Excellence scientifique • Protection et conservation des ressources • Bénéfices aux Canadiens
Scientific Excellence • Resource Protection & Conservation • Benefits for Canadians

# Analysis of Atlantic mackerel (*Scomber scombrus L.*) catch data gathered by a fisherman in Dingwall, Nova Scotia, from 1983 to 1990


François Grégoire and Kelly Fitzgerald

Fisheries Research Division
Department of Fisheries and Oceans
Maurice-Lamontagne Institute
P.O. BOX 1000, 850 route de la Mer
Mont-Joli (Québec)
G5H 3Z4



1991

**Canadian Industry Report of Fisheries and Aquatic Sciences 210**

Pêches et Océans
Fisheries and Oceans

Canada

## Rapport canadien à l'industrie sur les sciences halieutiques et aquatiques

Les rapports à l'industrie contiennent les résultats des activités de recherche et de développement qui peuvent être utiles à l'industrie pour des applications immédiates ou futures. Ils sont surtout destinés aux membres des secteurs primaire et secondaire de l'industrie des pêches et de la mer. 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 à l'industrie peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports à l'industrie 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 91 de cette série ont été publiés à titre de rapports sur les travaux de la Direction du développement industriel, de rapports techniques de la Direction du développement industriel, et de rapports techniques de la Direction des services aux pêcheurs. Les numéros 92 à 110 sont parus à titre de rapports à l'industrie 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 111.

Les rapports à l'industrie 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 Industry Report of Fisheries and Aquatic Sciences

Industry reports contain the results of research and development useful to industry for either immediate or future application. They are directed primarily toward individuals in the primary and secondary sectors of the fishing and marine industries. 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.

Industry 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 1–91 in this series were issued as Project Reports of the Industrial Development Branch, Technical Reports of the Industrial Development Branch, and Technical Reports of the Fisherman's Service Branch. Numbers 92–110 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Industry Reports. The current series name was changed with report number 111.

Industry 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.

Canadian Industry Report
of Fisheries and Aquatic Sciences 210

1991

# ANALYSIS OF ATLANTIC MACKEREL (*Scomber scombrus L.*) CATCH DATA GATHERED BY A FISHERMAN IN DINGWALL, NOVA SCOTIA, FROM 1983 TO 1990

by

François Grégoire and Kelly Fitzgerald[1]

Fisheries Research Division
Department of Fisheries and Oceans
Maurice-Lamontagne Institute
P.O. BOX 1000, 850 route de la Mer
Mont-Joli (Québec)
G5H 3Z4

1 Kelly Fitzgerald, P.O. BOX 44, Dingwall, Victoria County, Nova Scotia, B0C 1G0.

Cat. No. Fs 97-14/210E ISSN 0706-3694

Correct citation for this publication:

Grégoire, F. and K. Fitzgerald. 1991. Analysis of Atlantic mackerel (*Scomber scombrus L.*) catch data gathered by a fisherman in Dingwall, Nova Scotia, from 1983 to 1990. Can. Ind. Rep. of Fish. and Aquat. Sci. 210: vi + 19 p.

Cette publication est disponible en français.

# TABLE OF CONTENTS

# LIST OF FIGURES

## PREFACE

This report contains the results of an analysis of fishing data gathered by Kelly Fitzgerald of Dingwall, Nova Scotia. The data on mackerel catches in Mr. Fitzgerald's traps were gathered very meticulously. Publishing this industry report is a special way for the Department of Fisheries and Oceans to thank Mr. Fitzgerald for his initiative, strong sense of responsibility and close co-operation with us. The Department also considers this report to be an example of what can be accomplished in tandem with our partners in the fishing industry.

## ABSTRACT

An analysis of mackerel catch data collected between 1983 and 1990 for three traps owned by a fisherman in Dingwall (Nova Scotia), Mr. Kelly Fitzgerald, was conducted by the Maurice- Lamontagne Institute. The results indicate that the first mackerel are caught each year in late May. The beginning of each fishing season is marked, not by a gradual increase in catches, but rather by large mackerel catches. Catches and catch per unit effort have been on the decline since 1983. The fishing season in Dingwall is relatively short, around one month. No relationship was found between total annual catches or the length of the fishing season and the starting date of each season. The decrease in catch per unit effort could be explained by a change in the mackerel migratory pattern. Thermographs have been installed on the mackerel traps in order to determine the influence of water temperature on the coastal migration of the mackerel.

## RÉSUMÉ

Une analyse des données de captures de maquereaux enregistrées entre 1983 et 1990 aux trois trappes d'un pêcheur de Dingwall (Nouvelle-Écosse), M. Kelly Fitzgerald, a été effectuée par l'Institut Maurice-Lamontagne. Les résultats démontrent que les premières captures sont effectuées chaque année vers la fin de mai. Le début de chaque saison de pêche est caractérisé, non pas par une augmentation graduelle des captures, mais plutôt par des captures élevées de maquereaux. Les captures et les prises par unité d'effort présentent depuis 1983 une tendance à la baisse. La saison de pêche à Dingwall est relativement courte, soit environ un mois. Aucune relation entre les captures totales annuelles ou la longueur de la saison de pêche et la date du début de chaque saison n'a été observée. La diminution des prises par unité d'effort pourrait s'expliquer par un changement dans le patron de migration des maquereaux. Des thermographes ont été installés sur les trappes à maquereaux dans le but de déterminer l'influence de la température de l'eau sur la migration côtière des maquereaux.

# INTRODUCTION

## HISTORY OF COMMERCIAL CATCHES

Atlantic mackerel (*Scomber scombrus L.*) fishing in the Northwest Atlantic began in the 17th century. However, the first commercial catches were not recorded by the United States until 1804 and by Canada until 1876 (Anderson and Paciorkowski 1980). The pattern of commercial mackerel catches (Figure 1) is a reflection of natural variations of the fish stock and the presence or absence of a market. In the beginning, mackerel were caught by coastal fishermen. Prior to 1800, mackerel were caught using the beach seine method. This practice was later replaced by jigging. Few catches were recorded prior to 1815 (Figure 1). For example, the average annual catch between 1804 and 1814 was only 1,724 t. The beginning of American deep-sea fishing for saltwater mackerel resulted in a marked increase in catches beginning in 1815. Mackerel catches remained high between 1830 and 1885. However, this period was marked by natural variations in the abundance of mackerel (Sette and Needler 1934), particularly between 1835 and 1845. Between 1845 and 1885, average annual catches totalled 51,580 t.

The purse seine method was first used around 1850. It became more popular than jigging but did not result in any major changes in mackerel catches. However, its use caused a shift in American jig fishing from the Gulf of St. Lawrence to the New England shores (Anderson and Paciorkowski 1980). A peak of 106,038 t in 1884 preceded a dramatic drop in catches, which remained small until 1924. An increase in catches recorded shortly after 1925 was due to a large year-class in 1923 (Sette 1931). Following a peak of 49,200 t in 1944, catches decreased once more until around 1960. This drop was probably caused by the same fungal infection that especially affected herring (Maguire 1981).

Winter mackerel fishing by European countries began with an 111-t catch by Poland in 1962 (Anderson and Paciorkowski 1980). Total catches increased quickly after that, climbing from 39,000 t in 1967 to 430,000 t in 1973. Between 1969 and 1976, average annual catches were 304,133 t. There was a considerable drop in this fishing activity in 1977 when jurisdiction over the fisheries was extended to 200 nautical miles from shore by Canada in January and by the United States in April of that year. Total commercial catches increased gradually over the next few years, climbing from 34,446 t in 1978 to 71,735 t and 62,485 t in 1989 and 1990 (preliminary data, Grégoire 1991a). Joint programs between the United States and European countries caused this increase.

## CURRENT FISH STOCKS IN THE GULF OF ST.LAWRENCE

Despite two separate spawning grounds, along the New Jersey coast at Long Island and in the Gulf of St. Lawrence, Atlantic mackerel is managed as a single stock. Anderson (1975) proved that separate estimates of both groups or contingents would result in overfishing. Biomass estimates of the northern contingent cannot be made using conventional analysis techniques based on fishing statistics, the reason being that a major variable, mortality caused by fishing, is too low. To get around the problem, biomass is estimated using total egg production. Each year, the Maurice- Lamontagne Institute sends a research vessel into the Gulf of St.Lawrence. A certain number of stations are visited, and plankton samples are harvested. The eggs are counted in a laboratory, and the number of mackerel spawning is determined using a simple formula. The total number of eggs laid in a year is divided by the average number of eggs laid per female. The resulting number of females is multiplied by their average weight, with the answer being the biomass of the reproductive females. Assuming that there are as many males as females, the biomass is then multiplied by two. Using this formula, the biomass of reproductive mackerel in the Gulf of St. Lawrence increased from 357,000 t in 1983 to 1,747,000 t in 1986 and then to 1,772,683 t in 1988 (Figure 2). A low of 537,369 t in 1989 was not caused by an actual decrease in biomass but rather by bad timing between the peak in egg laying and the trip by the research vessel. In 1990, total egg production was estimated at $620.2 \times 10^{12}$ eggs, which represents a biomass of approximately 1,363,224 t (Grégoire 1991a). This formula has some shortcomings as regards the estimate of total eggs production and female fecundity. Studies are currently being conducted to improve our knowledge of female fertility. In 1990, mackerel catches totalled 62,485 t. The total Canadian catch was 20,098 t. The large year-class in 1982 was still present and accounted for 43.62% of the 33,246,000 Canadian catches and 37.16% of the 96,854,000 American catches.

## CATCHES IN THE DINGWALL TRAPS

Kelly Fitzgerald, a mackerel fisherman and co-author of this report, has been voluntarily recording all daily catches in his three traps since 1983. These traps are located in Aspy Bay, near Dingwall on Cape Breton Island (Figure 3). Mr. Fitzgerald used notebooks to record the weight of his catches that he sold to fish processors. Copies of these notebooks were sent to the Maurice-Lamontagne Institute, Department of Fisheries and Oceans, for analysis. The results were presented at the May 1991 meeting of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) (Grégoire 1991b).

The current system for gathering commercial fishing data from fixed coastal fishing gear such as traps makes it impossible to differentiate between catches specific to particular types of gear. Mr. Fitzgerald's mackerel catch data have provided an opportunity to gain new insights into mackerel fishing and migration in the Dingwall area. The value of this fishing data is enhanced by the fact that, contrary to our estimates, they point to a decrease in the abundance of mackerel. The purpose of this report is to provide fishermen and processors with analyses of mackerel fishing data in Dingwall. In addition, this joint report is intended to show what can be accomplished by fishermen and processors working in tandem with scientists at the Department of Fisheries and Oceans.

## METHODS

The Dingwall catch data are from all three traps. The catch per trap was not recorded, however. Fishing effort was defined as the number of days before the traps were raised. The traps are all attached to the shore by nets measuring 120, 95 and 50 fathoms in length respectively. Each trap is eight fathoms deep and measures 78 fathoms around. The mesh in each net is 12.7 centimetres (five inches) wide. The sides of the traps measure 3.81 centimetres (1.5 inches), and the bottoms, 4.45 centimetres (1.75 inches).

Catch per unit effort, which can be seen as an indication of the size of the stock, were calculated as being the ratio between total annual catches and the total fishing effort. They were analyzed according to the year and fishing effort. Fishing seasons were analyzed using graphs of daily and cumulative catches. Catch dates were recoded (1 for the first of May, 32 for the first of June, etc) in order to facilitate interpretation of the results and multiyear comparisons. Variations in annual migration were studied, taking into account the start and median date for each fishing season.

# RESULTS

## ANNUAL CATCHES AND CATCH PER UNIT EFFORT

Total annual catches in the Dingwall traps have been declining since 1983. The largest catches were in 1983, 1984 and 1987, at 270,182 kg, 296,869 kg and 271,743 kg respectively (Figure 4). The average over the past three years was only 138,223 kg, compared to 207,017 kg for the entire period. There has been an upward trend over the past three years. The total number of fishing days is relatively constant from one year to the next (Figure 5). The 1985 season was the shortest, at 30 days. The mackerel fishing season in Aspy Bay, with an average of 38.25 fishing days, is fairly short.

Annual catch per unit effort also declined during the period studied (Figure 6). Since 1983, they have dropped by almost half. Over the past three years, they increased noticeably but are still below initial levels. The lowest catch per unit effort were recorded in 1988. No relationship was found between catches and fishing effort (Figure 7) or between catch per unit effort and fishing effort (Figure 8). Thus, catches or catch per unit effort cannot be predicted using the number of fishing days.

## PROFILE OF DAILY CATCHES

The beginning of the fishing season in Dingwall is not marked by a gradual increase in catches. The first catches, around the end of May, are already large; sometimes they are the largest of the season (Figure 9). There are fairly wide fluctuations in daily catches, and their profile can vary from one year to the next. For instance, in 1983 and 1984, few catches were recorded between June 10 and 17. In 1985, large catches at the beginning of the season quickly declined after that. In 1987, there were few catches after June 6.

There was no particular pattern with the middle of each fishing season, which is expressed in terms of the median catch date (vertical lines in figures 9 and 10) and which is somewhat of an indication of migration. No relationship was found between the number of annual landings and the median date or start date of the fishing season. The same conclusions apply to the duration of the fishing season.

## CUMULATIVE DAILY CATCHES

The period during which few catches were recorded during the middle of the 1983 and 1984 seasons can also be seen by looking at the graphs of daily cumulative catches (Figure 10). For both of these years, the preceding period is marked by a plateau, where two "S" shaped curves instead of one could be drawn. The plateau signals a virtual halt in catches, caused by a lack of mackerel near the traps and not by a halt in fishing, the result, for instance, of bad weather. This phenomenon occurred in Dingwall prior to 1983 but did not re-occur after 1985.

## DISCUSSION

The mackerel fishing data for the Dingwall traps indicate that catches and catch per unit effort have been declining since 1983. This phenomenon cannot be attributed to any kind of change in the setting or positioning of traps. The traps have been put out in the same fashion for several years by highly experienced fishermen. An actual decrease in biomass is conceivable, provided that variations in catch per unit effort are considered as being representative of what is actually happening to the fish stock. Theoretically, catch per unit effort from each type of fishing gear can be used as an independent measure of the abundance of a fish stock (Chadwick *et al.* 1990). In the present case, there is however a significant and opposite trend between catch per unit effort at Dingwall and the estimate of abundance by the eggs method (Grégoire 1991b). Despite the presence of such a relationship, we cannot reject objectively the value of the Dingwall catch per unit effort as a valid index of abundance (Grégoire 1991b).

The decrease in catch per unit effort could be explained, however, by a change in mackerel migratory patterns along the coast. For some reason, a certain number of fish appear to be moving farther away from the coast and therefore more out of reach of the Dingwall traps. At the request of the Maurice- Lamontagne Institute, Mr Fitzgerald installed thermographs on his traps in 1991 to provide an insight into the effect of water temperature on the presence or absence of mackerel near the shore. Wind, which is also an important factor that could explain variations in mackerel coastal migratory patterns, was also recorded in 1991. It has already been proved for example that the presence of cod (*Gadus morhua*) in certain fishermen's traps was related to wind direction (Rose and Leggett 1988a; Rose and Leggett 1988b; Grégoire and Sinclair 1991). As mackerel move farther away from shore, the result of water temperature or wind, trap catches could decrease. On the other hand, catches with fishing gear farther out to sea could also increase. This was observed in the Northwest Atlantic Fisheries Organization's 4Vn Statistical Division, where Mr. Fitzgerald's traps are located (Figure 11). Fishing lines used off the coast bring in more mackerel. This trend has increased over the past few years. However, this figure does not take into account the effort associated with each type of fishing gear or changes in the time of use of one type versus another. The increase in fishing line catches may be nothing more than the result of an increase in the number of fishermen using this method.

Kelly Fitzgerald's fishing data have made it possible to learn a little bit more about the coastal migration of mackerel in the Dingwall area. We now know that the annual arrival of mackerel in this area is precisely timed. Prior to 1984, there were two major movements of mackerel in the area. The question can be raised as to why this is no longer the case today (disappearance or avoidance of a large year-class?). The Department of Fisheries and Oceans and Mr Fitzgerald will continue to work together over the next few years. For instance, in 1991, Mr. Fitzgerald took samples to gather more population data on catches and to monitor significant biological variables over time. A summary analysis of these samples indicates that the first mackerel caught at Dingwall were already quite mature. Dingwall is also an ideal location for tagging fish and studying them.

## ACKNOWLEDGEMENTS

The Department of Fisheries and Oceans would like to thank sincerely M. Kelly Fitzgerald for his collaboration and for all the work he has done. Our thanks are also addressed to Dr. Denis D'Amours and M. Daniel Le Sauteur for the review of this report.

## REFERENCES

Anderson, E.D. 1975. The effect of a combined assessment for mackerel in ICNAF Subarea 3,4 and 5, and statistical area 6. Int. Comm. Northwest Atl. Fish. Res. Doc. 75/14.

Anderson, E.D., and A.J. Paciorkowski. 1980. A review of the northwest Atlantic mackerel fishery. ICES. Rapp. P.-V. Réun. Cons. int. Explor. Mer, 177: 175-211.

Chadwick, M. et R.N. O'Boyle. 1990. L'analyse des données de captures et d'effort **[In:]** Brêthes,J.-C. et R.N. O'Boyle (éds) 1990. Méthodes d'évaluation des stocks halieutiques. Projet CIEO-860060, Centre international d'exploitation des océans, Halifax (Nouvelle-Écosse,Canada), 963p.

Grégoire, F. 1991a. Analyses des captures de maquereaux bleus (*Scomber scombrus L.*) en 1990 pour les sous-régions 2 à 6 de l'OPANO et présentation de certaines caractéristiques biologiques. CSCPCA Document de Recherche 91/## (in press).

Grégoire, F. 1991b. Étude des captures de maquereaux (*Scomber scombrus L.*) enregistrées aux trappes d'un pêcheur de Dingwall, Nouvelle-Écosse, pour la période comprise entre 1983 et 1990. CSCPCA Document de Recherche 91/## (in press).

Grégoire, F. et A. Sinclair. 1991. Effets des vents côtiers sur les débarquements commerciaux de morues (Gadus morhua L.) par les engins fixes des unités statitiques 4Sv et 4Sw. Rapp. tech. can. sci. halieut. aquat. 1795: vii + 54 p.

Maguire, J.-J. 1981. Maturité, fécondité, ponte et évaluation de la taille du stock reproducteur du maquereau atlantique (*Scomber scombrus L.*) dans le golfe du St-Laurent. Thèse de Maîtrise, Université Laval, 137 p.

Rose, G.A., and W.C. Leggett. 1988a. Atmosphere-ocean coupling in the northern Gulf of St.Lawrence: frequency-dependent wind-forced variations in nearshore sea temperatures and currents. Can. J. Fish. Aquat. Sci. 45: 1222-1233.

Rose, G.A., and W.C. Leggett. 1988b. Atmosphere-ocean coupling and Atlantic cod migrations: effects of wind-forced variations in sea temperatures and currents on nearshore distributions and catch rates of Gadus morhua. Can. J. Fish. Aquat. Sci. 45: 1234-1243.

Sette, O.E. 1931. Outlook for the mackerel fishery in 1931. U.S.Bur. Fish., Cir. 4, 10pp.

Sette, O.E., and A.W.H. Needler. 1934. Statistics of the mackerel fishery off the east coast of North America, 1804 to 1930. U.S. Bur. Fish., Invest. Rep. 19, 48 p.

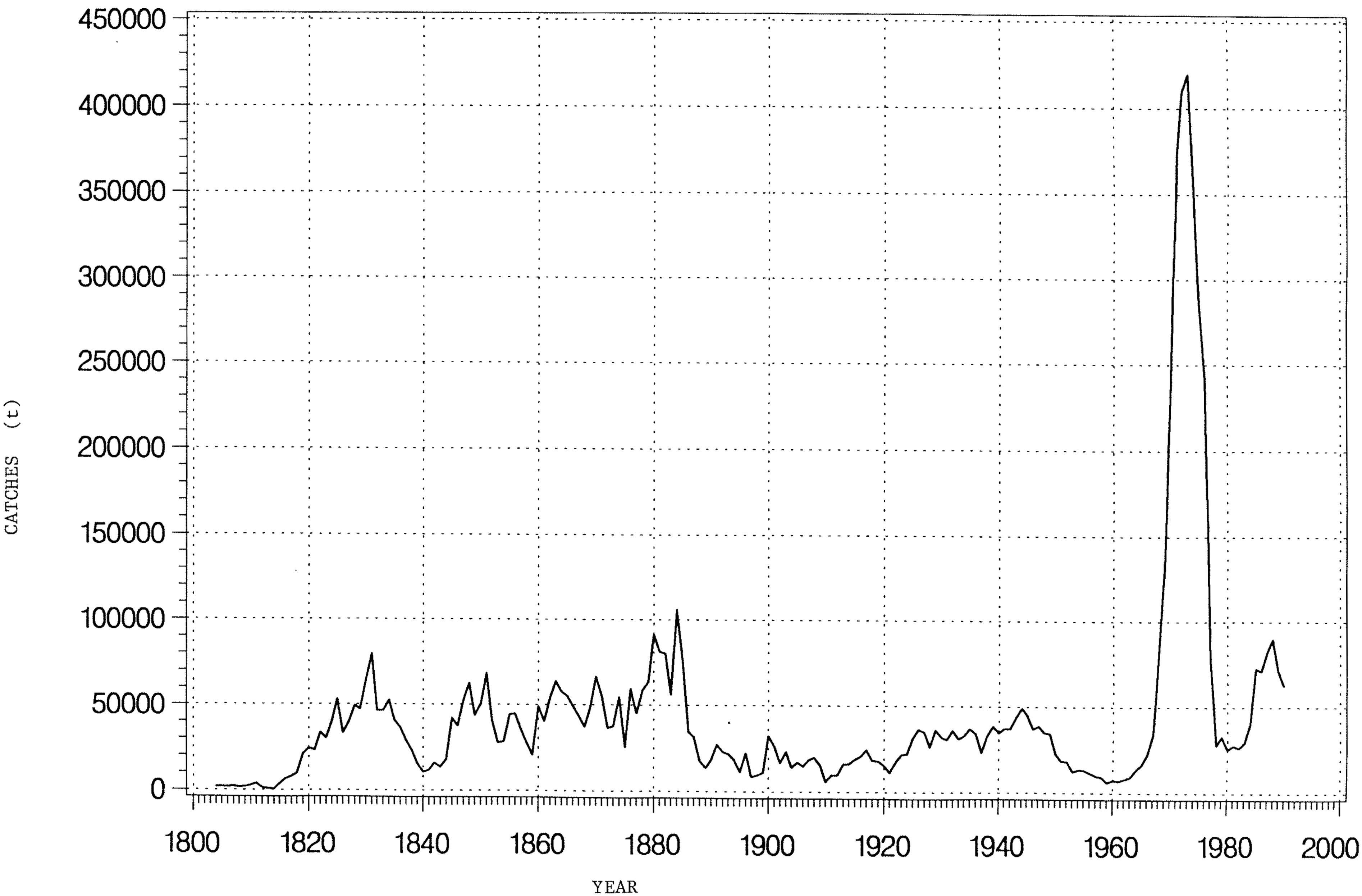


Figure 1. Total commercial mackerel catches (t) recorded by the United States since 1804 and by Canada since 1876 (from Anderson and Paciorkowski, 1980)

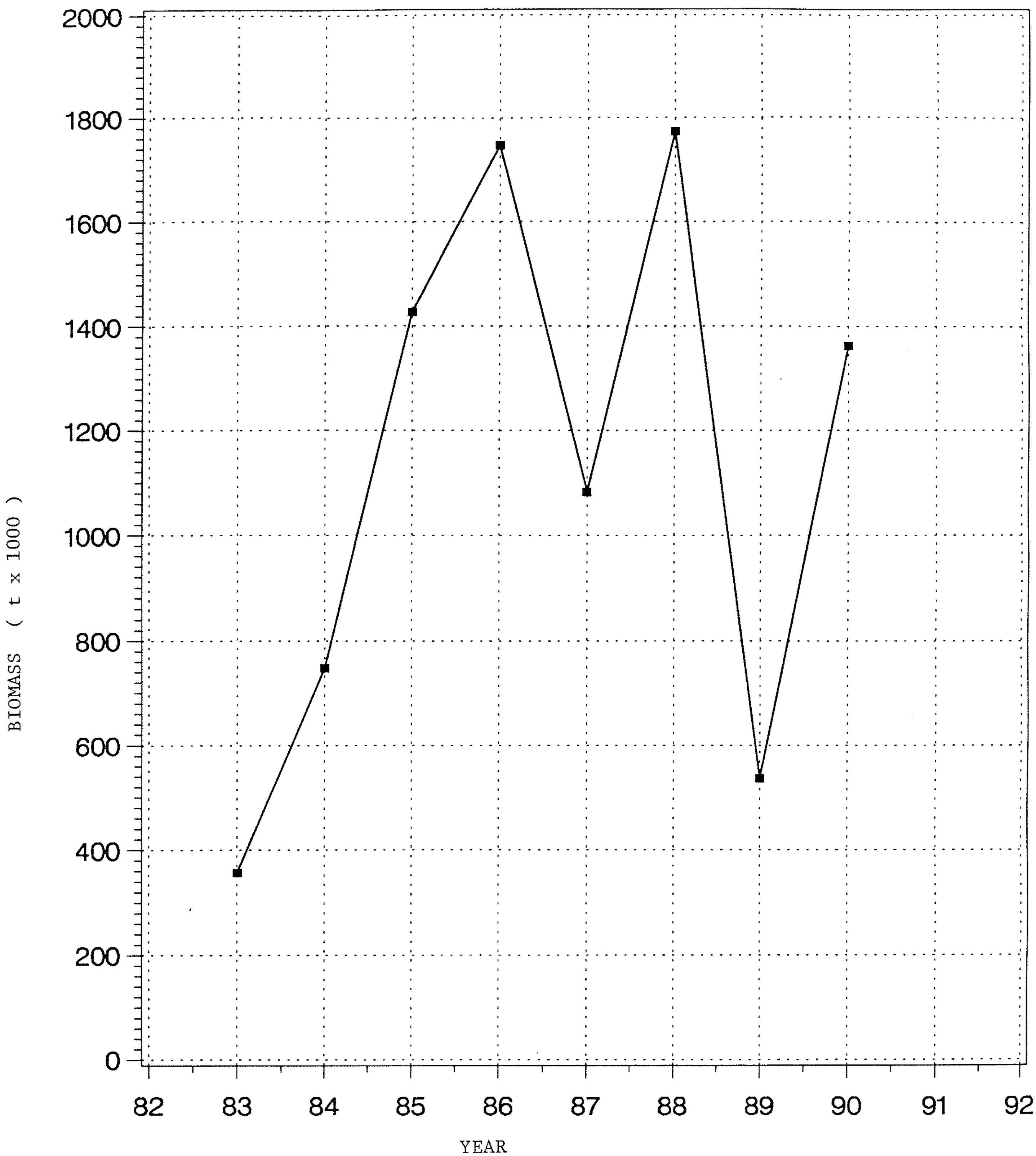


Figure 2. Annual biomass (t) of reproductive mackerel, northern contingent, as determined by total egg production.

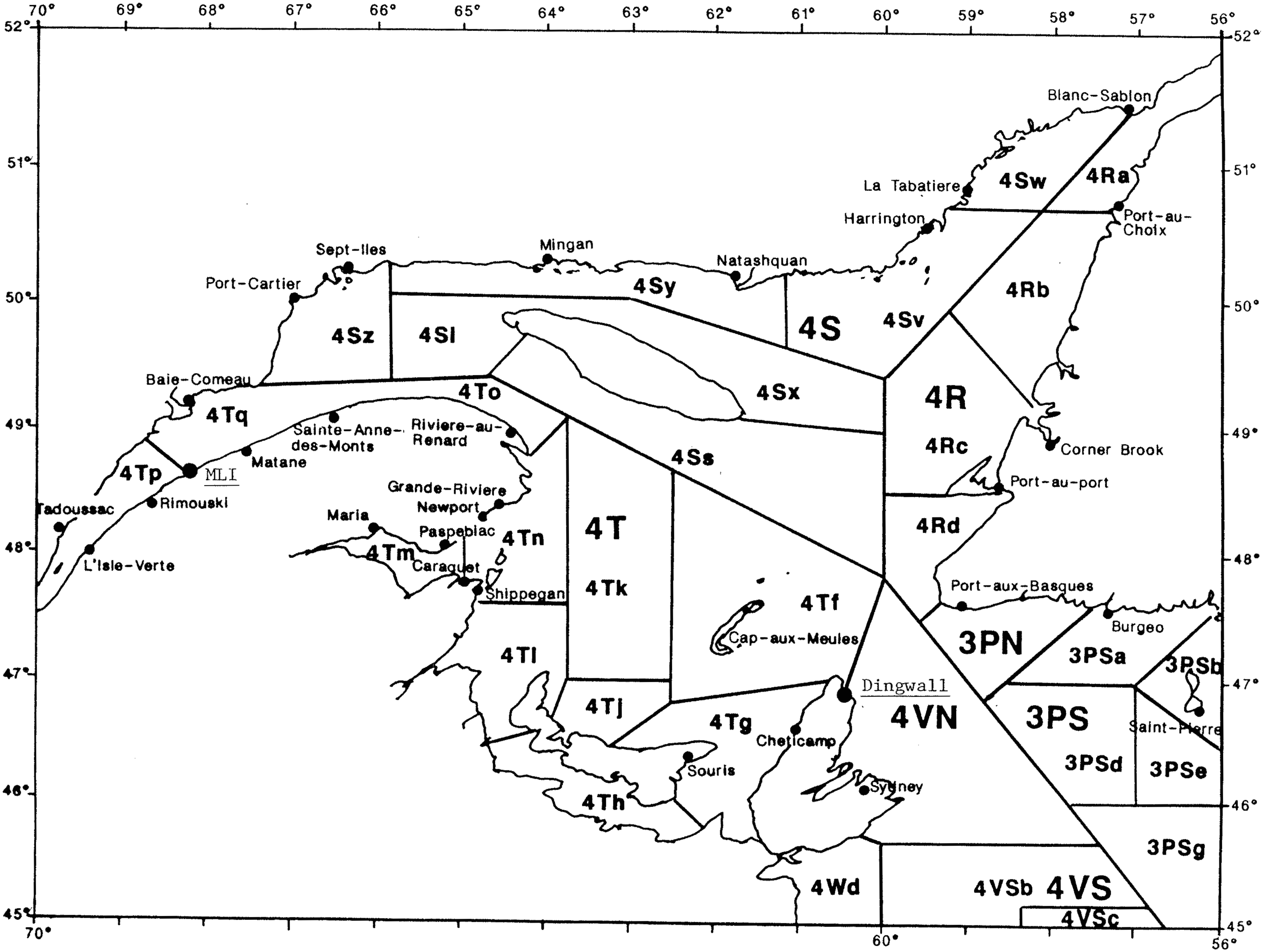


Figure 3. NAFO Statistical Division map for the Gulf of St.Lawrence and location of Kelly Fitzgerald's traps.

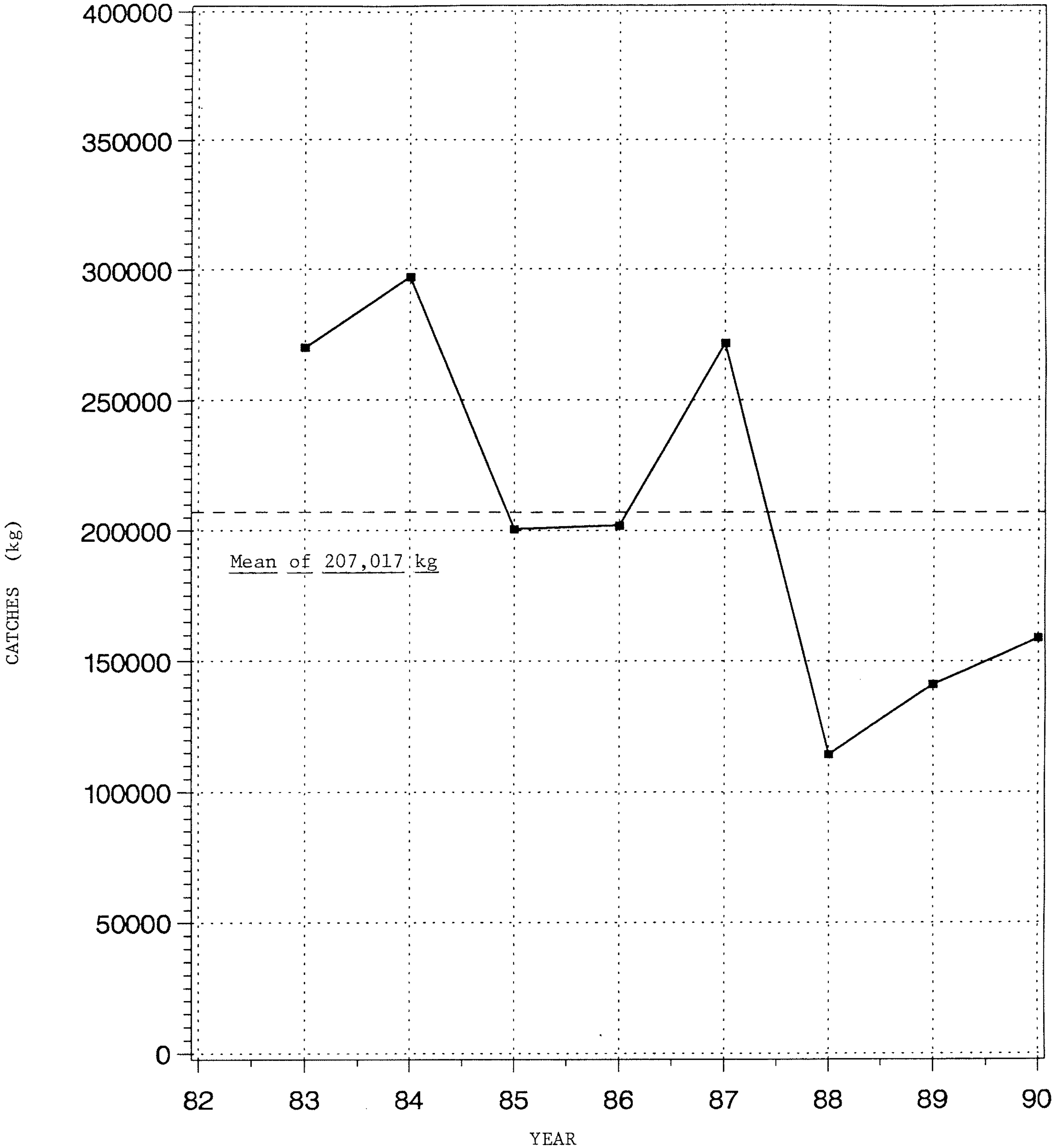


Figure 4. Annual mackerel catches (kg) in Dingwall traps, 1983 to 1990.

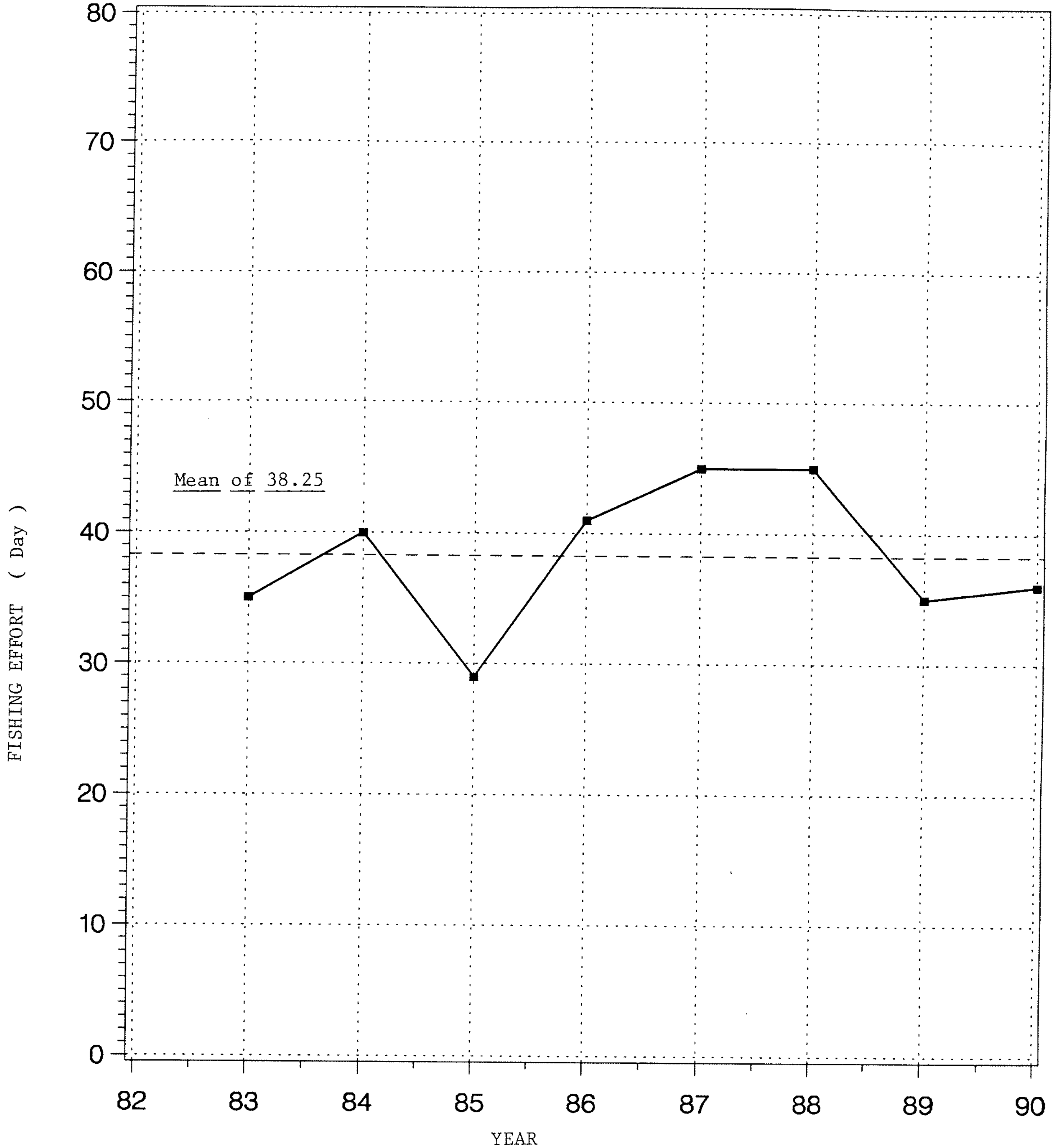


Figure 5. Total number of annual fishing days, Dingwall traps, 1983 to 1990.

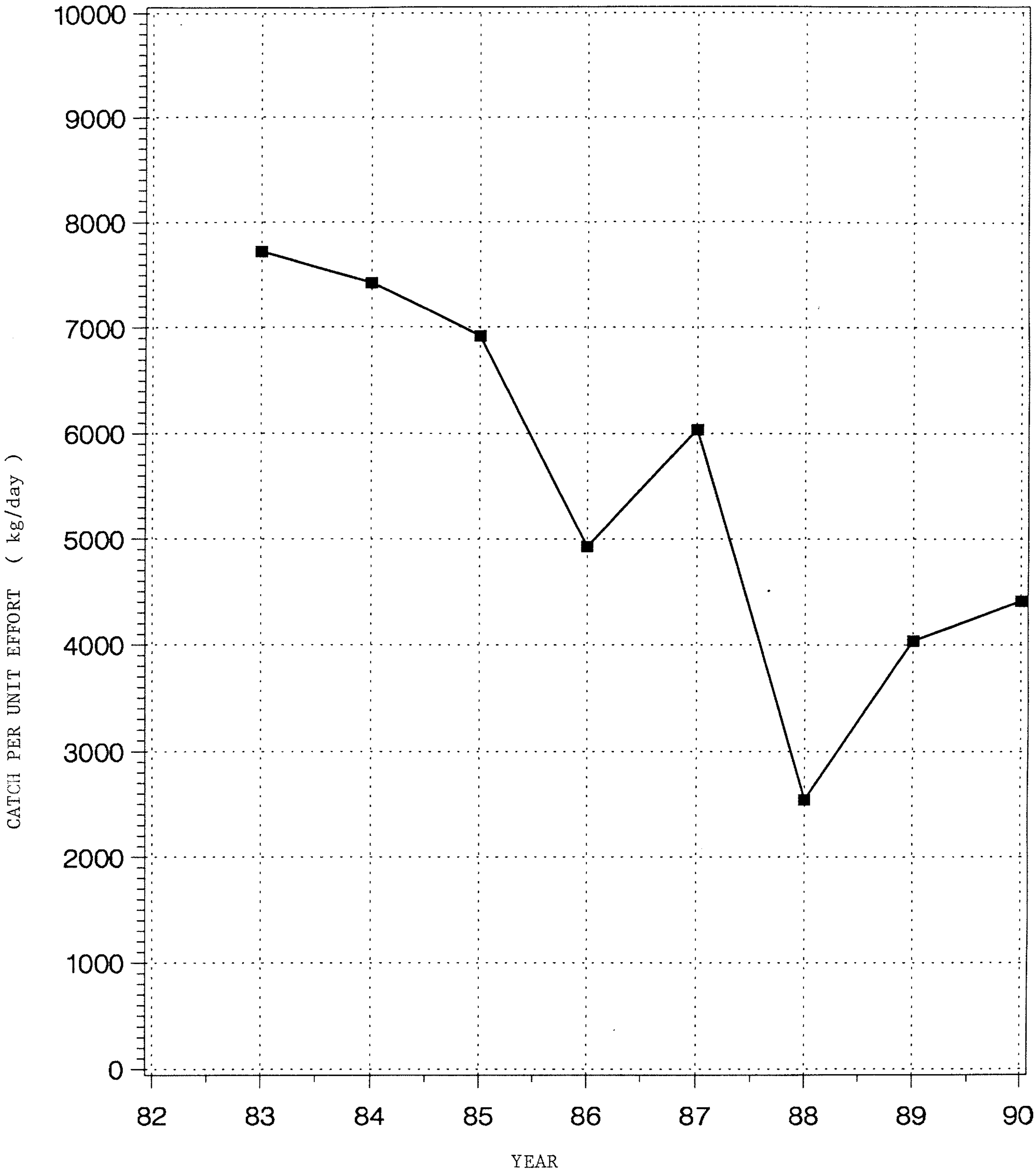


Figure 6. Annual catch per unit effort, Dingwall traps, 1983 to 1990.

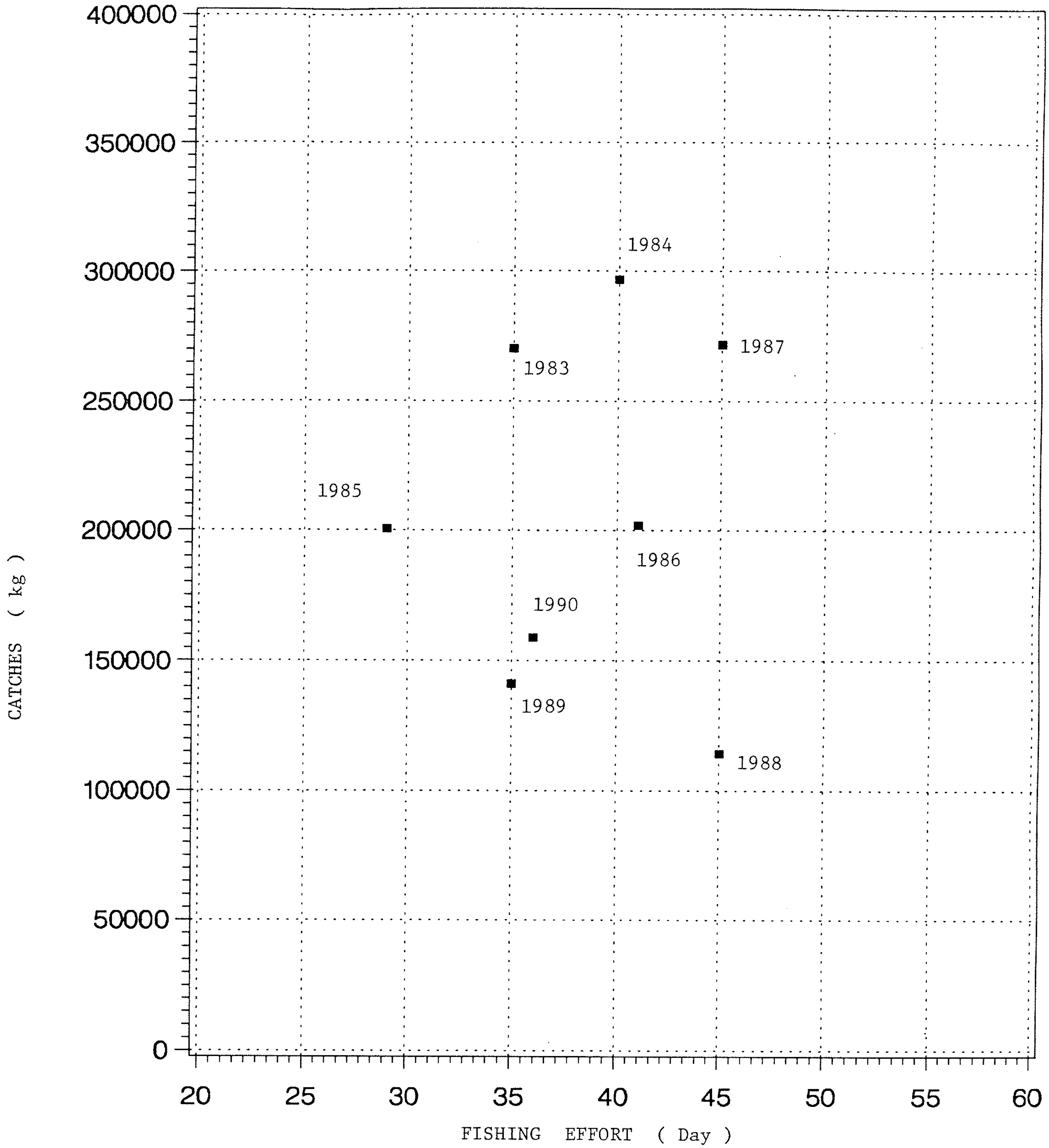


Figure 7. Relationship between total mackerel catches (kg) and fishing effort, 1983 to 1990.

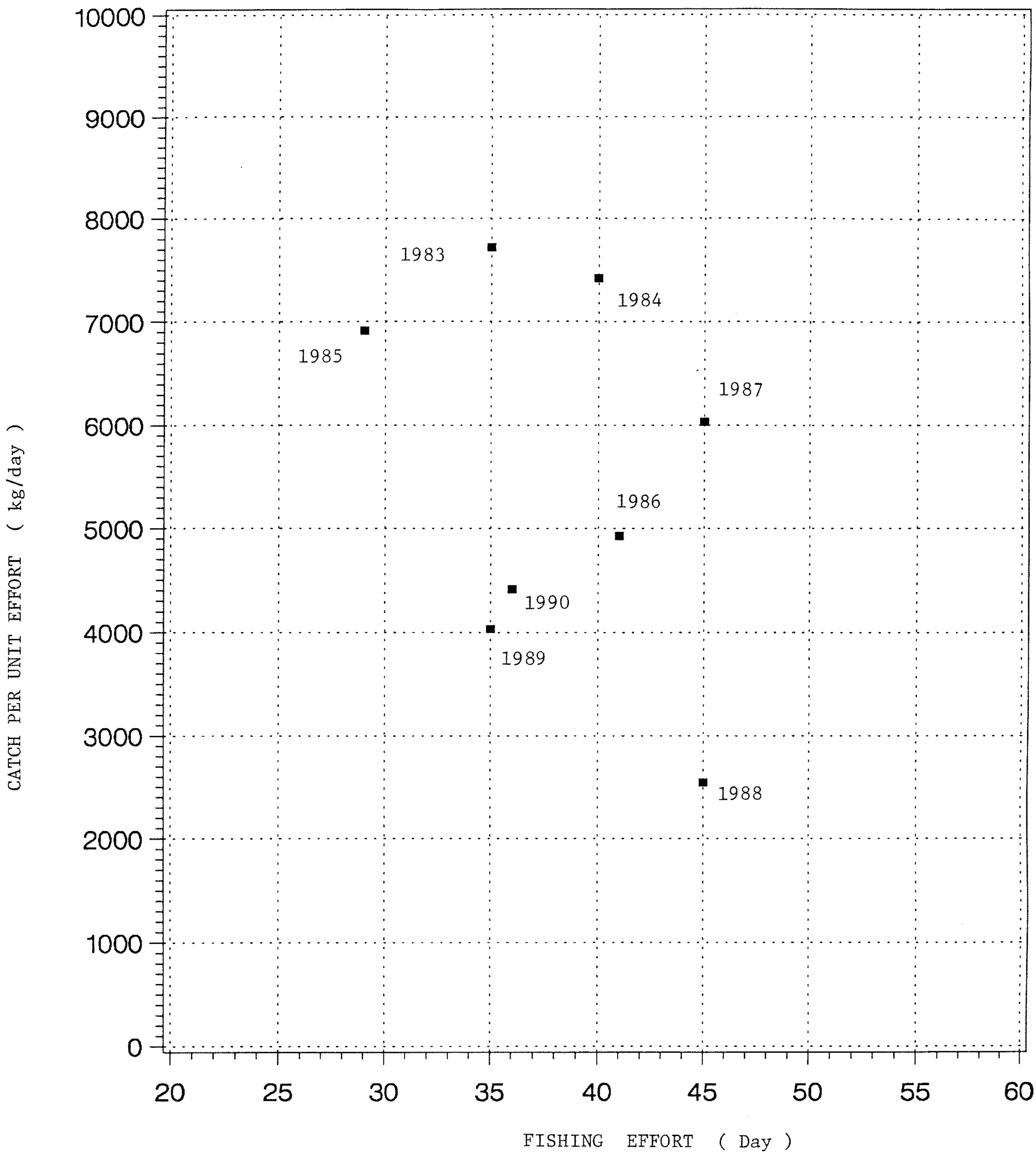


Figure 8. Relationship between annual catch per unit effort and fishing effort, 1983 to 1990.

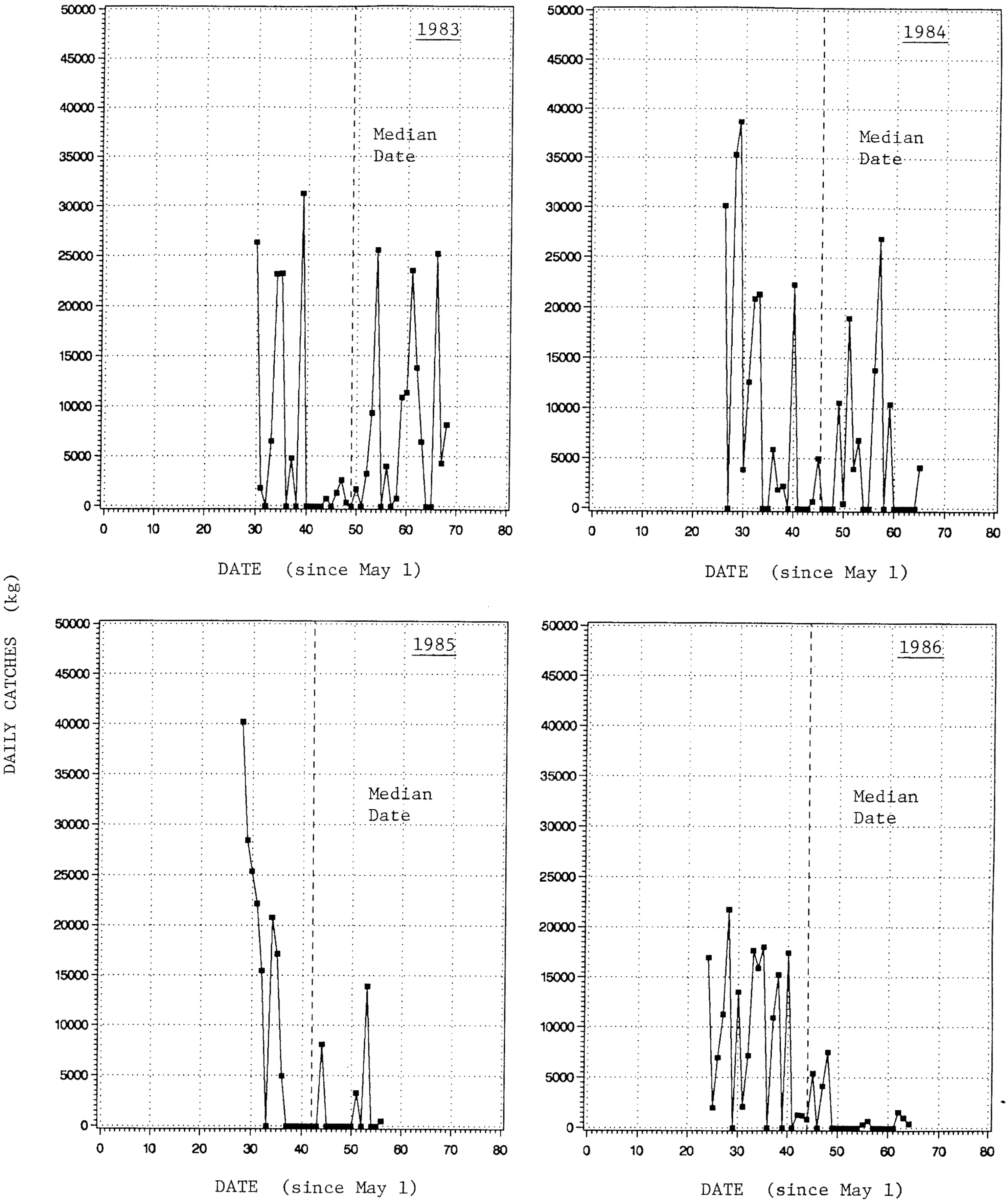


Figure 9. Profile of daily mackerel catches (kg), Dingwall traps, 1983 to 1990.

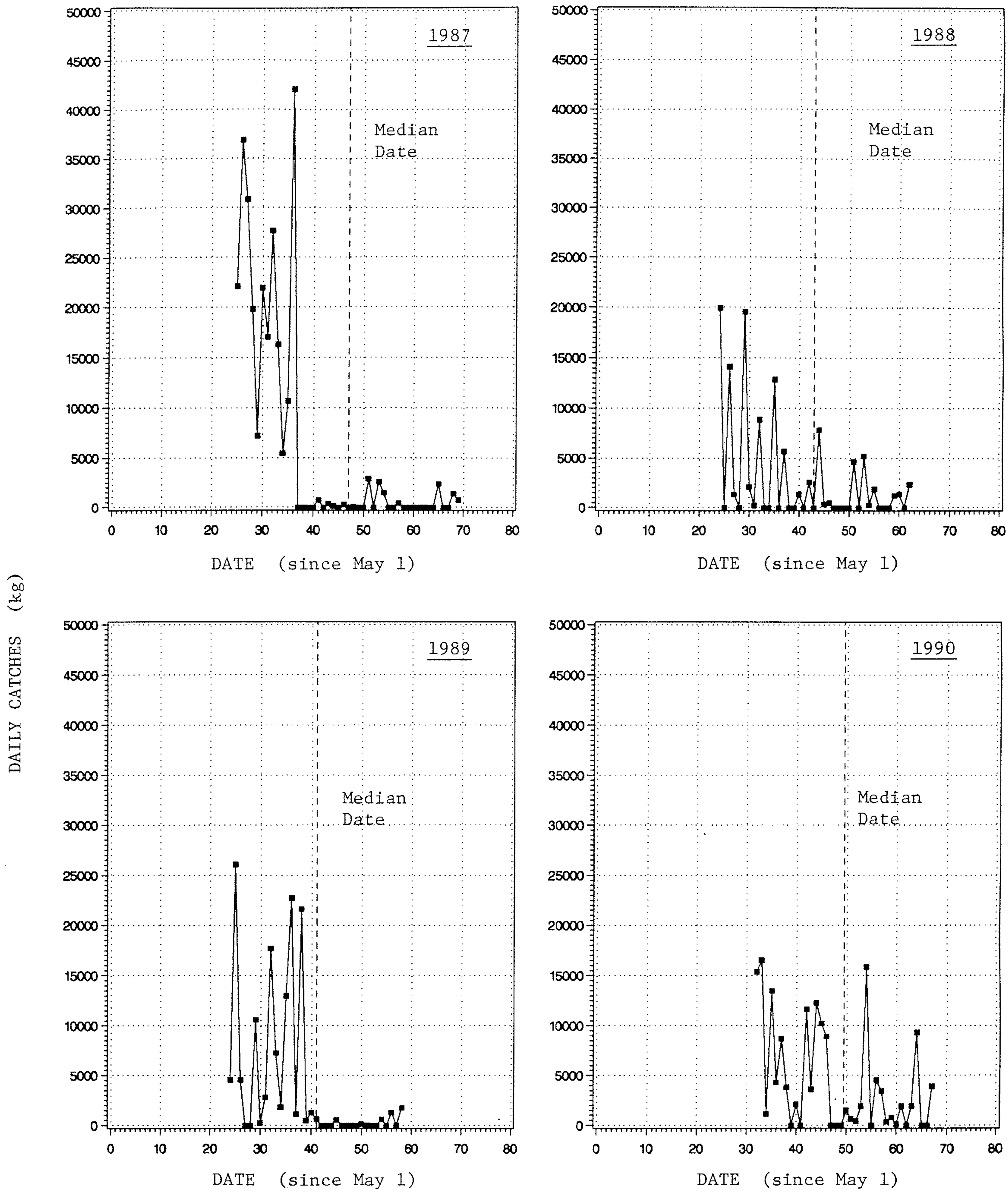


Figure 9. (Cont.)

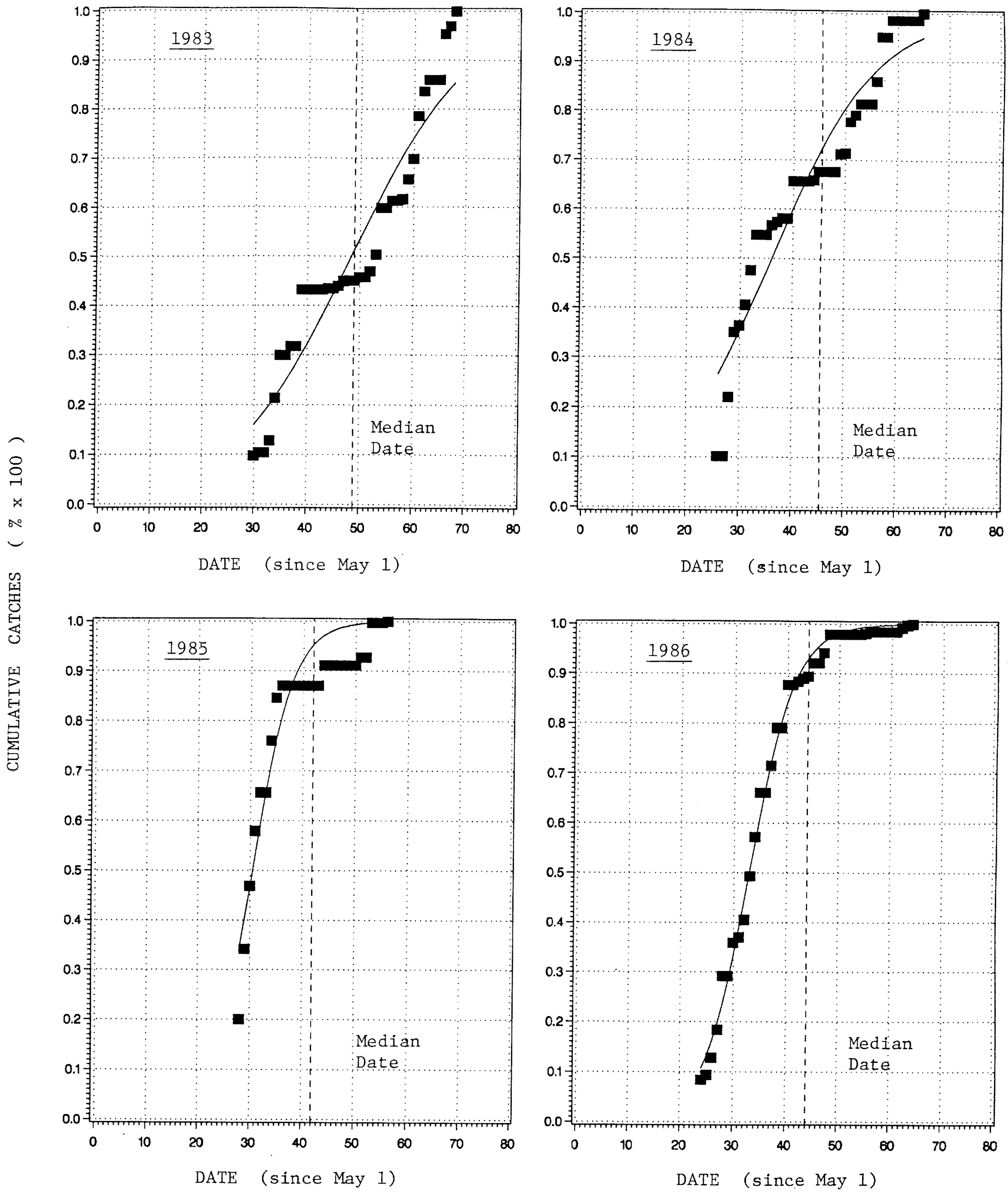


Figure 10. Profile of cumulative daily mackerel catches (kg), Dingwall traps, 1983 to 1990.

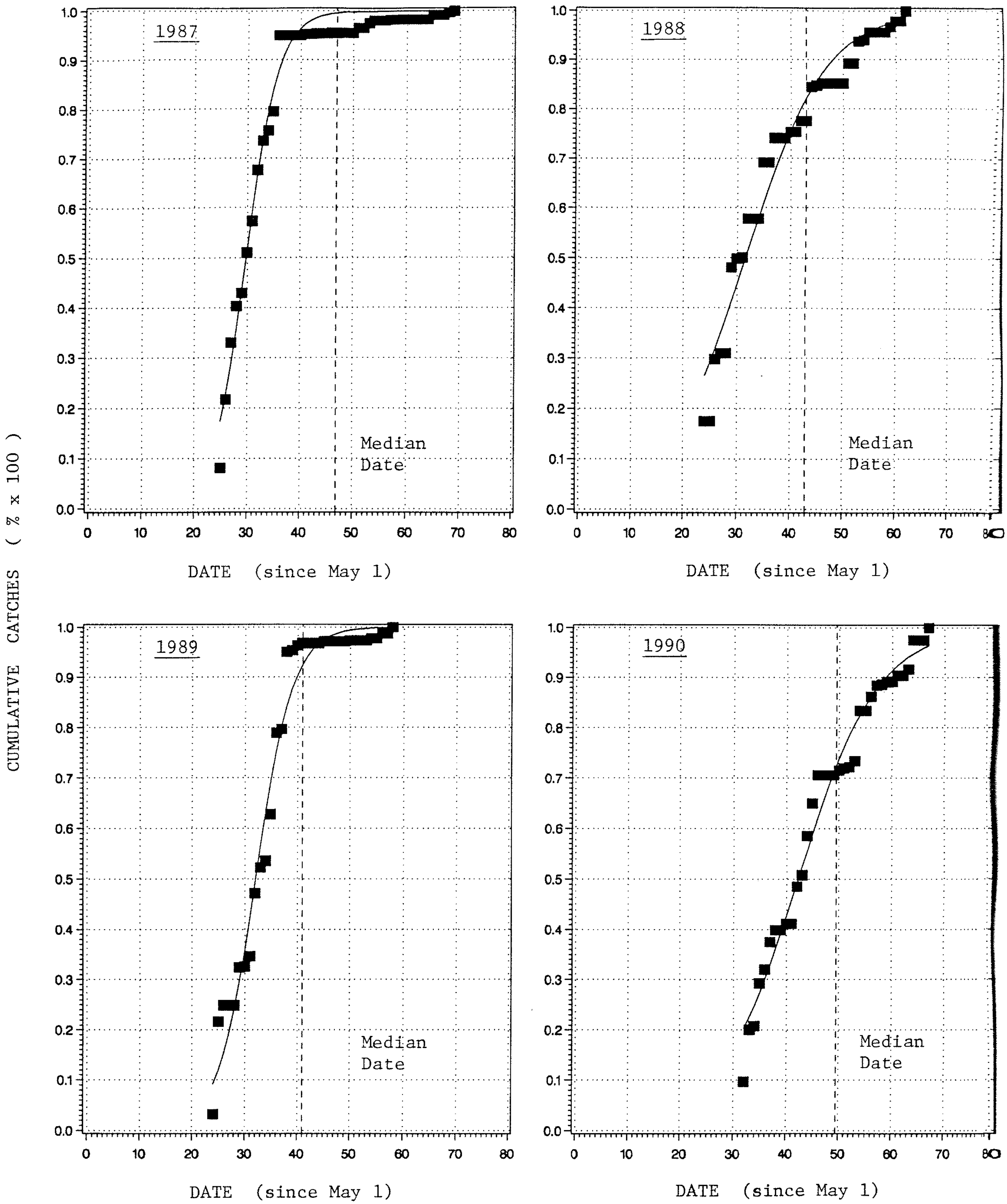


Figure 10. (Cont.).

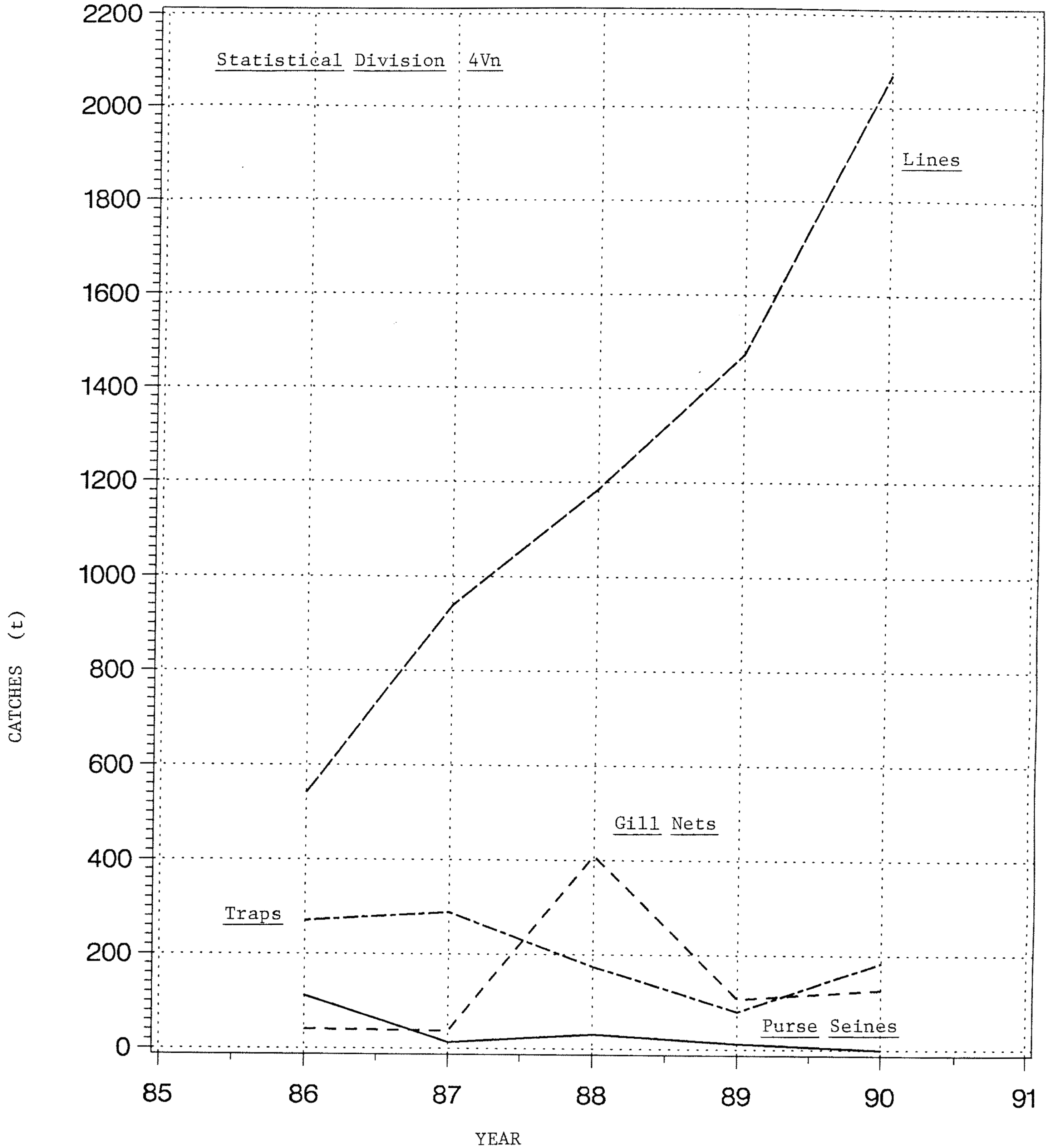


Figure 11. Total annual catches (t) for the four main types of fishing gear found in the NAFO's 4Vn Statistical Division, 1986 to 1990.