

**Results of the Pacific Halibut (*Hippoglossus stenolepis*) Bycatch Study Conducted During the British Columbia Trawl Fishery September 1991 - December 1994**

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RESULTS OF THE PACIFIC HALIBUT (*Hippoglossus stenolepis*)  
BYCATCH STUDY CONDUCTED DURING THE BRITISH COLUMBIA  
TRAWL FISHERY SEPTEMBER 1991 - DECEMBER 1994

by

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ABSTRACT

Fargo, J. 1995. Results of the Pacific Halibut (*Hippoglossus stenolepis*) bycatch study conducted during the British Columbia trawl fishery, September 1991 - December 1994. Can. Manuscr. Rep. Fish. Aquat. Sci. 2320: 33 p.

Data collected by onboard-observers during the British Columbia trawl fishery were used to determine catch ratios and mean CPUEs for Pacific halibut (*Hippoglossus stenolepis*) by target species group, season and area. Halibut catch ratios and mean halibut CPUEs were highest off the west coast of Vancouver Island, particularly when flatfish or lingcod was the target. They were lowest in the fishery off the west coast of the Queen Charlotte Islands which is primarily a rockfish fishery. They were higher in summer than in winter for most areas and differed among areas of the coast due differences in target species sought and differing fishery characteristics. Halibut catch ratios and mean CPUEs estimated for this study were generally higher than those for the last study conducted in 1981-82.

The mean size and physical condition of trawl-caught halibut varied among areas. The smallest fish were caught in Hecate Strait while the largest fish were caught off the west coast of Vancouver Island and the west coast of the Queen Charlotte Islands. Halibut caught in the fishery off the west coast of the Queen Charlotte Islands were in the poorest condition while those caught off the west coast of Vancouver Island and in Hecate Strait were in the best condition.

The halibut bycatch for the 1994 summer trawl fishery in Hecate Strait was estimated to be 713,000 lbs using the catch ratio of halibut/target species and 694,000 lb using mean halibut CPUE by target species. The halibut bycatch for the winter trawl fishery in the same area was estimated to be 336,000 lb using halibut catch ratios and 305,000 lb using mean halibut CPUE.

RÉSUMÉ

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Les données recueillies par les observateurs à bord des chalutiers pendant la pêche du flétan du Pacifique (*Hippoglossus stenolepis*) de la Colombie-Britannique ont servi à déterminer les taux de capture et les PUE moyens par groupe d'espèces recherchées, saison et zone de pêche. Les taux de capture et les PUE moyens du flétan les plus élevés ont été obtenus sur la côte ouest de l'île de Vancouver, notamment lorsque les espèces recherchées étaient des poissons plats ou la morue-lingue. Les valeurs les plus faibles ont été obtenues au large de la côte ouest des îles de la Reine-Charlotte où la pêche visait surtout le sébaste. Ils étaient aussi plus élevés en été qu'en hiver dans la plupart des régions et différaient selon la zone côtière en fonction de l'espèce recherchée et des caractéristiques de la pêche. Les taux de capture du flétan et les PUE moyens estimés au moment de la présente étude sont généralement supérieurs à ceux obtenus au cours de l'étude de 1981-1982.

La taille moyenne et la condition des flétans capturés au chalut différaient selon la région. Les plus petits poissons ont été capturés dans le détroit d'Hécate et les plus gros à l'ouest de l'île de Vancouver et des îles de la Reine-Charlotte. Les flétans dont la condition était la plus mauvaise ont été capturés à l'ouest des îles de la Reine-Charlotte tandis que ceux capturés à l'ouest de l'île de Vancouver et dans le détroit d'Hécate présentaient la meilleure condition.

Les prises accessoires de flétan de la pêche d'été au chalut pratiquée en 1994 dans le détroit d'Hécate ont été estimées à 713 000 livres, en appliquant le rapport entre les prises de flétan et celles des autres espèces recherchées, et à 694 000 livres, en appliquant le PUE moyen du flétan aux espèces recherchées. Les prises accessoires de flétan de la pêche d'hiver pratiquée dans la même zone ont été estimée à 336 000 livres en utilisant le rapport des prises et à 305 000 livres en utilisant le PUE moyen pour le flétan.

## INTRODUCTION

In 1991 a study of halibut bycatch in the British Columbia trawl fishery was undertaken through a joint agreement between the International Pacific Halibut Commission (IPHC) and the Department of Fisheries and Oceans (DFO). The primary purpose of the study was to assess the bycatch and mortality of Pacific halibut (*Hippoglossus stenolepis*) caught during the British Columbia trawl fishery. A secondary objective of the study was to relate mortality of trawl-caught halibut to various fishery and non-fishery factors. This information is necessary to provide advice to managers considering halibut bycatch reduction measures and for IPHC stock assessment and halibut allocation.

Halibut is a resource worth \$30 million in 1993 to B.C. longline fishermen with additional spin-off effects for the British Columbia economy. Management of the species is the responsibility of the International Pacific Halibut Commission (IPHC) which was established in 1923 by a convention between Canada and the United States. Halibut is a major target of the longline fleets operating from California to Alaska. It is also caught incidentally in various trawl fisheries in the same areas. However, retention of halibut by the trawlers has been prohibited since 1944. The bycatch and associated mortality of halibut caught in the B.C. trawl fishery has a direct bearing on the allocation to Canadian longliners. Furthermore, fishery agencies in the U.S. and Canada have agreed to significantly reduce halibut bycatch mortality incurred in the trawl fishery (Salveson et al. 1992).

Four previous studies involving the bycatch of halibut in the B.C. trawl fishery have been conducted. The first study (Hoag 1971) involved the estimation of bycatch in the domestic trawl fishery. The second addressed the mortality associated with trawl capture (Hoag 1975). The third (Ketchen 1981) summarized the incidental catch of halibut in the B.C. trawl fishery using data from a domestic trawl observer program from 1978-80. The fourth assessed halibut bycatch using data collected during a domestic trawl observer program conducted from 1981-83 (Stanley 1984). Although bycatch was estimated in the latter two studies, the physical condition of trawl-caught halibut was not assessed. Thus, incurred mortality could not be estimated. Interest in halibut bycatch mortality has been renewed in light of the changes that have taken place in the trawl fishery over the last decade. The latest study is on-going.

Although the present study concentrated initially on Hecate Strait, data have now been collected from every area on the B.C. coast. During 1991-92, the trawl observer program was funded jointly by the Canadian Department of Fisheries and Oceans

(DFO) and the IPHC. After the 1992 fishing season, the program was funded solely by DFO.

Observers collected detailed bridge log information for all tows observed, including effort, depth, area and fishing gear used. They estimated the species composition of the entire catch by weight and recorded the amount discarded and that kept. In addition, each halibut caught was measured and assessed for physical condition using criteria established by the IPHC (Hoag 1975).

This report describes the results of analyses of data collected by observers from 1991-94. I include estimates of mean halibut CPUE and halibut catch ratios. I use these statistics to estimate bycatch for the trawl fishery in Hecate Strait where the amount of data collected is sufficient to allow estimation. I also provide summaries of the results of analysis of size composition and physical condition data for trawl-caught halibut by area.

## METHODS

Data for this study were collected by observers aboard trawlers involved in the domestic trawl fishery. Between September 1991 and December 1992, observers were taken voluntarily by the trawl captains. The program became mandatory in 1993 and fishery managers could place observers aboard any vessel after that date by regulation.

At the beginning of trips, observers recorded information on vessel fishing gear and electronic equipment (navigational equipment, sounder type etc.). While aboard the vessel, observers attempted to monitor every tow that was made although this was not always possible. For each monitored tow they recorded bridge log data concerning time, depth and area of catch. They then estimated the weight of each species in the catch. To do this they selected random samples from the catch to fill six baskets of 100 lb capacity. They sorted the sample by species and obtained the weight of individual species in the sample. The species sample proportions were then applied to the estimate of the total catch to produce estimates of the total weights of each species in the catch. The proportions of each species discarded and kept were obtained by visual estimates, and in consultation with the vessel captains and crews.

In addition to species catch composition observers attempted to measure the length, to the nearest cm, of all halibut caught and to assess each halibut for physical condition using criteria developed by Hoag (1975). Briefly, halibut were classed into one of five condition states:

Excellent	- vigorous body movement; able to close operculum tightly; minor external injuries.
Good	- feeble body movements; able to close operculum tightly.
Fair	- no body movement; could close operculum tightly.
Poor	- no body movement; could not close operculum tightly; severe injuries (bleeding).
Dead	- no body or opercular movement.

To estimate halibut bycatch in the Hecate Strait trawl fishery, I used the same two methods used by Hoag (1971), Ketchen (1980) and Stanley (1984). I did not attempt to estimate halibut bycatch for the trawl fishery other areas because of the limited amount of data collected.

The first bycatch estimation method involves the use of the catch ratio of halibut to target species for the following species groups:

Pacific cod	( <i>Gadus macrocephalus</i> )
Rock/English soles	( <i>Pleuronectes bilineata</i> )/ ( <i>Pleuronectes vetulus</i> )
Dover sole/turbot	( <i>Microstomus pacificus</i> )/ ( <i>Atheresthes stomias</i> )
Pacific ocean perch	( <i>Sebastes alutus</i> )
Other rockfish	( <i>Sebastes</i> spp.)
Other flatfish	( <i>Plueronectidae</i> )
Other species	(species other than one of the six previous groups).

These species groups were the same as those that have been used for past analyses of bycatch. I calculated halibut catch ratios for both the kept catch and the total catch. I first estimated the catch  $c_{ij}$  by weight for each species group  $i$  for each tow  $j$  and the halibut catch  $h_j$  for each tow  $j$ . The target for each tow was the species or species group with the highest catch. If  $n$  is the number of tows where species group  $i$  is the target, then the ratio  $R_i$  of halibut to target species for species group  $i$  is

$$(1) \quad R_i = \sum_{j=1}^n h_j / \sum_{j=1}^n c_{ij}$$

In some instances there was more than one target species in the tow, e.g., when catches were equal. In these cases, the catch information was incorporated into the calculation of ratios for both target species. In addition to the halibut catch ratios, I also calculated the mean halibut CPUE for each target species for the total catch and kept catch.

I applied the halibut catch ratios and mean halibut CPUEs estimated from the observer data to tow by tow data from

the groundfish commercial catch/effort database to estimate the total bycatch of halibut for each area/season. If  $s_i$  is the sum of the catches of species group  $i$  for all cases where species group  $i$  is the target of the kept catch and  $R_i$  is the ratio of the kept catch for the target species as noted in equation (1), then the amount of halibut bycatch  $B$  for all species groups in this area is

$$(2) \quad B = \sum_{i=1}^7 (s_i R_i)$$

The second estimation method involves the use of CPUE. Using the mean halibut CPUE  $u_i$  and the corresponding effort  $E_i$  for the 1994 fishery for each target species  $i$  the estimate of the total halibut bycatch  $B_1$  for an area is

$$(3) \quad B_1 = \sum_{i=1}^7 u_i E_i$$

## RESULTS

### SAMPLING COVERAGE

A total of 1372 bottom tows were monitored during 114 trawl trips between September 1991 and December 1994. The total number of tows made during the commercial trawl fishery over the same period was 84,957 (Table 1,2). Excluding the Strait of Georgia, coverage over this time varied from 0.8% for the west coast Queen Charlotte Islands summer fishery to 7.8% and 6.4% for the Hecate Strait 1992 summer and 1991-92 winter fisheries, respectively.

Previous studies examined halibut bycatch separately during the summer (May-Aug) and winter (Jan-Apr, Sep-Dec) periods because of seasonal differences in catch rates for this species (Hoag 1971, Stanley 1984). For the purpose of comparison, I will discuss the results of the current study within this framework. However, in some cases it became necessary to combine fall and winter periods across years to assemble data sets large enough to produce meaningful analytical results. Initially, I estimated overall mean halibut CPUE and mean all-species CPUE to provide a relative scale of the bycatch by season and area (Figures 1 and 2).

## HALIBUT CATCH RATIOS

Previous investigations have shown that the incidental catch of halibut in the trawl fishery varies with the target species sought by trawlers (Hoag 1971, Ketchen 1981, Stanley 1984). I estimated the halibut catch ratio for both the kept catch and total catch by season and area. As in previous studies, the halibut catch ratio was lowest when rockfish species were the target and highest when flatfish species were the target (Table 3).

### Hecate Strait

In tows observed during the trawl fishery in Hecate Strait the halibut ratio was lowest for rockfish species and highest for flatfish species in both summer and winter. The relatively high halibut ratio for Pacific ocean perch during the 1991-92 winter fishery was computed from only one catch and cannot be considered representative of the perch fishery. Aside from rock and English soles, flatfish species with high halibut ratios were Dover sole/turbot, rex sole and starry flounder. Halibut ratios were similar seasonally for rock and English soles while those for Dover sole and turbot and Pacific cod were higher in summer than in winter. The overall halibut ratio for this fishery was also higher in summer than in winter. The catch in tows monitored during this fishery was dominated by Pacific cod, rock sole, English sole, Dover sole and turbot.

### West coast Queen Charlottes

The halibut ratio for the trawl fishery off the west coast of the Queen Charlotte Islands was lowest for rockfish species in summer and winter and highest for Dover sole and turbot in winter and lingcod ('other' species) in summer. The high ratio estimated for Pacific ocean perch was determined from a very limited sample size and cannot be considered representative of the perch fishery. The greatest proportion of the catch in tows monitored during this fishery was rockfish species other than Pacific ocean perch. The lack of data (12 tows observed) for the summer fishery in this area prevented a meaningful seasonal comparison.

### Queen Charlotte Sound

The halibut ratio for the trawl fishery in Queen Charlotte Sound was lowest for rockfish species and highest for Pacific cod, lingcod and flatfish species, most notably Dover sole and turbot. This was true for both the summer and winter

fisheries although the ratio for Pacific cod caught in the summer fishery, based on only a few tows, was quite low. Rockfish species dominated the catch of tows monitored in this fishery. The overall halibut ratio for this fishery was substantially higher in summer than in winter.

#### West coast Vancouver Island

The halibut ratio for the trawl fishery off the west coast of Vancouver Island was lowest for rockfish species and highest for flatfish species in both summer and winter. The halibut ratio for Pacific cod in the winter fishery was much lower for this area than the ratios determined for that species in other seasons/areas. The high ratio for Pacific cod estimated for the summer kept catch was the result of only one tow and cannot be considered representative of the fishery for Pacific cod in summer. The high ratios for Pacific ocean perch and 'other' rockfish for the summer fishery were also determined from only one tow. Petrale sole was the most abundant species in the catch of 'other' flatfish. Dover sole, turbot and rockfish species dominated the catch of tows monitored in this fishery during winter while lingcod, pollock, rex sole, petrale sole and spiny dogfish were the major components in summer. The seasonal difference in the overall halibut ratio for this area was more dramatic than for any other area. The overall ratio of halibut to total catch for the summer fishery was much higher than that for the winter fishery and was the highest of any fishery examined.

#### COMPARISON BETWEEN STUDIES

I compared halibut ratios for the kept catch in Hecate Strait and Queen Charlotte Sound from this study with those from the 1981-82 study (Stanley 1984). For Hecate Strait, the overall halibut ratio was higher in summer than winter for both studies. The halibut ratio for rockfish species in this area was also similar between the two studies. However, ratios for Pacific cod and flatfish species were higher for this study than for the 1981-82 study.

For Queen Charlotte Sound, the overall ratio was higher in summer than in winter for both studies. The ratios estimated for 'other' rockfish and Pacific ocean perch were similar across the two studies as well. As in the comparison for Hecate Strait, halibut ratios for Pacific cod, rock and English soles and lingcod ('other' species) were higher in this study than in the 1981-82 study.

## HALIBUT CPUE

The mean halibut CPUE in the B.C. trawl fishery has also been shown to vary with the species sought by trawlers and has been used in the past to estimate halibut bycatch for the trawl fishery (Hoag 1971, Stanley 1984). I calculated the mean CPUE for halibut by target species for the kept catch and the total catch for each area/season. As in previous studies, halibut CPUE was generally lowest in the fishery for rockfish (*Sebastes* spp.) and highest in the fishery for flatfish (Pleuronectidae). The standard errors were relatively high in this study compared to the 1981-82 study (Table 4). Overall summaries of mean halibut and all-species CPUE by area are presented in Figures 1,2.

I examined halibut CPUE data for differences with respect to season, area and target species. The CPUE data were not normally distributed and the median was used as a measure of central tendency for statistical testing. The statistical testing was limited by small samples size for all areas except Hecate Strait. In the case of the west coast Queen Charlotte Islands summer fishery and the Strait of Georgia no testing was attempted due to the lack of data. Previously, we had recommended a minimum sample size of 250 monitored tows (20 trips) for each seasonal fishery for Hecate Strait (Fargo et al. 1991). Sampling coverage for other areas was considerably lower; thus, the results of statistical testing among areas should be considered preliminary. As well, CPUE data were combined across months and seasons, in some cases, to produce reasonable sample sizes for testing. Thus the possible confounding effects of these factors is not accounted for in the results of the testing among areas.

There were significant overall seasonal differences in halibut CPUE (Kruskal-Wallis test,  $p < 0.0001$ ) (Table 5). Halibut CPUE was higher in summer than in winter. There were also significant differences in halibut CPUE among areas in both summer (Kruskal-Wallis test,  $p < 0.0001$ ) and winter (Kruskal-Wallis test,  $p < 0.01$ ) (Table 4). CPUE was highest in summer, in the fisheries in Hecate Strait and in winter, off the west coast of Vancouver Island, off the west coast of the Queen Charlottes and in Queen Charlotte Sound. There were significant differences in halibut CPUE among target species groups as well (Kruskal-Wallis test,  $p < 0.0001$ ) (Table 4). Halibut CPUE for rock/English soles, Dover sole/turbot and lingcod was significantly higher than that for the rockfish groups (Kruskal-Wallis test,  $p < 0.0001$ ).

### Hecate Strait

For tows monitored in the trawl fishery in Hecate Strait halibut CPUE was significantly higher in summer than in winter (Mann-Whitney test,  $p < 0.0001$ ). All-species CPUE for

Hecate Strait was significantly higher in summer than in winter as well (Mann-Whitney test,  $p < 0.0001$ ).

Halibut CPUE was significantly higher when rock sole/English soles were the target than when rockfish species were the target (Mann-Whitney,  $p < 0.0001$ ) regardless of season or type of catch (kept or total). Pacific cod accounted for the highest proportion of the catch in tows monitored in this area in winter while rock and English soles accounted for the highest proportion of the catch in tows monitored in summer (Table 6).

#### West coast Queen Charlottes

For tows monitored in the trawl fishery off the west coast of the Queen Charlotte Islands halibut CPUE was significantly higher in winter than in summer (Mann-Whitney test,  $p < 0.0001$ ). However, only twelve tows were observed in the summer fishery. All-species CPUE was significantly higher in winter than in summer as well (Mann-Whitney test,  $p < 0.05$ ).

Discounting the summer fishery where few data were collected, halibut CPUE was significantly higher for 'other' rockfish, Pacific ocean perch and Dover sole/turbot than for the other target groups in the total catch (Mann-Whitney test,  $p < 0.0001$ ) (Table 7). However, when the kept catch was considered, halibut CPUE was significantly higher for the rockfish groups than for Dover sole/turbot (Mann-Whitney test,  $p < 0.0001$ ). This is because catches of turbot coincidental with rockfish catches were largely discarded due to market preferences. Also, halibut CPUE for rockfish in this area was significantly higher (Mann-Whitney test,  $p < 0.001$ ) than it was in other areas. However, the standard error of the mean in this case was also very high. Obviously more sampling coverage of this fishery is needed. Rockfish species accounted for the highest proportion of the catch in tows monitored in this fishery in both summer and winter.

#### Queen Charlotte Sound

For tows monitored in the trawl fishery in Queen Charlotte Sound, halibut CPUE did not differ significantly between summer and winter. All-species CPUE in Queen Charlotte Sound was significantly higher in winter than in summer (Mann-Whitney test,  $p < 0.05$ ).

Halibut CPUE was significantly higher for lingcod/pollock ('other' species) in summer and Dover sole/turbot in winter than for the other groups. This was true of both the total and the kept catch (Table 8) (Mann-Whitney test,  $p < 0.0001$  for both). The relatively low halibut CPUE when rock and English soles were the target is reflective of the emphasis on rockfish

species in this fishery. Most fishing in this area takes place at depths deeper than those where the highest density of rock and English soles occurs. Rockfish species accounted for the highest proportion of the catch in tows monitored in this fishery in both summer and winter.

#### West coast Vancouver Island

For tows monitored in the trawl fishery off the west coast Vancouver Island, halibut CPUE was significantly higher in summer than in winter (Mann-Whitney test,  $p < 0.0001$ ), primarily due to the summer fishery for lingcod ('other' species). However, analysis of the summer fishery in this area was limited by the small amount of data collected. All-species CPUE was significantly higher in summer than in winter as well (Mann-Whitney test,  $p < 0.001$ ).

Halibut CPUE, was significantly higher for Dover sole/turbot in winter and lingcod in summer than for the other target groups (Mann-Whitney test,  $p < 0.0001$ ) (Table 9). Dover sole/turbot and rockfish species made up the greatest proportion of the catch in this area in winter while lingcod accounted for the highest proportion of the catch in summer.

#### COMPARISON BETWEEN STUDIES

I compared mean halibut CPUE by target group for the kept catch in Hecate Strait and Queen Charlotte Sound from this study to estimates from the 1981-82 study. Halibut mean CPUE was significantly higher in summer than in winter for both studies. Mean halibut CPUE for rockfish species and Dover sole/turbot was similar across the two studies. However, mean halibut CPUE for Pacific cod, rock and English soles and 'other' species (lingcod) was higher for the current study than the 1981-82 study. This was particularly true for the CPUE estimates for the summer fishery.

For Queen Charlotte Sound, the overall seasonal mean halibut CPUEs were similar between both studies. Halibut mean CPUE for Dover sole/turbot was also significantly higher in winter than in summer for both studies. Halibut CPUE for the other target groups was generally higher in the current study than in the 1981-82 study although the sample sizes in both cases are quite limited.

## SIZE COMPOSITION

The size of halibut caught in the B.C. trawl fishery has a significant effect on subsequent mortality (Hoag 1975, Clarke et al. 1992, Richards et al. 1994). The size of fish caught during this study differed among areas and seasonally within some areas (Figure 3).

In Hecate Strait and off the west coast of the Queen Charlotte Islands, the mean length of halibut caught in summer was significantly larger than that of fish caught in winter (1991-92) (t-test,  $p < 0.01$  for both). There was no significant seasonal difference in the mean length of halibut caught in the other areas. The mean length of halibut caught in Hecate Strait was significantly smaller than that of halibut caught in any of the other areas (t-test,  $p < 0.0001$ ). The mean length of halibut caught off the west coast of Vancouver Island and the west coast of the Queen Charlotte Islands was significantly larger than that for fish caught in the other two areas (t-test,  $p < 0.001$ ). There was no significance difference in the mean length of halibut caught off the west coast of Vancouver Island and off the west coast of the Queen Charlotte Islands. Hoag (1971) suggested that the differences in mean length among areas was related to migration patterns for the species with older fish migrating to offshore waters after the onset of sexual maturity.

## CONDITION FACTOR

The condition of trawl-caught halibut has been shown to be related to both fishery and non fishery factors (Clark et al. 1992, Richards et al. 1994). Not surprisingly, the most important fishery factor was the amount of time each fish spent on deck prior to release. I examined the condition data from the current study for seasonal and area differences which might be related to differences in the fishery among areas (Figure 4). It is realized that the differences in fish condition within and among areas reflect the variability among observers as well as the differences in real events among areas although the former is assumed to be negligible. I analyzed data from all areas except the Strait of Georgia where no data were available.

Halibut caught in winter in Hecate Strait and Queen Charlotte Sound were in better condition than fish caught in summer in those areas (Mann-Whitney test,  $p < 0.0001$ ). Halibut caught off the west coast of Vancouver Island were in better condition in summer than in winter (Mann-Whitney test,  $p < 0.0001$ ). Due to the lack of data for the west coast Queen Charlottes summer fishery (30 fish) no seasonal comparison for this area could be made.

Overall, halibut caught off the west coast of the Queen Charlotte Islands were in worse condition than those caught in any of the other areas (Mann-Whitney test,  $p < 0.0001$ ). Halibut caught in Hecate Strait and off the west coast of Vancouver Island were in better condition than fish caught in the other two areas (Mann-Whitney test,  $p < 0.0001$ ). There was no significant difference in the condition of halibut caught in Hecate Strait and off the west coast of Vancouver Island. Halibut caught in Queen Charlotte Sound were in better condition than fish caught off the west coast of the Queen Charlotte Islands but in worse condition than those caught in Hecate Strait and off the west coast of Vancouver Island (Mann-Whitney test,  $p < 0.001$ ). The testing here does not reflect possible differences in fish condition due to season and month within areas.

#### TIME-ON-DECK

I examined handling time (time-on-deck) for the trawl fishery in all areas except the Strait of Georgia and the west coast Queen Charlotte Islands in summer (Figure 5). As well, data for the winter fishery in Hecate Strait were available for 1993 only.

There were seasonal differences in time-on-deck for all areas (Mann-Whitney test,  $p < 0.0001$  for all). Time-on-deck was significantly longer in winter than it was in summer for all areas except Queen Charlotte Sound where the reverse was true (Mann-Whitney test,  $p < 0.0001$  for both).

There were significant differences in time-on-deck among all areas tested (Mann-Whitney test,  $p < 0.010$ ) except between Queen Charlotte Sound and off the west coast of Vancouver Island. Time-on-deck was shortest in the west coast Vancouver Island fishery and longest in the west coast Queen Charlotte Islands fishery. Time-on-deck was significantly longer in Hecate Strait than it was in Queen Charlotte Sound and the west coast of Vancouver Island (Mann-Whitney test,  $p < 0.001$ ). These results are fairly consistent with the results of the analysis of the halibut condition data. However there was one exception. Halibut caught in Queen Charlotte Sound were in slightly worse condition than those caught in Hecate Strait even though the average time-on-deck was longer in the Hecate Strait fishery.

#### BYCATCH

I applied the two sets of estimators derived from the observer data (halibut catch ratios and mean CPUEs) for the kept catch to tow by tow information for the 1994 trawl fishery in the groundfish database to estimate the bycatch of halibut by season

for the Hecate Strait fishery. I did not attempt to estimate bycatch for the other areas because of insufficient data.

The bycatch in both winter and summer was higher using the catch ratio estimators than using mean CPUE (Table 10). The highest bycatch of halibut occurred with rock/English soles in winter and with rock/English soles and other species, mainly lingcod in summer.

The estimate of the total bycatch of halibut in the Hecate Strait trawl fishery was 1.049 million lbs using the catch ratio estimator and 0.999 million lbs using mean CPUE. Hoag (1971) estimated the average annual bycatch of halibut in the Hecate Strait trawl fishery between 1962-69 to be 1.004 million lbs. Ketchen (1981) estimated the halibut bycatch for the 1980 Hecate Strait fishery to be 1.200 million lbs. Stanley (1984) estimated the average annual halibut bycatch between 1981-82 for this area to be 1.131 million lbs.

#### DISCUSSION

Catch rates for halibut were highest in the summer trawl fishery off the west coast of Vancouver Island and in Hecate Strait although the amount of data for the former area was limited. Higher catch rates were associated with tows made at shallower depths (<50 fa). The primary targets at these depths were flatfish species, Pacific cod and lingcod. These species all exhibit large fluctuations in abundance and fishing effort for them varies correspondingly. The bycatch of halibut by area varies over time as seen in the comparison between the results from this study and the 1981-82 study. The halibut ratios and mean halibut CPUEs were generally higher in this study than in the 1981-82 study. These differences could be due to changing biological, fishery or environmental factors.

During the observation period for the current study, rock sole, English sole and lingcod were at higher levels of abundance in 1991-92 than in 1981-82 (Fargo 1994, McFarlane and Leaman 1994, Stocker et al. 1994). Halibut abundance has declined since the mid 1980s (IPHC annual reports). Thus, the higher CPUEs observed for halibut in this study cannot be due an increase in the abundance of that species. Also, if halibut abundance was declining while abundance of some of the major target species, e.g. lingcod and flatfish was increasing we would expect that the halibut ratios would be lower for the current study than those for the 1981-82 study. Curiously, this was not the case. It is possible that changing environmental factors, known to affect the distribution of halibut (Perry et al. 1994), may have a significant influence on halibut bycatch. Ocean temperature differed between the two studies as did the range of depths fished by the trawl fleet.

Halibut mean CPUE in weight/h would also be affected if changes in size composition occurred between the two studies. However, an examination of the size composition for halibut caught in fisheries in Hecate Strait and Queen Charlotte Sound revealed no significant differences between the two studies. The rate of recruitment was fairly stable over the two study periods as well (IPHC Annual Reports).

A number of inconsistencies occurred in the halibut statistics that were used to estimate bycatch. The halibut ratios and mean halibut CPUEs differed substantially in some cases between the kept catch and the total catch. This is due to the discard rate which is in turn affected by markets and varies from year to year. For example, the ratio of halibut to rock and English soles in the summer fishery in Hecate Strait was 0.064 when the total catch was considered and 0.185 when the kept catch was considered. There was also a difference, albeit smaller, between mean halibut CPUEs for the same species, area and season, 60.6 kg/h for the total catch and 70.2 kg/h for the kept catch. This is due directly to the discarding of unmarketable species in this area. As well, the target of the total catch was not always the target of the kept catch. In Hecate Strait, for example, the amount of undersized sole discarded in a tow was enough in some cases to change the target species from rock/English sole for the total catch to some other species for the kept catch. There was also a confounding effect on the catch ratios and mean CPUEs when different target groups were caught coincidentally as was the case with some rockfish species and Dover sole/turbot. Thus, estimators determined from the total catch are more characteristic of the actual fishery than those derived from the kept catch. The number of target species categories also affected the values of the halibut ratios and mean CPUEs for the individual groups. This appeared to have less effect on the mean CPUE than on the catch ratio however.

These preliminary results suggest that mean CPUE may be preferable to halibut ratios for estimating total bycatch. Mean CPUE applied to the total catch is also preferable to that applied to the kept catch (landings). However, this will require much higher observer coverage or complete recording of discards by trawl vessel captains. There are also other approaches which, in the future, may provide more reliable estimates of halibut bycatch than either of the two methods used at present. Other investigators have used alternative models accounting for the combined effects of different target species to estimate halibut bycatch (Berger et al. 1989). There is some suggestion from results of this study that mortality incurred by halibut caught in the B.C. trawl fishery differs among areas. This is due, in part, to factors other than changing species composition. Fishery factors such as time-on-deck, length of tow, depth fished and weight of the catch and biological factors such as size and sex are also important as are oceanographic factors such as temperature. A model incorporating all of this information explicitly would provide improved estimates of halibut bycatch mortality for the B.C. trawl fishery. XBT data collected during

the observer program would allow this variable to be incorporated into the modelling of bycatch.

Finally, the high variability in the halibut catch-rate data indicates the need for continued data collection. Especially from the summer fishery off the west coast of Vancouver Island, the summer and winter fisheries in Queen Charlotte Sound and the summer and winter fishery off the west coast of the Queen Charlotte Islands. As well, the interannual differences in bycatch observed for the Hecate Strait fishery indicate that continued data collection is necessary in order to understand the dynamics of halibut bycatch.

Additional analyses incorporating oceanographic and fishery factors should be undertaken when sufficient data are collected in order to recommend the most effective measures for bycatch reduction. As well, there will be a need to evaluate bycatch reduction measures and the sampling coverage of the domestic trawl fishery necessary for this will undoubtedly have to increase. The problem of bycatch, in general, in the trawl fishery here and elsewhere is one of the most urgent that fishery managers, scientists and industry are facing. Comprehensive data collected during domestic trawl observer programs are essential to providing the most effective suite of bycatch reduction measures.

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Table 1. Number of tows made and observer sampling coverage (in bold) by month/year and area during the British Columbia bottom trawl fishery, September 1991 - December 1994.

AREA	YEAR	MONTH												TOTAL
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
HEC/DIX	1991									898	916	453	165	2432
										<b>14</b>	<b>94</b>	<b>21</b>	<b>8</b>	<b>137</b>
	1992	242	692	839	1395	1466	1403	833	702	652	527	536	171	9458
		<b>35</b>	<b>108</b>	<b>36</b>	<b>43</b>	<b>99</b>	<b>72</b>	<b>106</b>	<b>68</b>	-	-	-	-	<b>567</b>
1993	292	636	807	1467	1439	1546	833	621	896	964	969	390	10860	
	-	-	-	<b>10</b>	-	-	-	-	-	<b>25</b>	<b>24</b>	-	-	<b>59</b>
	1994	451	750	660	890	1112	1162	505	44	591	836	494	233	7728
	-	-	-	-	-	-	-	-	-	-	-	-	-	<b>0</b>
QCS	1991									520	620	147	24	1311
											<b>21</b>	-	<b>1</b>	<b>22</b>
	1992	247	441	381	634	962	1452	1143	604	695	452	96	29	7136
		-	<b>5</b>	-	<b>15</b>	<b>8</b>	<b>24</b>	<b>5</b>	-	<b>45</b>	-	-	-	<b>102</b>
1993	308	351	146	464	1148	1408	1010	417	481	585	223	48	6589	
	<b>18</b>	-	-	-	-	-	-	-	-	-	<b>3</b>	-	-	<b>21</b>
	1994	159	232	106	512	964	955	718	737	950	761	379	206	6679
	-	<b>1</b>	-	<b>6</b>	-	-	<b>8</b>	<b>10</b>	<b>5</b>	-	-	-	-	<b>30</b>
WCVI	1991									691	887	121	179	1878
									<b>28</b>	-	-	-	-	<b>28</b>
	1992	337	1227	898	585	1003	1215	1540	715	698	895	342	111	9566
		-	<b>24</b>	-	<b>5</b>	-	-	-	-	<b>1</b>	-	<b>20</b>	-	<b>50</b>
1993	556	1802	743	750	1479	1230	1085	594	840	1273	384	19	10755	
	<b>16</b>	<b>72</b>	<b>8</b>	-	-	-	-	-	-	<b>10</b>	-	-	-	<b>106</b>
	1994	731	1062	743	1097	1433	745	564	402	786	781	324	145	8813
	-	<b>2</b>	<b>36</b>	<b>26</b>	-	-	<b>31</b>	-	<b>17</b>	-	<b>42</b>	<b>15</b>	-	<b>169</b>
WCQCI	1991									0	61	79	29	169
										<b>1</b>	-	-	-	<b>1</b>
	1992	90	142	193	170	208	81	60	57	75	45	71	17	1209
		-	-	-	-	<b>7</b>	<b>3</b>	-	-	<b>12</b>	-	-	-	<b>22</b>
1993	94	135	128	309	271	139	74	59	76	212	111	43	1651	
	-	-	-	<b>13</b>	-	-	-	-	-	<b>5</b>	<b>4</b>	-	-	<b>22</b>
	1994	127	209	93	254	295	160	83	40	62	80	119	128	1650
	-	-	-	-	-	-	-	-	<b>2</b>	<b>19</b>	-	-	-	<b>21</b>
STGEO	1991									25	41	73	100	239
											<b>5</b>	-	-	<b>5</b>
	1992	111	118	225	180	137	74	0	136	130	213	298	129	1751
		-	-	-	-	-	-	-	-	-	-	-	-	-
1993	104	219	123	138	102	34	2	25	68	102	126	89	1132	
	-	-	<b>9</b>	-	-	-	-	-	-	-	-	-	-	<b>9</b>
	1994	111	164	202	116	145	102	6	0	48	88	99	133	1214
	-	<b>1</b>	-	-	-	-	-	-	-	-	-	-	-	<b>1</b>
<b>TOTAL</b>		3960	8180	6287	8961	1216	11706	8456	5153	9182	1033	5444	2388	92220
						<b>4</b>				<b>9</b>				
<b>TOTAL</b>		<b>69</b>	<b>213</b>	<b>89</b>	<b>118</b>	<b>114</b>	<b>138</b>	<b>121</b>	<b>120</b>	<b>92</b>	<b>202</b>	<b>87</b>	<b>9</b>	<b>1372</b>

Table 2. Number of trawl trips and observer coverage by month/year and area during the British Columbia trawl fishery, September 1991 - December 1994.

AREA	YEAR	MONTH												TOTAL
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
HEC/DIX	1991									106	115	68	29	318
										1	6	2	1	10
	1992	42	75	103	209	189	157	96	103	96	79	91	21	1261
		3	7	1	3	7	4	5	2	-	-	-	-	32
	1993	57	118	143	258	228	240	125	68	143	169	188	82	1819
	-	-	-	1	-	-	-	-	-	1	1	-	3	
	1994	97	166	114	158	164	130	79	8	105	141	110	47	1319
		-	-	-	-	-	-	-	-	-	-	-	-	0
QCS	1991									63	80	26	8	177
											4	1	-	5
	1992	40	60	55	124	129	165	131	69	94	67	22	11	967
		-	2	-	2	1	2	1	-	3	-	-	-	11
	1993	67	80	44	113	165	194	109	53	76	111	59	11	1082
	2	-	-	-	-	-	-	-	-	-	1	-	3	
	1994	44	63	29	99	127	107	80	59	102	91	70	48	919
		-	1	-	1	-	1	1	-	-	-	-	-	4
WCVI	1991									85	160	24	30	299
									1	-	-	-	-	1
	1992	93	199	149	137	184	219	254	112	119	176	59	26	1727
		-	4	-	2	-	-	-	-	1	-	1	-	8
	1993	144	356	130	169	307	241	203	116	149	312	87	8	2222
	2	5	1	-	-	-	-	-	-	1	-	-	9	
	1994	146	224	124	198	208	121	92	61	116	149	88	41	1568
		-	1	1	1	-	1	-	1	-	3	-	-	8
WCQCI	1991									0	12	15	4	31
										1	-	-	-	1
	1992	17	25	37	31	33	14	9	18	16	12	12	4	228
		-	-	-	-	1	1	-	-	2	-	-	-	4
	1993	16	32	33	48	47	32	15	13	16	36	32	15	335
	-	-	-	1	-	-	-	-	-	1	1	-	3	
	1994	21	25	19	34	43	17	13	6	13	18	15	19	243
		-	-	-	-	-	-	-	1	1	-	-	-	2
STGEO	1991									7	8	16	13	44
											1	-	-	1
	1992	24	28	40	19	28	15	0	13	24	33	47	25	296
		-	-	-	-	-	-	-	-	-	-	-	-	0
	1993	24	45	34	37	26	8	1	6	11	19	33	30	274
	-	-	1	-	-	-	-	-	-	-	-	-	1	
	1994	24	36	36	30	31	16	4	0	13	21	23	24	258
		-	1	-	-	-	-	-	-	-	-	-	-	1
<b>TOTAL</b>		856	1532	1090	1664	1909	1676	1211	705	135	1809	1085	496	15387
<b>TOTAL</b>		7	21	4	11	9	9	7	5	4	17	7	1	107

Table 3. The catch ratio of halibut to target species by area for tows monitored in the British Columbia trawl fishery between 1991-94.

Target species	Total catch								
	Hecate Strait			West coast Charlottes		Queen Charlotte Sd.		West coast Van. I.	
	Summer	Winter <sup>1</sup>	Winter <sup>2</sup>	Summer	Winter	Summer	Winter	Summer	Winter
Pacific cod	0.055	0.017	0.003	-	-	0.006	0.117	-	0.007
Rock/English soles	0.064	0.042	0.007	-	-	0.021	0.032	0.110	0.081
Dover sole/Turbot	0.112	0.021	0.068	-	0.025	0.021	0.054	0.023	0.061
Pacific ocean perch	-	0.061	-	0.000	0.051	0.010	0.011	0.073	0.018
Other rockfish	0.021	0.009	0.050	0.001	0.019	0.040	0.008	0.040	0.017
Other flatfish	0.092	0.051	0.096	-	-	-	-	0.150	0.091
Others	0.043	0.013	0.034	0.036	0.012	0.148	0.042	0.133	0.028
Total catch	0.046	0.016	0.029	0.002	0.018	0.055	0.020	0.071	0.028
	Kept catch								
Pacific cod	0.082	0.025	0.071	-	-	0.116	0.154	0.985	0.008
Rock/English soles	0.185	0.084	0.307	-	-	0.251	0.202	0.152	0.167
Dover sole/Turbot	0.070	0.049	0.120	-	0.012	0.060	0.062	0.012	0.072
Pacific ocean perch	-	0.061	-	0.000	0.108	0.007	0.013	-	0.022
Other rockfish	0.033	0.012	0.201	0.001	0.013	0.025	0.013	0.117	0.032
Other flatfish	0.127	0.098	-	-	-	-	-	-	0.179
Others	0.416	0.012	0.009	0.040	0.013	0.252	0.398	0.256	0.115
Total catch	0.104	0.030	0.046	0.002	0.022	0.085	0.031	0.126	0.040

<sup>1</sup> winter 1991-92

<sup>2</sup> winter 1993

Table 4. Mean CPUE and standard error for halibut caught in the B.C. trawl fishery from 1991-94.

Area	Mean CPUE (kg/h)		Halibut/groundfish (kg/t)		Tows observed (n)	
	<u>summer</u>	<u>winter</u>	<u>summer</u>	<u>winter</u>	<u>summer</u>	<u>winter</u>
HEC	64.7 ± 6.1	17.4 ± 1.5	65.7	27.0	336	359
WCQCI	1.1 ± 0.9	65.3 ± 23.0	2.7	43.9	12	53
QCS	35.0 ± 11.5	31.1 ± 7.0	57.5	35.0	60	115
WCVI	95.9 ± 22.5	19.5 ± 2.2	69.4	33.6	76	278

Table 5. Kruskal-Wallis test results for halibut CPUE data collected by observers between 1991-94.

Class variable	N	Median CPUE (kg/h)	Average rank	H	p
Summer	484	22.8	787		
Winter	806	8.6	561		
Overall	1290		646	112.1	<0.0001
(summer)					
HEC	336	28.5	261		
QCI	12	0.0	39		
QCS	60	8.3	175		
WCVI	76	19.2	244		
Overall	484		243	45.6	<0.0001
(winter)					
HEC	359	9.4	417		
QCI	54	17.3	483		
QCS	115	10.2	423		
WCVI	278	5.6	362		
Overall	806		404	17.3	<0.001
Pacific cod	245	9.0	759		
Rock/English	311	14.0	890		
Dover/turbot	282	15.5	865		
P. ocean perch	119	2.0	553		
Other rockfish	194	2.0	568		
Other flatfish	74	1.0	622		
Other species	318	10.0	826		
Overall	1543		772	119.4	<0.0001

Table 6. Mean halibut CPUE by target species group for tows monitored in the Hecate Strait trawl fishery, Sep 1991 - Dec 1994.

Target species	Total catch			Kept catch		
	Mean halibut CPUE (kg/h)	Standard error	Number of tows	Mean halibut CPUE (kg/h)	Standard error	Number of tows
<b>Sep 91 - Apr 92</b>						
Pacific cod	12.9	1.3	100	13.8	1.2	179
Rock/English soles	23.5	3.7	124	22.4	3.3	140
Dover sole/Turbot	14.8	2.3	37	14.1	3.4	30
Pacific ocean perch	4.4	4.3	7	6.3	3.1	14
Other rockfish	5.2	2.0	15	7.7	2.0	25
Other flatfish	14.6	3.9	20	6.4	2.1	21
Other species	11.8	2.1	95	5.9	1.3	31
<b>May-Aug 92</b>						
Pacific cod	57.3	9.9	72	65.3	10.7	103
Rock/English soles	60.6	8.3	151	70.2	8.8	183
Dover sole/Turbot	83.6	21.6	59	31.1	6.4	37
Pacific ocean perch	0	-	4	30.0	22.9	8
Other rockfish	3.9	2.0	9	22.5	15.3	12
Other flatfish	36.7	13.5	16	37.1	12.8	17
Other species	72.9	17.8	53	91.8	21.5	31
<b>Apr, Oct, Nov 93</b>						
Pacific cod	5.3	5.3	3	17.2	5.4	8
Rock/English soles	1.4	0.6	5	27.3	9.5	10
Dover sole/Turbot	41.1	7.2	20	53.0	9.9	18
Pacific ocean perch	0	-	2	0	-	2
Other rockfish	7.5	4.9	7	22.5	7.9	11
Other flatfish	4.4	4.4	3	0	-	2
Other species	29.4	6.2	32	11.9	3.9	20

Table 7. Mean halibut CPUE by target species group for tows monitored in the west coast Queen Charlotte Islands trawl fishery, 1991-94.

Target species	Total catch			Kept catch		
	Mean halibut CPUE(kg/h)	Standard error	Number of tows	Mean halibut CPUE (kg/h)	Standard error	Number of tows
<u>Summer</u>						
Pacific cod	-	-	-	0.0	-	1
Rock/English soles	-	-	-	0.0	-	1
Dover sole/Turbot	-	-	-	0.0	-	1
Pacific ocean perch	0.0	0.0	4	0.0	0.0	4
Other rockfish	0.3	0.3	8	0.3	0.7	8
Other flatfish	0.0	-	1	0.0	-	1
Other species	5.4	5.4	2	5.4	7.6	2
<u>Winter</u>						
Pacific cod	0.0	0.0	2	0.0	0.0	2
Rock/English soles	0.0	0.0	2	0.0	0.0	2
Dover sole/Turbot	24.4	15.0	11	8.7	3.5	8
Pacific ocean perch	38.3	38.3	3	71.6	43.0	4
Other rockfish	34.8	14.9	44	33.9	14.3	46
Other flatfish	0.0	0.0	2	0.0	0.0	2
Other species	4.2	4.2	3	4.2	4.2	3

Table 8. Mean halibut CPUE by target species group for tows monitored in the Queen Charlotte Sound trawl fishery, 1991-94.

Target species	Total catch			Kept catch		
	Mean halibut CPUE(kg/h)	Standard error	Number of tows	Mean halibut CPUE (kg/h)	Standard error	Number of tows
				<u>Summer</u>		
Pacific cod	3.2	3.2	2	14.0	23.9	6
Rock/English soles	4.0	4.0	2	22.8	25.7	8
Dover sole/Turbot	6.4	2.0	7	8.6	7.2	5
Pacific ocean perch	8.1	2.6	11	4.7	3.8	9
Other rockfish	11.8	4.6	13	7.9	7.7	15
Other flatfish	0.0	-	1	0.0	-	1
Other species	56.6	20.8	32	74.1	138.7	22
				<u>Winter</u>		
Pacific cod	24.4	10.6	12	30.7	6.6	24
Rock/English soles	4.2	2.8	8	19.3	4.5	18
Dover sole/Turbot	80.0	38.0	18	122.3	85.7	8
Pacific ocean perch	14.8	6.2	34	14.8	6.2	34
Other rockfish	8.5	2.3	37	10.3	2.2	43
Other flatfish	1.9	1.9	5	1.9	1.9	5
Other species	32.7	9.4	32	46.6	19.2	15

Table 9. Mean halibut CPUE by target species group for tows monitored in the west coast Vancouver Island trawl fishery, 1991-94.

Target species	Total catch			Kept catch		
	Mean halibut CPUE (kg/h)	Standard error	Number of tows	Mean halibut CPUE (kg/h)	Standard error	Number of tows
<u>Summer</u>						
Pacific cod	0.0	0.0	3	63.4	59.6	5
Rock/English soles	19.1	11.5	7	23.9	10.3	9
Dover sole/Turbot	13.5	4.0	20	8.7	2.8	12
Pacific ocean perch	3.0	3.0	4	3.9	3.9	4
Other rockfish	16.9	11.0	12	25.5	16.6	19
Other flatfish	9.0	9.0	4	3.9	3.9	4
Other species	138.3	34.2	48	127.1	33.2	49
<u>Winter</u>						
Pacific cod	3.3	0.7	50	4.2	1.2	54
Rock/English soles	2.7	2.7	11	6.8	2.7	21
Dover sole/Turbot	32.0	4.5	114	34.2	5.7	87
Pacific ocean perch	8.4	1.9	45	8.5	1.6	55
Other rockfish	8.3	2.6	55	11.1	2.2	74
Other flatfish	11.7	4.0	22	20.5	5.6	29
Other species	11.6	4.9	44	12.8	12.3	16

Table 10. Halibut bycatch (000's lbs) for the Hecate Strait trawl fishery using ratio and mean CPUE methods for target species kept in the British Columbia trawl fishery in 1994.

Target species	Summer		Winter <sup>1</sup>	
	ratio	CPUE	ratio	CPUE
Pacific cod	52	130	49	53
Rock/English soles	286	342	214	196
Dover sole/Turbot	90	67	31	19
Pacific ocean perch	-	8	8	2
Other rockfish	21	26	20	20
Other flatfish	0	0	0	0
Others	264	121	14	15
Total catch	713	694	336	305

<sup>1</sup> September 1991 - April 1992



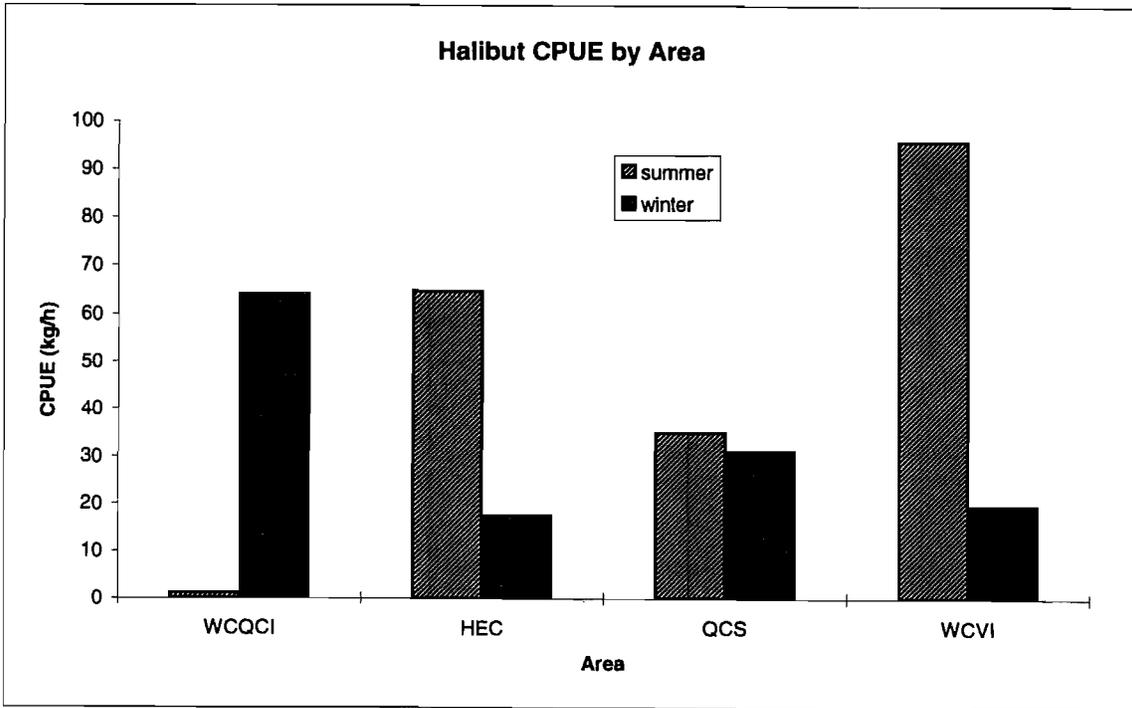


Fig. 1. Mean halibut CPUE for the B.C. trawl fishery by area and season, 1991-94. WCQCI - west coast Queen Charlotte Islands HEC - Hecate Strait; QCS - Queen Charlotte Sound; WCVI - west coast Vancouver Island.

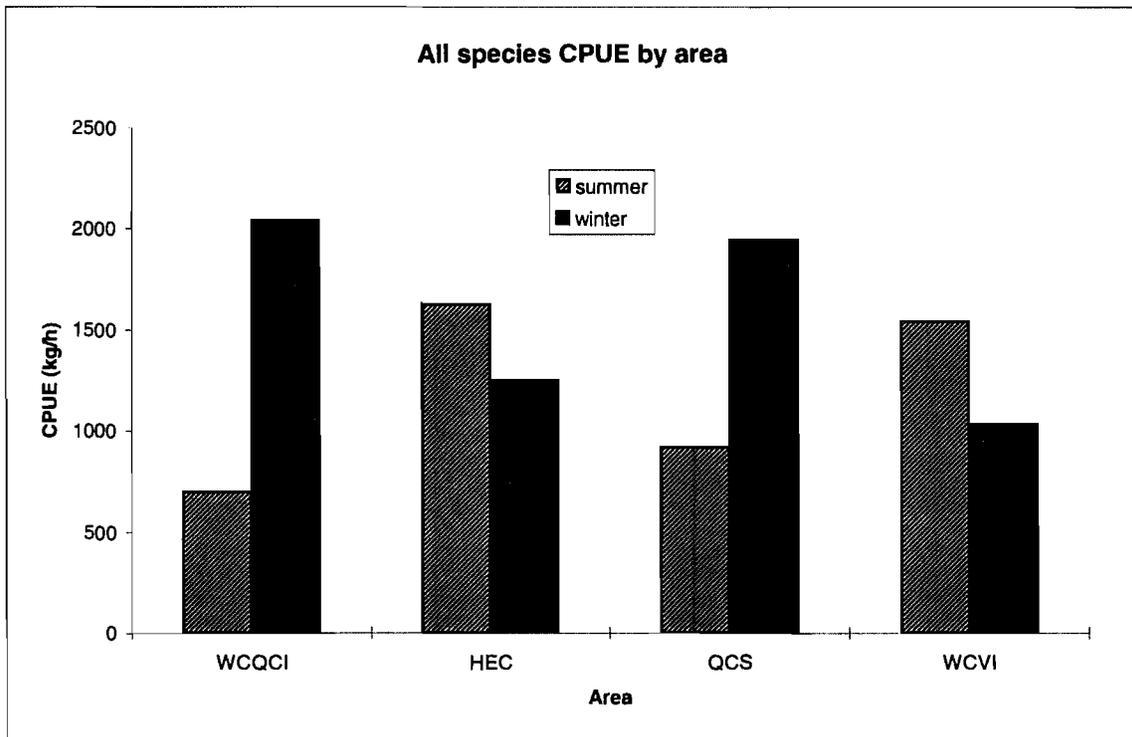


Fig. 2. Mean all-species CPUE for the B.C. trawl fishery by area and season, 1991-94. WCQCI - west coast Queen Charlotte Islands HEC - Hecate Strait; QCS - Queen Charlotte Sound; WCVI - west coast Vancouver Is.

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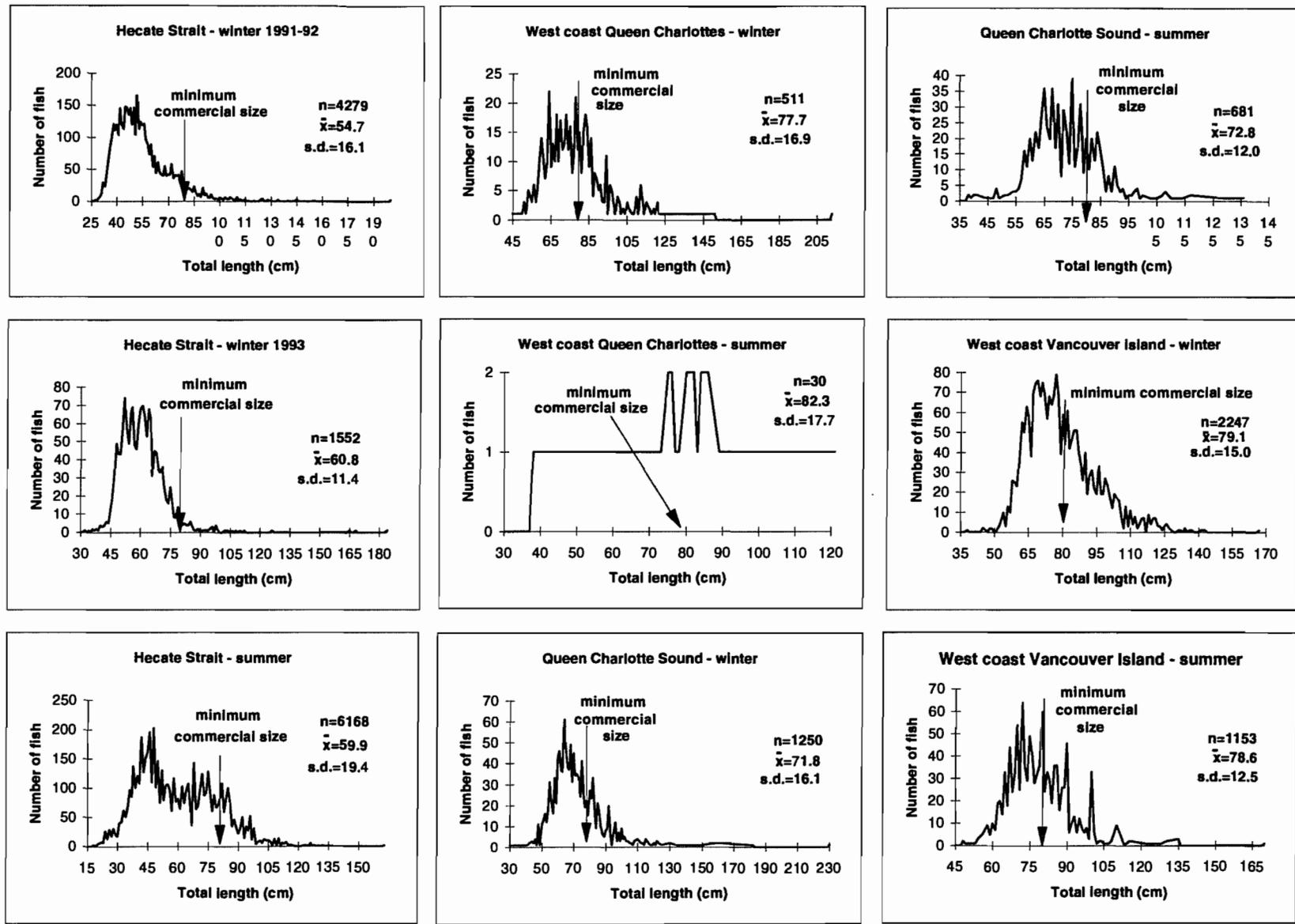


Fig. 3. Size composition of halibut caught in the B.C. trawl fishery by area and season, 1991-94.



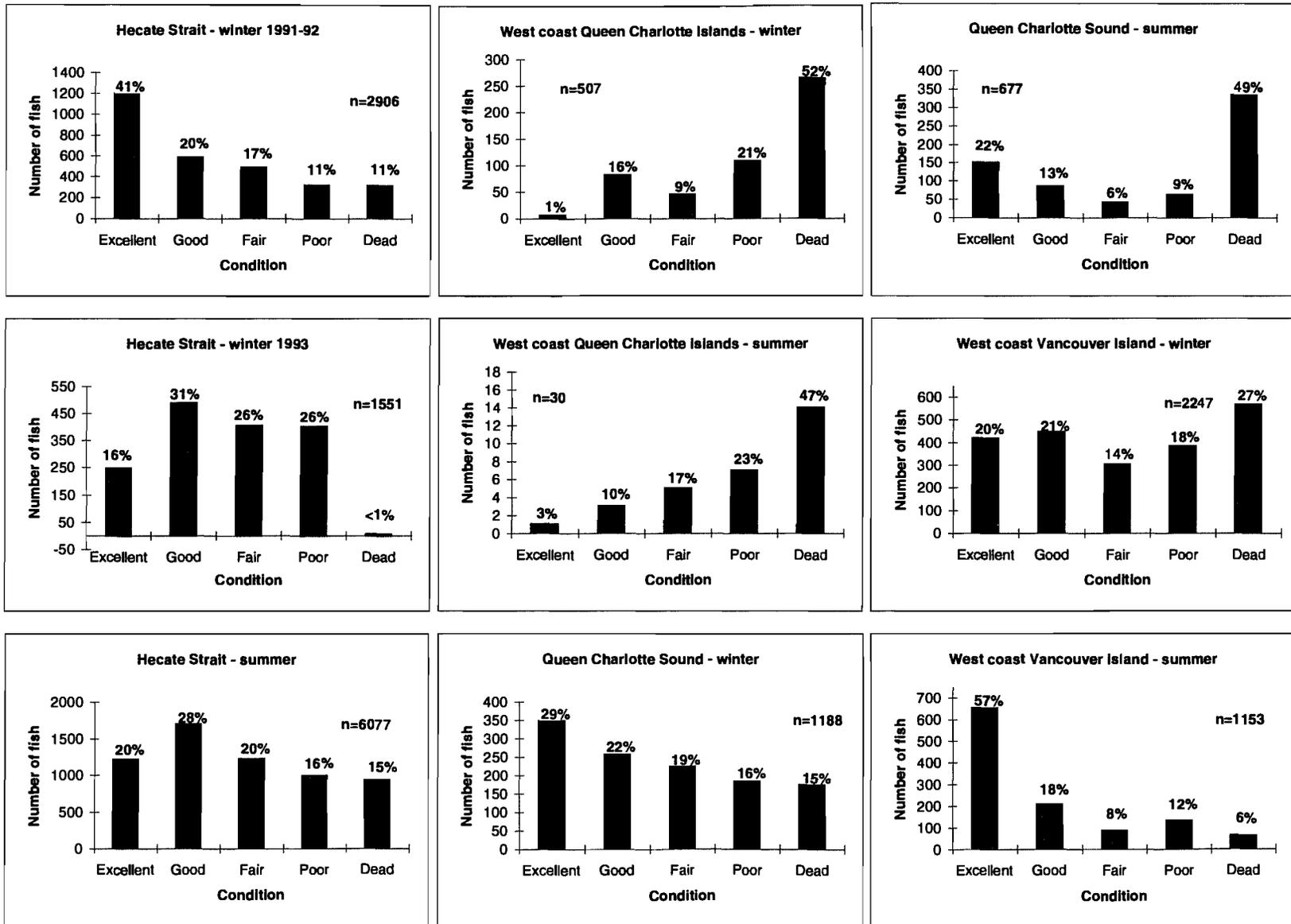
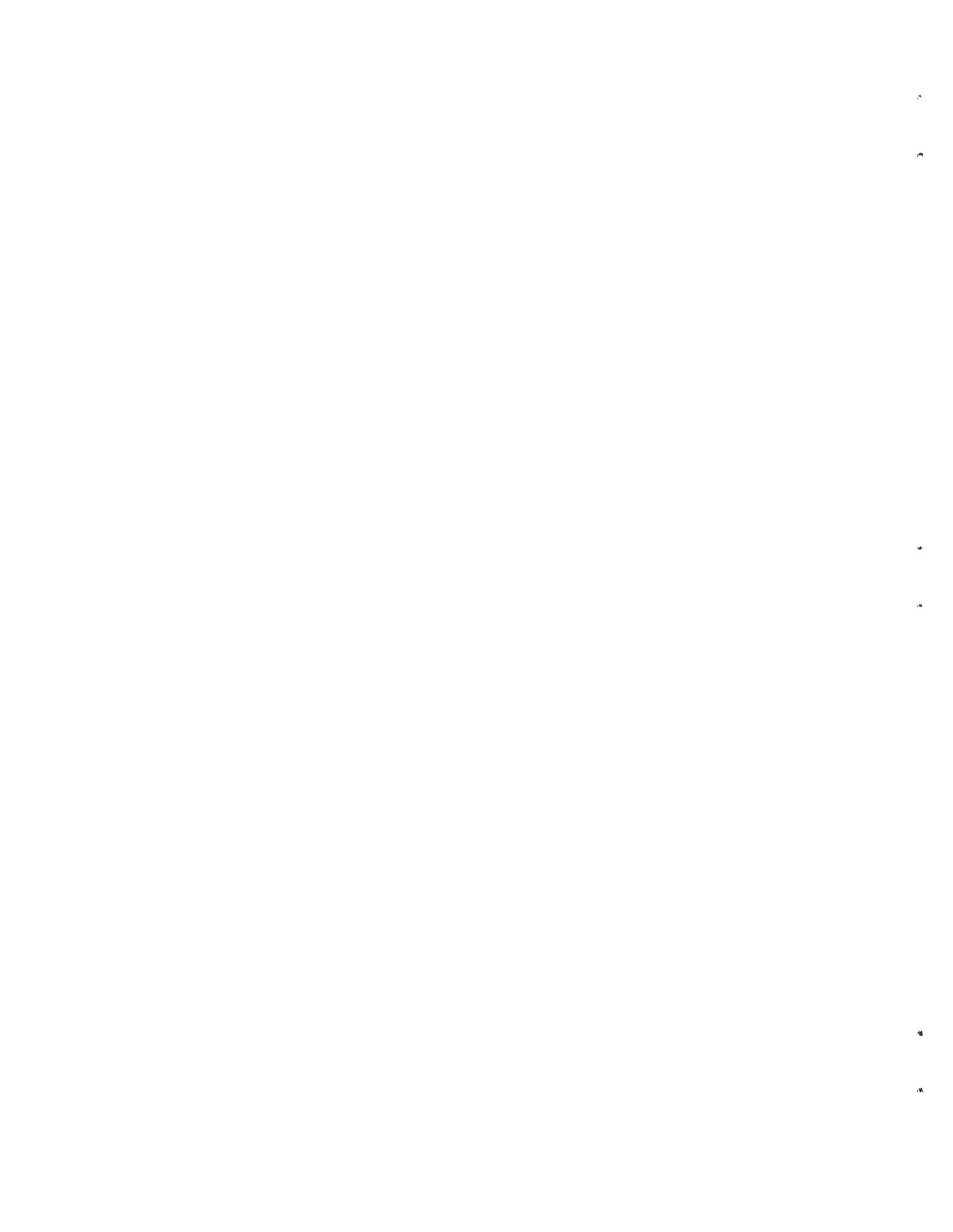


Fig. 4. Physical condition of halibut caught in the B.C. trawl fishery by area and season, 1991-94.



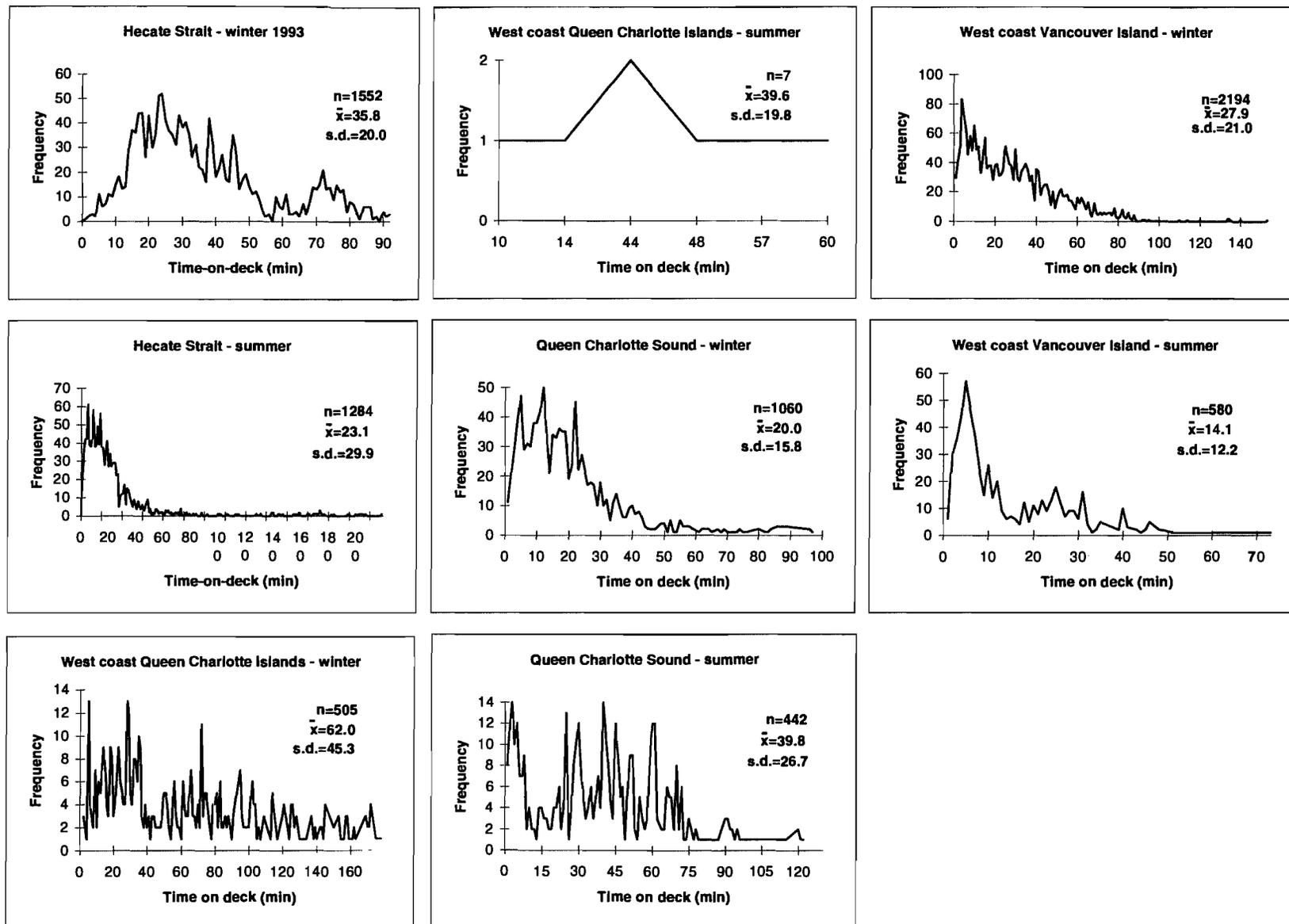


Fig. 5. Time on deck for halibut caught in the B.C. trawl fishery by area and season, 1991-94.