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Taihoro Nukurangi

Stock assessment of school shark: documentation of the results of a questionnaire sent to selected commercial fishers

Larry Paul, Elizabeth Bradford

Final Research Report for
Ministry of Fisheries Research Project SCH1999-01
Objective 2

National Institute of Water and Atmospheric Research

December 2000

Final Research Report
For Project SCH1999-01 – Objective 2

Report Title:	Stock assessment of school shark: documentation of the results of a questionnaire sent to selected commercial fishers	
Authors:	Larry Paul, Elizabeth Bradford	
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5. Project Leader:	Elizabeth Bradford	
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7. Executive Summary and Conclusions

The questionnaire to commercial fishers for school shark (*Galeorhinus galeus*) was directed at clarifying several ambiguities in the catch effort data that had become apparent during both the fishery characterisation study, and the CPUE standardisation study. It also elicited general information on school shark and their fishery that was considered relevant to both these studies.

It requested comment on the definition of this fishery: geographically, by depth, and by target species. It enquired whether fishers had changed (in particular, extended) their fishing grounds recently (potential localised depletion), and whether new electronic aids (e.g., GPS) had aided fishing. It sought clarification on the specifications of fishing gear used (i.e., effort variables) for lines and set nets, and whether these had changed, or the recording of them had changed, over recent years. It requested information on the main distinction between different line-fishing methods. Comments were sought on the seasonality of catches, and on market requirements that would influence the size of sharks targeted and/or landed. An important question sought fishers' opinions on why the estimated catches were often recorded as processed weight, rather than greenweight as required. Another question dealt with the reliability of target species information. Fishers were invited to comment on the presence of pupping or nursery grounds in their areas.

The responses indicated that some fishers did record their effort parameters incorrectly or ambiguously. They also revealed that some fishers expected the Ministry of Fisheries to understand that their recorded catches were processed weight rather than greenweight. They indicated that the target species was nominated in different ways by different fishers, or under differing circumstances, making the identification of true target fisheries, and the interpretation of zero catches, difficult. Some fishers did avoid catching large females, and

grounds dominated by juveniles were avoided. Because school shark often aggregate by size, fishers can target for market preferences.

In general, the results confirmed suspicions that catch effort data for this fishery, and probably for similar fisheries (mixed species, several methods, small targeted catch), were unreliable because many fishers were completing their catch (CELR) forms incorrectly or ambiguously.

8. Objectives

To document the school shark questionnaire results.

9. Methods

In order to understand some anomalies in catch and effort data held by the Ministry of Fisheries, and extend our knowledge of the fishery, a questionnaire was sent to those school shark fishers who had returned several tags from the school shark tagging programme, and who appeared to have worked consistently in this fishery. An invitation was extended to discuss any matters further by telephone interview. The covering letter sent out is attached as Appendix 1 below. A simpler version of the questionnaire was given to the Inshore Working Group. The responses were compiled and commented on.

10. Results

Of 13 questionnaires sent to fishers, six were returned. Two extended and very informative telephone discussions were conducted, at the request of the fishers concerned. Two further responses were received from fishers who received the simpler Working Group version. In Appendix 2 to this Research Report, the resulting information is set out in order of the questions asked, in the sequence: background to the question, question, responses, comment on the responses. This text incorporates the actual questionnaire.

11. Conclusions

See Executive Summary and Conclusions, above.

12. Publications

Bradford, E. 2000: Standardised catch rate indices for New Zealand school shark, *Galeorhinus galeus*, 1989–90 to 1998–99. Draft *New Zealand Fisheries Assessment Report 2000/00*. 75 p.

Paul, L.J. & Sanders, B.M. 2000: A description of the commercial fishery for school shark, *Galeorhinus galeus*, in New Zealand, 1945 to 1999. Draft *New Zealand Fisheries Assessment Report 2000/00*. 50 p.

13. Data Storage

None. The written responses to the questionnaire are all contained in this report.

Appendix 1:

Copy of the letter to fishers which accompanied the questionnaire

May 2000

Dear

Ministry of Fisheries Project SCH1999/01: Stock assessment of school shark

NIWA is undertaking a research project, funded by the Ministry of Fisheries, directed at gaining more understanding of the New Zealand school shark fishery. We have been working through commercial catch and effort data for the fishery provided by the Ministry. We have encountered some apparent ambiguities in the information, and we are asking for your assistance in understanding them.

We obtained your name and address from Neil Bagley (NIWA, Wellington) because you have returned school shark tags at some time in the past, and therefore could be considered a school shark fisher.

We should make it clear that although we have access to commercial fisheries data by vessel and day, trip, or month, the vessel registration numbers have been re-coded by the Ministry. **We do not know – or need to know – the true identity of vessels. We do not want to know which data come from your own vessel.** About 800 vessels report a catch of school shark each year, and we are looking for broad patterns.

Our work has two objectives. First, we have to "characterize" the school shark fishery in New Zealand. This involves describing when, where, and how school shark are caught, and with what target species. We intend to calculate a "standardized catch rate" index, using the main catching vessels. If this catch rate index proves to be acceptable, it could be used in the stock assessment for school shark.

This project was started partly because we do not yet have a good understanding of the fishery, and partly because there is a move in many parts of the world to pay more attention to shark fisheries. They tend to operate satisfactorily for a while, and then quite suddenly decline. Most have a slow recovery rate. We have no evidence that the New Zealand school shark fishery is in a state of decline, but what is happening needs careful investigation.

The Australians have studied their school shark fishery for many years, and are beginning to understand why it is not performing as well as it should. One of the many advantages that the Australian scientists have over us, is that the assessment and management of their shark fishery has had considerable input from the shark fishers themselves over many years.

We are particularly interested in changes that have occurred during the past 20 years.

The New Zealand catch and effort information based on fishing returns contains quite a few errors. Fishing effort information is almost entirely lacking prior to about 1980, though some is available for the late 1970s through work done on the rig fishery. Hence, we can only hope

to provide catch rate indices from 1980 onwards at most, and possibly only from 1990 when the current data recording system came into being. We suspect that some of the data problems we have found result from different ways of entering data in the CELR forms, and we would like your help in interpreting the real situation.

We prepared the questions for shark fishers that are included with this letter. We ask for your co-operation in answering at least some of them and so help improve knowledge about the fishery.

We give some background explanation for our questions, and then pose the questions. Space is left after each question for your answer. Maps of New Zealand are provided on which we suggest you mark the general area where you fish for school shark. Please feel free to answer as few or as many of the questions as you want, and to make any additional comments you consider appropriate.

A stamped addressed envelop is enclosed, for your convenience in replying.

If you wish to contact us directly please telephone NIWA collect (04) 386 0300 between 8:30 and 4:30 and ask for one of us.

We would also be happy to hear from you via e-mail.

e.bradford@niwa.cri.nz
l.paul@niwa.cri.nz

If you have a shark fishing colleague who has not received our letter, but would like to respond separately, please either pass on a copy of this, or advise us of his name and address.

Thanking you
Yours sincerely

Elizabeth Bradford and Larry Paul
NIWA Scientists

Appendix 2:

Stock assessment of school shark: documentation of the results of a questionnaire sent to selected commercial fishers

L.J. Paul & E. Bradford

INTRODUCTION

NIWA was contracted by the Ministry of Fisheries, under Project SCH1999/01 'Stock assessment of school shark', (a) to characterise the school shark fishery, i.e., describe it in terms of catch and/or landing by region, fishing method, target species, etc., (Paul & Sanders 2000) and (b) to develop national and/or regional CPUE indices (Bradford 2000). Most of the data required for this work were extracted from the Ministry's CATCHEFF database.

School shark (*Galeorhinus galeus*) are often caught in association with rig (*Mustelus lenticulatus*) and occasionally with elephant fish (*Callorhinchus milii*) and spiny dogfish (*Squalus acanthias*) in the set net fishery. In the longline fishery, they are often caught in association with bluenose (*Hyperoglyphe antartica*), groper (*Polyprion oxygeneios, P. americanus*), or ling (*Genypterus blacodes*). They are bycatch in most fisheries, especially trawl fisheries. In this report, the abbreviation 'sharks' refers to school shark.

As work progressed, it became desirable to enquire a little further into how this fishery operated, and how at least some of the fishers filled in their fishing returns. Ambiguities in the data strongly suggested that a considerable number of fishers had misunderstood the instructions necessary to fill in the CELR forms correctly.

With Ministry of Fisheries approval, a questionnaire was sent to the 13 commercial fishers who had returned the majority of the school shark tags in an earlier research project (Hurst *et al.* 1999), and who obviously were, or had been, important participants in the fishery. We obtained their names and addresses from their tag return information. They were not (and could not be) identified from the Ministry's fisheries data we were working with, where fisher identification (vessel registration number) was coded. The fishers could identify themselves on their reply or not, as they chose (most did). Six fully or partly completed questionnaires were returned, and extended telephone interviews were conducted with the two fishers who indicated they would like to discuss some issues further. A draft version of the questionnaire was also distributed to members of the Inshore [Stock Assessment] Working Group. This group did not provide a collective response, but two fishers responded individually. They did not directly answer the questions in the main questionnaire, but their comments have been allocated to appropriate sections in the following account. There were 23 questions in the questionnaire, plus a map of New Zealand showing fishing statistical areas to be annotated (e.g., with fishing grounds) if necessary.

Although eight responses is a small sample for a questionnaire, we believe it is a good representation of the main shark fishers in the fishery. Although about 800 fishers report a catch of school shark, in any one year only 10 or so fishers land a substantial quantity of targeted school shark. The questionnaire was directed at these, more knowledgeable fishers, not those for whom this species is only an incidental catch.

The eight fishers who responded directly or indirectly to the questions are listed here as A–H. For several reasons (e.g., fishing method not applicable) they did not answer all questions. Their fishing methods, and regions fished, cover the main school shark fisheries. They are:

A Set net; Southland.
B Mainly set net, some trawl; east coast South Island.
C Trawl and set net; east coast South Island.
D Bottom trawl; west coast South Island.
E Bottom longline; formerly Cook Strait, now northwest North Island.
F Formerly longline, now trawl; east coast North Island.
G Set net; east coast South Island.
H Bottom longline and set net; Cook Strait, northwest South Island, southwest North Island.

This report addresses each of the 23 questions that were asked, in the sequence: (a) general background to the question (why it was asked), including, *in italics*, the background text provided in the questionnaire; (b) the question as worded; (c) fishers' responses, written, and from subsequent telephone discussion; (d) the NIWA comment on responses. Within the latter, where appropriate, comments are added (as ***CPUE***) on how the data were used in the CPUE standardisation procedure by Bradford (2000).

We have retained the respondents' wording as much as possible, and where changes or additions were considered necessary for clarification, or where paraphrasing was required, these are added in square brackets.

This report partially overlaps the characterisation study (Paul & Sanders 2000) and gives some rationale for decisions made when performing the CPUE standardisations (Bradford 2000). However, it can be considered a stand-alone document.

THE QUESTIONNAIRE

This was prefaced by the following explanation to fishers:

We start with a general statement on each issue, and then pose one or more numbered questions. We have tried to arrange these so that only a short answer is required. However, should you wish to provide additional information please do so, referring back to one or more of the question numbers. There is inevitably some overlap between our questions. Most issues are linked.

Although most of the issues within the questionnaire *were* linked, we grouped them as best we could within broad categories.

GENERAL

Background Questions (1) and (2) were asked simply to identify the fishery (region, method) that each respondent worked in.

(1) What method(s) do you use when fishing for school shark?

A Set net.
B 95% set net; 5% trawl.
C Trawl and set net.
D Bottom trawl.
E Bottom longlining.
F I used to longline, now trawl.
G Set net.
H Longline and set net.

(2) Where do you mainly fish?

A [The Southland/Stewart/Snares shelf.]
B Canterbury Bight.
C Canterbury Bight.
D [Western South Island, area] 034.
E [Northwest North Island], between the Viti canyons and North Cape, mainly on or around the 200 metre line.
F [East coast North Island] SCH 2.
G Mainly [East coast South Island] SCH 3.
H Areas 7 and 8 [Cook Strait, and west coast between Capes Foulwind and Egmont].

Comment The responses represented the main fisheries (by region and fishing method, as defined in Paul & Sanders 2000), reasonably well.

DEFINING THE SCHOOL SHARK FISHERY: TARGET SPECIES

Background In both parts of this project (fishery characterisation, CPUE), the issue arose of how best to define the school shark fishery. In the characterisation study, what was the total fishery, and the target fishery? In the CPUE study, when were there sufficient data to give acceptable results from the standardisation? What was an appropriate combination of fishing gear and target species?

For our work on catch rate (or CPUE – catch per unit effort), we have defined the "target" shark fishery as:
(a) the setnet fishery where either ***school shark*** *or* ***rig*** *was given as the target species, and*
(b) the bottom longline fishery where ***school shark*** *was given as the target species.*

(3) Do you accept this definition of the "target" fishery? Or (with setnets) is there a significant difference (e.g. area, gear) between targeting school shark and rig? (See also question 11, on netting for both species)

C [School shark] and [rig are] generally caught together with [the] same gear in the gillnet fishery and are target species, but are generally bycatch in the trawl fishery although on some occasions around river mouths on full moon pockets of [school shark] can be target fished [by trawl].

E Yes. [When] I bottom longline, I target school shark.

F [Suggests we should consider changes in bycatch CPUE, especially from trawl fisheries.] To ignore the trawl catch in any stock or CPUE analysis would result in deficient outcomes. ... target fishing generally occurs in concentrated or restricted areas. Changes in CPUE in bycatch fisheries can be a very strong indicator to the relative strength of a fishery [and] ... could be more informative than trying to extrapolate from limited target data.

H I believe you can target either school shark or rig when set netting, simply by mesh size.

Comment From the MFish catch and effort data, the setnet fishery with either school shark or rig as the target species predominantly targets school shark in the south (SCH 5) and rig in the north (SCH 1). The lack of depth or positional information in the CELR data meant that sets which targeted rig in areas where there was actually little chance of catching school shark could not be identified and removed from the analysis. In the CPUE characterisation study, it was also clear that vessels which target fished both school shark and rig caught significantly more shark on days when it was listed as the target, than on days when rig were listed as the target. This suggests that school shark and rig were targeted in different ways (supported by respondent H); the possibility that the target species was recorded after the catch mix was known is, at least in some of the set net fisheries, considered less likely.

Changes in school shark bycatch rates in fisheries using methods other than setnet are difficult to interpret as abundance indices since they depend upon changes occurring in the target fishery as well as changes in the school shark abundance. In nearly all cases, there were insufficient data available to perform the standardisations. The school shark bycatch of the ling longline fishery on the Chatham Rise was considered briefly. School shark are a regular bycatch in some trawl fisheries, but at a low level. Anecdotal information (from respondent B) suggested a decline in the shark bycatch in Canterbury Bight trawl fisheries (accompanied by a decline in the size of sharks caught). Although this is entirely plausible, the data were not investigated; this fishery targets red cod, flatfish, stargazer, and elephant fish, and varies considerably spatially and seasonally. This issue of examining non-targeted school shark

CPUE (as raised by respondent F) is valid, and there could be trends of declining bycatches observed by some fishers, but it is a difficult point to investigate in the catch effort data.

CPUE The catch effort data with school shark listed as target species were added to those used in the CPUE standardisations. In the CPUE study, two categories of vessels/trips were used: (1) for setnets, trips when vessels targeted either school shark or rig (with a school shark catch above a set threshold), and trips when vessels targeted school shark target only; (2) for longliners, those vessel/trips where school shark was the target.

DEFINING THE SCHOOL SHARK FISHERY: TOTAL FISHING AREA

Background If a single CPUE index was to be calculated for New Zealand, the geographical extent of the fishery needed to be defined. The most useful limit was likely to be depth, as used in Australia.

The stock assessment work on school shark in Australia uses the 200 m depth contour to define the outer boundary of the region in which their "target" (school shark and rig) fishery operates. In Australia, the school shark and rig (gummy) fisheries are probably more closely linked than they are here. The Australian assessment uses the whole seafloor area within 200 m, and the catch from each statistical fishing area, to calculate a total index of abundance for each of their two species. We want to define the extent of the New Zealand shark fishery in a similar way, and get a single index for this country. We believe most targeted school shark in New Zealand are taken from waters less than 200 m.

We know that school shark also forms a substantial bycatch in other bottom longline fisheries. In particular, the ling bottom longline target fishery on the Chatham Rise and in other areas has a large school shark bycatch. This fishery almost certainly is operating in waters of greater than 200 m depth. There are small bycatches of school shark in other fisheries in water deeper than 200m, even by tuna longliners over very deep water. We will be tabulating all these catches, but not including them in our main analysis.

(4) Is 200 m a reasonable depth for the outer boundary of the "target" school shark fishery in New Zealand? If not, what would you suggest?

A I generally fish inside 200m. Sea lice are normally very aggressive in deeper water. Yes, I think 200m a reasonable depth for the outer boundary.
B Yes.
C Yes.
D Yes.
E No. 300m would be better. A lot of the time, I work around 260m. In winter months, the school shark are in deeper water.
F Most of our catch comes from 200m+ as bycatch of SKI and HOK fisheries.
H Yes, from the shoreline to the shelf [edge?]

Comment (CPUE) It became clear that the standardised catch rate analyses in the regional fisheries we had defined (not quite the standard Fishstocks) were inadequate and the idea of forming a single New Zealand wide index was abandoned. This information was therefore not needed. If further work is done on this fishery, 300 m would be an appropriate outer boundary, although because of the proximity of the 200 and 300 m isobaths this would add little to the area(s) calculated.

FISHING GROUNDS

Background In fisheries where fish stocks are not evenly distributed, but are either permanently or seasonally aggregated, it is common for fishers to initially "fish down" the grounds closest to home ports, and/or where the fish are most easily found, and then move further afield. This is particularly true in relatively new fisheries, or where the fishing effort has quite recently increased, as is the case with school shark. In such cases, CPUE trends are likely to be of limited value, as new populations are being progressively exploited over time.

The information we are working with identifies fishing activities only to the standard Fishing Statistical Areas. Consequently, we are only able to pick up very large changes, over time, in the geographical distribution of fishing effort and catch. That is, movement between these areas. We don't expect you to go into detail (which we accept is your confidential information), but we are interested in knowing about any changes in the fishing grounds being worked within an area, either as different localities along the coast, or as different depths. We have provided some maps of New Zealand that we suggest you use to mark the general areas you fish for school shark.

(5) Have you, or the fishers in your area, shifted your targeted fishing for school shark during the 1980s or 1990s, either to new positions along the coast, or into a different depth range?

A No. [Fishing] changes from year to year, some places are good one year and then no good for several years. A lot of fishing around Stewart Island is restricted to tides. [Areas] 029 and 027 can only be worked about 7 days a month when tides are weak and weather permitting.

B I fish in area 022 set netting for school shark. However, the elephant fish bycatch problem in this area [over-catching elephant fish when targeting other species] makes it hard to catch school shark quota. It is also getting hard to catch school shark before the trawlers hammer the small patches that do turn up.

C No. SCH catches of any quantity appear to be inshore or around river mouths out to 50 m.

D No.

E No significant changes through 80s and 90s.

G [Areas closed by Marine Reserves and Sanctuaries have forced me to fish further afield. This means I need a full day of good weather to reach the ground, complete my fishing operation, and return safely.]

H Yes, in the 1980s and early 1990s. [Supplemented by maps, showing bottom longlining in the Cook Strait region (Kaikoura/Kapiti/Tasman Bay) in the 1980s, and then set netting as well as bottom longlining extending westwards from Cook Strait to Capes Foulwind and Egmont in the 1990s.]

Comment There was no clear information in these responses of a shift to more distant grounds as a result of local depletion. Respondent B, however, in a follow-up discussion, conceded that school shark had become much scarcer over the region he had traditionally fished. It was harder to get a good catch on these grounds when targeting by setnet, and the bycatch of school shark taken by trawl was declining. Respondent H, in his response to the next question (6), mentions a decrease in fish size and the need to fish further afield.

(6) If you have moved or expanded your area of fishing, has this been in order to maintain a reasonable catch of the same size range of school shark. Or to target a different size range – perhaps of higher market value?

A I target the smaller shark which are more in schools around Dec–Feb. Also the weather is better in Southland at this time of year.

C No.

E Always moving or expanding in order to look for new areas, and the market [now] demands a smaller size range of school shark (2–6 kg trunks).

H In some areas that were worked hard in the 1980s the size of the school shark dropped dramatically. It was then a case of having to go further afield to find larger fish. More recent years have seen a good mixture of large and small fish move back into some of these areas, while [we are] still getting good runs of migrating fish at the appropriate time of the year.

Comment Respondent E, in a follow-up discussion, stated that he fished over a very large geographic area, and had a fair knowledge of where to find different size groups of sharks (their distribution, as discrete schools, varied seasonally over his fishing area, and at any one time they varied from south to north, and from inshore to offshore). His fishing strategy was to locate a school (or concentration) of sharks by using exploratory lines, and then work it only if it proved to comprise fish in the required size range. Respondent H certainly had to go further afield to maintain his catch of the same size range of fish, but then implied that these fish did subsequently reappear in at least some areas. While the loss of large fish was very probably due to hard fishing, it may also have reflected a natural change in distribution.

FISHING GEAR

Background Fishing gear inevitably changes (improves) over time, in both structure and operation, often in ways that are not easily recorded in the effort parameters used in CPUE analyses. Questions 7 to 16 were intended to elicit responses that would clarify whether the gear parameters being used in the school shark CPUE work had changed significantly over time in some way that was not apparent to us.

(A) Setnets

There was a major change in setnet gear with the introduction of monofilament nets in the late 1970s; these have different catching characteristics from the earlier nets. We will be using catch and effort data only from the late 1980s onwards, and assuming that by then all nets were monofilament. However, there may have been later changes in setnet construction (net depth, gauge, etc.), or fishing practices (net haulers, etc.), we should take into account. There have also been improvements in fish finding and navigation aids (GPS, etc.).

(7) Have there been any major changes in school shark setnets since the change to monofilament? What were they?

A No.
B [The] only change [has been] from 10 mesh deep to 15 mesh deep.
C No. In area 3 [the Canterbury region], we catch elephant fish, rig, and school shark in gillnets, and one set of gear fishes efficiently on all these species.
E Comment: I can work (bottom line) in one area for several months, but when the area is fished by fishers using set nets, I have to move (sours fishing ground).
F Set netting rates are very mesh size dependent as is the size composition of the catch. This will lead to deficient outcomes.
H The mesh has got finer and stronger.

Comment Changes in the number of meshes (i.e., the depth of the net) and how nets are set could influence catch rate. A setnet code of practice has been introduced in QMA 3 in an effort to prevent the entanglement of Hector's dolphins; nets here seem to be set tighter than they were before. There appears to have been no major New Zealand-wide modification of setnets since monofilament was introduced; though respondent H mentioned a trend to finer and stronger gauge material which will presumably have improved catching power. There have been some regional changes in gear characteristics and fishing practices to minimise bycatch (e.g., dolphins in SCH 3), to target particular size groups of school shark, or to maximise the catch of several species together in the same gear (e.g., shark, rig, and elephant fish).

CPUE No information was obtained which could be directly incorporated in the standardisation work, but the implied variation in fishing practices is a concern.

(8) Has GPS, or an improved sounder/fish finder, etc. altered the way you fish for school shark? If so, very briefly describe how.

A GPS saves us a lot of time looking for nets in rough weather, up to 2 hours per day. [Concerning "fish finders"], I personally find when the sounder is clear with no fish sign whatsoever, I catch most shark!!

B No, I don't believe you can see SCH on the sounder. [Also,] GPS doesn't really help. Fish are on the move from deep to inshore waters where we catch them between 20 m to 80 m.

C No. 15 years ago, it was the tree on top of the hill lined up with the mountain, and now it's GPS co-ordinates.

E [GPS allows me to] get to grounds and [deploy/recover] gear quicker.

H Only for fishing the outer shelves, the reason being you [now] knew where you were all the time.

Comment The influence of GPS probably varies between fisheries. It is important in offshore areas, where traditional "marks" are difficult to use, but much less so in well-known coastal waters where landmarks and distance travelled are more straightforward to determine.

The mesh size information provided by fishers contains some confusing values. We would like to get some idea of the main mesh sizes used in your area.

(9) What mesh size(s) do you (and others in your region) use when targeting school shark?

A In 1984 we started with 9 in. mono, then went to 8 in., then in 1997 went down to 7.5 in. Trying to target small shark (best price). Also trying not to go too small and catch too many [spiny] dogs.

B Mainly 7 in, some boats use small amounts of 6.5 in.

C 6.5 to 7 in, and 7 to 15 meshes deep.

D 8 to 9 in.

H 8 in. (or 205 mm), sometimes 7 in. (175 mm) when targeting in smaller fish zones.

Comment This point inevitably overlaps with others. Mesh size has changed in some (possibly most or all) regions as the dominant and/or market-required size of targeted school shark has changed. The mesh size by some boats in some areas is a compromise, being used for a mixed catch of school shark, rig, and (off Canterbury) elephant fish.

CPUE The setnet mesh sizes as recorded in the CELR data increased from north to south. Missing or confusing mesh size values were usually "corrected" by us either to the value normally used by the vessel in question, or to the most frequently used mesh size in the area fished by that vessel.

The fisheries information also includes some confusing values on length of net set. If three 1000 m nets are set, the total net length is sometimes given as 1000 m, and sometimes as 3000 m.

(10) How do you, and the fishers you know, record the length of the nets you set?

A They are made to 220 m length.
B Most boats from Timaru set-netting only use 1 or 2 nets of equal length. I have two nets of 1300 m recorded as 2600 m shoot. Other boats from Timaru do the same.
C Total length of net carried on boat, no matter how they are set.
D Nets are made in 200 m lengths.
H Total length, from anchor to anchor. If I had three 1000 m nets it would be recorded as 3000 m.

Comments (CPUE) Some values of net length in the CELR data appeared wrong (and almost certainly were). Values of net length considered to be outside the normal range were modified by us according to the fishing pattern of the vessel, or that particular fishing operation was removed from the data. Some vessels always recorded the same net length and mesh size, and this is considered to be 'net carried on vessel' rather than 'net fished'. Errors in the recorded value of net length fished contribute significantly to errors in the calculated raw catch rate.

Have the number and length of your nets changed over time? How?

A In 1984 we had 12×220 m. [From] 1990 [we had] 15×220 m, [in an] extended boat. [We have] also gone from two sets in a day in the 1980s to one in the 1990s.
B Yes, I use less net now because of the elephant fish [bycatch] problem.
C The lengths of nets are shorter now, as in the 1980s boats were running up to 4 500 yards but now this is regulated.
H Not really.

Comment The apparent increase in abundance of elephant fish in QMA 3 has caused difficulty for some fishers once they exceeded their elephant fish quota. (This will be a general difficulty in mixed species fisheries when the relative abundance of species changes over time.) The issue of unwanted catches of other species in a mixed fishery was raised by one respondent here because of its relevance to the amount of gear set, and its more general importance in the way the fishery operates.

Has the way you recorded this information changed over time? How?

B No.
C No.
H No.

Some fishers target both school shark and rig, and it is not clear to us how different these two fishing operations are.

(11) Do you target both school shark and rig? If so, how do you manage your nets? A different mesh for each species? Do you set them in different ways, or in different locations?

A Rig have more set areas inshore, most under 40m. You do catch more rig in 7 in nets. But also run the risk of catching dogs as well.

B Both fisheries are very similar; same mesh set in the same way, but sometimes in different locations.

C Yes. See question 3 [School shark and rig are caught together with the same gear.].

D No. Rig and shark are bycatch only. [Trawler]

G [There is a complex relationship between mesh size, and fishing for rig as well as school shark.] Rig in QMA 8 is fished with 6 in mesh targeting males. QMA 3 uses 6.5 to 7 in, QMA 5 has gone to larger mesh to avoid rig [when fishing for school shark]. But while this avoids the bulk of the rig, it has the effect of catching more of the larger breeding females. [In] Golden Bay big females [are caught] behind the Spit, and mainly smaller males in the middle of the Bay. QMA 7 uses predominantly 7 in mesh.

H Rig fishing: [Use ?up to] 6.5 in. (160 mm) mesh x 15 meshes deep, usually in depths [of] 5 [to] 50 m.
School shark [fishing: Use] 7.5 to 8 in. mesh x 15 meshes deep, usually in depths ranging [from] 100 to 200 m. Occasionally target large school shark [in] 20 to 60 m depth using no less than 8 in. mesh, sometimes up to 9 in.
Big school shark tend to bounce off [the] smaller mesh used for rig, and rig will swim straight through 8 in. mesh.

Comment: Clearly, targeted set netting for school shark and rig varies by region. In some places, both species may be targeted with the same gear, possibly at the same time, although only one target species can be recorded per day. Elsewhere, school shark and rig are targeted in quite different ways.

(B) Longlines

Bottom longlining is the other main fishing method targeting school shark. It is probable that there are some important characteristics of this method that are not clear to us in the information we are working with.

(12) Can you explain the way you (and perhaps the other fishers you know) record the way you set your lines? (e.g., "I usually set 4 lines, of 500 hooks each, and haul them after 5 hours").

D When I did longline 10 years ago, we set 1 line of 400 hooks and hauled after 1 hour.

E I set two lines of 500 hooks each and start hauling in one and a half hours. Re-set then start hauling other line. Set on daylight and last line is set one hour before dark. Up to 10 lines per day.

H Mostly kept down to 250 hook sets. Maybe 4 to 6 sets per day. Each line fishing 2 to 3 hours.

Comment (CPUE) The number of sets was a significant variable incorporated in the catch rate standardisations. It appears that some fishers record their number of hooks as number of hooks on their line times the number of times the line was set. Others only record the number of hooks on their line. For these the total number of hooks fished would be the number of

hooks on the line multiplied by the number of sets. These different recording patterns could not be resolved satisfactorily.

(13) Have you changed this pattern during the 1990s? More lines, more hooks, longer soak time?

E No.
H No.

Comment The minimal response to this question was disappointing. We suspect that changes have occurred over time. In a follow-up discussion, respondent E described a searching strategy that he adopted when he shifted to his new fishing region (the northwest coast), setting initial lines to locate the centre of a concentration of sharks, then setting subsequent lines in localities and depths determined (a) by the sex and size range of sharks present, and (b) by the market requirement at the time. He did not describe a change over time, but his fishing operation was obviously flexible, and is considered by us to have changed as he became more familiar with the distribution of sharks in the region, and perhaps as market requirements changed.

Background There is always a tendency for vessels using older, or simpler, fishing methods to ascribe any decline in their catches to the introduction of new fishing methods. Auto-longliners were operating in some regions in the 1980s, and their activity increased again during the 1990s, targeting ling on offshore grounds, taking school shark as bycatch. We wondered what relationship existed between these vessels, and the more traditional vessels targeting school shark.

Auto-longliners have the ability to set large numbers of hooks in a day. A substantial quantity of school shark is caught as bycatch in the ling target fishery, although these boats do not seem to target school shark.

(14) Whether you work an auto-longliner or not, do you have any comments on the fishing patterns of these larger vessels?

B Yes. The stock of school shark in area 022 is declining, with less mature female fish being caught now compared with 10 to 15 years ago. It has been my opinion that long line boats working in the deep are partly responsible for this.
E Unsure, as I have never worked alongside autoliners.
H Only the fact that quota has been removed from the smaller fishing fleet to accommodate the bigger autoliners.

Comment The MFish catch and effort data do suggest that the school shark bycatch rate in the longline fishery for ling on the Chatham Rise has declined in recent years. The comment by respondent H is a separate issue, but useful in indicating a probable change in fleet structure over time.

Background A large number of line fishing method codes are recorded (bottom longline, surface longline, handline, pole-and-line, dropline, dahnline, trotline, trolling) in the effort parameters. In the fishery characterisation study, it was necessary to just group some as "minor methods". A question arose over dropline, dahnline, and trotline; these are not officially defined, and dropline/dahnline are often linked. There is also some ambiguity in

published definitions. It seemed logical to combine these three methods as "droplines", but the opinion of fishers was sought.

*The other main lining methods listed are **Dahn lines**, and **trot lines**. They are usually employed when targeting groper, bluenose, and ling, but they also take a moderate catch of school shark.*

(15) How would you describe the essential difference between these two methods?

E Very similar methods.

H A Dahn line usually has 30 to 50 hooks. Each [line] has its own buoy and anchor. [They are] mostly set against rock walls, with the current holding the line upright. Trot lines usually have 10 to 15 hooks, which are attached to a buoyant backbone. On the bottom of the trot line is a weight, which serves to hold the hooked line straight up and down. The whole set-up is anchored via the ends of the backbone line. [A diagram accompanying this note made the arrangement clear.]

(16) Do you think it possible that some fishers use these terms rather loosely, generally describing "a vertical line with a moderate number of hooks at the bottom end, fished near reefs rather than across a flat seafloor"? Would it be appropriate for us to combine Dahn and trotlines in our analysis (or trotlines and bottom longlines), given that we do not have a very large catch of school shark from either Dahn or trotlines?

B Dahn and trotline are mainly used for HPB, BNS, and LIN, not SCH. So Dahn and trotline are essentially the same. [In follow-up discussion, this respondent described trotlines as being a horizontally linked series of droplines/dahnlines, with the sections carrying hooks hanging vertically near or above rough ground. In contrast with longlines, which are laid across more open seafloor.]

E Dahn and trotlines should be used together in analysis because the hooks are set off [above] the bottom. Whereas, bottom longline hooks are hard on the bottom. There would be a substantial difference in figures [on school shark catch rates].

H [School shark are] definitely not [caught on] Dahn lines because they stand nearly vertical. Hook access to school shark is minimal. [Sharks are caught on] trot lines maybe, only because up to 200 lines [hooks?] may be hung off the main backbone, thereby giving school shark a greater number of accessible hooks.

Comment The few comments received did confirm our belief that droplines/dahnlines and trotlines could be combined, and we used the general name 'dropline', as this was the common feature of these lines. The hooks were fished vertically, even though in trotlines (essentially, linked droplines) there might be a considerable horizontal element in their deployment. Respondent H pointed out that trotlines would catch more sharks than dahnlines, but this would mainly result from their greater size, with more (but not a greater proportion) of their hooks being near the seafloor. It would not be appropriate to combine dahnline or trot line with bottom longline data in a CPUE study, but reasonable in a descriptive study of the fishery.

Subsequent investigation suggested that this meaning of 'trotline' might be restricted to Australasia; the trotlines commonly fished for catfish in American rivers and estuaries appear to be a variety of longline. The derivation of 'dahnline' (also spelt/misspelt danline, dhanline, sometimes capitalised) proved elusive. Dahn is often believed to be Scandinavian in origin, but is actually an early (17^{th} C.) English word, originally 'dann', applied to floats marking Danish fishing gear, as in "that's a Danish float" (Burgess 1973, and dictionaries). It

subsequently came to be used for any large float, marked with a flag (daytime) or light (at night), attached to fishing gear, not necessarily a line (Danish seiners use dahn buoys), to a mooring, or deployed to mark an underwater hazard such as a minefield. A dahn buoy could, therefore, be used to mark a longline. We believe that 'dahnline' should not be formally equated with dropline, although we suspect that it is used colloquially in this sense by New Zealand fishers, this being the reason for combining 'dropline/dahnline' in the Ministry's fishing method codes.

SEASON

Background There is a moderate to strong seasonal pattern in the catches in many school shark fisheries, with some regional differences. We were interested in finding out whether this seasonality reflected the real abundance of school shark in a region, or resulted from fishers switching to targeting school shark when the season for more profitable fisheries had finished, or perhaps some other reason.

We have noticed that many school shark fishers target school shark for only a few months.

(17) Do you specifically target for school shark

(a) when it is abundant in your region, or

A December–February Bigger schools of shark around.
B Yes.
C December–March gillnet for rig, school shark, and elephant fish.
H Yes.

(b) to fill your quota, or

A The quicker you can catch [your] quota, the less wear and tear and effort.
B Yes.
H Yes.

(c) for some other reason?

A Better weather.
B No.
D [Not applicable], Bycatch only.
E It is my primary target species, so I fish it for the majority of the year (not during the tuna season).

Comment The few responses do suggest an increase in fishing when school shark are abundant, but better weather, associated fisheries (e.g., rig, elephant fish), and alternate fisheries (e.g., tuna) are also relevant.

RECORDING "CATCHES" AND "LANDINGS"

Background We quickly became aware of discrepancies between the values of "catch" and "landing" in the data sets of the Ministry of Fisheries that clearly reflected more than the former being an approximation, the latter a recorded value, or the latter (landings) including quantities of school shark not recorded as a catch because they were not in the top five species in a catch. We believed we knew the cause, but sought opinions from fishers.

We are working with two main data sets: ***estimated catches****, and recorded* ***landings****.*

As anticipated, there is a poor relationship between these values for some vessels, mainly trawlers, where school shark are usually not among the top five species in a catch, and consequently are not recorded as an "estimated catch" but do appear in the "landings" data.

There should be a closer relationship for the setnet and line vessels which target school shark, or which catch significant quantities as a bycatch. This is often true, but there are also cases where the catches and landings differ by a factor of (approximately) two. As this is the conversion factor later used to convert trimmed or processed weight to greenweight (whole weight), we wonder if there has been some confusion in recording the "state" of the catch, and the landing, and in subsequent application of the conversion factor.

On the CELR form, Catch/Effort Data panel, there is one column (coloured blue), labelled Target Species/Total (kg). This is intended to record the target species, and then the total catch (all species) of that set. The target species weight should be in another column. That is, the target species code should appear twice (if it is actually caught), and its weight once.

(18) Estimated catches are supposed to be recorded as greenweight. If they have been recorded as trimmed weight, is this fact likely to have been clearly noted on the form?

A Yes.
B We apply the conversion factor before entering greenweight.
C LFR forms and CELR should be checked by MFish for landed weight, and as for the estimated weight I put down 30 kg per bin.
D Yes.
E Yes. This is how I record.
H Don't know. I have always used greenweight.

Comment With hindsight, our question was not clear enough, and the 'yes' from respondents A, D, and E is ambiguous. The response from C implies an expectation that the Ministry of Fisheries will check and convert all weight values. There *is* no place to record state on the top panel of the CELR form. From discussions with these and other fishers, we believe that trimmed (= processed, trunked) weight is recorded by some fishers, rather than greenweight. A note is perhaps hand-written to indicate this in the margin of the CELR form's top panel, but this may not be noticed and/or acted on before or during data entry. Our understanding is that the Ministry's data entry procedure does not allow modification of the values recorded on the forms by fishers. We suspect that a variety of recording procedures are used by fishers. Stock assessment studies based on these data are now compromised because it is difficult (or more often not possible) to cross-check data from different parts of a form, or from separate but related forms, once they have been entered into the electronic database(s) accessible to

stock assessment staff. It would be necessary to examine the original forms to clarify ambiguities, and this is no longer permitted.

CPUE The 'estimated catches' for many vessels were often erroneous, being about half the recorded landings for the month or year. The annual ratio of total landings to total estimated catch, by vessel, was used to convert each vessel's estimated catch weights to the landed weights. This procedure would be adequate if each fisher recorded his data consistently through a year, but we believe this was not always so.

(19) Can you suggest any other reason why, for vessels making good catches of school shark, landed weight values should be about twice the estimated catch weight values?

B They don't know the conversion rate.
E No.
H No. Maybe shocking [weight] estimates by the crew passing information on to the skipper after the fish have been sorted.

Comment Respondent B confirms our suspicion that some fishers estimate their catch weights after processing (and perhaps stacking in bins), and convert it up to the (original) greenweight.

(20) Do you believe some fishers find the CELR form layout confusing, and might record target species weight in that coloured column?

B They could be better. I believe the conversion factors of each species should be printed on each CELR book or be sent out with permits yearly.
C (i) Target species columns are a waste of time as your target is usually your highest volume of quota holding, or your target species to enable you to bycatch trade. We in the industry believe that apart from your fishing area, method, and date the top column [target species code] is never used by MFish and is a waste of time filling it in as we cannot truthfully show what we are targeting. (ii) After a hard day at sea I myself have made silly mistakes on CELR [forms]. Being in the quota management system from the beginning [I] find them easy to follow and understand, but [they] may be not so easy for beginners or new skippers.
D No.
E Yes.
G The CELRs are limited to only one target species. I have for many years wanted this changed as it is confusing. In my own fishery, I write in this space SPO in summer and SPD in the winter, even though I am targeting SCH and SPO and all my other quota [species] as well, as they all frequent the same area. This is how my catch history was established.
H Unknown.

Comment The note from respondent B again suggests that some fishers quantify their catch in processed weights, and to complete the top panel of the CELR form they convert back to greenweight. This is not what the Ministry of Fisheries assumes, and is likely to be a major source of confusion in database values. Note (i) from respondent C, and the note from respondent G, do not answer our question, but raise another important issue that we followed up in discussion with several fishers. 'Target species' is a term used by fishers (on their CELR or TCEPR forms) in several ways: the single species targeted, the main of several species targeted, the species for which most quota is still held, the species which legalises a subsequent bycatch trade, the main species actually caught, whether it was targeted or not, or simply just a logical species for that area and fishery. We believe there are three difficulties in interpreting the recorded target species, and sometimes the weight of this species, when

undertaking stock assessments. (1) The fisher may have misinterpreted this double-purpose column, and entered the target species and its weight rather than the total catch weight. (2) To comply with quota holding and bycatch trading requirements, the fisher enters the most advantageous target species regardless of whether it was the species sought, or caught in greatest quantity. Understandably, to the fisher, compliance with fisheries regulations takes precedence over the reliability of stock assessments. (3) The fisher is legitimately targeting two or more species at the same time, and records a single species arbitrarily, or because it is the species for which he holds most quota, or because he caught it in greatest quantity.

CPUE The problems surrounding the concept of 'target species' make it difficult to determine when the school shark catch was zero. Both the zero and small catches make important contributions to the CPUE standardisations. Methods exist for treating zero catches (provided we can define them) as part of the CPUE standardisation, but they do not adequately account for the high proportion of small catches. Consequently, the CPUE standardisations were unreliable.

MARKET OR OTHER NON-QMS RESTRICTIONS ON SCHOOL SHARK CATCH

Background As in many fisheries, market requirements drive some aspects of fishing behaviour, and must be taken into account when interpreting catch trends.

The two main impacts of the discovery of high mercury levels in large sharks occurred in 1972 and 1978. Recorded landings of school shark declined in those years. We have heard that (non-regulatory) restrictions have been placed on the landing of large school shark in the past few years. We assume these restrictions arise out of market concerns, perhaps for mercury content.

(21) Is this information correct? And if true, what is the actual nature of the restriction, how long has such a restriction been in place, and how widespread is it (i.e., is it general for the area, or imposed only by some companies)?

A If you don't sell your shark to certain Australian buyers (about three, I think), your shipment of shark will always be checked by Australian Inspectors and rejected. It is not what you know, but who!!

B No.

C There was a decrease in the price but no restrictions. I don't believe the markets for school shark are as good since the mercury level statistics came out.

D We have no restrictions on school shark maximum size.

E Yes, mercury and market restrictions, [but] only imposed by some companies.

G In [QMA 3], large school shark attract a significantly lower price, and especially in the deep water [they] are released alive. Large females are caught occasionally in summer close in to the beach in QMA 3 but are also more present in the deeper waters, 100–200 m.

H Not by the fish receivers I have landed to, but I do know of some fish receivers who prefer smaller fish exclusively for the fish and chip trade. Plus some fishermen who have never known how to bleed larger school shark properly.

Comment In a follow-up discussion, respondent E also reported releasing large females, generally alive. A longliner, he used long enough snoods for the fish to remain swimming until hauled to the boat, and he also made relatively short sets. These price differentials and market restrictions that make large female school shark undesirable catches, in some regions

at least, have two impacts. (1) They are good for the population; fecundity is quite strongly size-related, and maintaining a good number of breeding females is essential for the stock's commercial survival. (2) They make assessing the biomass of mature females even more problematic. In those regions where large females are abundant (regularly or seasonally), they may be difficult to avoid, and if caught, may be released (alive or dead) and not recorded. If these fish *are* recorded as caught, but are not landed, the relationship between catch and landing values becomes even more problematic.

FISH SIZE

Background Although few fisheries take a random catch from the target species, shark fisheries are probably the most difficult to interpret. Shark populations are typically segregated by size and sex, and fisheries in different regions tend to exploit the species at different stages in its life cycle. Because sharks have a low fecundity, exploitation of large mature females is undesirable. It is already known that the Kaipara Harbour fishery takes these females, but the nature of the populations being harvested elsewhere is less well known.

Like most shark species, school shark gather (yes, school) by size and often by sex. We have some information on this (from trawl surveys, fisheries observer records, and the industry-run shark logbook scheme), but we could interpret the fishery better if we had more. As you will be aware, school shark are landed in a trunked state, at irregular intervals, often in small quantities, at ports all around the country. It is difficult for NIWA staff to sample and measure the commercial catch.

(22) Are the school shark you catch predominantly of a similar size? And the same sex? Are you aware of any regular seasonal change in this? Has the average size in your area changed during the last 20 years?

A [Southland:] You get a greater mix of sexes in larger schools.

B [East coast South Island:] [In follow-up discussion, respondent stated that the sharks were not particularly segregated by size and sex, and the largest females were caught rather randomly. He had, however, noted a distinct decrease in average size of school shark in general, as well as a decline in numbers, over the last decade.]

C [East coast South Island:] Generally when catching school shark in the [Canterbury] Bight, the size always varies, and females in pup are not that common. [But] with catching a big amount of fish [it is] more so [and] you will catch 2 or 3 females in pup on their own.

D [West coast South Island:] Sharks are usually of consistent size depending upon depth. 140–200 m large; 80–140 m small; inside [less than] 80 m [depth] often very large females.

E [Northwest North Island:] Yes, because that is the size I target. Different areas have different sexes, but same sex in each area. I am aware of regular seasonal changes. Average size in my area has not altered in last 20 years.

F [East coast North Island:] SCH distribution is size dependent, smaller fish inshore, larger fish offshore. Large fish can occur in waters 400 m+ and are bycatch in the ling, groper, and bluenose fisheries.

H [Cook Strait, and central western coasts:] Similar size, yes. Same sex, no. Seasonal change, no. Change in average size, no.

Comment Although the replies seem to vary there is some consistency to them. North Island fishers do note differences in the distribution of sexes and size groups. In a follow-up discussion, respondent E was able to closely define the distribution of these groups by

latitude, depth, and season, and he stated that he used this knowledge to target fish which met market requirements. In particular, he avoided large females, and juveniles. He also observed that when he was fishing (with a series of longlines) on a big aggregation of school shark, i.e., one extending over a relatively large area, the size, and sometimes sex, differed at each end of the school. Respondent A, fishing Southland waters, recorded something similar: a "greater mix of sexes in larger schools". However, it remains unclear whether both these observations refer to a single large school being more mixed (both species present), or to small and predominantly single sex schools occurring in close proximity and being interpreted as a larger, mixed school. Both respondents (B and C) who fished the Canterbury Bight reported no particularly obvious segregation by size or sex. The characteristics of the school shark population in this region are poorly known. Immature sharks including 0+ pups are present, but adults have seldom been taken during research trawl surveys (Hurst *et al.* 2000, NIWA unpub. data), although females must be there at least briefly to pup. The South Canterbury Bight is the southernmost nursery ground, but it is not known whether the pregnant females migrate there from the north (Cook Strait and North Island), east (Chatham Rise) or south (Southland). In general terms, all respondents confirmed what was known or suspected of school shark distribution patterns around New Zealand, but did not greatly extend it.

BREEDING GROUNDS

Background There is uncertainty over the distribution and relative importance of school shark nursery grounds around New Zealand. Although pupping grounds have generally been assumed to be in or near large harbours and shallow bays, small juveniles are regularly caught in shallow but open coastal regions, and along quite exposed surf beaches. We took this opportunity to tap fishers' understanding of the subject, based on their catches of fully pregnant females, and their knowledge (and potential avoidance) of areas where very young pups occurred.

We are interested in knowing where any large females carrying full-term pups occur. We know from trawl survey data that new-born school shark pups (25–35 cm) are found in shallow coastal waters all around the North Island and the top half of the South Island, off open coasts, as well as in sheltered bays and (from other information) in harbours. In Australia, there have been changes in the importance of some inshore school shark nursery grounds. New Zealand's breeding grounds are not well known.

(23) Do you know any areas where large numbers of 25–35 cm pups are found? Have any areas in your region where pups occurred in the past ceased to have pups? Where are the large females found, just prior to pupping?

A Between [areas] 029/027, Southwest Cape to Potama Island [the southernmost tip of Stewart Island], there are the most females in pup I have ever seen, normally June–September. Not unusual to catch 4–8 tonne per day. Last January–March 2000, I noticed very few females with eggs.

B [In a follow-up discussion (requested by the respondent) it was stated that he knew of two localities in the Canterbury Bight. (1) North of Oamaru, between the Waitaki and Waimate river mouths, and (2) around the Rakaia river mouth. Pups 30–40 cm (0+) occur out to about 5 miles or about 25m depth. He thought this may have been an association with lower salinity water. He could make no comment on changes in numbers, but didn't fish the area much. Large females were not particularly localised (at least in recent years), but some did carry full-term pups.]

C Just north of Timaru and inside 1 mile there appears to be a frequent [presence] of juvenile school shark about January–March.

D Large females are usually found in 20m or less from Pt Elizabeth to Cape Foulwind [Greymouth to Westport]. We don't catch large numbers because they are fast swimmers. Large numbers of pups occur behind the reef at Pt Elizabeth at certain times.

E 25–35 cm pups [occur] in shallow [water] along the coast. I keep out of shallows so I do not catch pups, but as far as I am aware, all areas of pups are still producing. Large females prior to pupping are found in the shallow [water] heading for Kaipara Harbour.

H Large females go into shallow water in the summer time to drop their litters. [Ceased to have pups], Tasman Bay. [Large pregnant females found], don't know.

Comment The presence of females "in pup" at the southern tip of Stewart Island is interesting, as pups have not been recorded from this far south. The season (June–September) suggests that these females may subsequently move north to pup along either the east or west coast of the South Island. Other comments are in general agreement with what is known, in fact they serve to illustrate what little is known.

ADDITIONAL COMMENTS

Background Some of the comments made on the returned questionnaires were outside the immediate scope of the questions.

On the general abundance of school shark

A [Southland, set netting] I have been targeting school shark since 1984. In the last ten years [I] have noticed school shark [becoming] more abundant every season. Last January, one day I caught nearly 14 000 kg greenweight out of 15×200 m nets. Best prior [catch] was around 1990 with 12 000 kg.

B [East coast South Island, set netting] [In the follow-up discussion, this respondent conveyed his strong impression of a decline in school shark abundance in SCH 3, and probably also SCH 5 (hearsay from other fishers).]

On using more than one fishing method in a day

B [In the follow-up discussion, the issue of fishing methods getting confused during a day's fishing was raised. The problem we sometimes encountered in the catch effort data was encountering an unlikely method (e.g. lobster potting) being recorded with a school shark catch, when all other records from the vessel in question were for a more appropriate method (e.g., lining or set netting). The respondent confirmed that there could be a recording problem when multiple fishing methods were used on the same day and not (as required) adequately distinguished. He used his own situation as an example: set netting and trawling. He ran a trawler which was more often used as a set netter, with its trawl gear removed. However, both methods could be used on the same day. The vessel would leave port, trawl out to a known fishing ground, lift the trawl, fish a set net (in his case) or a line (dropline, longline, or handline) for a few hours, and then trawl again during the return trip towards home port.]

Comment This fishing pattern (fishing methods appropriate for school shark used on the same or adjacent days by the same vessel) had in fact been observed in the catch effort data, and accepted as reasonable. There are implications for fishing effort if only the crude measure of 'fishing day' is used, but not if gear parameters (number of tows, net length, hook number) are used.

On using data from bycatch fisheries

F To ignore [the] trawl catch in any stock or CPUE analysis would result in [a] deficient outcome. As you will appreciate, target fishing generally occurs in concentrated or restricted areas. Changes in CPUE in bycatch fisheries can be a very strong indicator of the relative strength of a fishery.

Comment This could well be true, provided there are enough trawl bycatch data (in this case, on school shark) to give an adequate mean CPUE, and the trawl fishery remains reasonably constant, in terms of target species, area fished, etc., over time. We did not attempt any study on a school shark bycatch fishery; there were no recognisably large fisheries meeting the above criteria, and uncertainties over the recording of school shark as processed weight instead of greenweight seriously diminish the value of estimated catch records.

On the impact of fishing restrictions unrelated to school shark

G Areas being closed by marine reserves and [the Hector's dolphin Sanctuary around Banks Peninsula] have cut down available days to fish. [For example, working] Pegasus Bay. When we were fishing inside the Sanctuary, it [our fishing ground] was only one and a half hours away from home. If the weather was going to turn nasty in the afternoon, we could still fish the morning. Now, with a minimum of four hours to travel, that day would not be viable and a whole day's fishing must be lost. Therefore, these unavailable days take a disproportionate slice of a short season.

On conversion factors

G Why is there a different conversion for SCH DRE [dressed] and HGU [headed and gutted] when the cuts are the same?

Comment Our questions 18–20 indirectly involved conversion factors, by addressing the issue of discrepancies between estimated weights and recorded landings that we believed resulted from the former being processed weights, entered without being converted up to greenweight. The point raised here is separate: why are there two conversion factors? We are also unclear about this. In 1990 the conversion factor was 2.00 for both dressed and headed and gutted school shark (The Fisheries (Conversion Factors) Notice 1990). In 1993 this position was amended, to our knowledge without specific comment, to a dressed conversion factor of 1.95 and a headed and gutted conversion factor of 1.85. Dressed was defined as: "the state in which the fish has been headed and gutted; and the pectoral fins of the fish have been removed, whether or not the tail has been removed at a point behind the posterior base of the anal fin." In 1999 this definition was amended to: "the state in which (i) in addition to gutted, the head has been removed by a cut immediately behind the base of the pectoral fin, [and] (ii) the pectoral fins of the fish have been removed, whether or not the tail has been removed at a point behind the posterior base of the anal fin." (Fisheries (Conversion Factors) Amendment Notice No. 2 1999.) Headed and gutted was defined in 1990 as: "in addition to gutted, the state in which the head and that portion of the body immediately forward of the pectoral fin have been removed, whether or not the tail has been removed at a point behind the posterior base of the anal fin. (Fisheries (Conversion Factors) Notice 1993.)" The difference between these two categories seems to be whether the head has been removed behind (DRE) or forward (HGU) of the pectoral fin; but in both categories the pectoral fins are not included. We suspect this subtlety is not appreciated by some fishers, who continue to use the processed state code they have traditionally used.

DISCUSSION

In most cases, the answers to this questionnaire confirmed our suspicion that some fishers were not completing their catch effort (CELR) forms in the manner intended. There were problems with effort (gear) parameters, target species nomination, and with recording processed weight instead of greenweight. The answers also confirmed our belief that this was a complex fishery, with different parts of the population targeted (or taken) in different regions, and with some market control over the size of fish caught (or retained). Useful new information was obtained on several topics, which is likely to be of interest to anyone who attempts an analysis of school shark catch rates in the future.

Our difficulties in interpreting the data from the CATCHEFF database initially motivated this questionnaire. However, our subsequent inability to develop satisfactory standardisation models (Bradford 2000) meant that errors in the raw catch rates were less important than the structural problems in the models. After correcting for landed state (converting processed weight to greenweight) we believe that the school shark catch rates we used are *qualitatively* reasonably similar to the true ones. However, any errors in the raw catch rates will make a *quantitative* change in the detailed shape of the standardised catch rate indices.

We went to considerable lengths to word our questionnaire as clearly as possible. We provided some background information to most if not all questions, and tried to construct the questions so that only a brief answer needed to be written. However, some of the responses we received showed that our questions had not always been fully understood (although the responses were still interesting, and have been used elsewhere in appropriate parts of this report). It is clearly as difficult to write an unambiguous questionnaire as it is to design unambiguous fishing return forms.

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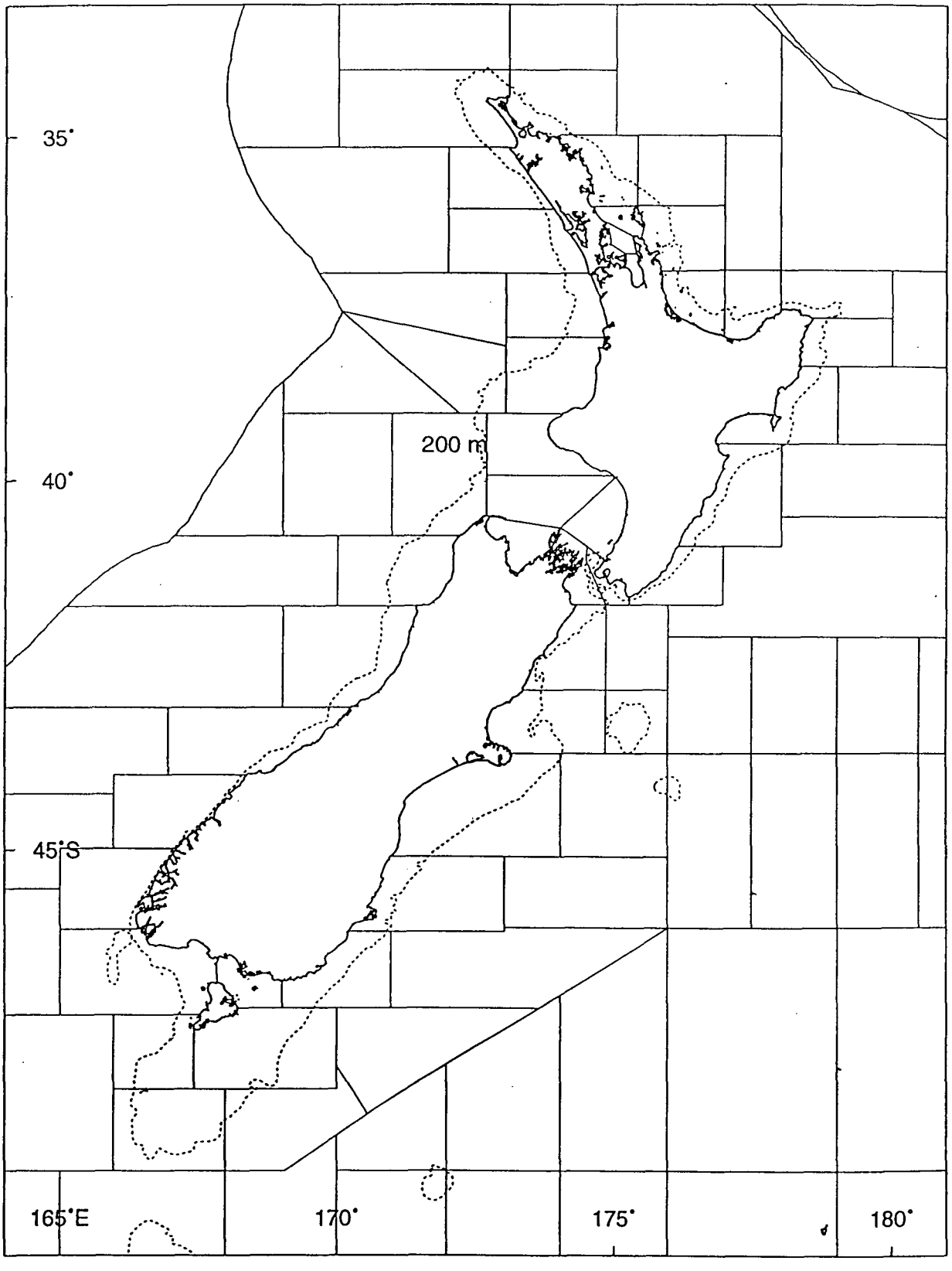

Figure 1: The map which accompanied the questionnaire sent to fishers, on which they were invited to mark their fishing grounds, or any other relevant information. Statistical fishing areas are shown but not numbered.

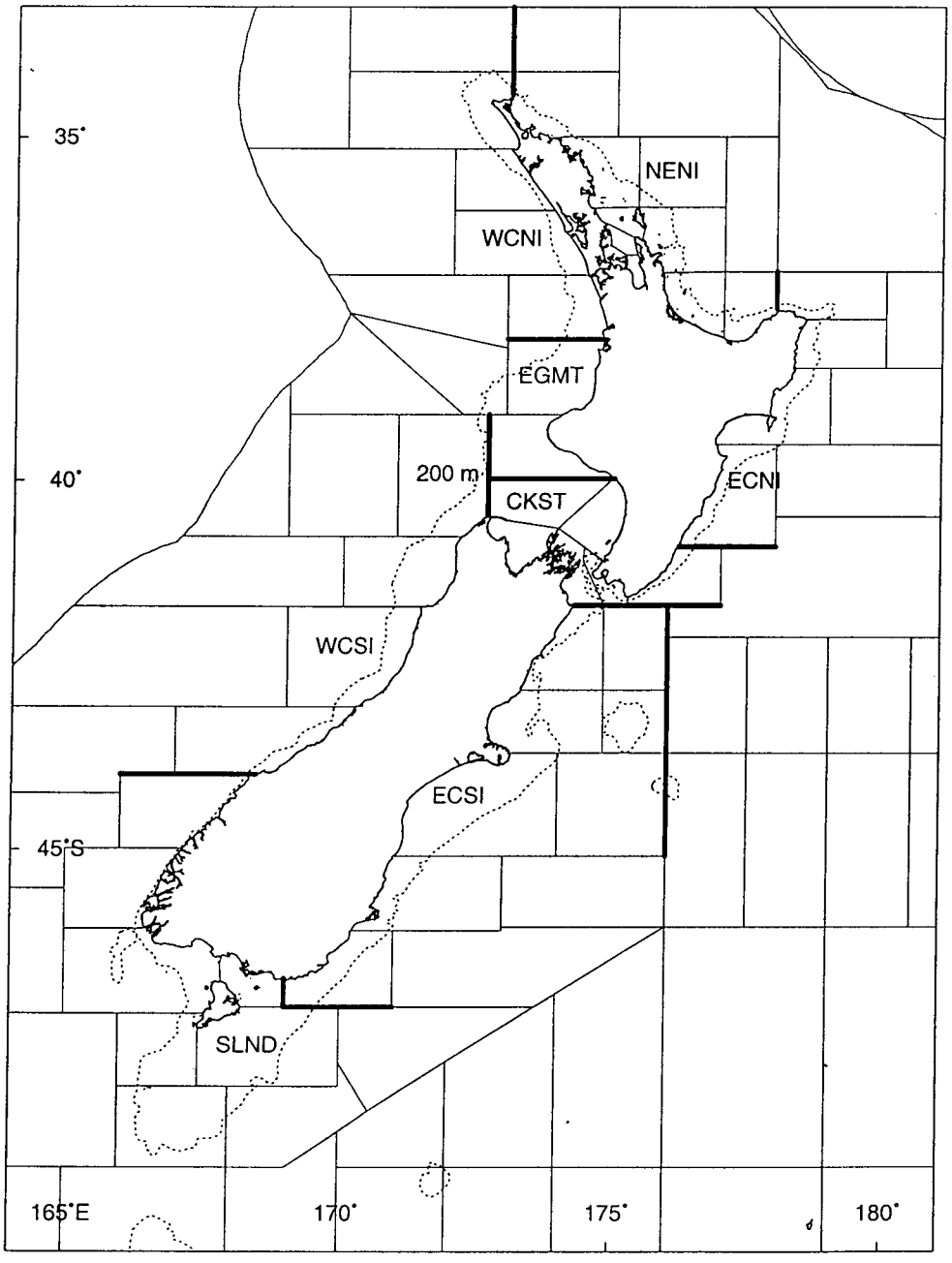

Figure 2: Map showing the broad fishing regions used in the study of the school shark fishery. For the purposes of the questionnaire, the northern Egmont region and the West Coast North Island region were combined as 'Northwest North Island'.