Fisheries Research Services Report No 9/95

USING ANGLING RECORDS TO INTERPRET TRENDS IN ADULT ATLANTIC SALMON (*Salmo salar* L.) STOCKS: ANALYSIS OF CATCH AND EFFORT DATA FROM 11 ESTATES ON THE RIVER SPEY BETWEEN 1992 AND 1994

G W Smith, R Laughton and J Bray

May 1995

The Scottish Office Agriculture and Fisheries Department
Marine Laboratory
Victoria Road
Aberdeen

USING ANGLING RECORDS TO INTERPRET TRENDS IN ADULT ATLANTIC SALMON (*Salmo salar* L.) STOCKS: ANALYSIS OF CATCH AND EFFORT DATA FROM 11 ESTATES ON THE RIVER SPEY BETWEEN 1992 AND 1994

G W Smith, R Laughton* and J Bray*

SOAFD Marine Laboratory, Aberdeen
*Spey District Fishery Board, 121 High Street, Forres

INTRODUCTION

The recent decline in net fisheries for Atlantic salmon (*Salmo salar* L.) in Scotland (Shearer, 1992), has increased the importance of rod catches as a source of information on the status of the stocks from which the catches are derived (Smith *et al.*, 1993; Smith *et al.*, in press).

Identifying trends in salmon stocks from catch statistics is fraught with difficulty, however (eg Lakhani, 1986; Shearer, 1986; Bielak and Power, 1988). For example, although returning adult salmon enter many of Scotland's major salmon rivers throughout the year (Shearer, 1992), fish are only sampled over a defined fishing season. There is also increasing evidence that the catchability of fish may vary during their riverine migration (Laughton, 1991; Smith and Laughton, 1993), while the size of the catch will also depend upon environmental factors such as river flow and temperature (Alabaster, 1970; Alabaster, 1990; Gee, 1980). An accurate measure of angling effort is also required if underlying trends in stock dynamics are to be inferred with any degree of confidence from trends in angling catch (eg Shearer, 1986).

In 1991 the Spey District Fishery Board and the Scottish Office Agriculture and Fisheries Department set up a project to standardise the collection of both catch and angling effort data over a wide area of the River Spey. The aim of the study is to determine the information required to interpret catch statistics in relation to salmon stocks and to set up a long term data set from which future trends in the Spey stock dynamics could be reliably monitored.

This progress report summarises some analyses of the data collected in this first three years of the project, 1992 to 1994. Individual salmon weights and catch and effort data are analysed together with the effect of river flow upon salmon catch per unit effort (CPUE). Some intended future developments of the study are also outlined.

MATERIALS AND METHODS

To maintain the confidentiality of the data from individual estates, each is identified only by a unique number (Table 1). All estates are situated on the main stem of the River Spey, except estates 19 and 20 which are situated on a major tributary, some 50 km from the mouth of the river.

Catch return forms were completed daily for each estate. Ghillies completed the forms for all estates except estate 20 where each individual angler collected the same information. Data from both successful and unsuccessful anglers were collected from each estate.

The forms were designed to record

- Date
- Spot measurements of river temperature and height
- Time each angler spent fishing
- Number and weight of each MSW salmon (multi sea-winter salmon, returning to spawn after more than one winter at sea), grilse (one sea winter salmon) and sea trout taken. As with much of the reporting of salmon catches in Scotland (Shearer, 1992), the sea ages of the fish were largely estimated on the basis of their weights; no scale samples were taken from which age could subsequently be confirmed.
- The bait/lure used.

For each estate, the daily catch and angling effort employed was recorded over the whole of the angling season, February to September. Fishing effort is expressed as the total time spent fishing by all anglers.

RESULTS AND DISCUSSION

1. **Size and Sea Age of Salmon**

Figure 1 shows the weight distributions of those fish identified as either MSW salmon and grilse throughout the angling season. In the early part of the season MSW salmon constituted the great majority of the catch (Fig. 1a). Grilse began appearing in significant numbers in June (Fig. 1b) and dominated the catches from July onwards (Fig. 1c). The weight distributions of fish taken in the Spey at each of these times of year showed no obvious change over the three years of the study to date.

As has already been noted elsewhere (Smith *et al.*, in press) the weights of MSW salmon showed a marked seasonal pattern. The data presented here confirm that, in each of the three years analysed, the recorded weights of MSW salmon underwent a marked decline after the month of July compared with earlier in the angling season. This may have arisen because in the final months of the angling season, when grilse began to dominate the angling catches, a significant proportion of the grilse catch was misclassified as the more prized MSW salmon, "grilse error" (Shearer, 1985). For further consideration of "grilse error" see Shearer (1992) and Dunkley *et al.* (1993).

In the absence of independent confirmation of sea age, data from all fish have been aggregated together for the rest of this report.

2. Seasonal Patterns of Catch, Effort and Catch Per Unit Effort

Seasonal patterns of mean daily salmon catch have remained generally similar in each of the three years of the study (Fig. 2a). In the first five months of the angling season (February to June) there was a slight rise in catches averaged over all estates, followed by a sharp increase in July when significant numbers of grilse began appearing in the catches (Fig. 1). Such relatively high catches were subsequently maintained until the end of the angling season. Fishing effort did not closely mirror catch rates, and although maximum fishing effort was expended in the summer months, angling effort remained relatively stable over much of the angling season in all three years (Fig. 2b).

The relative stability of the angling effort over the Spey as a whole may, in part, reflect the structure of the fisheries studied. As with many of Scotland's major salmon rivers the total number of anglers fishing many of the estates in the present study is limited, the anglers often having to book months or years in advance. This severely constrains anglers' abilities to vary fishing effort either seasonally or in response to perceived short term changes in success rates. Although the pattern of fishing effort on waters fished by angling clubs may depart from these generalised observations, none is currently represented in the study.

As a result of the relatively constant fishing effort over the angling season, the seasonal pattern of catch per unit effort (CPUE: expressed as the mean salmon catch for a single rod fishing for one hour) was similar to the catch data, a slight rise in CPUE in the first five months of the angling season, followed by a sharp increase in July (Fig. 2c). Of some interest, however, may be the distribution of CPUE in those final three particularly productive months (July to September). There was considerable variation in the relative success of anglers in each of these months during the study period, and there is some evidence to suggest that river flow have may been associated with inter-annual variations in CPUE.

Mean daily river flow data were provided by the North East River Purification Board from their river gauging station at Boat o'Brig, some 17 km from Spey mouth. Figure 3 shows CPUE and flow data for the months of July to September in each of the years 1992 to 1994. In order to show differences between years most clearly, both CPUE and flow data are expressed as percentage differences from mean values calculated for each month over the present study period, 1992 to 1994. In all but one month (September 1994), lower than average flows were associated with lower than average CPUE, while months following lower than average flows were associated with higher than average CPUE.

There is thus some evidence that low flows are associated with lower than average catches but, all things being equal, are generally followed by higher than average catches the following month. However, the present

analysis is based on only three years data during which time relatively few months experienced particularly low flows. A more definitive statement on the relationship between flow and CPUE must await the collection of a longer time series. A larger data set may also allow us to test the assumption implicit in the above analysis that the relationship between flow and catch is constant between estates in different parts of the river system.

One aspect of the data which has not been investigated until now is how CPUE in individual estates varies with their relative position along the river system. Figure 4 shows how, in each two month period through the angling season, the CPUE varied between estates in 1992 (Fig. 4a), 1993 (Fig. 4b) and 1994 (Fig. 4c). Again, although generalisations based on three years study can only be provisional, two points may be worthy of note.

Although less obvious early in the angling season when CPUE is particularly low, highest catches are associated with the lower estates. Thus, trends in the catch/effort data for the lower estates may obscure those trends from the higher estates when, as in much of this report, the data is analysed over the whole of the Spey rod fishery.

It is also clear that estate 20 enjoys a higher CPUE than would be predicted by its position within the Spey. This may be due to the very different fishing conditions experienced by anglers in this estate, positioned near to the top of one of the Spey's tributaries. On the other hand, this is the only estate in which individual anglers rather than ghillies have been asked to complete the catch/effort forms. The extent to which each of these factors have contributed to the higher than expected CPUEs observed in the present analysis will be explored in the coming years.

3. Trends in Catch Per Unit Effort Over the Study Period

Recent studies have demonstrated that salmon catches early in the fishing season were subject to serious decline during the 1970s and 1980s (Shearer, 1988; Laughton and Smith, 1993). As was noted in both studies, however, the lack of associated fishing effort data limited the usefulness of such analyses in interpreting trends in the returning adult stocks. By collecting angling effort data, the present study has attempted to address these perceived shortcomings of previous analyses. Figure 5 shows trends in CPUE in each two month period over the three years of the study so far. There is no evidence of any significant trends in the CPUE associated with the Spey rod fishery over this short period.

4. The Immediate Future of the Catch/Effort Study

The main aim of the project is to build a long term data set from which trends in the status of the underlying stocks of salmon supporting the Spey rod fisheries may be inferred. The sites outlined in Table 1 account for approximately 40% of the reported rod catch on the Spey and thus constitute a significant sample of the Spey rod fishery. We have demonstrated over three years that the collation and analysis of each season's data from these sites can be completed within six months of the end of the angling season and therefore that the present sampling strategy is a practical and sustainable one. With the support of the estates concerned, data will continue to be collected from the present study sites for the immediate future. As these sites provide information from most of the geographical range covered by rod fisheries on the Spey, it is not envisaged that effort will be put into expanding the number of estates involved in the study.

There are, however, two related areas of the project in which the data collection may be extended.

- We currently lack data from angling association waters, where the pattern of fishing effort may be markedly different from estates currently studied. Some effort will be put into identifying suitable angling associations who may be willing to cooperate with the study in the future.

- Although total angling effort is recorded for each angler, information on the relative proportions of time spent fishing for salmon and sea trout is currently unknown. The form has been modified for the 1995 season to allow ghillies/anglers to identify the target species.

ACKNOWLEDGEMENTS

We are grateful to all proprietors, ghillies and anglers who have contributed considerable time and effort to the study and to the North East River Purification Board for the provision of Spey river flow data. Both the Spey District Fishery Board and SOAFD provided much encouragement for the project and Tony Hawkins, Dick Shelton and Alastair Johnstone provided useful comments on a draft of this report. The Marine Laboratory typists prepared the final manuscript.

REFERENCES

Alabaster, J.S. 1970. River flow and upstream movement and catch of migratory salmonids. *Journal of Fish Biology*, **2**, 1–13.

Alabaster, J.S. 1990. The temperature requirements of adult Atlantic salmon *Salmo salar* L., during their upstream migration in the River Dee. *Journal of Fish Biology*, **37**, 659–661.

Bielak, A.T. and Power, G. 1988. Catch records - facts or myths. In: *Atlantic Salmon: Planning for the Future* D. Mills and D. Piggins (eds), pp235-255. Croom Helm, London.

Dunkley, D., Maclean, J.C. and Main, J.M.A. 1993. The effect of misreporting grilse as salmon on the reported Scottish national catch. *International Council for the Exploration of the Sea* ANACAT Committee CM 1993/M:40.

Gee, A.S. 1980. Angling success for Atlantic salmon (*Salmo salar*) in the River Wye in relation to effort and river flows. *Fisheries Management*, **11**, 131–138.

Lakhani, K.H. 1986. Salmon population studies based upon Scottish catch statistics: statistical considerations. pp.116–120 In: *The Status of the Atlantic Salmon in Scotland* (ITE Symposium No. 15) D. Jenkins and W.M. Shearer (eds), pp16-20. Natural Environment Research Council, Institute of Terrestrial Ecology, Abbots Ripton.

Laughton, R. 1991. The movements of adult Atlantic salmon (*Salmo salar* L.) in the River Spey as determined by radio telemetry during 1988 and 1989. *Scottish Fisheries Research Report*, **50**, 35pp.

Laughton, R. and Smith, G.W. 1993. Recent trends in the rod catches of Atlantic salmon (*Salmo salar* L.) from four sites on the River Spey. *Aquaculture and Fisheries Management*, **24**, 671-679.

Shearer, W.M. 1985. Salmon catch statistics for the River Dee, 1952-83. In: *The Biology and Management of the River Dee* (ITE Symposium no. 14) D. Jenkins (ed.), pp127-141. Natural Environment Research Council, Institute of Terrestrial Ecology, Abbots Ripton.

Shearer, W.M. 1986. An evaluation of the data available to assess Scottish salmon stocks. In: *The Status of the Atlantic Salmon in Scotland* (ITE Symposium No. 15) D. Jenkins and W.M. Shearer (eds), pp91-111. Natural Environment Research Council, Institute of Terrestrial Ecology, Abbots Ripton.

Shearer, W.M. 1988. Fisheries in the Spey Catchment. In: *Land Use in the River Spey* (ACLU Symposium No. 1) D. Jenkins (ed.), pp197-212. Aberdeen Centre for Land Use, Aberdeen.

Shearer, W.M. 1992. *The Atlantic salmon. Natural history, exploitation and future management*. Halsted Press, New York: 244pp.

Smith, G.W. and Laughton, R. 1993. The relationship between rod catches and the distribution of adult Atlantic salmon (*Salmo salar* L.) during the initial phase of riverine migration. *Aquaculture and Fisheries Management*, **24**, 681-683.

Smith, G.W., Laughton, R. and Dora, S.J. 1993. Angling effort and the rod catches of salmon (*Salmo salar* L.) and sea trout (*Salmo trutta* L.) on seven estates on the River Spey in 1992. *Scottish Fisheries Research Services Report, 11/93.*

Smith, G.W., Laughton, R. and Dora, S.J. An analysis of rod catches of Atlantic salmon (*Salmo salar* L.) and angling effort on the River Spey. *Proceedings of the symposium on Stock Assessment in Inland Fisheries*, Hull, April 1994. In press.

TABLE I

Distances upriver of the 11 estates on the River Spey participating in the study and the years in which catch and effort data were collected from each

Estate	Distance upriver (km)	Years Studied		
		1992	1993	1994
3	11.0	✓		
5	18.9	✓	✓	✓
6	22.3	✓	✓	✓
7	25.1		✓	✓
11	35.0		✓	✓
17	44.2	✓	✓	✓
19	50.5	✓	✓	✓
20	83.2	✓	✓	✓
22	68.2	✓	✓	✓
25	90.1		✓	✓
26	90.1		✓	✓

FIGURE LEGENDS

Figure 1 Frequency distributions of the weights of putative MSW salmon (grey bars) and grilse (black bars) through the angling season. Data from each year are shown separately, catches from all estates have been aggregated. Scales on the Y axis have been varied from month to month in order that each weight distribution pattern can be seen most clearly.

a) Catches taken between February and May
b) Catches taken in June
c) Catches taken between July and September

Figure 2 Seasonal patterns of mean daily salmon catch, angling effort and catch per unit effort in the years 1992 to 1994. Data from each year are shown separately, catches from all estates have been aggregated. The error bars indicate the standard error of each mean.

a) Mean daily catch
b) Mean daily angling effort
c) Catch per unit effort

Figure 3 The relationship between catch per effort and river flow between July and September in each of the three years of the study, 1992 to 1994. Both CPUE (grey bars) and flow (black bars) in each month are expressed as a proportion of the appropriate mean monthly values averaged over the three years of the study.

Figure 4 The relationship between CPUE at individual estates and their relative position along the Spey river system. For each estate studied, mean CPUE in each two month period is shown. Estates are arranged in increasing distance from the river mouth. All estates are situated on the main stem of the River Spey, except estates 19 and 20 which are situated on a major tributary, some 50 km from the mouth of the river (Table 1). The scales on the Y axis have been varied through the season to emphasize the pattern within any given two month period.

a) 1992
b) 1993
c) 1994

Figure 5 Trends in CPUE over the study period. For each two month period, trends in the mean CPUE over the three years of the study, 1992 to 1994, is shown.

Fig. 1a

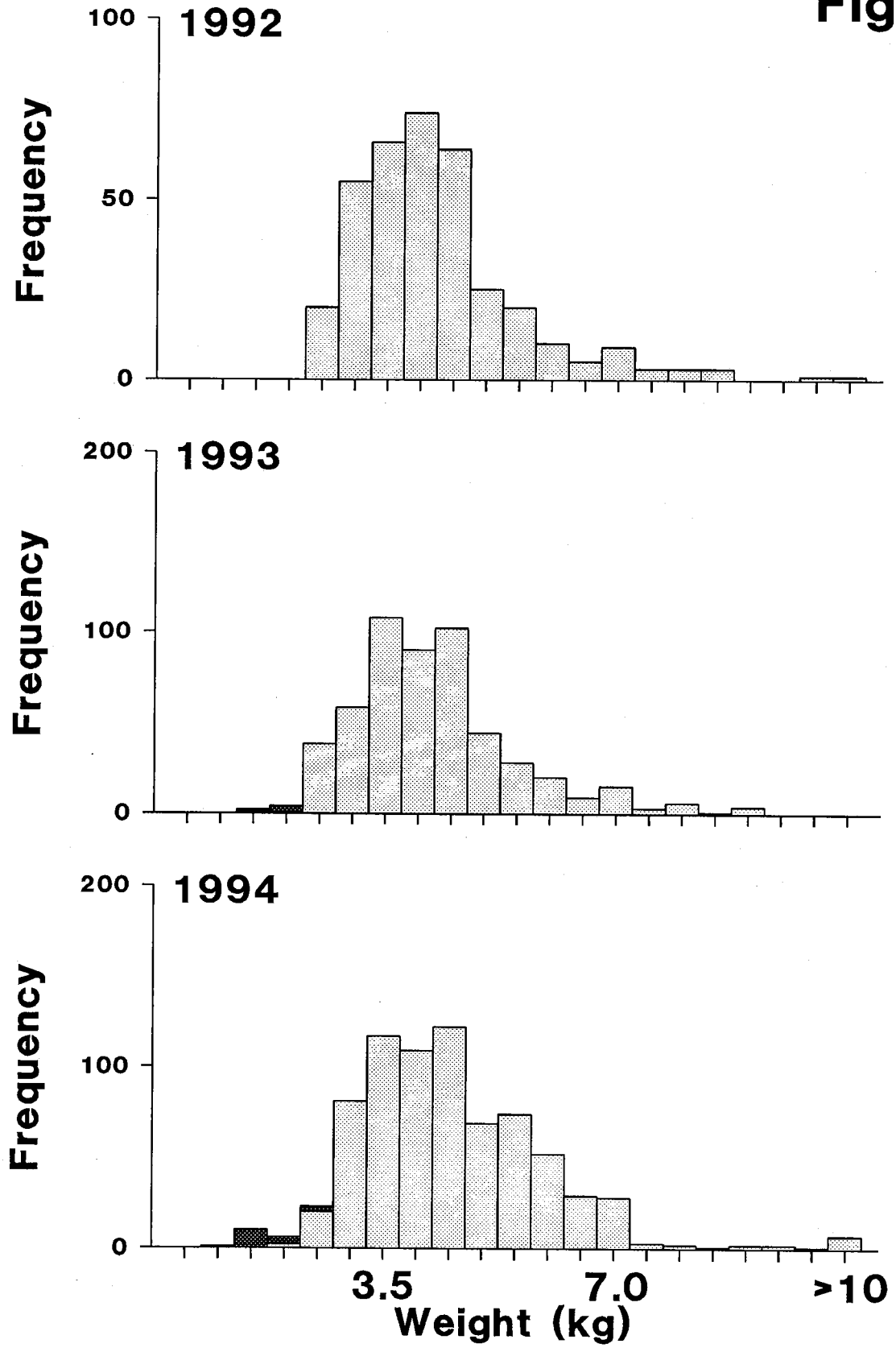

1992
100
50
0
Frequency
1993
200
100
0
Frequency
1994
200
100
0
Frequency
3.5
7.0
>10
Weight (kg)

Fig 1b

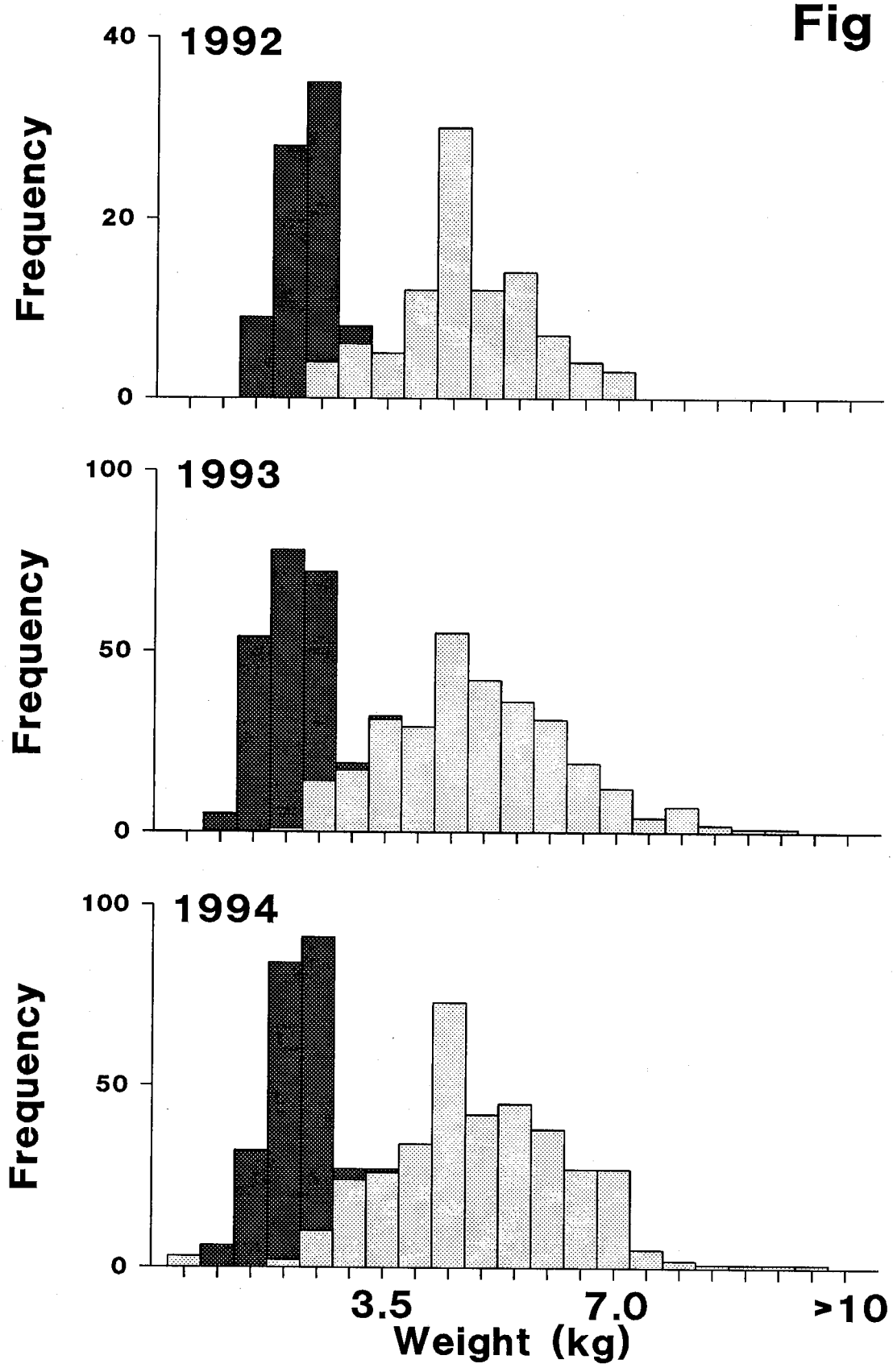

1992
40
20
0
Frequency
1993
100
50
0
Frequency
1994
100
50
0
Frequency
3.5
7.0
>10
Weight (kg)

Fig. 1c

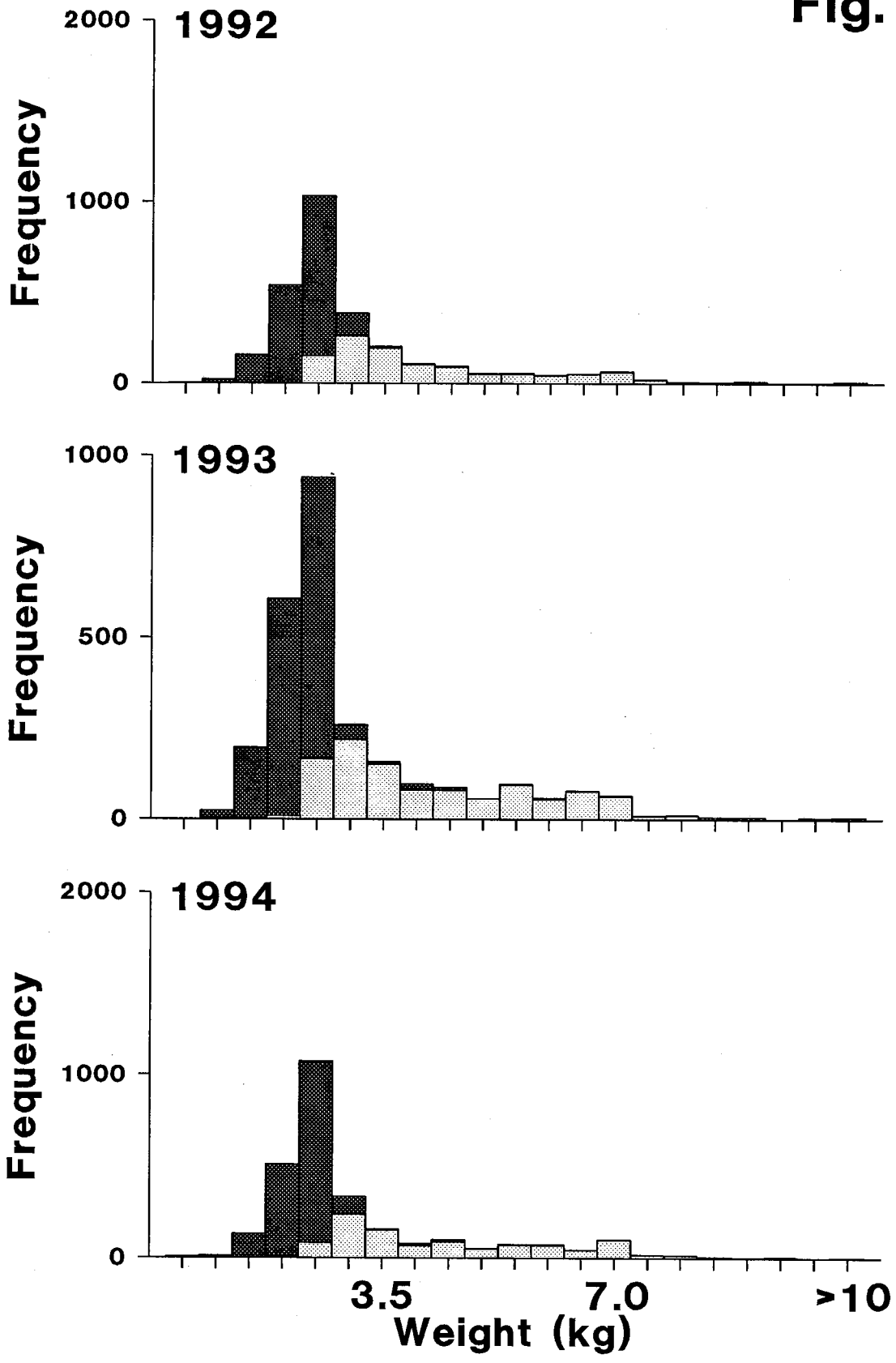

1992
2000
1000
0
Frequency
1993
1000
500
0
Frequency
1994
2000
1000
0
Frequency
3.5
7.0
>10
Weight (kg)

Fig. 2a

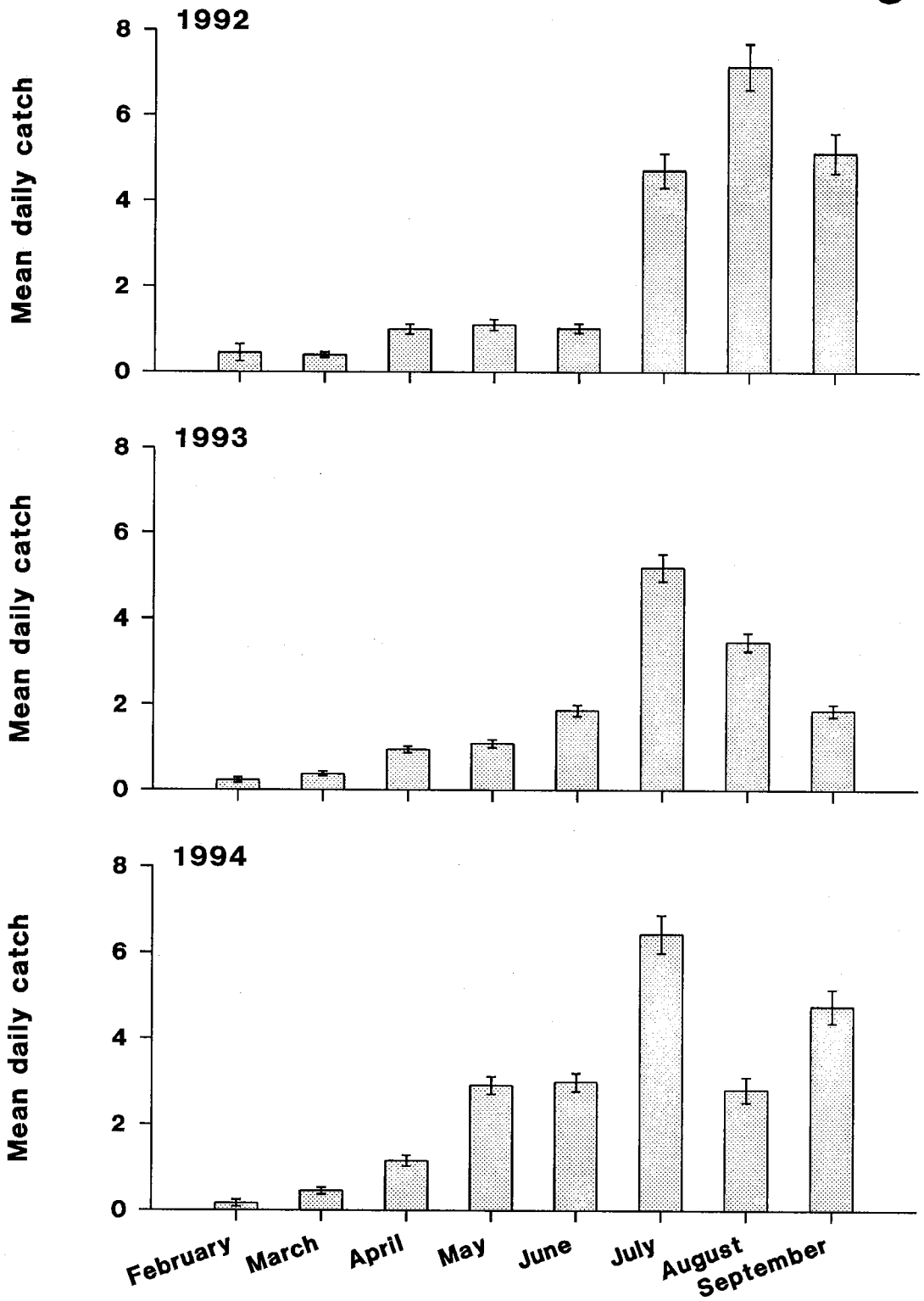

1992
1993
1994
Mean daily catch
Mean daily catch
Mean daily catch
0
2
4
6
8
February
March
April
May
June
July
August
September

Fig. 2b

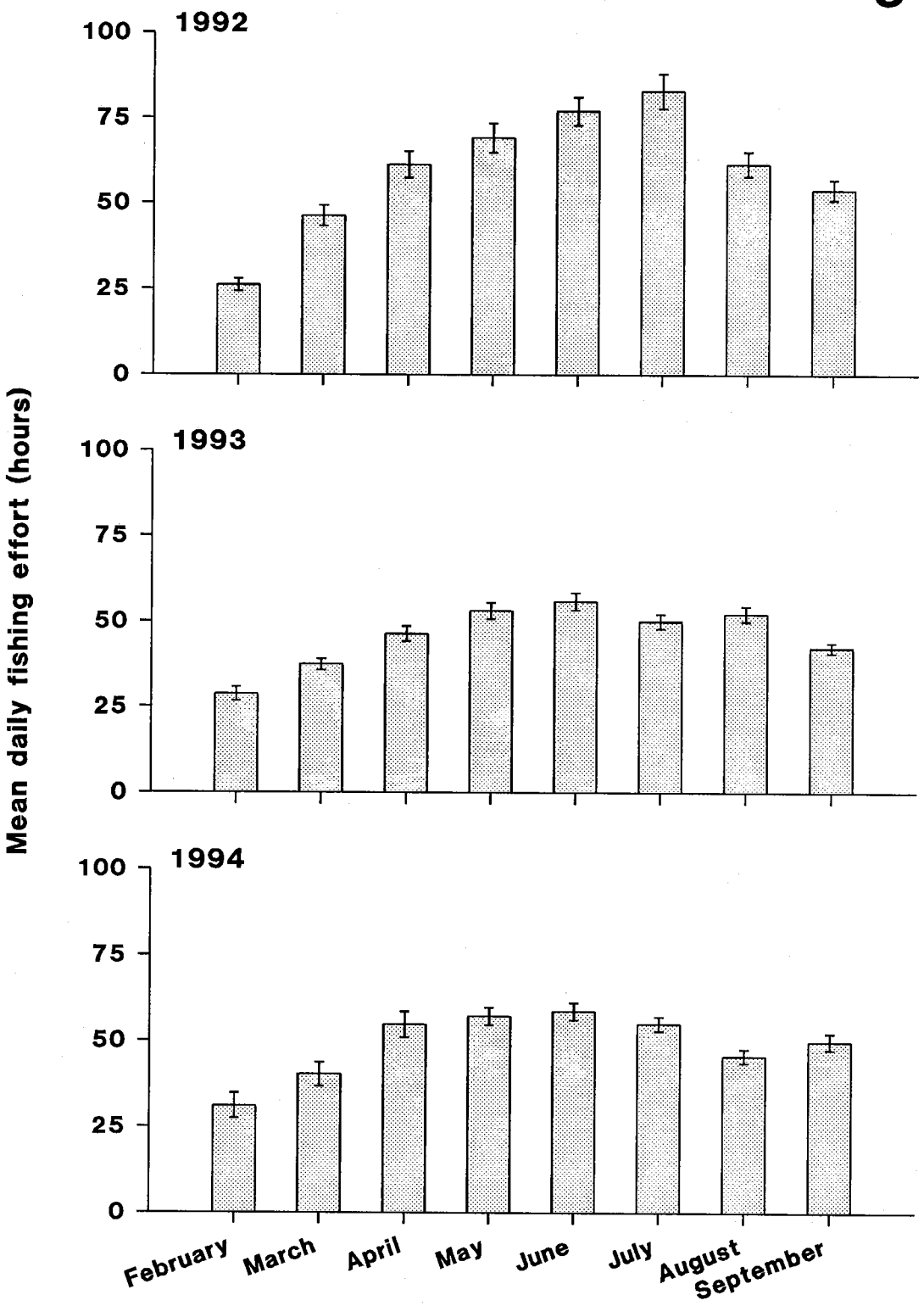

1992
1993
1994
100
75
50
25
0
Mean daily fishing effort (hours)
February
March
April
May
June
July
August
September

Fig. 2c

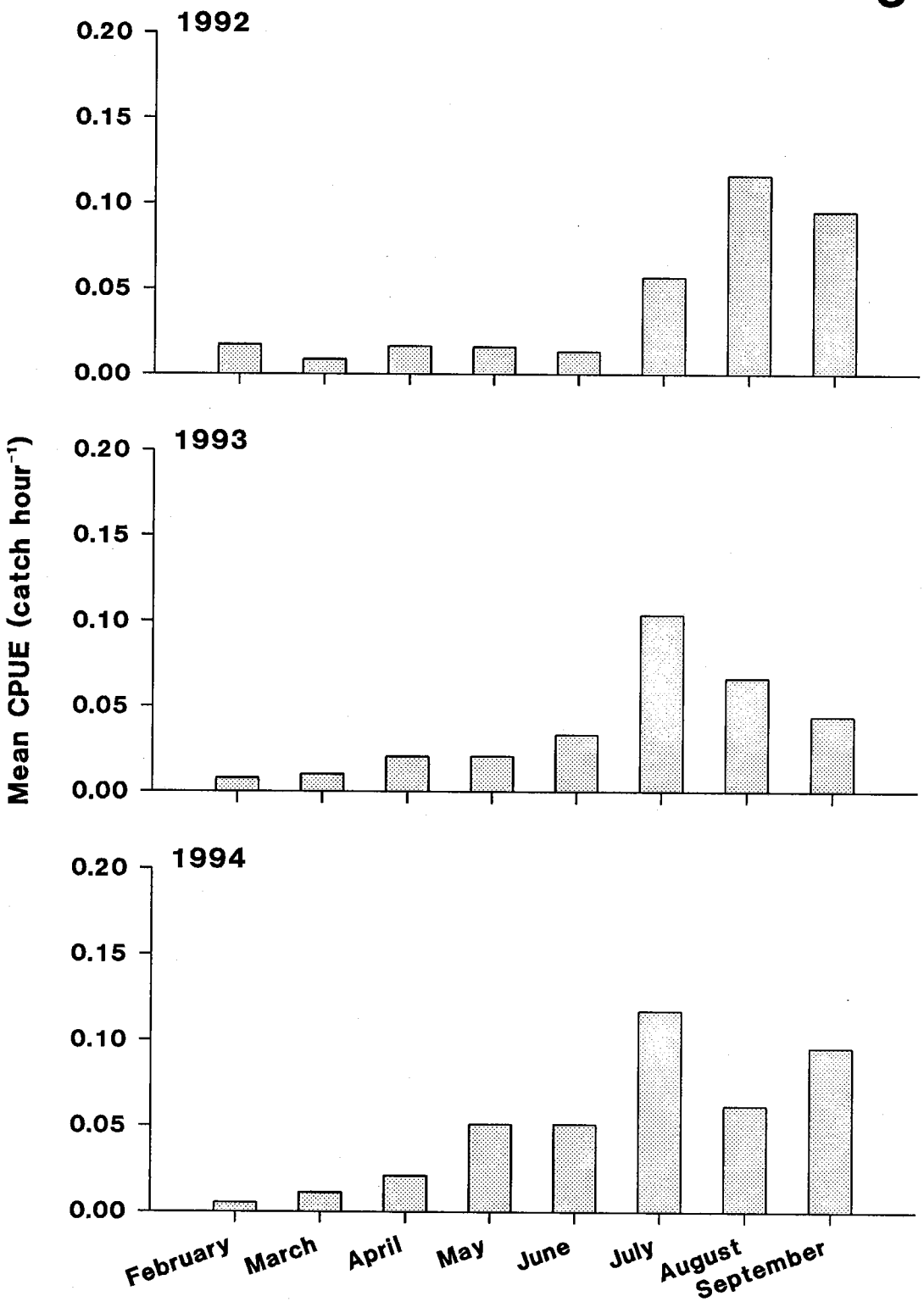

1992
1993
1994
0.20
0.15
0.10
0.05
0.00
Mean CPUE (catch hour^{-1})
February
March
April
May
June
July
August
September

Fig. 3

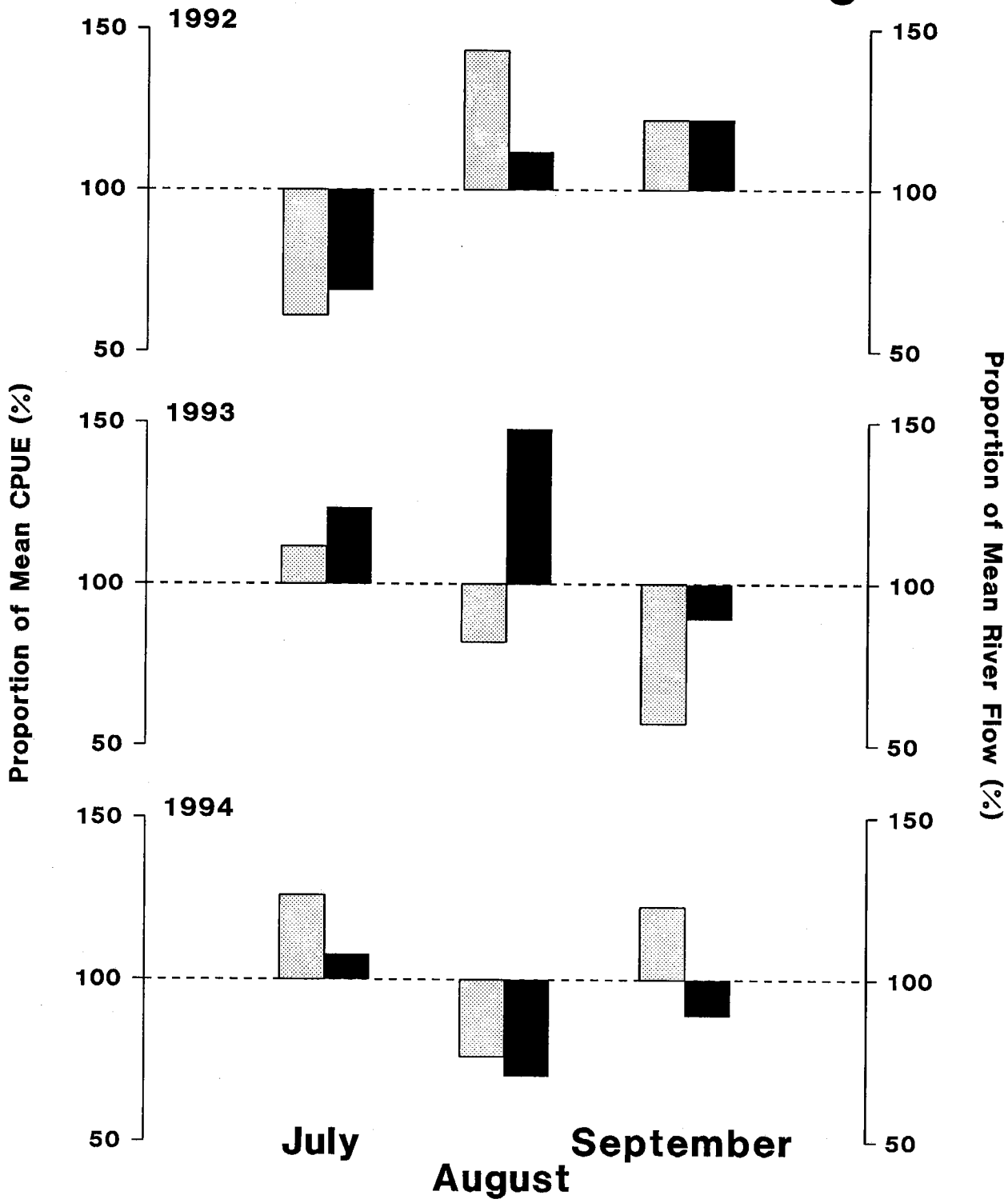

1992
1993
1994
150
100
50
Proportion of Mean CPUE (%)
Proportion of Mean River Flow (%)
July
August
September

Fig. 4a

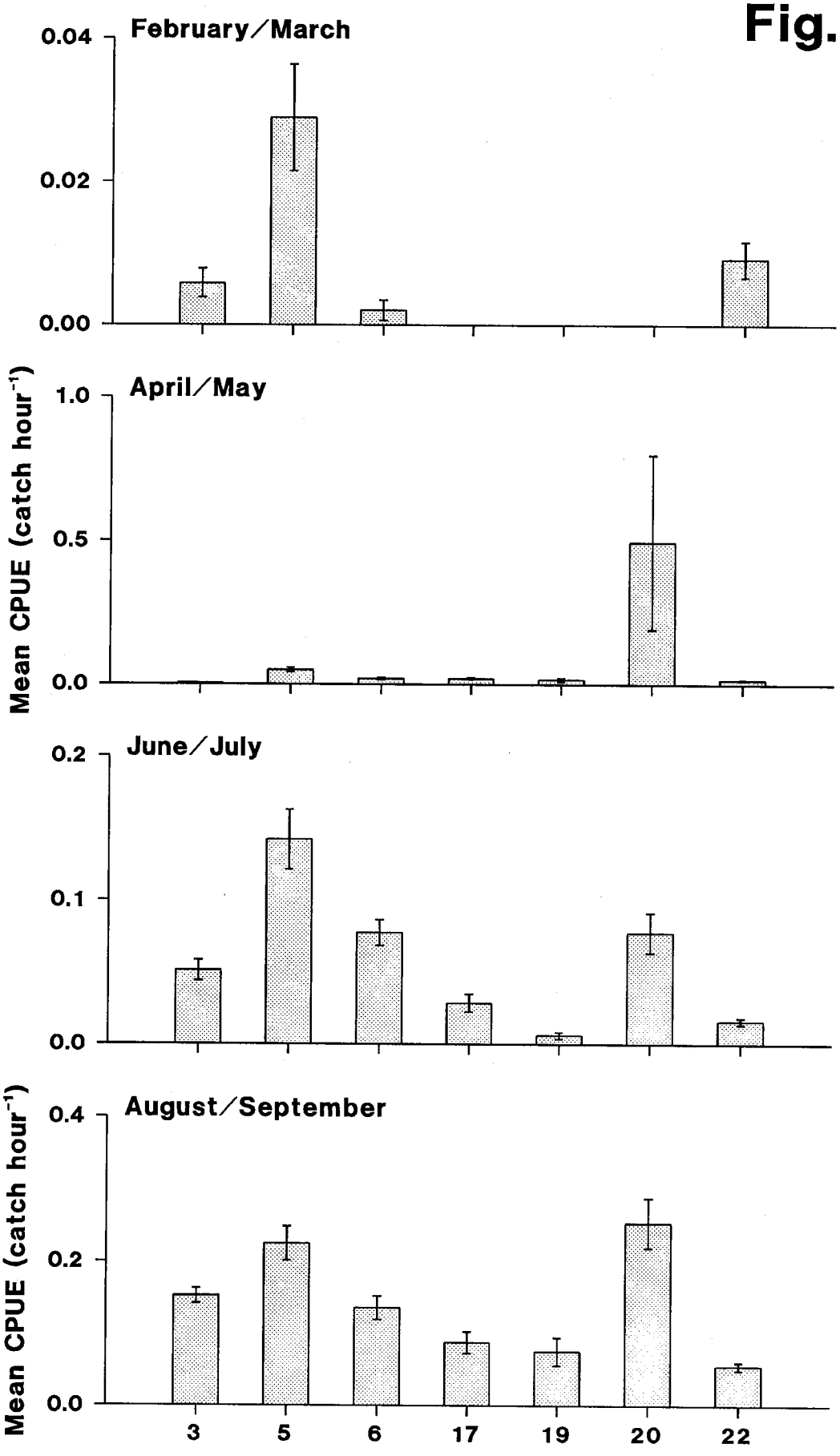

February/March
0.04
0.02
0.00
April/May
1.0
0.5
0.0
June/July
0.2
0.1
0.0
August/September
0.4
0.2
0.0
Mean CPUE (catch hour^{-1})
Mean CPUE (catch hour^{-1})
3
5
6
17
19
20
22
Site Number

Fig. 4b

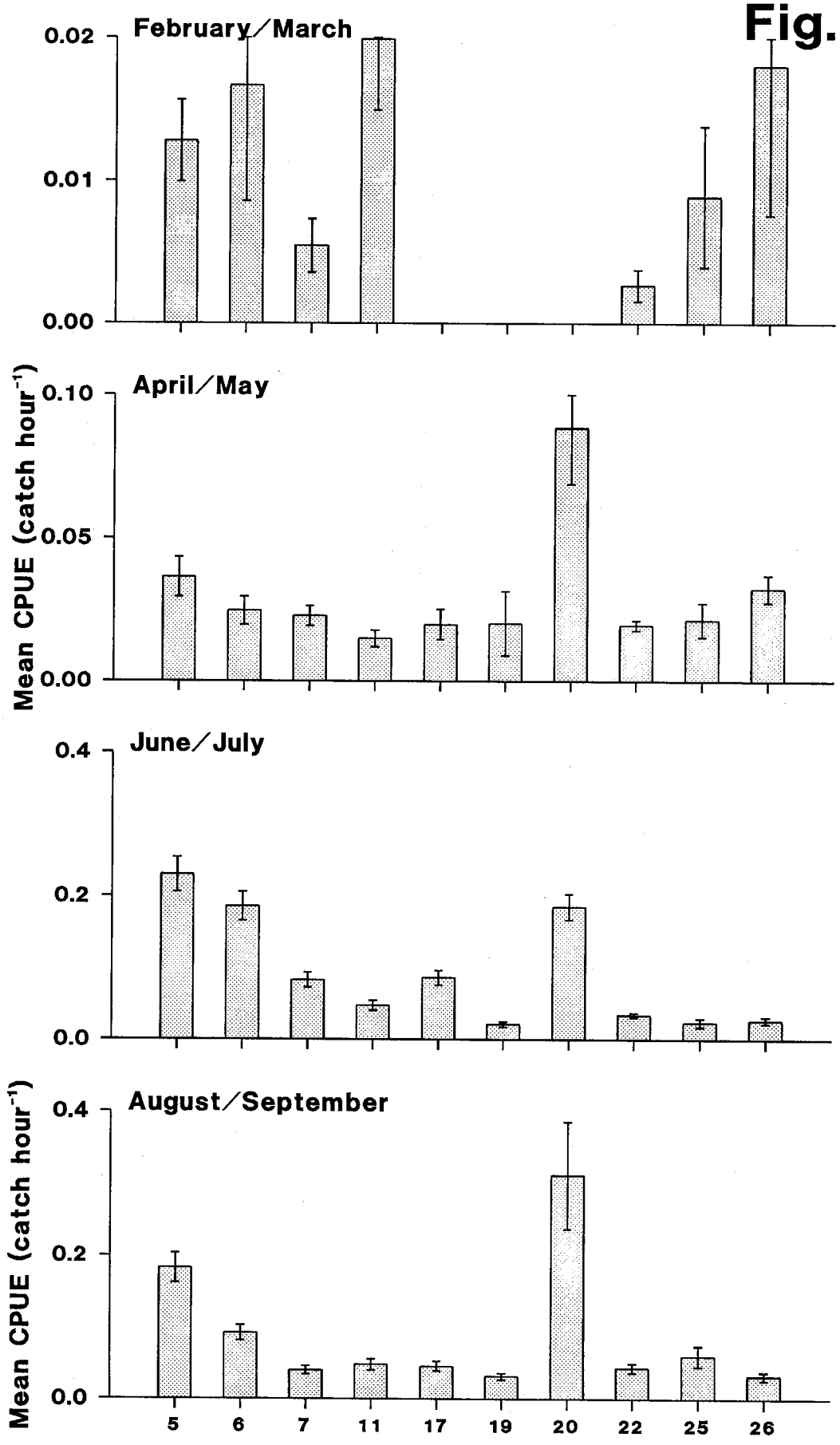

February/March
0.02
0.01
0.00
April/May
0.10
0.05
0.00
June/July
0.4
0.2
0.0
August/September
0.4
0.2
0.0
Mean CPUE (catch hour^{-1})
Mean CPUE (catch hour^{-1})
5
6
7
11
17
19
20
22
25
26
Site Number

Fig. 4c

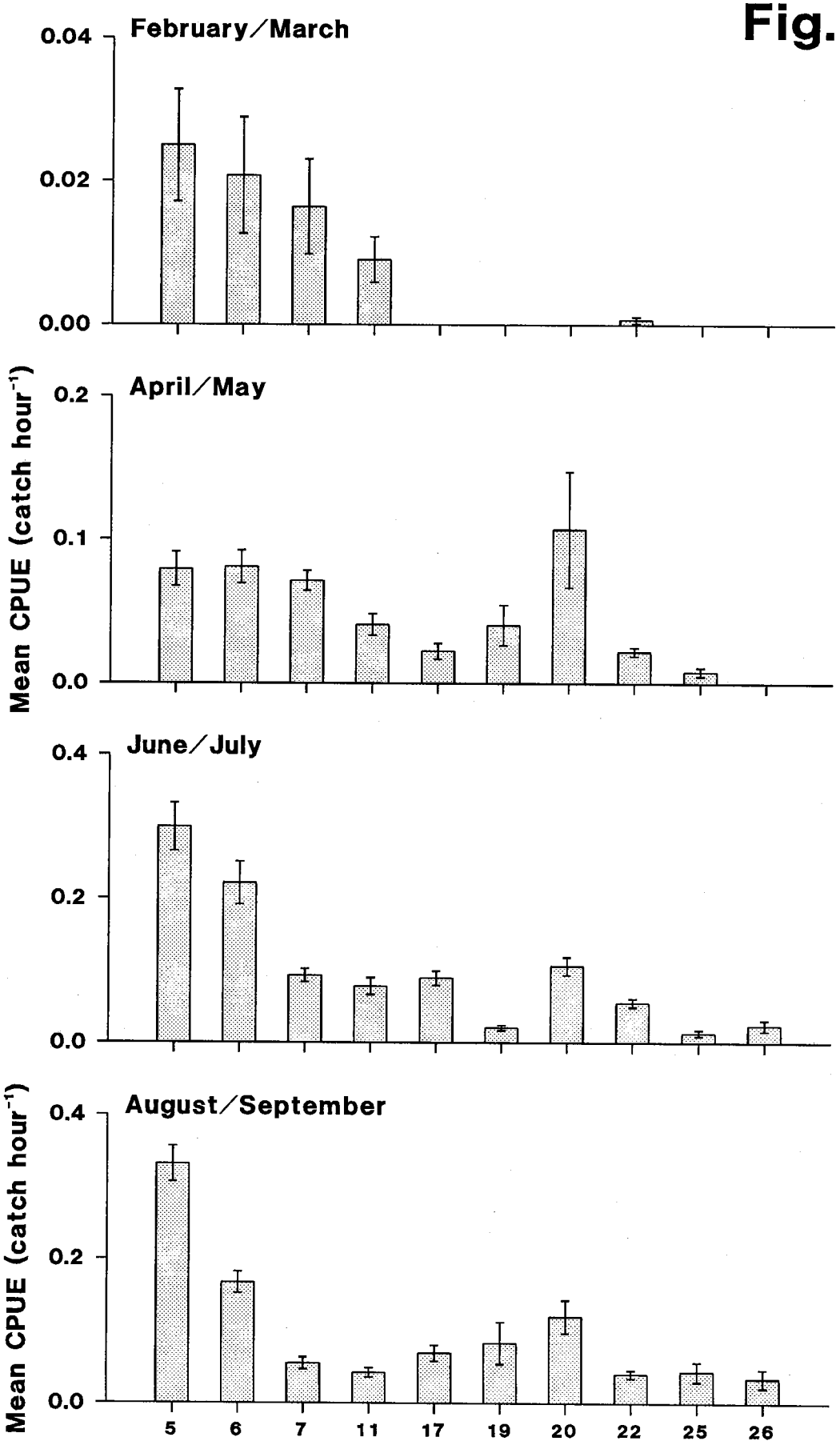
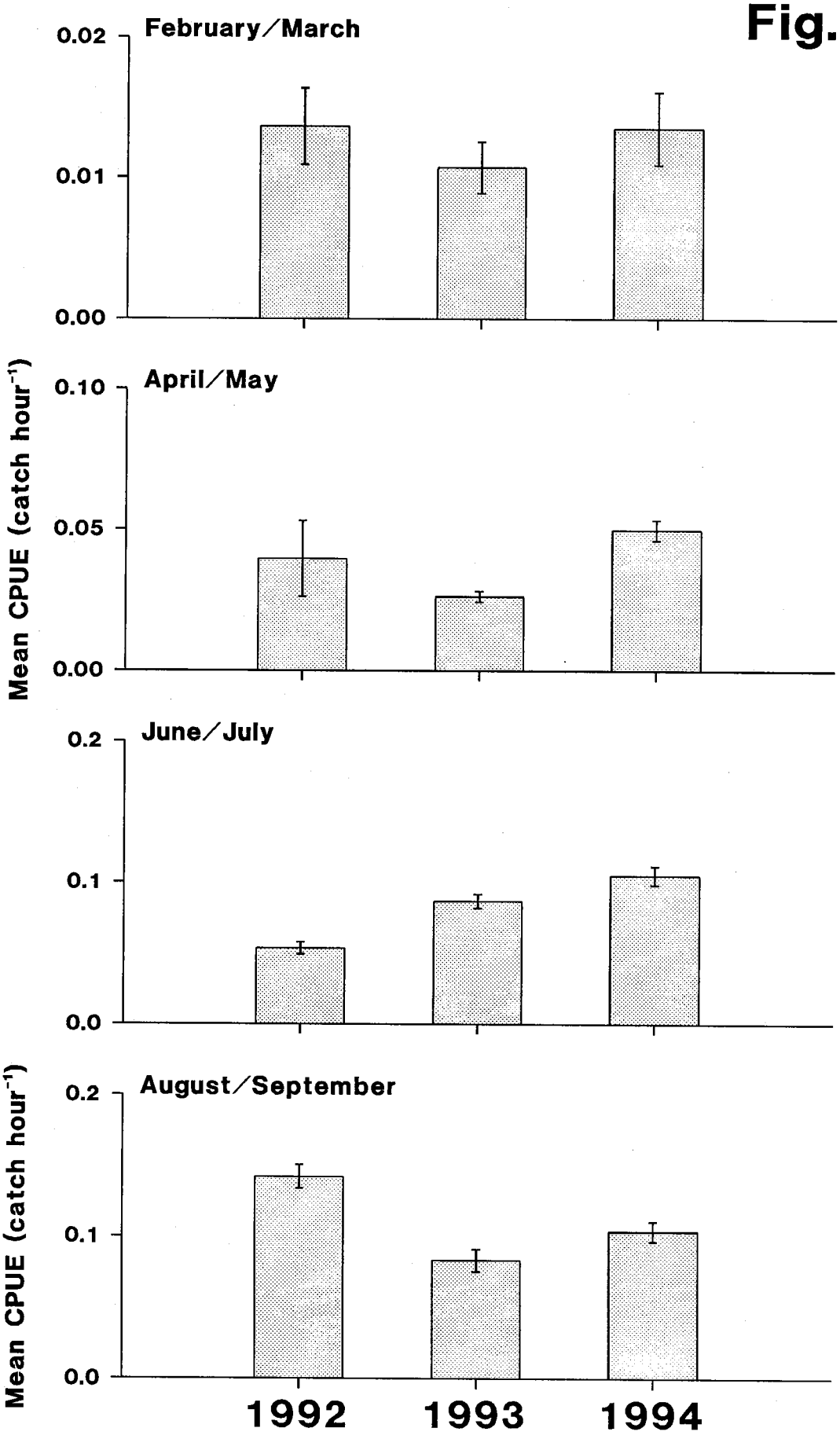

February/March
0.04
0.02
0.00
April/May
0.2
0.1
0.0
June/July
0.4
0.2
0.0
August/September
0.4
0.2
0.0
Mean CPUE (catch hour^{-1})
5
6
7
11
17
19
20
22
25
26
Site Number

Fig. 5


February/March
0.02
0.01
0.00
April/May
0.10
0.05
0.00
June/July
0.2
0.1
0.0
August/September
0.2
0.1
0.0
Mean CPUE (catch hour^{-1})
Mean CPUE (catch hour^{-1})
1992
1993
1994