38413

An Aerial Survey of Near-Shore and Mid-Shore Lobster Fishing Distribution off Southwestern Nova Scotia, Spring and Fall 1983-1984

G.J. Sharp and R.E. Duggan

Fisheries Research Branch
Scotia-Fundy Region
Halifax Fisheries Research Laboratory
Department of Fisheries and Oceans
Halifax, Nova Scotia
B3J 2S7

October 1985

Canadian Manuscript Report of
Fisheries and Aquatic Sciences
No. 1847

Fisheries and Oceans Pêches et Océans

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1–900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 901–1425 were issued as Manuscript Reports of the Fisheries Research Board of Canada. Numbers 1426–1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Manuscript Report of

Fisheries and Aquatic Sciences 1847

October 1985

AN AERIAL SURVEY OF NEAR-SHORE AND MID-SHORE LOBSTER FISHING DISTRIBUTION OFF SOUTHWESTERN NOVA SCOTIA, SPRING AND FALL 1983-1984

by

G.J. Sharp and R.E. Duggan

Fisheries Research Branch

Halifax Fisheries Research Laboratory

Department of Fisheries and Oceans

P.O. Box 550

Halifax, Nova Scotia

B3J 2S7

Cat. No. FS 97-4/1847E ISSN 0706-6473

Correct citation for this publication:

Sharp, G.J. and R.E. Duggan. 1985. An aerial survey of near-shore and mid-shore lobster fishing effort in southwestern Nova Scotia, spring and fall 1983-1984. Can. MS Rep. Fish. Aquat. Sci. 1847: vi + 37 p.

CONTENTS

LIST OF FIGURES

ABSTRACT

Sharp, G.J. and R.E. Duggan. 1985. An aerial survey of near-shore and mid-shore lobster fishing effort in southwestern Nova Scotia, spring and fall 1983-1984. Can. MS Rep. Fish. Aquat. Sci. 1847: vi + 37 p.

The distribution of lobster fishing activity in southwestern Nova Scotia was examined using an aerial visual counting technique. Fall 1983 fishing activity was restricted to the near-shore zone and was a factor of 4 to 10 lower in intensity than the spring 1984 fishing period. Spring fishing activity extended to the 92.7 km limit of the inshore zone.

RÉSUMÉ

Sharp, G.J. and R.E. Duggan. 1985. An aerial survey of near-shore and mid-shore lobster fishing effort in southwestern Nova Scotia, spring and fall 1983-1984. Can. MS Rep. Fish. Aquat. Sci. 1847: vi + 37 p.

La distribution de l'activité de pêche aux homards au sud-ouest de la Nouvelle-Ecosse a été examinée en utilisant une technique de comptage visuel aérien. L'activité de pêche à l'automne 1983 était limitée à la zone près des côtes et était un facteur de 4 à 10 inférieur en intensité que durant la période de pêche du printemps 1984. L'activité de pêche du printemps 1984 s'étendait à la limite de 92.7 km de la zone côtière.

INTRODUCTION

Landings from the lobster fishery in Statistical Districts 32, 33, and 34 (Fig. 1) in southwestern Nova Scotia have, relative to other Maritime lobster fisheries, remained reasonably stable since the mid 1940's, fluctuating between 2,200-4,000 t (Fig. 2). An "offshore" lobster fishery was developed in 1971 to provide employment for vessels displaced by closure of the swordfish fishery. The offshore fishery was restricted to beyond a line (Fig. 3) 92.7 km from shore (Pezzack and Duggan 1983). Inshore fishermen opposed this fishery from the beginning, feeling that exploitation of the offshore areas would be detrimental to the inshore fishery. An annual exploitation rate of 70-80%, at a minimum size 15-20 mm below size of maturity suggests the inshore area receives some of its annual recruitment from some other areas. Stasko (1978) hypothesized that recruitment for the inshore areas probably originates in the deeper offshore waters (beyond 32 km). In 1979 the above information, and continuous pressure from inshore fishermen to close the offshore fishery, resulted in the establishment of a rectangular closure area over Browns Bank (Fig. 1) within which all lobster fishing was prohibited (Pezzack and Duggan 1983). A. Campbell and D.E. Graham[1] (unpubl. data) reported that inshore fishermen, who had traditionally fished within 32 km from shore, began in the early 1970's to move lobster gear further offshore, in some instances as far off as the 92.7 km boundary of the offshore lobster fishery. These new areas were referred to as "mid shore" (Fig. 1). During the late 1970's there was a trend of increasing effort in these areas. Lobsters in the mid-shore catches are similar to offshore catches with a larger mean carapace length, a smaller percentage of short lobsters, and a higher percentage of berried females than in inshore catches. Neither the extent of the mid-shore fishery nor its apparent seasonal and annual variations have been well defined (A. Campbell and D.E. Graham, pers. comm.).

The lack of reliable techniques for assessing effort in the lobster fishery has been noted by Anthony and Caddy (1980). Logbooks used in the offshore fishery are not practical for the large fleet of small vessels that pursue the near-shore and mid-shore fisheries. We cannot select out mid-shore fishermen as the area is not subdivided within the 50 nm (92.7 km) limit. Aircraft have been used recently to assess effort distribution in the eastern Canadian lobster fishery through visual counts (Conan and Maynard 1983) and aerial photography (Pringle and Duggan 1983) of lobster trap buoys.

In this study aerial visual counts of lobster trap buoys were used to determine the outer boundary of lobster fishing effort in the fall and spring of the 1983-1984 District 4A lobster fishery.

[1]A. Campbell and D.E. Graham, Fisheries Research Branch, Department of Fisheries and Oceans, St. Andrews, N.B. EOG 2XO

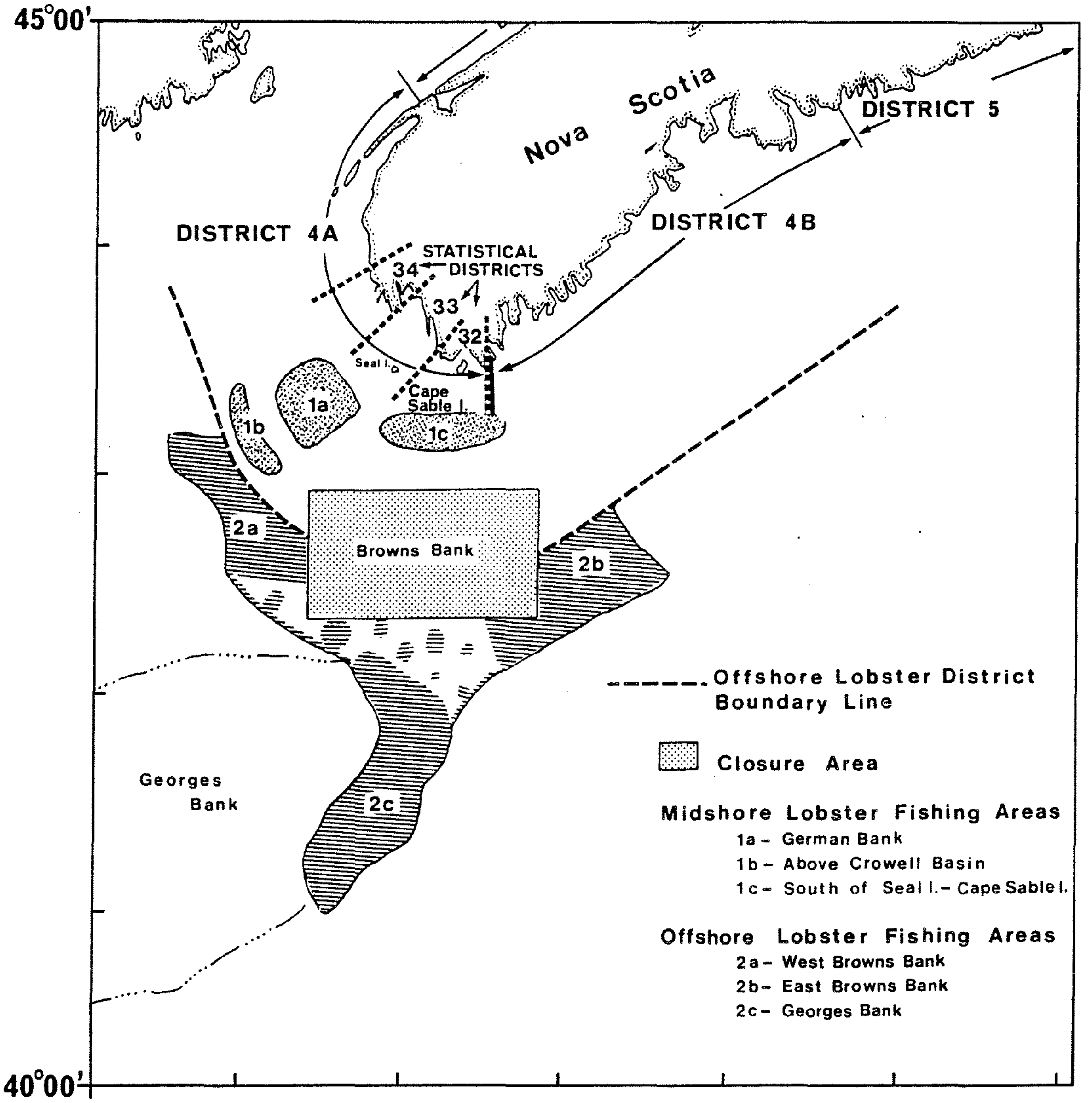


Figure 1. Mid-shore and offshore lobster fishing areas as identified by A. Campbell and D.E. Graham (unpubl. data) in relationship to the 50 nm (92.7 km) offshore line and the Browns Bank closure zone, and statistical districts in southwestern, Nova Scotia.

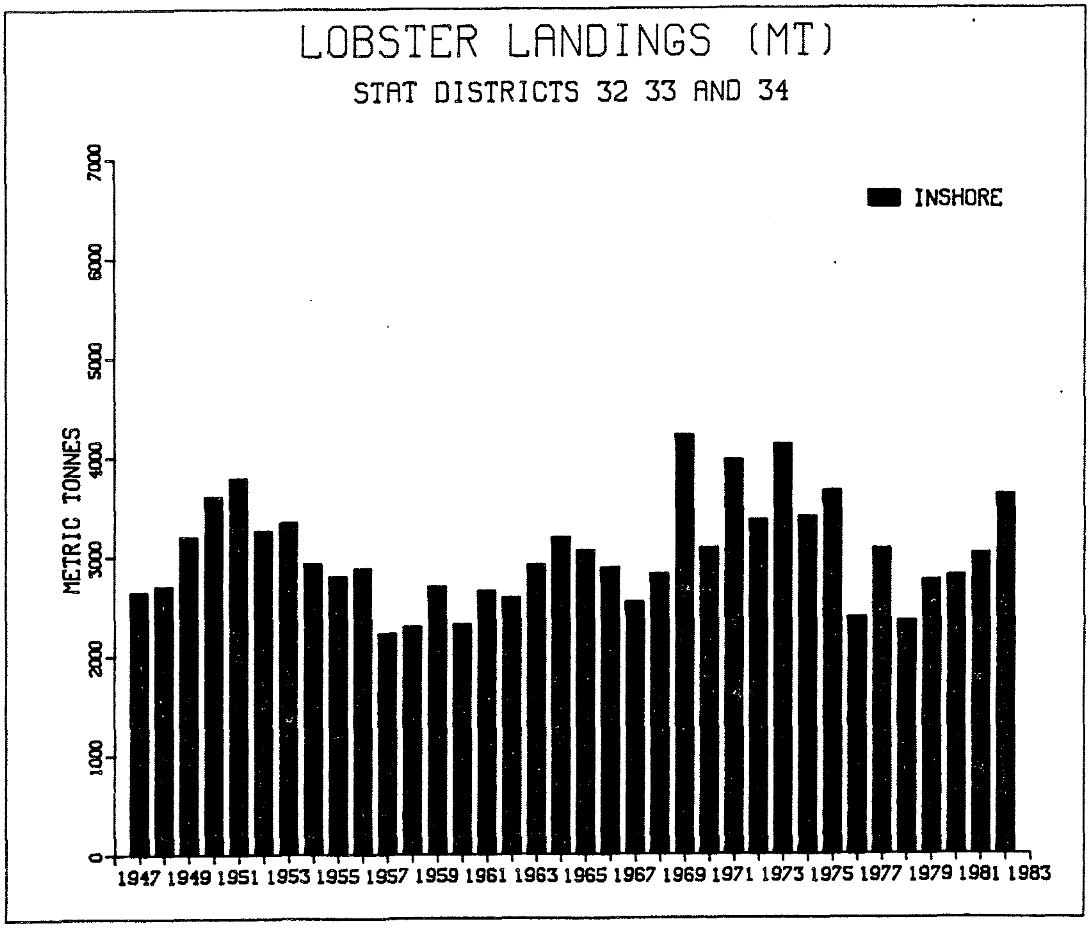


Figure 2. Annual lobster landings (metric tons), 1947-1982-- Statistical Districts 32, 33, and 34 (Yarmouth to Cape Sable Island).

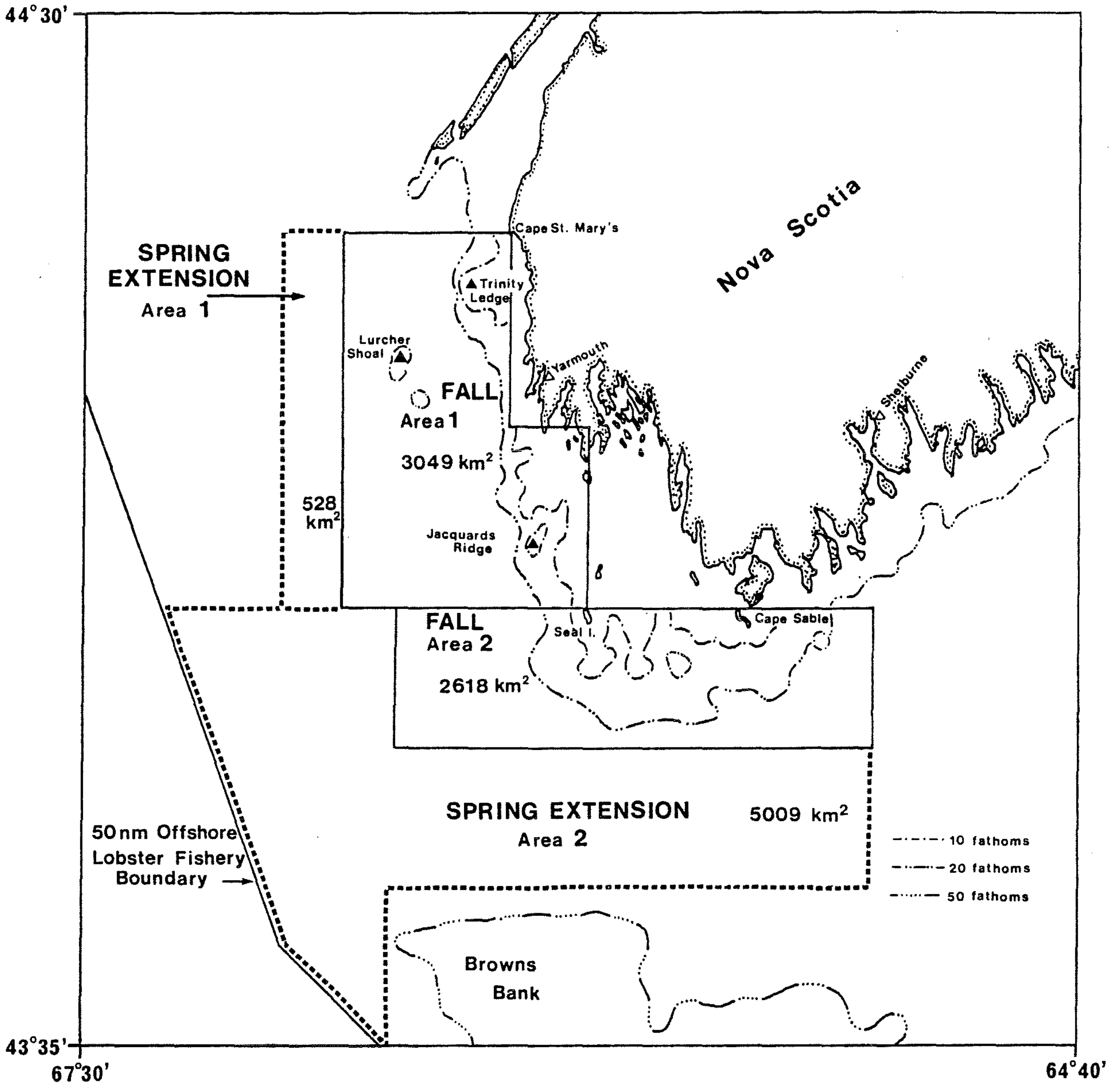


Figure 3. Areas surveyed by aerial observation for lobster trap buoys, fall 1983 and spring 1984 - southwestern Nova Scotia.

MATERIALS AND METHODS

To determine approximate sizes of areas to be investigated, preliminary flights were made in the fall of 1983 and spring of 1984 at altitudes from 610-2,438 m to identify and record locations of lobster boat activity. During these flights, 10 x 50 binoculars could detect fishing boat activity as far away as 15 km at an altitude of 2,458 m; lobster fishing activity could be confirmed at an altitude of 610 m. Maximum distances from shore for lobster fishing were 28 km in Area 1 and 31 km in Area 2. No activity was detected beyond these points. The flights were made during ideal weather conditions when fishermen could be expected to be working their most-distant gear. Based on this information, two areas (total 5,707 km^2) were surveyed in the fall (Fig. 3). Flight lines were plotted along lines of longitude or latitude parallel to the longest side of each area to save flight time used in turns. Coincidently, the lines were roughly parallel to the shore. The amount of flying hours available limited flight line spacing to 3 nm (5.5 km). Flight lines were flown successively further from the coast until no buoys were encountered on an entire line. One line in Area 1 was reflown in the opposite direction to check the ability to replicate lines and to check the accuracy of buoy counts.

The lobster fishing season in District 4A begins the last Tuesday in November and ends on May 31. Normally gear is retrieved just prior to December 25 and reset during February or March (A. Campbell, pers. comm.). The fall survey began 2 wk after the season opened to allow adequate time for setting and dispersal of lobster traps (December 9, 12, 17, 18). Lobster-sampling personnel in the area provided information on gear-setting methods, permitting the calculation of ratios for the number of traps per buoy. The spring survey occurred on May 11, 15, and 16 during the period of peak fishing effort. For this survey the area was expanded toward the 50 nm (92.7 km) line or to the Browns Bank closure zone in Area 2. The Area 1 boundary was moved approximately 25 km to the west to account for extended spring fishing (Fig. 3). The total spring survey area was 11,204 km^2.

The survey aircraft was a high-wing, twin-engine, Norman Britten Islander. The flight crew included a Department of Fisheries and Oceans technician to coordinate and supervise the program, a computer operator, and two observers to count buoys. Lines were flown at an altitude of 213 m at an air speed of 185 km/h. Ground speed varied with wind speed and direction. Beginning and end points of flight lines and observation points were read from a Sitex Model 757 Loran C receiver which was modified for aviation. The aircraft Loran was used as a back up in the event of equipment malfunction. A Hewlett-Packard Model 9825A computer which automatically recorded time (GMT) of observations was used to record coordinates of observation points and port and starboard buoy counts. The computer was programmed to produce an audible signal 15 sec after completion of each entry which required approximately 15 sec. To provide a back up for equipment failure, the operation was recorded by placing a remote microphone of a microcassette recorder in a headphone of the aircraft intercom. The data were transferred from the on-board computer to the Cyber system at the Bedford Institute of Oceanography, Dartmouth, N.S., for plotting using an Issco Company DISSPLA 8.2 program. Calculation of buoy density was based on an observational track of 900 m in width. Track width was determined by successive fly overs of a pre-set and measured array of buoys. Densities were calculated for the total length of each flight line. Contouring of buoys per observation point was by manual interpolation. Distances from shore for fall/spring comparisons were standardized by establishing two baselines (Fig. 4 and 5).

RESULTS

FALL

In Area 1, 54.6% of buoys were within the 20-fm line (37 m) (Fig. 4a and b). The remainder were found in deeper water to depths of 30 fm (55 m). The outer limit of buoys in Area 2 closely followed the 20-fm (37 m) contour (Fig. 5a and b).

Environmental conditions affected buoy counts more significantly than observation errors. Replicate counts on Pass 6 were 243 and 207; westward counts were lower in both directions (Fig. 6). The major factor contributing to this result was sun glare. The replication of Pass 3 on a flooding tide and a slack tide gave total counts of 176 versus 302 (Fig. 7). Lower altitude observations revealed submerged buoys on flooding and ebbing tides.

A cross-track error mode on the aircraft Loran C enabled planned flight paths to be followed within ±1.5 km when flight conditions were poor and to within ±0.2 km in good conditions. For a description of prevailing weather, see Appendix Table 1.

Direct observation of fishing activities found a trend to 6 trap trawls (3 traps/buoy) at the edge of the 20-fm contour and paired gear (2 traps/buoy) in near-shore areas (Fig. 8). However, these data were insufficient to allow calculation of trap densities beyond the 20-fm line.

SPRING

In Area 1, except for a small pocket of effort 60 km from the Tusket Island to Seal Island baseline, all observed buoys were within 40 km of shore (Fig. 9a and b). Maximum counts of greater than 200 or more (port plus starboard) were restricted to the near-shore area between Seal Island and Tusket Island.

In Area 2, effort was very concentrated in a triangular area between Cape Sable Island, Seal Island, and a point 10 km offshore within the 20-fm line (Fig. 10a and b). A diffuse low level of effort extended out to the Browns Bank closure zone and the offshore boundary.

FALL/SPRING BUOY DENSITIES

Flight-line length was different in the Cape Sable Island area between fall and spring surveys. The shorter fall flight lines were used to calculate the total buoys per line and to standardize buoy densities per square kilometer.

In Area 1, spring effort near shore was four to ten times higher than fall levels and was sustained to 40 km (Fig. 11a). Beyond 40 km there was a sharp decline toward fall values. Spring/fall effort patterns were very similar from 22 km seaward. Except for a pocket of effort near Lurcher Shoal

Grid Number One – Dec 9–12 1983

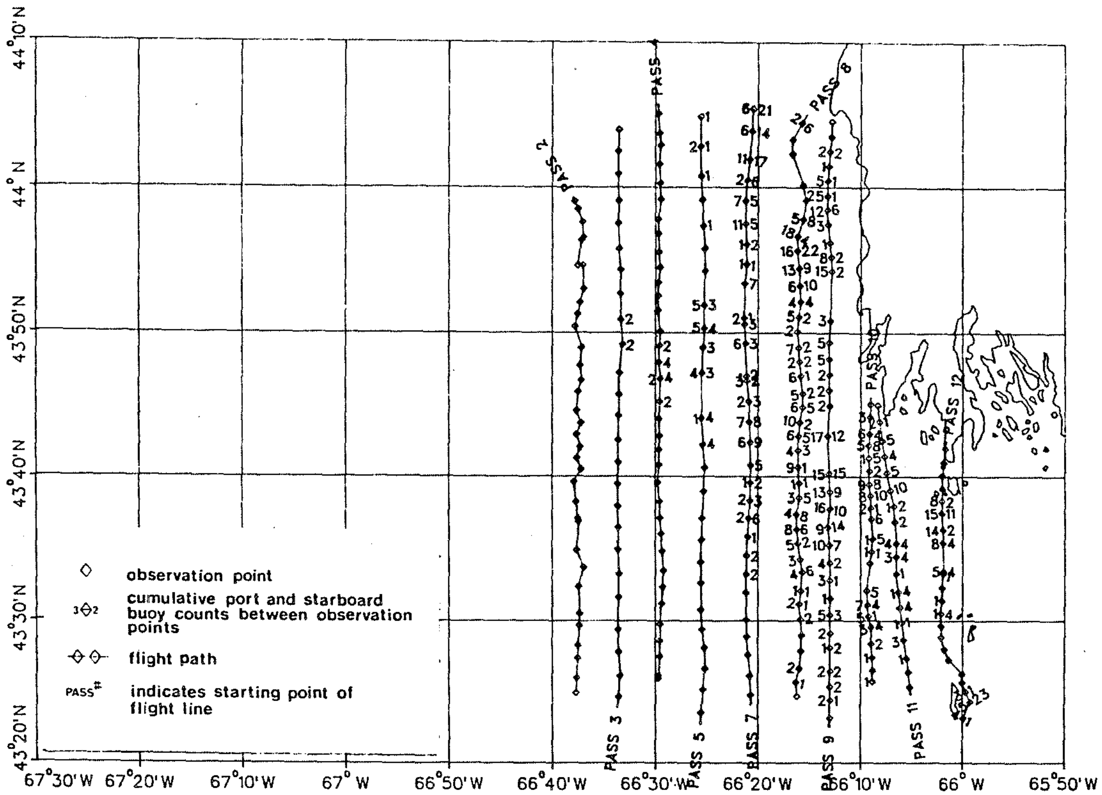


Figure 4a. Flight lines, observation points, and port and starboard buoy counts in Area 1 of the December 1983 aerial survey of lobster trap buoys - southwestern Nova Scotia. (Numbers represent cumulative counts between observation points).

Grid Number One – Dec 9–12 1983

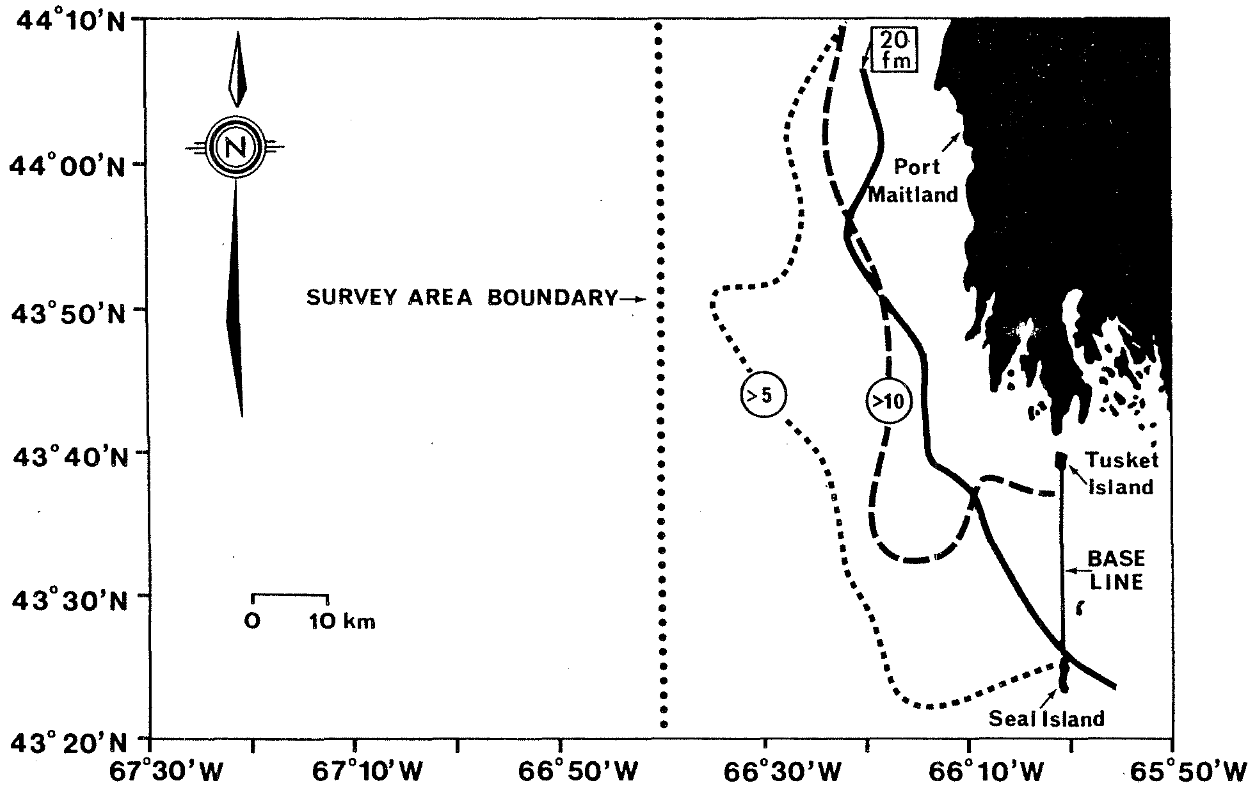


Figure 4b. Contours of lobster trap buoy counts per observation point port and starboard in Area 1 - fall 1983.

Grid Number Two – Dec 17,18, 1983

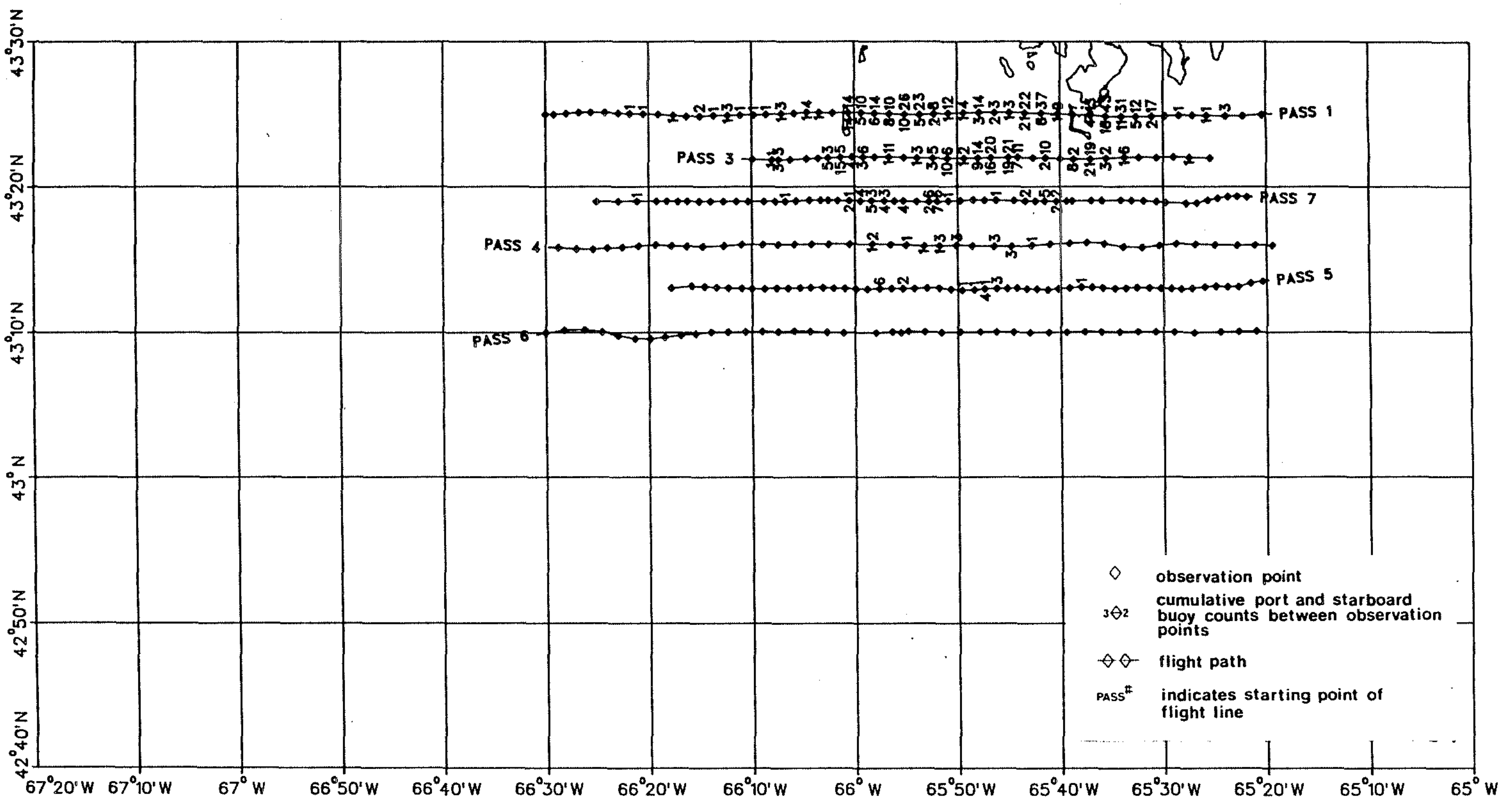


Figure 5a. Flight lines, observation points, and port and starboard buoy counts in Area 2 of the December 1983 aerial survey of lobster trap buoys - southwestern Nova Scotia. (Numbers represent cumulative counts between observation points).

Grid Number Two – Dec 17,18, 1983

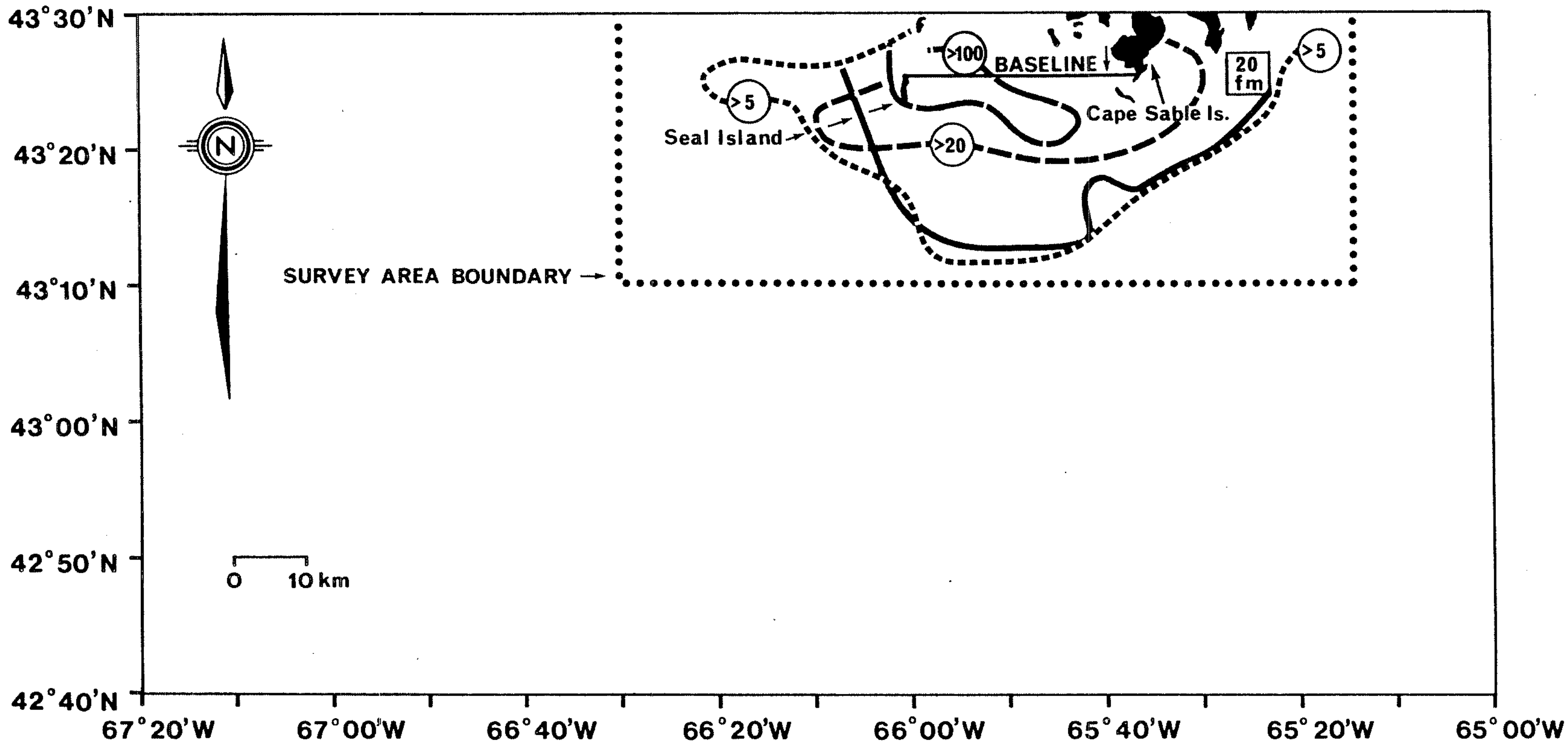
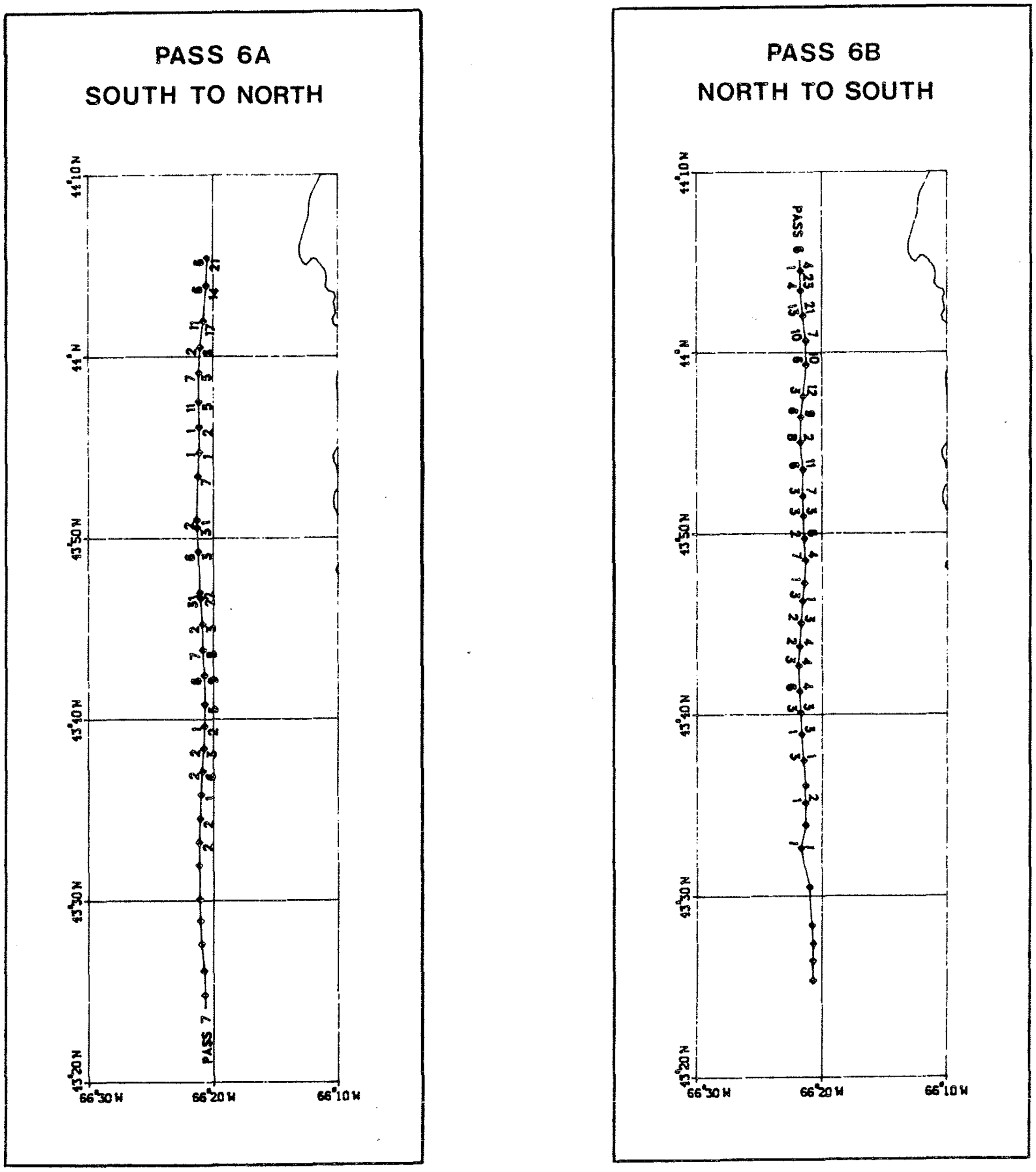


Figure 5b. Contours of lobster trap buoy counts per observation point port and starboard in Area 2 - fall 1983.



TOTAL BUOY COUNTS

	PASS 6A	PASS 6B
PORT	77	145
STBD.	130	98

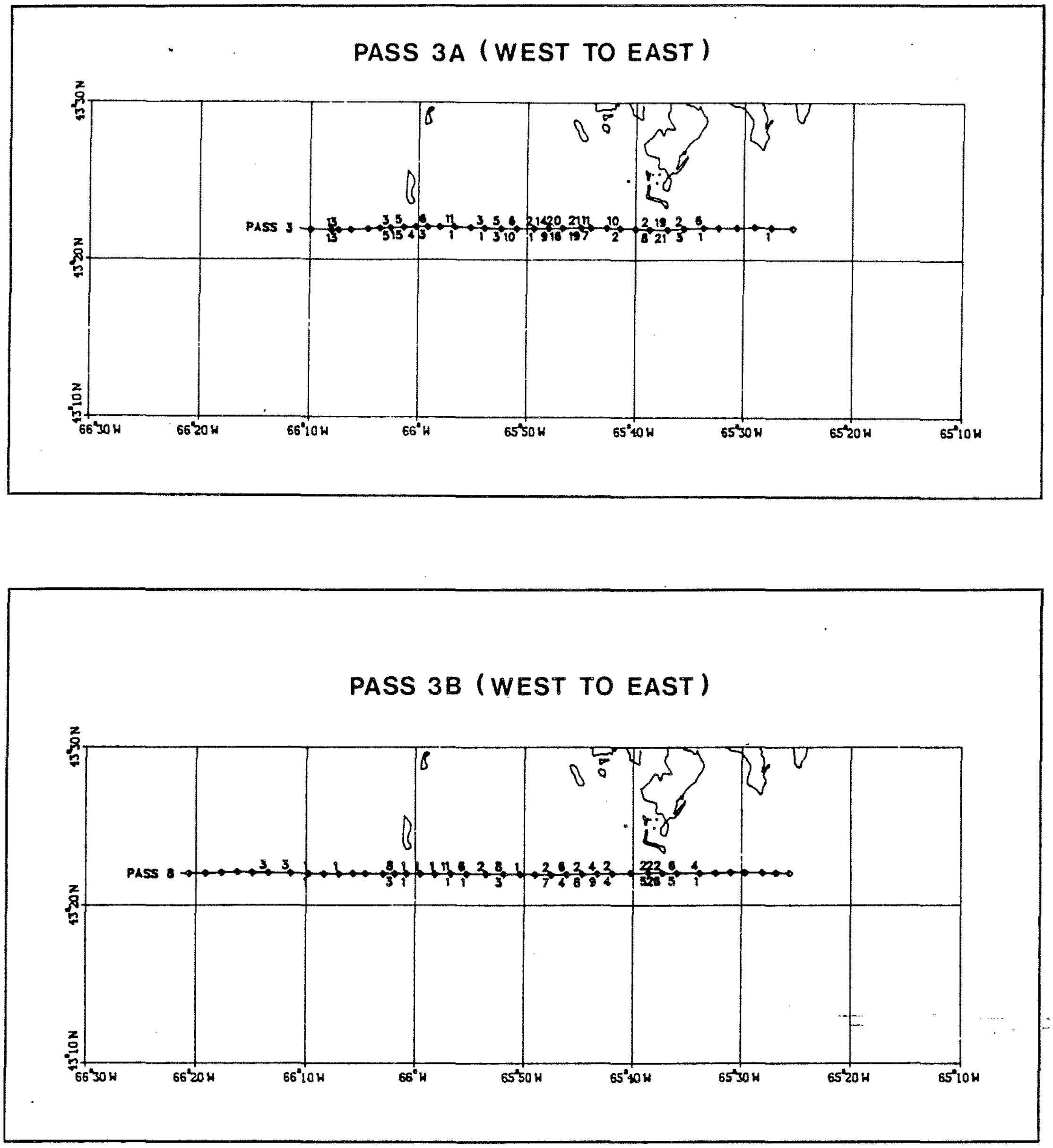
◇ observation point

3◇2 cumulative port and starboard buoy counts between observation points

◇-◇ flight path

PASS# indicates starting point of flight line

Figure 6. Port, starboard, and total buoy counts on replicate flight lines consecutively flown in opposite directions. Pass number indicates start point. (Numbers represent cumulative counts between observation points.)



TOTAL BUOY COUNTS

	PASS 3A	PASS 3B
PORT	159	89
STBD.	143	77

◇ observation point

3◇2 cumulative port and starboard buoy counts between observation points

◇◇ flight path

PASS# indicates starting point of flight line

Figure 7. Port and starboard buoy counts on a flight line replicated during flooding tide (December 12) and slack tide (December 17). (Numbers represent cumulative counts between observation points.)

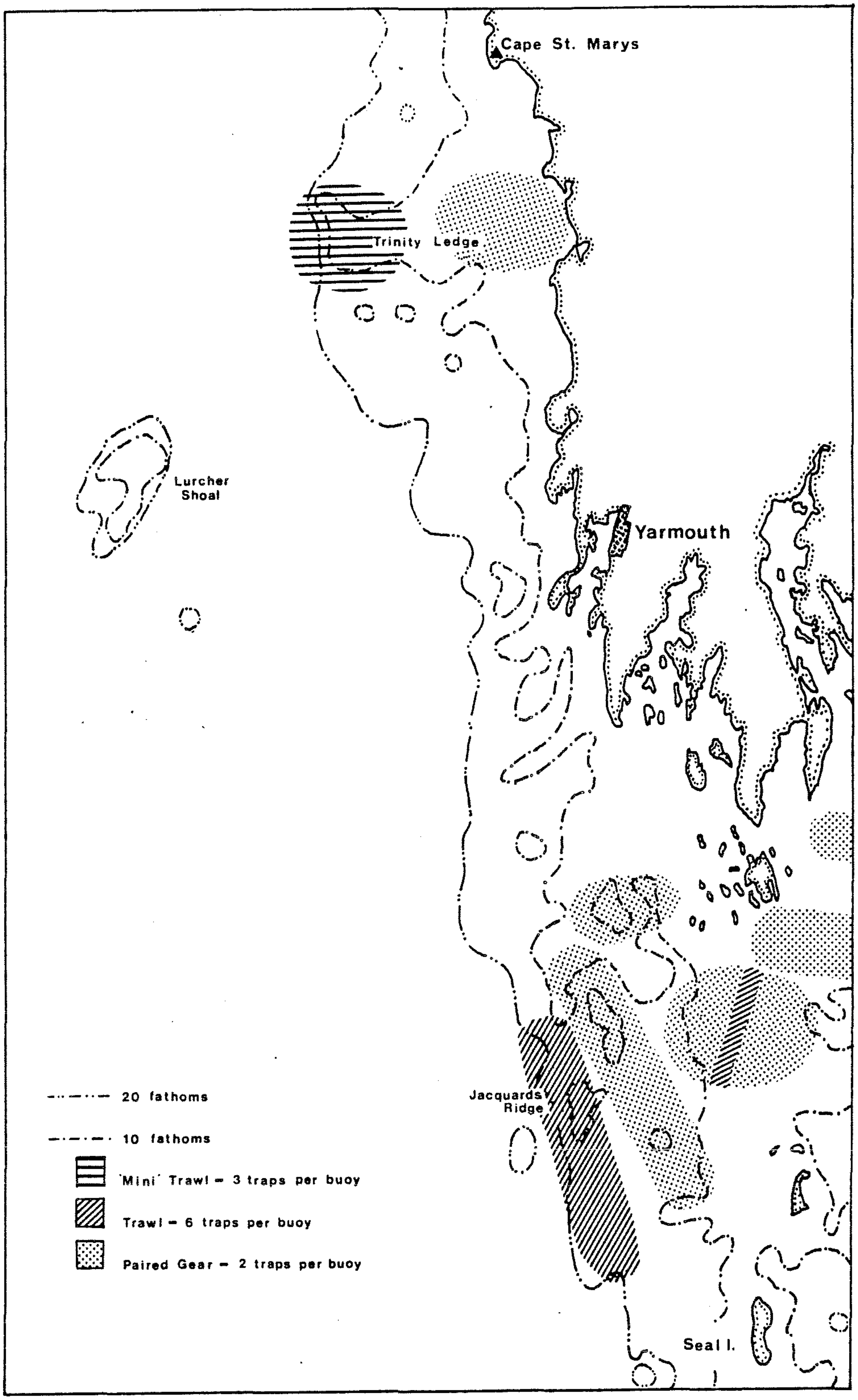


Figure 8. Lobster trap/buoy ratios in some areas where different gear-setting methods are used in southwestern Nova Scotia.

Grid Number One – May 16, 1984

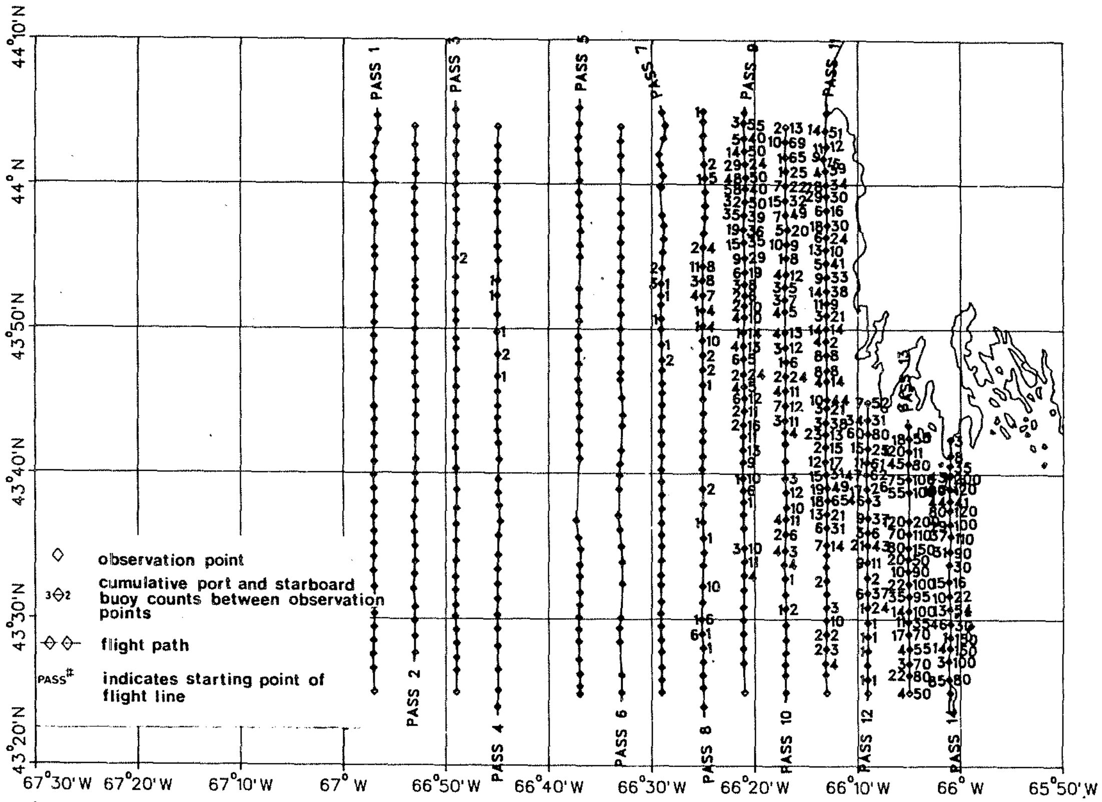


Figure 9a. Flight lines, observation points, and port and starboard buoy counts in Area 1 of the May 1984 aerial survey of lobster trap buoys - southwestern Nova Scotia. (Numbers represent cumulative counts between observation points.)

Grid Number One – May 16, 1984

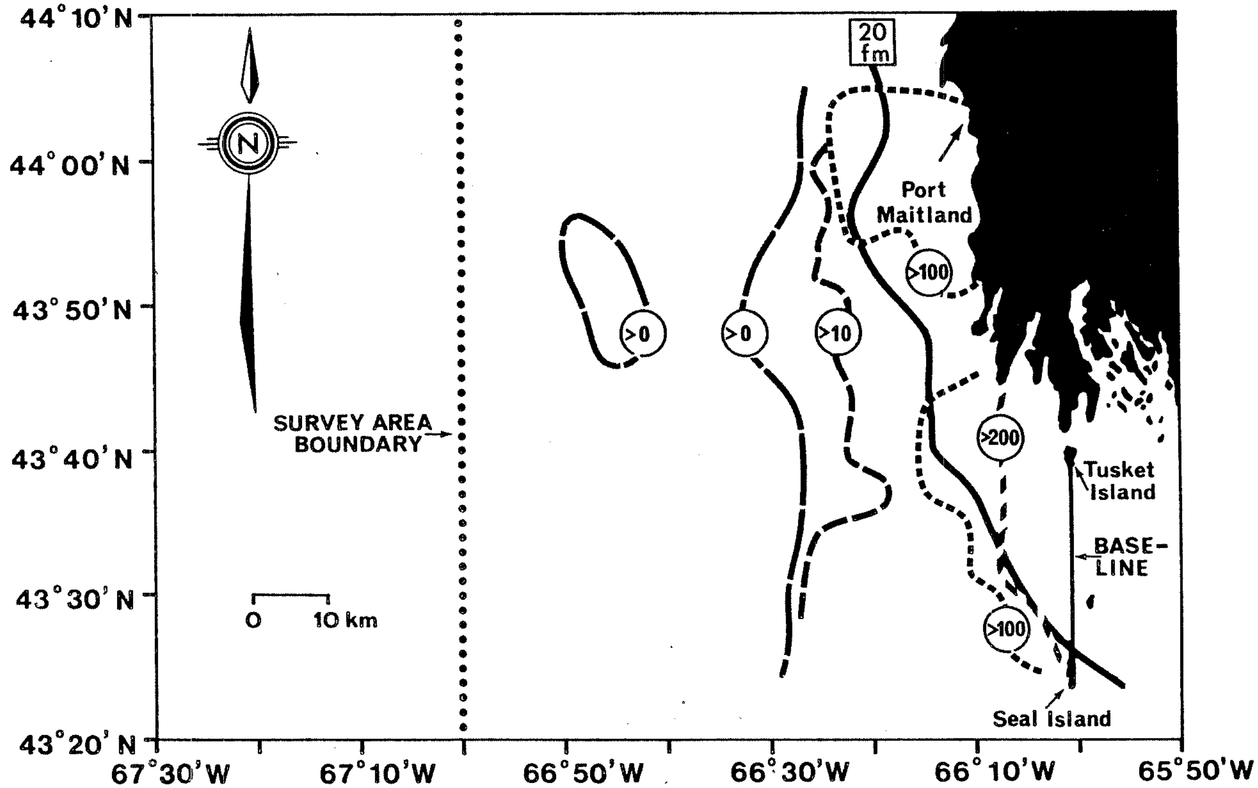


Figure 9b. Contours of lobster trap buoy counts per observation point port and starboard in Area 1 – spring 1984.

Grid Number Two – May 11,15, 1984

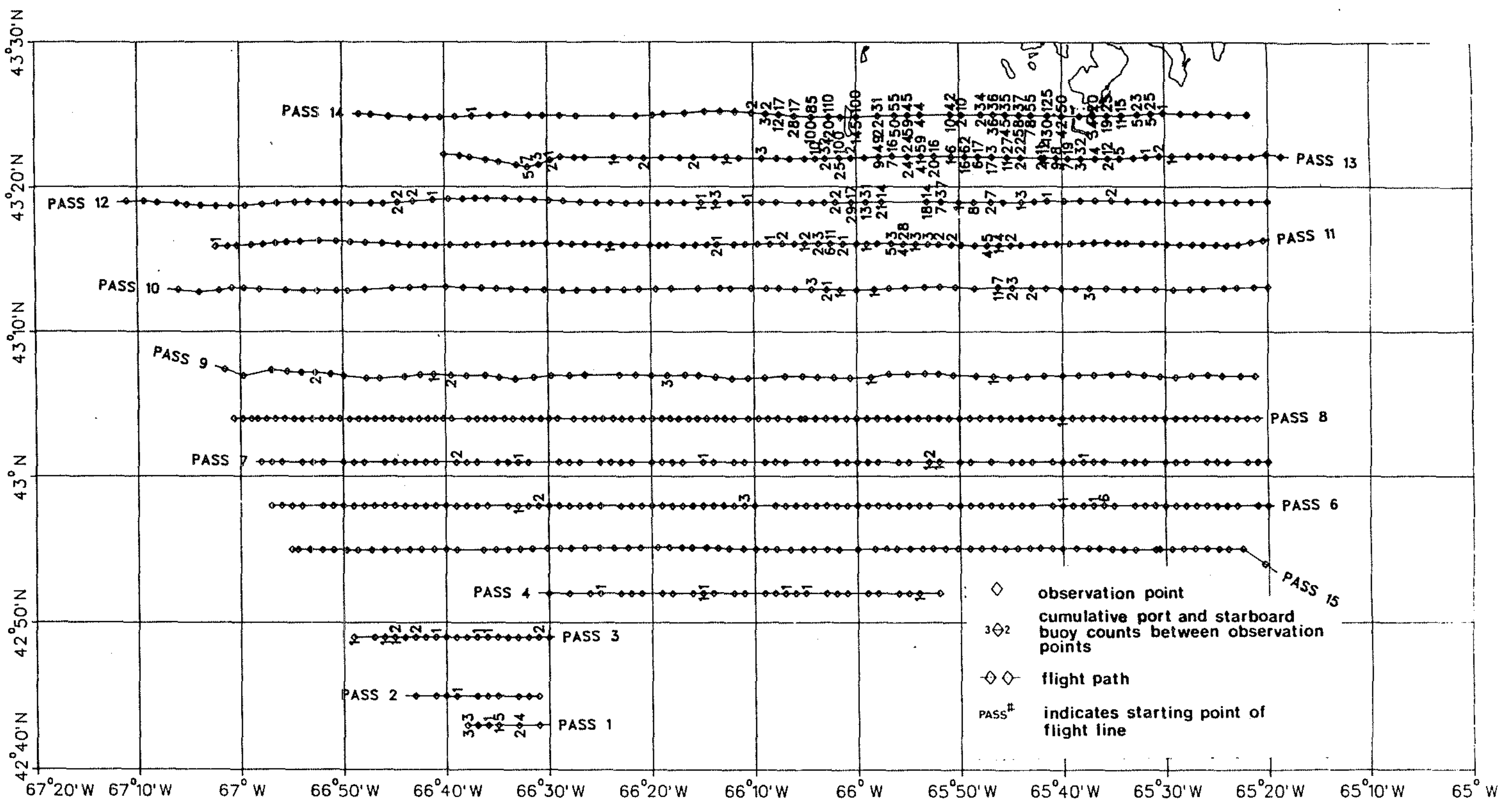


Figure 10a. Flight lines, observation points, and port and starboard buoy counts in Area 2 of the May 1984 aerial survey of lobster trap buoys – southwestern Nova Scotia. (Numbers represent cumulative counts between observation points.)

Grid Number Two – May 11,15, 1984

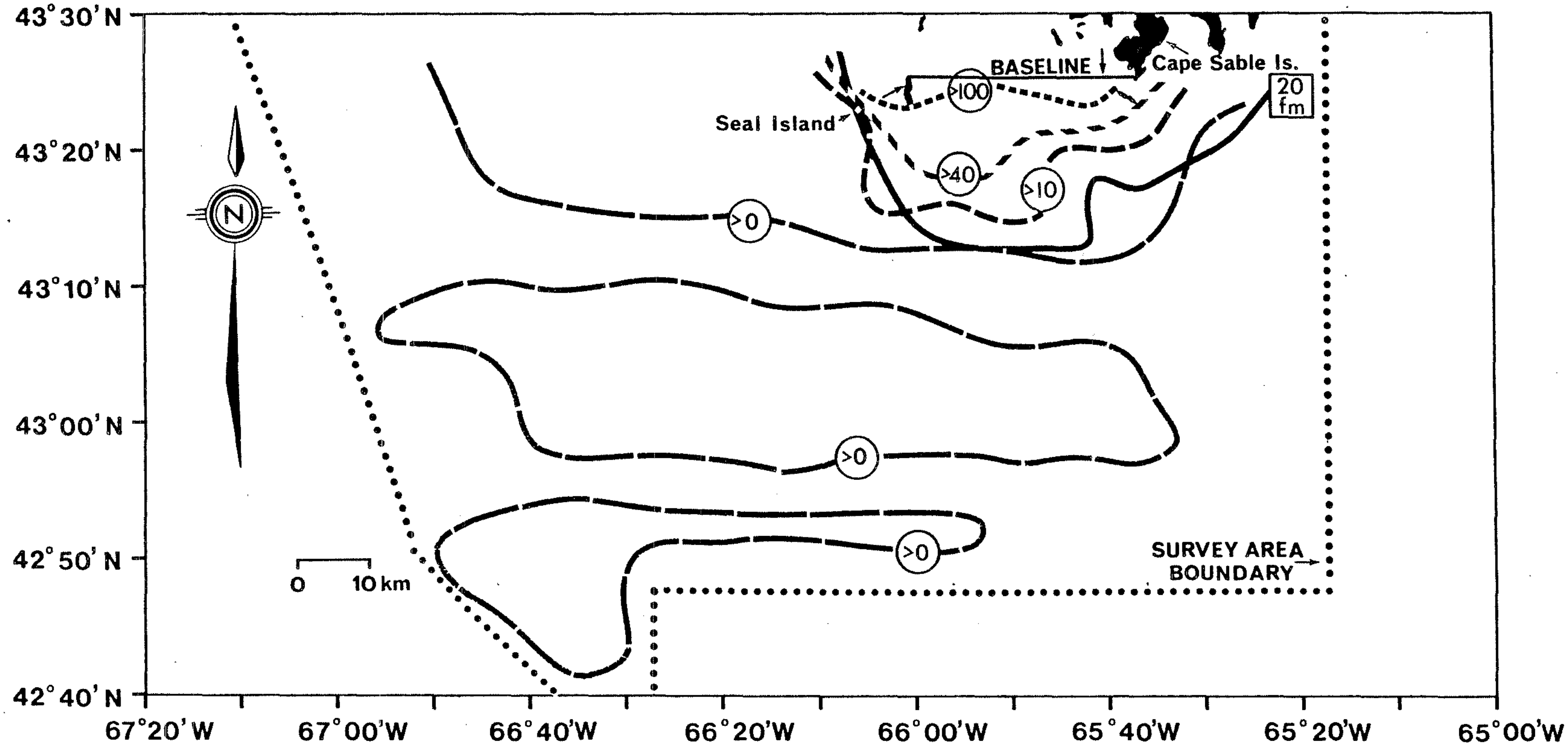
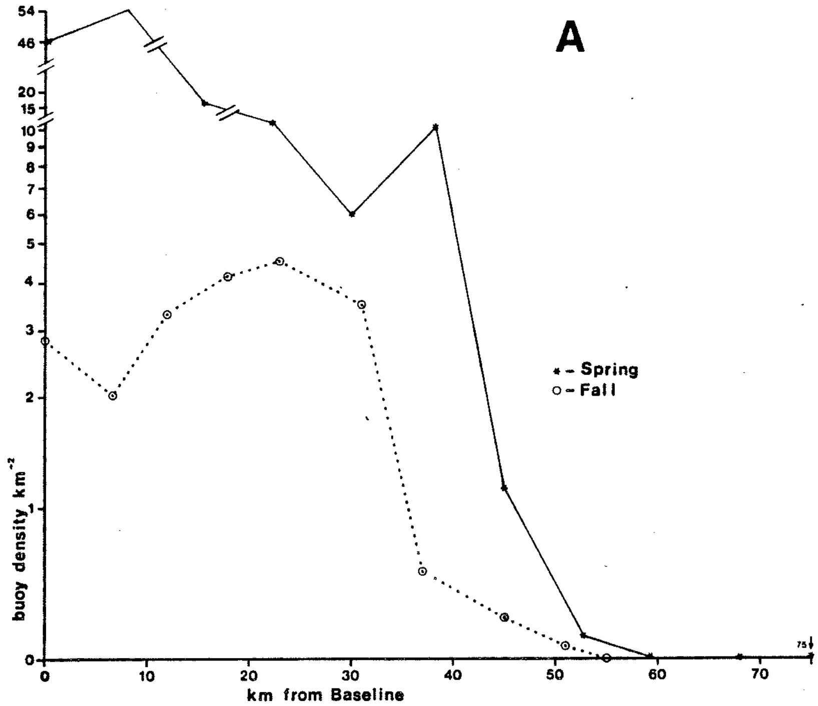


Figure 10b. Contours of lobster trap buoy counts per observation point port and starboard in Area 2 - spring 1984.



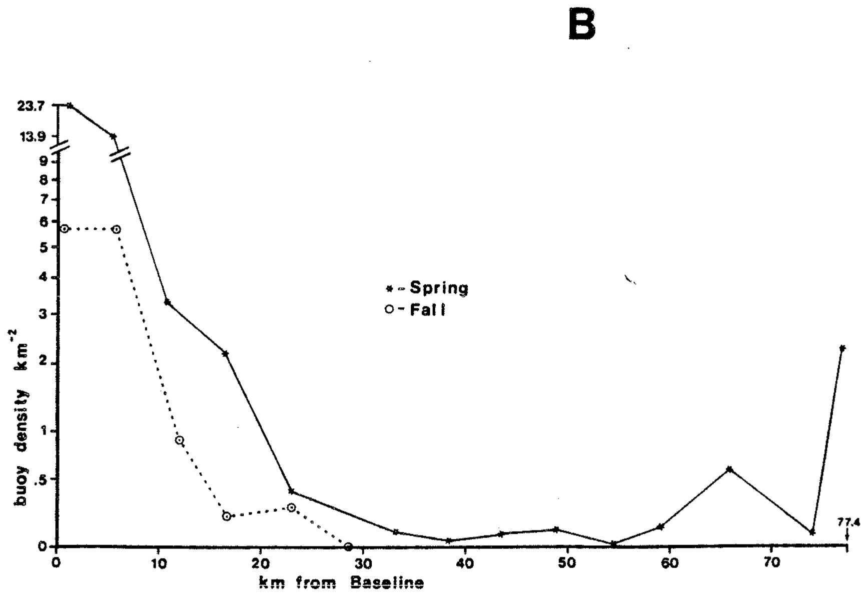


Figure 11a. Lobster buoy densities per square kilometer in relationship to distance offshore from Wedgeport to Seal Island baseline Area 1 - fall 1983 and spring 1984.

Figure 11b. Lobster buoy densities per square kilometer in relationship to distance offshore from Cape Sable to Seal Island baseline Area 2 - fall 1983 and spring 1984.

(Fig. 11a), Area 2 near-shore buoy densities were four times greater in the spring than in the fall (Fig. 11b). Fall and spring effort declined rapidly out to 27.5 km. However, this represented the seaward limit of fall effort, while in the spring buoys were set as far as 77.4 km offshore. During the spring a low concentration of 0.6 buoys km^{-2} was found very near the offshore boundary. These buoys represent trawls of gear exceeding 6 traps $buoy^{-1}$ to a maximum of 25 traps $buoy^{-1}$.

DISCUSSION

A higher level of effort in the late spring than in late fall is typical for this fishery (A. Campbell, pers. comm.). During this survey, weather conditions were significantly better in the spring, permitting smaller boats to venture further offshore. Such good weather also presents a lower risk of trap loss. Wind strength directly affected our ability to detect buoys; high wind causes rough areas and whitecaps. In the fall, winds were higher in velocity on three of the four survey days than in the spring (Appendix Table 1).

The accuracy of this methodology was further limited by tides pulling buoys under the surface. Due to the rapid change in tidal timing between Yarmouth and Cape Sable Island it was not possible to fly the area entirely at slack tide. Sufficient numbers of replicate lines to determine the level of error were not flown. The variation in port to starboard (P/S) ratios were high. In the fall for Area 1 P/S ratio was 1.0±0.6; for Area 2, 0.9±0.8. Analysis of P/S ratios in Conan's and Maynard's (1983) study indicates that these ratios are correlated with the observer. Conditions in the Gulf of St. Lawrence where the Conan and Maynard study occurred are more homogenous between flight lines due to consistent bathymetry, current, and tidal conditions. In southwestern Nova Scotia current and bathymetry can vary dramatically between flight lines and from port to starboard on a flight line. There was no consistent observer error as the P/S ratio varied from 2.2 to 0.2 between flight lines for the total survey.

The level of accuracy for buoy counts drops exponentially beyond 500 m from the centre of a flight path (D. Maynard, pers. comm.[2]). Since we calculated an observation range of 450 m on each side in test flights, we remained within the zone of maximum accuracy. In areas where counts exceeded 50 per side per observation, point numbers were estimates rather than individual counts. However, the near-shore areas having high buoy densities were not the prime focus of our study. Photographic methods provide an accurate record of high-effort densities and indicate that buoy densities above 200 km^{-2} are common in the near shore (G.J. Sharp and R.E. Duggan, unpubl. data).

The mid shore off Cape Sable Island was apparently supporting a low-level effort in the spring of 1984 relative to the near shore. A relatively abrupt drop in buoy counts beyond the 20-fm line in the Cape Sable Island area indicates a much lower effort than in the near shore. However, the use

---

[2]D. Maynard, Fisheries Research Branch, Department of Fisheries and Oceans, Moncton, N.B. E1C 9B6.

of trawls of traps (6-25 $buoy^{-1}$) in the mid shore results in more traps than the buoy count suggests. Due to a trial regulation allowing a flexible trap limit, 1984 was not a typical year for the mid-shore region. Previously the limit was 375 traps; the new regulation allowed for a maximum of 75 traps unused in the fall to be added to the spring effort. There was little response to the option of a larger spring trap limit (Fisheries Operations Branch, Department of Fisheries and Oceans, Yarmouth, N.S.). However, the existence of effort to the edge of the 50 nm (92.7 km) line indicates some fishermen still consider it economical to fish at this range from home port in the spring regardless of regulation changes.

This survey provided a previously unavailable description of effort patterns for future comparisons.

ACKNOWLEDGEMENTS

Special thanks to G.Y. Conan and D. Maynard, Fisheries Research Branch, Gulf Region, for logistic and technical support. T.W. Rowell and D.S. Pezzack provided constructive criticisms of the manuscript. Thanks also to our observers, P. Thibodeau and K. Welch; to T. Helm for computer operation and drafting; to T.J. Deveau for computer programming and plotting; and to S.P. Dowell and M.M. Guy for manuscript preparation.

REFERENCES

Anthony, V.C. and J.F. Caddy (ed.). 1980. Proceedings of the Canada-U.S. Workshop and status of assessment science for N.W. Atlantic lobster (Homarus americanus) stocks (St. Andrews, N.B., Oct. 24-26, 1978). Can. Tech. Rep. Fish. Aquat. Sci. 932.

Conan, G.Y. and D.R. Maynard. 1983. Aerial survey of spatial distribution of effort in lobster fishery of southern Gulf of St. Lawrence. Int. Coun. Explor. Sea C.M.1983/K:13.

Pezzack, D.S. and D.R. Duggan. 1983. The Canadian offshore lobster (Homarus americanus) fishery - 1971-1982. Int. Coun. Explor. Sea C.M.1983/K:34.

Pringle, J.D. and R.E. Duggan. 1983. A remote sensing technique for quantifying lobster fishing effort. Can. Tech. Rep. Fish. Aquat. Sci. 1217.

Stasko, A. 1978. Inshore-offshore S.W. Nova Scotia lobster stock interaction: a hypothesis. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 78/37.

Appendix

Table 1. Weather conditions on air survey flight days, Yarmouth airport - fall 1983 and spring 1984.

Date	Spring
May 11	Wind - SW 10 kn Cloud - high scattered Precipitation - nil
May 15	Wind - W 12-18 kn Cloud - scattered to broken Precipitation - nil
May 16	Wind - W 10 kn Cloud - 1/10 cumulus Precipitation - nil
Date	**Fall**
Dec. 9	Wind - SW 14-24 kn Cloud - scattered and broken 6-10 kn Precipitation - nil
Dec. 12	Wind - light to SE 15-26 kn Cloud - clear to broken Precipitation - nil
Dec. 17	Wind - light to W 8-12 kn Cloud - broken to overcast Precipitation - light rain and snow
Dec. 18	Wind - NW 18-25 kn to WNW 28-38 kn Cloud - broken to scattered Precipitation - nil