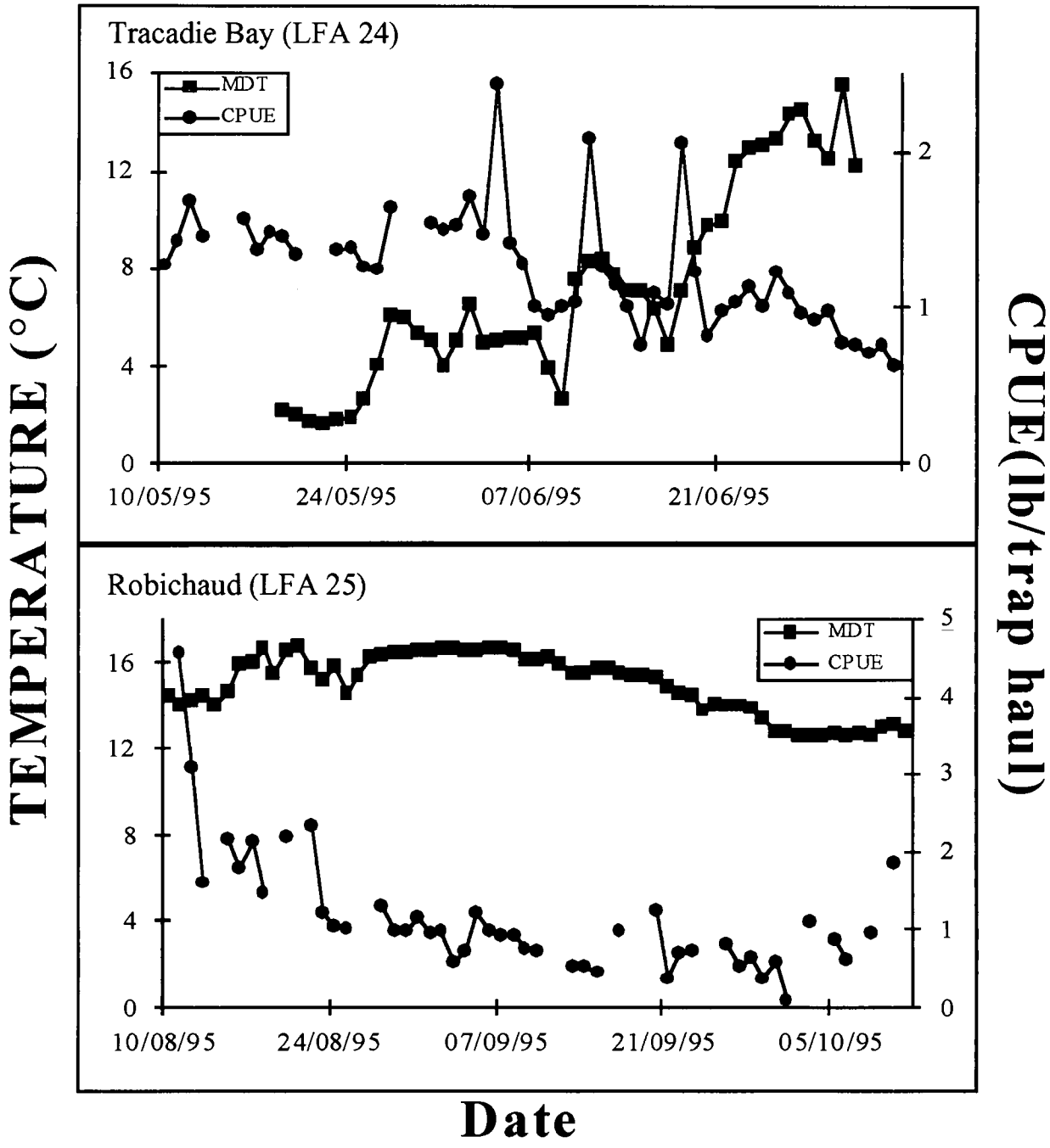

Figure 3. Trends in the mean daily temperature (MDT) and catch per unit effort (CPUE) for Tracadie Bay (LFA 24) and Robichaud (LFA 25), in 1995.

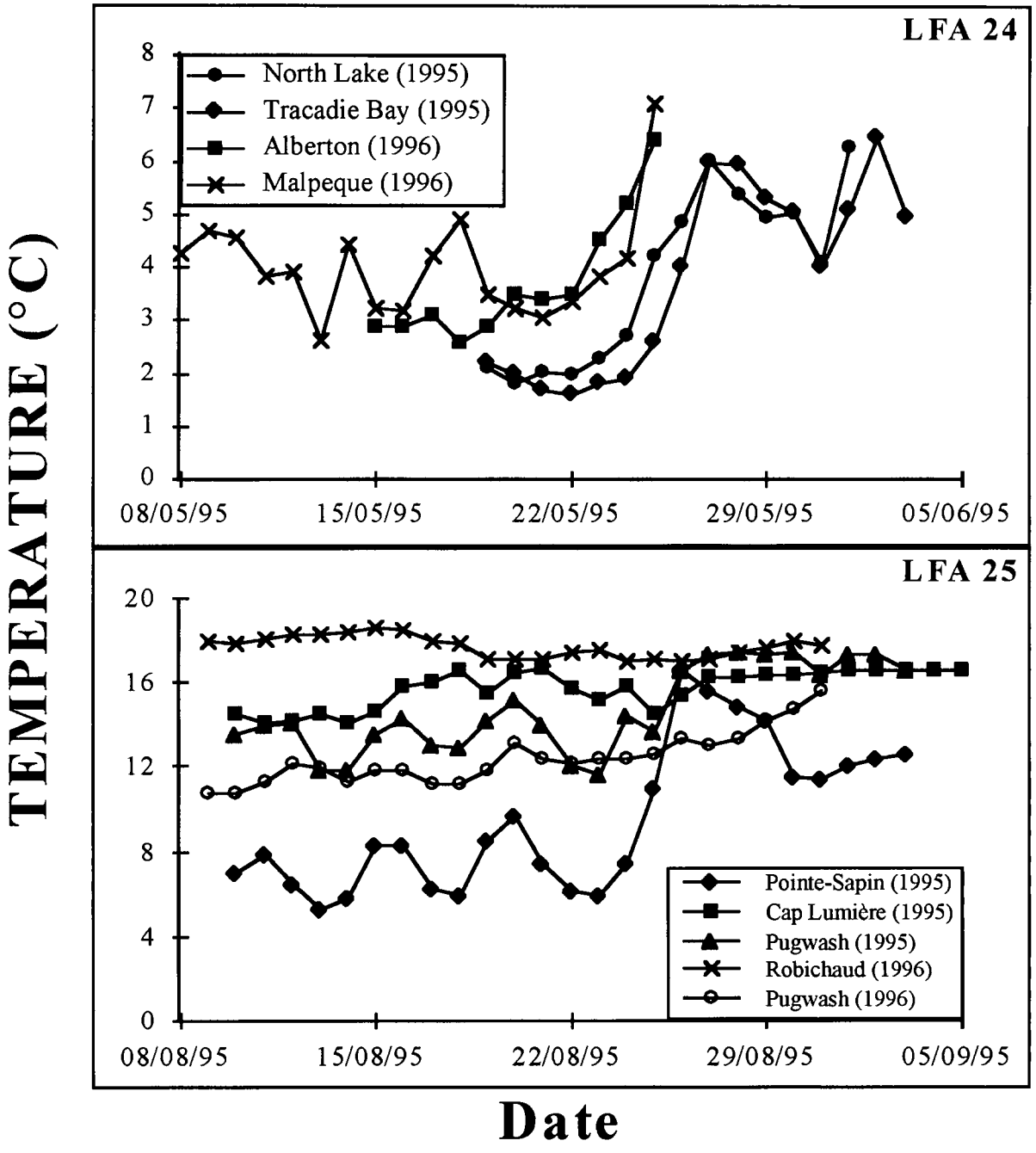

Figure 4. Mean daily temperature for all study sites in LFA 24 and 25.

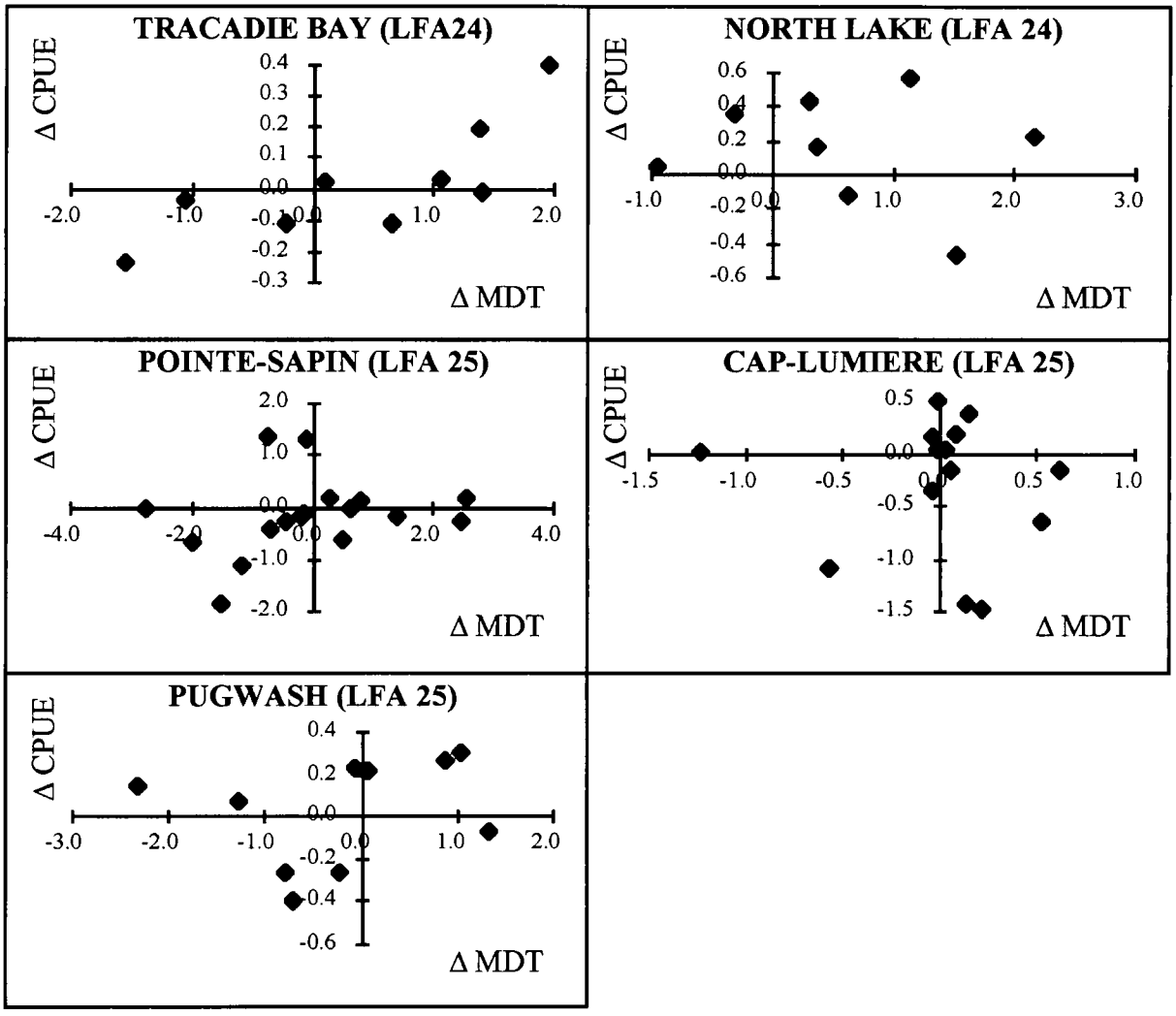

Figure 5. Relationship of the paired transformed data of catch per unit of effort (Δ CPUE) in relation to mean daily temperature (Δ MDT) for Tracadie Bay (r = 0.77), North Lake (r = -0.16), Pointe-Sapin (r = 0.23), Cap-Lumière (r = -0.08) and Pugwash (r = 0.24) in 1995.

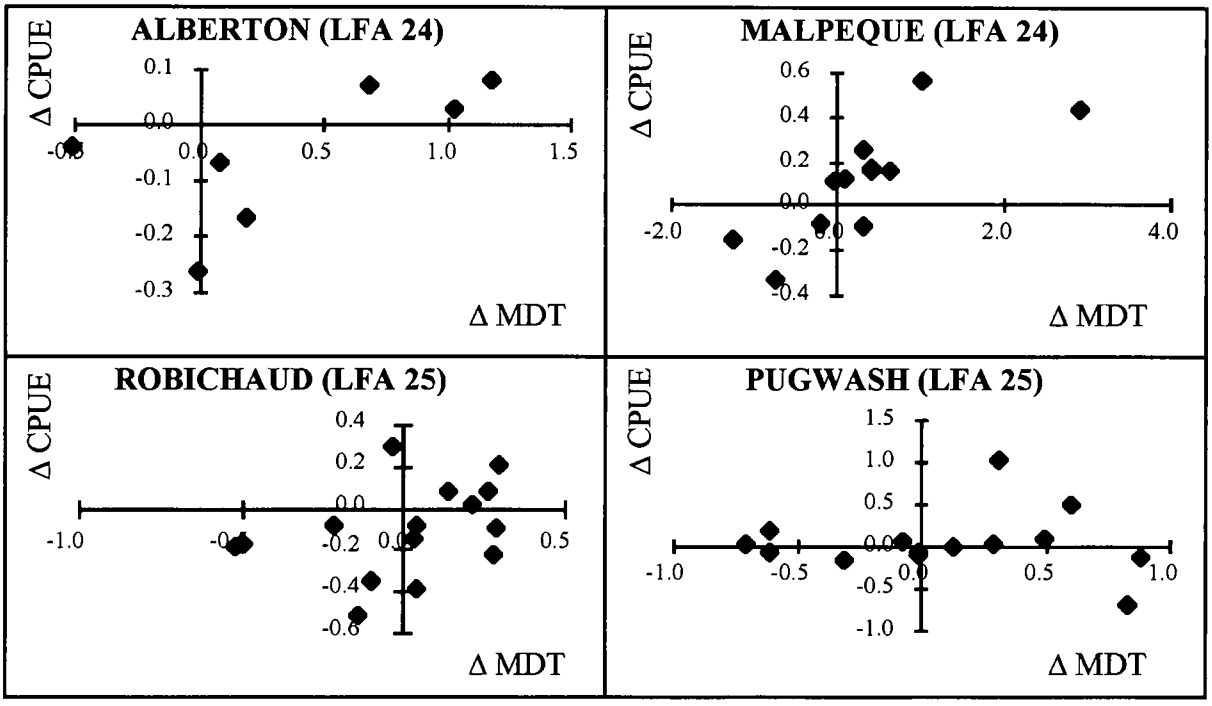

Figure 6. Relationship of the paired transformed data of catch per unit of effort (Δ CPUE) in relation to mean daily temperature (Δ MDT) for Alberton (r = 0.63), Malpeque (r = 0.77), Robichaud (r = 0.35) and Pugwash (r = -0.11) in 1996.