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Development of a New Fishery for Tanner Crabs (*Chionoecetes tanneri* Rathbun, 1893) off British Columbia: 2003 Status Report

Développement d'une pêche nouvelle au crabe des neiges du Pacifique (*Chionoecetes tanneri Rathbun*, 1893) au large de la Colombie-Britannique : Rapport d'état pour 2003

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Abstract

This paper presents new information gathered since the previous report on offshore Tanner crab (*Chionoecetes tanneri*) fishery development in 2000. Results of DFO trap and trawl surveys, Industry trap surveys, landings from an experimental trap fishery and bycatch from groundfish trap and trawl fisheries were used to examine distribution of Tanner crabs off the coast of British Columbia (B.C.) and identify areas with potential to support a commercial fishery. Abundance increased from the B.C.-Washington border to peak abundance off central and northern Vancouver Island, then decreased off the mouth of Queen Charlotte Sound and off the Queen Charlotte Islands.

Landings and observer data from the experimental fishery were used to examine impacts of a directed trap fishery on Tanner crabs and other species caught incidentally. Bycatch rates were relatively low and the primary bycatch species were scarlet king crabs (*Lithodes couesi*) and sablefish (*Anoplopoma fimbria*). Concern was noted at the relatively high catch rates of female and undersize male Tanner crabs.

Landings from the experimental fishery and other offshore fisheries were used to describe impacts of these fisheries on the Tanner crab resource. Bycatch of Tanner crabs from the groundfish trawl fishery increased from 30 t in 1996 to 133 t in 2002. Limited data from observer trips and DFO trap surveys suggest that Tanner crabs are regularly encountered in the sablefish trap fishery.

New information was used to critically examine the existing assessment framework and verify biological assumptions used to date. Preliminary biomass estimates were calculated from catch rates in the Industry trap survey and swept-area abundance estimates from DFO trawl surveys. A proposed depletion experiment was not successful as fishers moved gear when catch rates dropped to an economic threshold which led to unrealistic stability in catch-per-unit-effort.

Bitter crab disease, infection of crabs by the parasitic dinoflagellate *Hematodinium* sp., may play a role in determining year-class strength in Tanner crabs. Prevalence ranged from 1-13% of Tanner crabs examined in a limited number of tows during DFO trawl surveys.

Recommendations included initiation of annual assessments using trawl gear in the experimental fishery area and an unharvested control area; restriction of fishery development to the west coast of Vancouver Island; continuation of an experimental fishery to examine productivity from a limited area of the coast; development of an ecosystem-based management framework for fisheries on the continental slope; examination of the feasibility of tagging studies for Tanner crabs; effort standardization studies to examine the relationship between soak time and catch rate; evaluation of gear modifications to exclude females and undersize males in the trap fishery; and completion of the trawl survey off the Queen Charlotte Islands.

Résumé

Ce document présente des nouvelles données sur le crabe des neiges du Pacifique *Chionoecetes tanneri* recueillis depuis la dernière publication en 2000 du dernier rapport sur le développement d'une pêche hauturière de ce crustacé. Nous utilisons les résultats des relevés au casier et au chalut effectués par le MPO et des relevés au casier effectués par l'industrie, ainsi que les données sur les débarquements d'une pêche expérimentale au casier et les prises accessoires des pêches du poisson de fond à la trappe et au chalut pour établir la répartition de ce crabe au large de la Colombie-Britannique et identifier les endroits qui pourraient alimenter une pêche commerciale. L'abondance de *Chionoecetes tanneri* augmente à partir de la frontière canado-américaine, culmine au large de la côte centrale et nord de l'île de Vancouver, puis diminue au large de l'embouchure du détroit de la Reine-Charlotte et des îles de la Reine-Charlotte.

Les données sur les débarquements et celles recueillies par les observateurs de la pêche expérimentale ont été utilisées pour établir les impacts d'une pêche dirigée de *C. tanneri* au casier sur ce crabe des neiges et d'autres espèces capturées de façon incidente. Les taux de prises accessoires étaient relativement faibles, les principales espèces capturées de façon incidente étant le crabe royal écarlate (*Lithodes couesi*) et la morue charbonnière (*Anoplopoma fimbria*). Par contre, les taux de prises relativement élevés de femelles et de petits mâles *C. tanneri* préoccupent.

Des données sur les prises de *C. tanneri* récoltées dans le cadre de la pêche expérimentale et d'autres pêches hauturières ont été utilisées pour décrire les impacts de ces pêches sur cette ressource, constatant que les prises accessoires issues de la pêche du poisson de fond au chalut sont passées de 30 t en 1996 à 133 t en 2002. Les données limitées provenant de sorties d'observateurs et de relevés au casier effectués par le MPO donnent à penser que ce crabe des neiges est régulièrement capturé dans les casiers de pêche de la morue charbonnière.

De nouveaux renseignements sur *C. tanneri* ont été utilisés pour faire un examen critique du cadre d'évaluation existant de cette ressource et vérifier les hypothèses biologiques utilisées jusqu'à maintenant. Nous faisons des estimations préliminaires de la biomasse reposant sur les taux de capture du relevé au casier effectué par l'industrie et les estimations de l'abondance dans les aires balayées au chalut par le MPO. L'expérience d'épuisement proposée n'a pas réussi car les pêcheurs ont déplacé leurs engins lorsque les taux de capture sont tombés sous un seuil économique, ce qui a résulté en une stabilité artificielle des prises par unité d'effort.

La maladie du crabe amer, infection causée par le dinoflagellé parasite *Hematodinium* sp., peut jouer un rôle dans la détermination de l'abondance des classes d'âge de *C. tanneri*. La prévalence d'infection variait de 1 à 13 % chez les individus examinés provenant d'un nombre limité de traits des relevés du MPO au chalut.

Introduction

The primary purposes of this paper are to present information gathered since the last report (Workman *et al*. 2000), to identify information needs and present proposals for future work to meet these information needs. The specific objectives of this paper are:

1. To delineate the distribution of Tanner crabs off the British Columbia coast, and examine potential areas which might support a commercial fishery;
2. To examine the impacts of a directed Tanner crab trap fishery on both Tanner crabs and other species that are caught incidentally;
3. To examine total impacts on the Tanner crab resource from all fisheries;
4. To critically examine assessment methodology and biological assumptions used to date; and
5. To make recommendations for the continued development of deep water Tanner crab fisheries off British Columbia.

Sources of Data

To meet these objectives we will look a several sources of information. We will review:

- results of DFO trawl and trap surveys (1999-2003);
- results of Industry trap surveys (1999-2003);
- performance of the experimental fishery off the west coast of Vancouver Island (1999-2003); and
- estimated removals of Tanner crab in groundfish trawl and trap fisheries.

Trawl surveys were completed by DFO from the research vessel CCGS W.E. RICKER between 1999 and 2003 (Table 1), with supplementary trap surveys in the first three years (Table 2). These surveys used a Campelen 1800 shrimp trawl rigged with a rockhopper groundline (McCallum and Walsh 1997, Walsh and McCallum 1997, Workman *et al*. 2001). Detailed location, catch composition and biological information were collected for each tow. The entire catch was sorted to the lowest possible taxonomic level and weights recorded to the nearest 0.1 kg. Total number caught was recorded for all crab species.

DFO trap surveys were completed from the CCGS W.E. RICKER in 1999-2001. We used top-loading conical traps with 40 mm mesh and standardized bait loads to 1 kg frozen squid and 1 kg frozen herring. Soak times were approximately 24 hours. The traps did not have escape rings. Detailed location, catch composition and biological data were taken from each string.

Industry completed distributional trap surveys of most areas of the coast in 1999, 2000 and 2003 (Table 3). They used top-loading pyramidal traps covered with 70 mm synthetic mesh. Soak times were approximately 24 hours and bait loads were standardized to 1 kg of frozen squid. Escape rings were sealed for the survey. Detailed location and catch composition data were collected for each string and biological data were collected for approximately 100 crabs per string.

Industry also conducted experimental fisheries in Pacific Fisheries Management Areas (PFMA) 125 and 126 between 1999 and 2003 (Table 4). They used the same traps as were used in the trap survey, but the traps were fitted with a single escape ring with a diameter of 100 mm in 1999/2000 and 120 mm thereafter. Soak times varied from several days to several weeks depending on weather and other logistics. Detailed location and catch information were collected for each string, and biological data was collected from a subsample of the catch of each string.

Catch data from trap surveys and experimental fisheries were summarized in different ways depending on the resolution of the data. Wherever possible, catch rates were calculated by averaging catch trap-by-trap, and the variance computed at this resolution. Occasionally during experimental fisheries, data was collected on a string-by-string basis; in these cases catch rates are total catches for the string divided by the number of traps fished on that string, and the variance component represents only variance between strings. Observers collected catch by sex information and measured only a subsample (sometimes the catch from 10 traps, sometimes 100 crabs). Thus, catch rates for large male crabs represent expansion of counts from the subsample to the entire catch for the string, and the estimated variance again represents only variance between strings. Catch data were summarized by depth stratum (Table 5), by PFMA (Figure 1), and by blocks of 10' latitude (Figure 2).

Biological data collection followed Jadamec *et al*. (1999) and included sex, shell condition, injuries, mating marks, incidence of diseases, missing appendages, carapace width (CW) claw length and height (for males > 80 mm CW), width of the 5th abdominal somite (for females > 40 mm CW), and egg color from ovigerous females. Individual weights were routinely taken on DFO surveys, but only sporadically during Industry surveys due to equipment limitations and logistic difficulties.

DFO databases were queried to provide additional information on removals of Tanner crabs by groundfish vessels, primarily the trawl fishery for thornyheads (*Sebastolobus alascanus* and *Sebastolobus altevelis*) and the trap fishery for sablefish (*Anoplopoma fimbria*).

Distribution and Abundance of Tanner Crabs in British Columbia

Geographic and Bathymetric Distribution

Grooved Tanner crabs, *Chionoecetes tanneri*, are known from Mexico to the Gulf of Alaska in water between 29 and 1,944 m (Rathbun 1925, Pereya 1968, Hart 1982, Phillips and Lauzier 1997). Two other species of *Chionoecetes* found in British Columbia are also found at these depths in B.C. The inshore Tanner crab, *C. bairdi*, is found between 6-474 m, although generally <200 m in B.C. (Hart 1982). The triangle Tanner crab, *C. angulatus*, has been found as shallow as 90 m and as deep as 3,000 m in other parts of its distribution, but is known from between 1,069 and 2,430 m in B.C. (Hart 1982, Jadamec 1999).

Phillips and Lauzier (1997) postulated that *C. tanneri* occupied a thin strip of habitat in appropriate depths on the continental slope of B.C. They presented data from museum collections and fishery catches that supported a coastwide distribution in B.C. Data from trap and trawl surveys after 1999 confirm that *C. tanneri* are present on the continental slope off the west coast of Vancouver Island (WCVI), at the mouth of Queen Charlotte Sound (QCS), and off the west coast of the Queen Charlotte Islands (WCQCI).

Information gathered during an experimental fishery and one research cruise off WCVI in the late 1980s found *C. tanneri* between depths of 325-770 m (Jamieson *et al*. 1990). The fishery in 1988 and 1989 encountered maximum abundance of large male crabs at a depth of approximately 550 m.

DFO Trawl Surveys

DFO trawl surveys between 1999-2003 found *C. tanneri* at depths between 400 and 1,460 m. Trawl surveys completed in the late summer and fall off WCVI in 1999 and 2001 consistently found maximum densities (kg/km^2) of Tanner crabs in stratum 3, between 800-1,000 m (Table 6). The 2003 trawl survey, which was completed in the spring, found maximum densities in stratum 2, 600-800 m, with nearly as high a density in stratum 3. Densities of large males (≥112 mm CW) were highest in stratum 2 for all three surveys.

The 2000 DFO trawl survey off the mouth of QCS found maximum densities of Tanner crabs in stratum 2, although stratum 1 was not sampled (Table 7). Catches in this area were largely made up of large male crabs, therefore the highest density of large males was also found in stratum 2.

The 2002 DFO trawl survey was terminated early due to equipment failure, therefore does not represent the entire WCQCI, only the northern portion between 53°39'N and 54°20'N. Maximum density of all crabs and large male crabs were in stratum 3, between 800-1,000 m (Table 8).

Shifts in bathymetric distribution between fall and spring were examined by comparing count data from the survey in August and September of 2001 with data from the April 2003 survey. Legal-size males (≥112 mm CW) were distributed in strata 2-4, with peak abundance in stratum 3 in the fall and a relatively even distribution over these three strata in the spring (Figure 3). Adult male crabs (≥80 mm CW) were generally found in strata 2-4 (600-1,200 m) with peak abundance in fall in stratum 3 and in spring in stratum 4 (Figure 4). Adult female crab (≥80 mm CW) were also found in strata 2-4, but abundance peaked in stratum 2 and declined with depth (Figure 5). This pattern was consistent in both spring and fall. Juvenile crabs (<80 mm CW) were found in strata 2-5 (600-1,400 m) with peak abundance in strata 2 and 3 in the fall and in stratum 5 in the spring (Figure 6).

DFO Trap Surveys

Trap surveys completed between 1999-2001were not comprehensive, usually fishing only one or two strings in a given depth stratum and only fishing three strings in a stratum once. The 1999 survey off WCVI found maximum densities of male and female crabs in stratum 3, but the maximum density of large male crabs was found in stratum 2 (Table 9). The 2001 survey caught relatively few female crabs. Peak density of male crabs was found in stratum 1, and all of these crabs were large males.

We summarized catch rates by latitudinal block (Table 10) and PFMA (Table 11), but the coverage is not comprehensive, and the data not particularly informative.

The 2000 survey off the mouth of QCS was the only survey to fish traps in strata 6 and 7, but these strings did not catch any *C. tanneri* (Table 12). Catch rates in other strata were generally low, with maximum rates for all sex and size categories in stratum 3. Catch rates for all males and large males were greatest in latitudinal block 2 (Table 13) and PFMA 130 (Table 14), although these areas received more effort than the others and effort in general is too low to give much credence to the data. Catch rates for females were low.

Industry Trap Surveys

The Industry trap survey off WCVI was completed in winter and spring of 1999/2000. Highest average catch rates for males and large males were in stratum 2, between 600-800 m (Table 15). Average catch rates for females were generally low with a peak in stratum 3. Catch rates for male crabs exceeded 3.0/trap only in latitudinal blocks 3, 10 and 13 (Table 16). Catch rates for large males only exceeded 3.0/trap in blocks 10 and 13. Catch rates for females were low except in block 6, where average catch was 2.03/trap. The highest average catch rate for males and large males was in PFMA 126 and lowest in PFMA 123 (Table 17). Catch rates for females were generally less than one/trap with the highest average rate in PFMA 124.

The Industry trap survey off WCQCI in 2000 was incomplete, failing to sample all depth strata (Table 18) and not sampling the southern portion of the area (Table 19). Catch rates for males and large males were generally low, with the highest catch rate in stratum 3 not exceeding two/trap (Table 18). Catch rates greater than one/trap for males and large males were only recorded in blocks 9 and 10 (Table 19). The highest average catch rate for females (0.18) was recorded in block 13. Catch rates for males were considerably lower in PFMA 101 than PFMA 142, while the reverse was true for females (Table 20).

The Industry trap survey off WCQCI in 2003 was more complete. Male catch rates were still low relative to WCVI, only exceeding one/trap in depth strata 2 and 3 (Table 18). Catch rates for females were low, but peaked in stratum 3. Catch rates for males were highest in block 13 (1.03/trap), followed by blocks 11, 3 and 10 (Table 19). Catch rates for large males only approached 1.0/trap in blocks 13 and 11. Catch rates for females were generally low and peaked in block 7. Catch rates for all sexes and size categories were relatively even in PFMAs 101 and 142 (Table 20).

Experimental Fisheries

As noted above, data from experimental fisheries off WCVI were not collected in a consistent manner. Catch for some strings was collated for each trap on the string, while for others only a subsample of traps from each string was recorded. In some cases in 2002/2003, total catch by string was recorded along with the number of traps on each string. Each of these situations is assessed separately in the following section.

Catch rates from the fishery in 1999/2000 differed depending on how the data were collected. For strings where all traps were sampled, catch rates for males and large males were higher in depth stratum 1 than stratum 2 (Table 21). Catch rates for females were low, but slightly higher in stratum 2. The opposite trend was evident when data from strings that had only been subsampled was summarized, with mean catch rates of males and large males higher in stratum 2 than in stratum 1. The trend in female catch rates was the same as in the completely sampled strings, although catch rates were considerably higher from the subsampled strings. Trends were more consistent geographically, with block 11 exhibiting higher catch rates for all sexes and size categories (Table 22). All strings in this year were in PFMA 126 (Table 23).

In the 2000/2001 fishery, all strings that were completely sampled for catch composition were in depth stratum 2 (Table 24). For strings that were subsampled, catch rates of males and large males were similar, while females were caught at a higher rate in stratum 1. Catch rates of males and large males were slightly higher in block 9 than in block 8 (Table 25), and in PFMA 126 than 125 (Table 26), in both data strings.

Catch rates of males and large males in the 2001/2002 fishery were consistently higher in stratum 2 than in stratum 1, and limited sampling from stratum 3 indicated that catch rates there were less than in stratum 2 (Table 27). Catch rates for females were highest in stratum 1, regardless of the sampling method. Catch rates by block were not consistent, with male catch rates higher in block 9 when all traps are sampled and in block 10 when strings were subsampled (Table 28). Likewise, female catch rates were highest in block 8 when the entire string was sampled, but higher in blocks 9 and 10 when strings were subsampled. Results by PFMA were also inconsistent (Table 29).

Three data formats were recorded in the 2002/2003 fishery: all traps on a string sampled, only a subsample of traps sampled on each string, and a total count of crabs caught and traps fished per string recorded. All data were from stratum 2, so no trends by depth could be detected (Table 30). Catch rate trends for male crabs were inconsistent by block (Table 31), and data for subsampled strings were all from the same PFMA (Table 32). Female catch rates were highest in block 10.

Relative Abundance

Densities from trawl surveys were highest off WCVI (Table 6), and lowest off QCS (Table 7). Densities off WCQCI were higher than QCS, but less than WCVI. The 2002 trawl survey was not completed due to equipment failure, so these results are not representative of the entire area.

Using large males as an indicator, catch rates from Industry trap surveys off WCVI in 1999/2000 (Table 17) were considerably greater than catch rates off WCQCI in either 2000 or 2003 (Table 20). Limited trapping by DFO in QCS in 2000 (Table 14) indicated that catch rates there were higher than off WCQCI, but less than those off WCVI.

In general, relative abundance increased from the B.C.-Washington border to peak abundance off the central and northern portions of WCVI, then decreased in QCS and off WCQCI (Figure 7).

Impacts of the Tanner Crab Fishery

Catch and Effort

The experimental fishery off WCVI has been run for four seasons (Table 4). The 1999/2000 season was relatively short, running from late January to the end of March 2000. Four vessels participated and landed approximately 35 t of Tanner crab (Table 33). The 2000/2001 season was of similar duration, had only one participating vessel, and landed approximately 45 t. The 2001/2002 season began in December 2001 and continued to March 2002. Three vessels participated and landed approximately 71 t. The 2002/2003 season had the earliest start date, November 2002, but finished in January 2003 when the lone vessel participating stopped fishing to assist in completion of the Industry trap survey off WCQCI. Total landings for 2002/2003 were approximately 8.5 t. Catches were predominantly males crabs ≥112 mm CW, but with increased contribution by females in the last two seasons (Table 34).

Effort, in terms of number of strings and number of traps fished, increased steadily from 1999/2000 to 2001/2002, but declined in 2002/2003 (Table 35).

Selectivity

Other Species

Observers recorded bycatch of species other than Tanner crabs from the experimental fisheries off WCVI (Table 35). The primary bycatch by number in each year was scarlet king crabs, *Lithodes couesi*, except in 2001/2002 and 2002/2003 when observers recorded smaller invertebrates (snails, sea urchins, brittle stars and sea cucumbers) that had not been reported in previous years. In these years, scarlet king crabs were still the most numerous macrofauna, but were outnumbered by smaller urchins and snails. Scarlet king crab catch rates were generally low off WCVI (Table 36), increased slightly off QCS (Table 37) and were highest off WCQCI (Table 38, Figure 8).

The most numerous vertebrate bycatch was sablefish, with 128 recorded over the four years of experimental fishery (Table 35). Other species of fish were encountered infrequently, with a total of 15 thornyheads, five Dover sole, two Pacific grenadiers (*Coryphaenoides acrolepis*), one daggertooth (*Anotopterus nikparini*) and one viperfish (*Chauliodus macouni*) reported.

Bycatch from Industry trap surveys was more diverse, as these surveys were more extensive both geographically and bathymetrically. Bycatch from Industry surveys off WCVI in 1999/2000 included, in order of decreasing abundance, scarlet king crabs, sablefish, shortspine thornyheads, unidentified fish, longspine thornyheads, Pacific grenadiers, the deepwater crab *Paralomis* *multispina*, red king crabs, sandpaper skate, sea stars, Dover sole and octopus (Table 39). These data are from 290 strings totaling 5,094 traps.

The Industry survey off WCQCI in 2000 consisted of 60 strings totaling 1,035 traps. Major bycatch species were scarlet king crabs and sablefish, with minor contributions by longspine and shortspine thornyheads and Pacific grenadiers (Table 40).

Observers recorded bycatch from 144 strings totaling 2,677 traps from the Industry survey off WCQCI in 2003. The primary bycatch species, in decreasing order of abundance were scarlet king crabs, *Paralomis multispina*, snails, sablefish, triangle Tanner crabs, grenadiers, sea stars, sea urchins and brittle stars (Table 41).

Undersize and Female Tanner Crabs

Catches in the experimental fisheries off WCVI included undersize males and females. Undersize males were relatively uncommon in catches, but females accounted for a considerable portion of the catch in some years: 7% in 2000/2001, 22% in 2001/2002 and 49% in 2002/2003.

Total Fishery Removals of Tanner Crabs in British Columbia

To fully understand population dynamics of Tanner crab stocks in B.C., we must examine all impacts, including removals by fisheries directed at other species. Because *C. tanneri* lives in relatively deep waters off the continental shelf, the only fisheries which might have incidental catches are the deepwater trawl fishery for thornyheads (*Sebastolobus alascanus* and *S. altivelis*) and the trap fishery for sablefish (*Anoplopoma fimbria*).

Thornyhead Trawl Fishery

Workman *et al*. (2000) documented increased effort and catches of Tanner crabs off the coast of B.C. They indicated that these increases were due to the groundfish trawl fleet pursuing thornyheads in deeper water, particularly when targeting longspine thornyheads, which live deeper than shortspines.

We summarized Tanner crab catch from the groundfish trawl fishery from 1996-2002, as estimated by observers (PacHarvTrawl database, Pacific Biological Station, Nanaimo; G. Workman and K. Rutherford, pers. comm.). Estimated catches of Tanner crabs have increased from less than 30 t in 1996 to over 133 t in 2002 (Table 42). These catches came primarily from WCVI (PFMA 123-127) and catches in PFMA 123-125 increased steadily since 2000. Catches in PFMA 127 and 130 peaked in 2000 and have declined since. Catches from WCQCI (PFMA 101 and 142) increased sharply in 2000 and have remained high since.

Sablefish Trap Fishery

Sablefish were fished historically by trawl and longline gear. A trap fishery began in 1973, and has accounted for 70-86% of annual sablefish landings in B.C. since 1991 (Haist *et al*. 2001). Sablefish assessments do not include information on incidental catches of other species, nor are observers required. We have very little information regarding Tanner crab encounter rates in this fishery.

Ten observer trips were completed on sablefish vessels in 2000-2002. One trip was observed in 2000, one in 2001 and eight in 2002 (M. Wyeth, DFO, PBS, pers. comm.). Tanner crabs were reported from the trip in 2001 and four of the trips in 2002 (Table 43). Tanner crab encounter rates for strings set below 450 m ranged from 40% to 100%, and two trips in May and June of 2002 caught over 0.5 t of Tanner crab. The trips that were observed were limited in geographic scope and were not representative of the fishery as a whole, therefore, expansion of the observer data to the entire fishery is not warranted.

Workman *et al*. (2000) examined catch records from DFO trap surveys of sablefish in B.C. Tanner crabs (either *C. tanneri* or *Chionoecetes* sp.) were encountered in 95 of 377 strings (25%) of trap gear, ranking third after arrowtooth flounder (*Atheristhes stomias*) and shortspine thornyhead. Inshore Tanner crabs (*C. bairdi*) were encountered in five strings. These data were not limited to deepwater (>450 m) strings, so some portion of crabs reported as *Chionoecetes* sp. could be *C. bairdi*. Information on counts or weights of crabs by string was not consistently collected.

We summarized Tanner crab encounters in strings set in deep water (>450 m) from DFO trap surveys for sablefish stocks off B.C. between 1990-2002 (Table 44). Encounter rates for Tanner crabs, measured as a percentage of all strings set below 450 m, ranged from 34% in 2002 to 70% in 1999. Overall encounter rate was approximately 50%, but catch per string was relatively low at just greater than four crabs per string.

Assessment Methods and Biological Assumptions

Assessment Methods

Biomass Estimation

Workman *et al*. (2000, 2002) developed preliminary estimates of biomass for *C. tanneri* in B.C. They used results of the 1999 DFO trawl survey to estimate density of Tanner crabs per unit area. These estimates were then expanded over estimates of Tanner crab habitat by PFMA (Table 45) to give estimated total biomass (Table 46). Total biomass estimates were then scaled using trap catch rates from the 1999/2000 Industry trap surveys to give weighted estimates of biomass for other areas off WCVI (Table 47).

We used catch rates from the 2003 Industry trap survey off WCQCI to calculate preliminary weighted biomass estimates from these areas (Table 47). However, we present these estimates for comparative purposes only, and acknowledge reduced confidence in estimates derived from data collected several years apart.

Depletion Estimates

The experimental fisheries off WCVI were initially proposed to provide an independent estimate of stock size that could be compared to estimates from trawl surveys (Workman *et al*. 2000). The intent was to collect fishery data and use a depletion model to estimate initial stock size. The fishery has not achieved the TAC in the last three seasons (Table 33). Reasons for this were largely logistic; late starts to seasons, conflicting priorities (the only vessel fishing WCVI in 2002/2003 left to complete the Industry trap survey off WCQCI) and lack of directed effort as fishers could not commit to the fishery on short notice.

We could not detect depletion effects of the entire area at these levels of effort and catch. Although there were some indications of depletion within small local areas in 2001/2002 (G. Workman, Pacific Biological Station, pers. comm.), none of these produced a meaningful signal in a depletion model. Fishers indicated that they would fish an area until they were no longer achieving catch rates of 10 legal crabs/trap, then move to new locations within the fishery area (P. Edwards, TCJVFA, pers. comm.). This results in a classic pattern of hyperstability of CPUE in which depletion would not be detected until no new locations could be accessed.

Biological Characteristics

Size

Size of *C. tanneri* caught by research trap and trawl surveys 1999-2003 ranged from six mm, probably instar III or IV, (Tester and Carey 1986) to 173 mm. Industry trap surveys and experimental harvest 1999-2003 reported some crabs larger than 180 mm, but these were not consistent with other biological information, and were considered to be recording errors. B.C. maximum sizes agree with those from Alaska (170 mm, Sommerton and Donaldson 1986) and Oregon (181 mm, Pereyra 1966). Although our data is rather sparse for WCQCI, we could not detect significant differences in mean size of adult crabs from the southern and northern extremes of their range in B.C.

Growth

The smallest size mode encountered in trawl surveys was 10 mm, after which modes occurred at approximately 14, 18, 26, 35, 49, and 65 mm (Figure 9). These modes were present in all three surveys conducted off WCVI indicating a consistent growth rate between years. Moulting appears to produce an average increase in size (CW) of approximately 35% up to at least 80 mm when growth rates diverge by sex. Females appeared to undergo one final moult to a mean size of about 100 mm, an increase of about 25% (Figure 10), whereas males continue to grow at 30-35% to produce modes at 110 mm and finally 145 mm.(Figure 11) This last mode covered a large width range (120-160 mm) and may in fact be composed of more than one cohort. However, data from the experimental fishery show a unimodal distribution with a mean size of approximately 135mm.

From trawl data collected in April 2003, the smallest crabs captured were 11 mm, with the first distinct mode at about 14 mm. This and subsequent modes at 19 and 25 mm probably represent yearling crabs (instars V, VI, VII of Tester and Carey 1965) which settled throughout the previous summer. The survey in April is too early for current year's larvae to have settled given that hatching occurs in February/March to produce a first benthic instar of approximately 4-5 mm CW.

Sex Ratio

Sex ratio (male : female) for immature crabs (<75 mm) from research trawl catches is virtually 1:1. Above 75 mm CW, males outnumber females by a ratio of 2.05:1. For research traps with no escape rings and 40 mm mesh fished during the summer, males outnumber females by a ratio of 2.40:1. In the experimental harvest during 2002/2003 using pyramidal traps with 120 mm escape rings fished during the winter males outnumber females by a ratio of 1.05:1. All of the females retained in the experimental harvest were smaller than the escape ring diameter and were probably retained as a function of their tendency to aggregate during the breeding season.

Maturity

Determination of maturity in Tanner crabs is based on morphometric allometry of claw dimensions versus carapace dimensions for males, and width of the 5th abdominal segment versus carapace width for females. Male maturity codes for *C. tanneri* were calculated as:

$$MC = \ln(CL) - 1.41(\ln(CW)) + 2.97$$

where CL = chela length (mm) and CW = carapace width exclusive of spines. The relationship that was presented by Jamieson (1990) was modified by increasing the constant in the expression from 2.92 to 2.97 to provide an even distribution of positive and negative values about 0 on the x axis (Workman *et al*. 2001). Positive values indicate a morphometrically mature crab. Data from the trawl survey indicate the clear separation of mature and immature crabs (Figure 12). In the absence of an algorithm to assign maturity codes for females, the width of the 5th abdominal segment was divided by the carapace width (Workman *et al* 2001). Values above 0.5 were taken to indicate morphometric maturity in females.

Using these criteria, data from the 2002-2003 experimental fishery indicate that 95% of males captured were mature (Figure 13), while 98% of females captured were mature (Figure 14).

<u>Size at Maturity</u>

Previous examination of size and maturity data estimated size at maturity to be 112 mm CW for males and 88 mm CW for females (Workman *et al*. 2000, 2002). Data collected since 1999 did not result in significant changes to these estimates.

Shell Condition

The experimental harvest was composed of both old-shell (1 year or greater since last moult) and new-shell crabs. Shell age is a subjective evaluation based on a number of well defined criteria (Jademec *et al*. 1999) and there may be a tendency to underestimate the number of old-shell individuals. However, the data appeared consistent between years. The male component of the experimental harvest was composed of 67% new-shell crabs, while the female component was 29% new-shell. This ratio suggests that mature crabs have an intermoult period of not much greater than 2 years after reaching maturity after which time they either moult to a larger size or die.

The size distribution of mature males was fairly broad, from approximately 110-170 mm CW. Both new-shell and old-shell crabs were present throughout the distribution, but old-shell males appeared in lower proportion. There were no strong modes within the distribution, which may suggest a single mode, suggesting a single cohort and a terminal moult.

Female *C. tanneri* were mature over a fairly broad size range (83-120 mm CW). Their moult to morphometric maturity is probably a terminal moult since there is no evidence from their width frequency histogram to suggest more than one mode at the mature size. Old-shell female crabs are only encountered after they have moulted to morphometric maturity indicating at least an annual moult up to that stage.

Reproduction

Reproduction appears to take place on a strictly annual basis. All ovigerous crabs encountered in the summer surveys have new egg masses; likewise crabs captured during the winter harvest have eyed eggs, with newly extruded egg masses appearing in February. The DFO trawl survey in April 2003 produced very few crabs with eggs in the process of hatching, the majority having newly extruded (yellow) eggs. From the experimental fishery information, it appears egg release takes place between late February and late March. Breeding apparently takes place immediately after egg release for multiparous females. Primiparous females appear to breed thoughout this period also. Primiparous females apparently are not bred as softshell crabs as in other *Chionoecetes*, but as hardshell animals following a moult during the previous spring/summer period. Of over 100 new-shell female crabs examined, none showed either evidence of manipulation by a male (mating marks on the legs) or insemination (spermatophores in the spermatothecae). In contrast, nearly all ovigerous females showed grasping marks and enlarged spermatothecae (although no spermatophores were found). The shells of some old-shell ovigerous crabs examined showed evidence of at least 2 separate breeding events. It is likely that adult females are capable of producing at least 2 batches of eggs during their reproductive careers, although it is unclear whether they also use stored sperm to fertilize multiple egg clutches (as with most other Majid crabs) or whether annual breeding is required. Confirmation of reproductive condition awaits analysis of samples collected in April 2003.

It would appear from the experimental harvest data that the targeted population for this fishery is composed predominantly of large, hard shelled males aggregated for breeding. Most of these are morphometrically mature (Figure 13) which would appear to be a prerequisite to breeding since all of the receptive females are hard-shell. There does not appear to be bipartite breeding as with *C. bairdi*, where soft-shell crabs are dispersed and bred by smaller males while multiparous females form aggregations with morphometrically mature males (Somerton 1982, Moriasu 1987, Moriasu *et al*. 1988, Donaldson and Adams 1989, Sainte-Marie and Hazel 1992). The tendency to aggregate for breeding in *C. tanneri* is responsible for the high level of bycatch of female ovigerous crabs in the experimental harvest and presents a challenge to exclude them from harvest in this fishery.

Bitter Crab Disease

Bitter Crab Disease (BCD) is caused by infection of crab hosts by the parasitic dinoflagellate *Hematodinium* sp. (Love *et al*. 1993). The parasite causes a fatal wasting disease, and affects the taste of infected crabs. Advanced infections of BCD can be diagnosed macroscopically by a distinctive lightening of the color of the carapace from scarlet or orange to pinkish, which gives infected crabs a cooked appearance. Secondary indications of infection include white lines along the underside of each leg and milky hemolymph (Love *et al*. 1996). Crabs are relatively unaffected until advanced stages of the infection, at which time they become moribund and die.

The disease is known from shallow water Tanner crabs (*Chionoecetes bairdi*) and snow crabs (*C. opilio*) from Alaska and the Bering Sea (Meyers *et al*. 1987, 1990, 1996; Eaton *et al*. 1991; Love et al. 1993) and snow crabs in the Atlantic (Taylor and Khan 1995; Taylor *et al*. 2002; Pestal *et al*. 2003). Phillips and Lauzier (1997) speculated that *C. tanneri* might be susceptible to BCD, and crabs exhibiting macroscopic evidence of BCD were observed in the 1999 DFO trawl survey. Infection by *Hematodinium* sp. was confirmed in subsequent samples of *C. tanneri* collected off WCVI during the 2001 DFO trawl survey and the 2002 experimental fishery (Bower *et. al.* 2003).

We examined Tanner crabs caught in the DFO trawl survey off WCVI between April 3-10, 2003 (tows 1-15 only) for evidence of infection by *Hematodinium*. To date, the histological examination of tissue samples has been completed for 246 crabs. Based upon casual observations of the size distribution of the crab catch, we have arbitrarily divided the results into two size categories, crabs with a carapace width of < 30 mm and those with carapace widths ≥ 30 mm. A relatively high proportion of the catch from some tows were crabs in the < 30 mm size category (likely all yearling crabs hatched the previous spring). These small crabs appeared to have a higher prevalence of macroscopic signs of BCD compared to the crabs ≥ 30 mm, especially in tows 11 and 13.

We sampled 91 crabs exhibiting macroscopic signs suggestive of BCD infection (Table 48). Nineteen of the 20 crabs with CW ≥30mm were confirmed to be infected through histological examination. Thus, we demonstrated 95% accuracy when comparing macroscopic diagnosis with histological examination, or an error rate of 5% false positives. Sixty-four of 71 small crabs (CW <30 mm) diagnosed macrosopically were proven to be infected after histological examination. We had 90% accuracy when comparing macroscopic diagnosis with histological examination, or 10% false positives. Overall, our accuracy was 83/91 crabs, or 91% accuracy.

We randomly sampled 155 crabs from all of those that appeared healthy, with no visual signs of BCD infection. Fifty-eight of 60 large crabs (CW ≥30 mm) showed no infection after histological examination, for 97% accuracy. Two large crabs showed light to moderate *Hematodinium* infections after histological examination for an error rate of 3% false negatives. Eighty of 95 small crabs (CW <30 mm) showed no infection after histological examination, for an accuracy of 84%. Fifteen small crabs were found to harbour *Hematodinium* infections for an error rate of 16% false negatives. Overall, our accuracy was 89% (138/155) when comparing apparently healthy crabs to results of histological examination.

Almost all crabs (including juveniles) that had macroscopic signs suggestive of BCD that were confirmed positive by histological examination had infections of very high intensity. These crabs usually exhibited an average of more than 50 *Hematodinium* nuclei per field at 400X magnification in either the heart or hepatopancreatic tissue in histological sections. This advanced stage of infection is probably terminal and it is unlikely that these crabs would have survived for much longer. It is doubtful that they were able to function normally, and their moribund condition suggests that they would only be sampled in trawl surveys and not be caught during a trap survey or fishery. Also, crabs of small size are not usually caught in a trap survey. The intensity of infection was generally light to moderate in crabs that macroscopically appeared healthy. However, 5/15 juveniles that appeared normal harboured infections of high intensity.

For smaller crabs (CW <30 mm), the accuracy of macroscopic diagnosis of BCD in comparison to microscopic histological examination for *Hematodinium* sp. was lower than that for larger crabs with 10% false positives and 16% false negatives. The margin of error for misdiagnosis by macroscopic examination is 6% favouring false negative (derived by 16% false negative minus 10% false positive). It appears that macroscopic diagnosis of BCD (prevalence of infection) in samples of smaller crabs is less accurate, with a tendency to underestimate the "true" infection rate by approximately 6%.

At least one crab was confirmed positive for BCD by histology from 10 of 15 tows examined (Table 49). Catches of *C. tanneri* were very low in the other five tows, ranging from zero to five crabs, and no samples were examined histologically. Overall infection rates of BCD ranged from 0.9% to 12.7% (using a conservative calculation of only counting the histology confirmed positives divided by the total catch). The size distribution of crabs caught in tows 11 and 13 was largely comprised of smaller crabs (CW <30 mm), so in these two cases the true prevalence of infection is likely about 6 % higher than indicated here.

Although all of the above results pertain solely to the grooved Tanner crab (*C. tanneri*), we now have both histological and PCR (DNA) confirmation that macroscopic diagnosis of BCD in an triangle Tanner crab (*C. angulatus*) from tow 10 was indeed a *Hematodinium* infection. We believe that this is a new host record for BCD (*fide* Bower *et al*. 2003).

Discussion

Distribution and Abundance

Trawl and trap surveys off WCVI and WCQCI have defined areas of major abundance along the coast. We have relatively poor knowledge of QCS for which there are only limited DFO trawl and trap survey data. As was proposed during earlier phases of this fishery, (Jamieson *et al*. 1990, Phillips and Lauzier 1997) *C. tanneri* is present along the entire B.C. coast with major concentrations off WCVI (Figure 7). Their distribution appears largely determined by presence of suitable habitat (within bathymetric boundaries), preferring fine grained sediments with low slope. This habitat type is most prevalent off WCVI, otherwise present (with few exceptions) as a thin ribbon over the rest of the coast. *C. tanneri* are also known from seamounts off the coast of B.C and Alaska (Hughes 1981; P. Edwards, TCJVFA, pers. comm.).

Depth distribution for *C. tanneri* in B.C. from our trawl survey data is approximately 400–1,460 m (although Hart (1982) reports them to 1,784 m in B.C. and to 1,944 m elsewhere). The bulk of the adult population occupies the 600-1,200 m range during the summer months. Distribution appears to be slightly deeper off WCQCI than in the south, however, the absolute depth does not appear to be greater. Females tend to occupy a slightly narrower depth range than males, being absent from trawl catches below 1,160 m whereas males persisted to 1,460 m. Aggregation for breeding occurs in the late winter in 600-800 m, with most hardshelled crabs found at these depths. During the April 2003 survey, female distribution was markedly shallower than surveys in late summer, suggesting dispersion after the annual breeding congregation near 700 m depth (Figure 14). Most female crabs found in deep water were recently moulted to morphometric maturity but were as yet unbred.

Industry trap surveys provided information on legal-size male distribution, but were not useful for determining distribution of females or juveniles due to selectivity characteristics of traps. Catch rates of legal-size males peaked in depth stratum 2 (600-800 m) off WCVI in 1999/2000 (Table 15). Legal-size male catch rates were highest in latitudinal block 10 (Table 16) and PFMA 126 (Table 17).

The Industry survey off WCQCI was incomplete in 2000. Results of the 2003 Industry survey show peaks in legal-size male catch rates in depth stratum 3 (Table 18), latitudinal block 13 (Table 19) and roughly comparable abundance in PFMAs 101 and 142 (Table 20). Overall, legal-size male catch rates were generally higher off WCVI than WCQCI.

Juveniles (<80mm CW) are distributed between 600-1,600 m, overlapping adult distribution. Peak juvenile abundance is approximately 900-1,300 m. This suggests that settlement of larvae takes place over a fairly broad depth range. We found no juvenile *C. tanneri* below 1,600 m, whereas juvenile *C. angulatus*, virtually identical in size, were only found below 1,200 m and continued to at least 2,000 m. This suggests relatively reliable seaward transport of *C. tanneri* larvae from the depth of release near 700 m. Little is known of the planktonic larval phase, however, distribution of juveniles from trawl catches appears to be quite patchy, indicating either the requirement of a specific substrate for settlement and early juvenile development, as yet undefined, or patchy recruitment from the plankton. The upper boundary and indeed the patchiness of the benthic distribution of juveniles may also be strongly influenced by abundance of predators. Thornyheads, sablefish, Dover sole, grenadiers and other fish species are known to feed extensively on juvenile *C. tanneri* (Phillips and Lauzier 1997). Areas below 1,200 m may serve as a refugia for juveniles, as predator abundance decreases rapidly below that depth.

Our primary concern regarding the use of swept area methods to estimate biomass is quantification of the area swept by the trawl. This has three components: Tanner crab catchability coefficients, the effective width of the trawl while it is being towed and the amount of time the trawl was on the bottom.

Crab catchability was assumed to be 1.0. This is the value used by Workman *et al*. (2000) and other investigations that use trawls to assess *Chionoecetes* crab resources (Dawe *et al*. 1997; Hebert *et al*. 1999; Biron *et al*. 1999).

Workman *et al*. (2000) used Simrad ITI net sensors to estimate the effective width of the Campellan trawl at 14.97 m, and we have used this as a constant in our estimates. Although it is possible that the net opening may change due to depth, current or vessel speed, we do not have the technology to routinely measure net dimensions at the depths required for this survey.

We also lack the technology to directly measure the time the trawl spends in contact with the bottom. Both the depths surveyed and the speed at which the net is towed make qualitative impressions of time of contact with the bottom (changes in vessel speed or warp angle) difficult. Without technology to directly measure depth of the net at a given time, our ability to precisely quantify time on bottom and distance traveled is compromised.

In spite of these concerns, fishery-independent trawl assessments remain the only means to assess all age and size classes of Tanner crabs. Trap gear used in commercial fisheries will not retain juveniles, will not catch crabs compromised by BCD and has documented problems with hyperstability of CPUE. More work is required on correlating trawl and trap catch rates, so we can use two data sources to estimate biomass and track changes or trends.

The most striking difference between results of the trap survey and experimental fishery is that catch rates in the fishery are greater by an order of magnitude. We used only catch per trap in our analyses. We recognize that there is a relationship between catch and soak time, likely increasing to some asymptote once traps are saturated. This relationship is likely not linear, and because we do not know what this relationship is, we cannot standardize for soak time. If we are to use fishery-dependent data in assessments, future research should include effort standardization studies to examine the effects of soak time.

We note that female catches were considerably higher in 2001/2002 and 2002/2003 than in previous years. This may be a result of starting the fishery earlier in the year and fishers having to search for aggregations of males while avoiding females, or may be a result of different levels of resolution in observer data.

Impacts of a Directed Tanner Crab Trap Fishery

Selectivity

The experimental trap fishery produces very clean catches of mature, hardshell male tanner crab at or above market size, especially if fishers are able to avoid concentrations of female crabs during late winter.

Bycatch of fish is low and most of the fish species reported can be released with relatively high expectation of survival, particularly sablefish, thornyheads and sole, all of which lack swim bladders and thus suffer less from decompression effects.

Our primary concerns are bycatch of female and undersize male Tanner crabs and bycatch of other crab species. Undersize males comprise a relatively minor portion of trap catches in the experimental fishery, however, we have recorded relatively high catch rates of ovigerous females that could leave traps (*i.e.*, they fit through escape rings, but do not leave). Retention of females was relatively low in 1999/2000 (Figure 15), 2000/2001 (Figure 16) and 2001/2002 (Figure 17), but increased in 2002/2003 (Figure 18).

Although fishers attempt to avoid concentrations of females, catch rates for females have been realtively high the last two seasons. We think there is promise in gear development that would exclude undersize males and females from entering traps, possibly through modifying the collar arrangement on the entry tunnel. We encourage further research into gear configuration and determining discard mortality rates.

Bycatch of other crab species, specifically *Lithodes couesi*, were relatively low in the experimental fishery. However, relatively high abundance of other crabs indicated by data from Industry and DFO surveys off WCQCI lead us to be concerned should a fishery in the north be proposed.

Total Impacts on Tanner Crab Stocks

Catches of Tanner crab in the experimental fishery are well documented due to observer coverage and validation of landings. Although catch rates for females and undersize males are relatively low, the fate of discards is still unknown.

Tanner crab encounters by the groundfish trawl fleet are estimated from observer data, but these estimates are not particularly precise because of the subsampling methodology used (Workman *et al*. 2000). These estimates also include only those crabs retained by the gear and recognizable to observers. The effect of this fishery on smaller crabs that are captured and then lost through the net is not quantified, nor is the effect on softshell crab that are crushed and extruded through the net. Our survey catches suggest that a large number of juvenile crabs may be encountered by the trawl, crushed and abraded, then extruded through the net. The complete impact of the fishery cannot be estimated from observer records.

Tanner crab catches in the sablefish trap fishery are not well documented. Preliminary information from DFO surveys suggests that Tanner crabs are commonly caught in sablefish traps, as does the limited information available from observed sablefish trips.

The condition of crabs that have been captured by trawl is generally poor, and would be much worse considering the difference in tow duration between surveys and the fishery. It would be incautious to assume that any crab passing through the net or released at the surface would survive. Crabs taken in sablefish traps are generally in good condition, suffering only from decompression, temperature changes, exposure to air and possibly blunt trauma (depending on handling stresses during sorting and method of release). While it is more likely that some crabs encountered in the sablefish trap fishery would survive catch-and-release, we do not have data to indicate what discard mortality rates might be.

Biological Assumptions

Growth and Age

Growth is probably quite rapid during early life stages, possibly an adaptation in response to heavy predation observed on smaller size crabs by thornyhead rockfish, Dover sole, sablefish, sculpins and numerous other opportunistic fish species. Assuming 2 -3 moults per year during the first 2 years and an average moult increment of 35%, crabs may reach mature size near 80 mm in as little as 3 years after completing a minimum of 11 moults. After reaching sexual maturity, moulting is probably annual and it is possible that males, at least, skip moult after reaching reproductive maturity. Given a maximum life span of 3 years after the last or terminal moult, the life span of *C. tanneri* is probably in the range of 6-9 years rather than up to 15 years, as was proposed earlier (Phillips and Lauzier 1987). More work is required to disprove the initial impression of a slow growing, long lived species, however the ramifications to management of a fishery for this species would be considerable given a shorter life span and reproductive career of 2-3 years.

Shell Condition

The presence or absence of a terminal moult in mature male *C. tanneri* has yet to be resolved. There are serious implications for assessments depending on which hypothesis is followed. If there is a terminal moult, then males will remain reproductively active for only two or rarely three years, and maximum age is likely in the range of 6-7 years. If males older than 5 years skip moult and have greatly reduced moult increments, it is possible that maximum life span could be 15 years, with nearly a decade of reproductive output. In the first case, harvest strategies could be more aggressive as natural mortality rates are high and the reproductive pool turns over rapidly. In the latter case, harvest strategies must be more conservative, maintaining a pool of reproductively active males in the population.

There is no compelling evidence to suggest that male *C. tanneri* have a terminal moult such as is seen in their shallower water congeners (Tester and Carey 1986, Somerton and Donaldson 1996). The width distribution of males from 120-160 mm could be composed of crabs from more than one instar, each of which are composed primarily of morphometrically mature individuals. Competition during the breeding season is apparently intense and most hardshell crabs show signs of violent physical encounters with other crabs. Often claw tips are broken off and there are frequently lesions infected by chitinoclastic bacteria. The degree of shell wear, accumulated injuries and epibiont fouling indicates a maximum shell age of about 3 years. The absence of a large accumulation of old-shell animals and the paucity of very old shell (senescent) crabs from trawl or trap samples is further evidence that they probably do not survive past their second breeding season.

Data gathered during DFO surveys showed that old-shell adult males are much less abundant than new-shell adult males. If we assume a terminal moult, then this indicates that males do not live for more than 1-2 years after this moult. If they did live longer we would expect to see a larger pool of old-shell males supplemented by a smaller number of new-shell males. If we assume that the data are unimodal, then we see a broad size range of animals making up a single cohort all moulting into maturity in a given year. If we assume that animals will likely live for two years but only rarely live for three years after the terminal moult, then we would expect to see the greatest proportion of terminal moults in new-shell condition, with the old-shell and senescent portions of the population reduced by one or two years natural mortality.

However, if we assume a different life history model with skip moults and small moult increments, we would expect to see nearly the same distribution of size and shell condition, perhaps skewed to the left. New-shell crabs would be present throughout the distribution as crabs moulted to successively larger sizes, with smaller proportions of old-shell crabs present as each cohort is reduced by natural mortality. In this model, we might expect that most crabs moult or die after two years until they approach maximum size and that senescent crabs might only be seen near the maximum size. This model is less likely, however, as each moult exposes the crab to potential predation while in softshell condition. The trade-off for increased risk of mortality would be increased size and probability of reproductive success. To result in our observed size distribution, moult increments would have to be successively smaller for each moult event presumed to occur. Small moult increments would not proffer large benefits in terms of increased fitness, and would entail larger risks through vulnerability in softshell condition.

The most parsimonious situation is one involving fewer moults and greater moult increments. The implications of this are lower maximum age and reproductive span and more rapid turnover of reproductive males. If this is true, then Tanner crabs might support more aggressive fishing rates. However, more data or results of a tagging program are required to definitively understand moult patterns in adult Tanner crabs.

Bitter Crab Disease

Our preliminary results from the 2003 trawl survey off WCVI indicate that *Hematodinium* infection may play an important role in *C. tanneri* population dynamics. The prevalence of infection of smaller crabs suggests that BCD infection may be an important determinant of year-class strength, and thus recruitment to the fishable population. Our results are preliminary; a more detailed analysis of infection rates by sex and size class is warranted.

We believe that sampling of trap catches, whether from fishery or survey, will seriously underestimate the prevalence of BCD in Tanner crabs. Taylor *et al*. (2002) cited similar possible bias in detecting BCD in snow crabs in Newfoundland. Traps selectively retain larger crabs, and fishery samples will only represent the legal male component of the population. Trawl surveys are the best source of information on BCD infection rates because they have lower size selectivity and will collect listless or moribund crabs that would not be able to enter traps (*i.e.*, trawls will catch both healthy and compromised crabs while traps will only catch healthy or mildly infected crabs).

To fully understand the impacts of BCD on Tanner crab populations in BC we need to examine infection rates in geographic areas other than WCVI and describe changes in infection rates seasonally and annually. Taylor *et al*. (2002) suggested that BCD was more prevalent in snow crabs in Newfoundland in October than in May-June, but cautioned that these reports were based on macroscopic diagnoses only; infection rates may be as high in the spring and summer but not detectable until the infection advances to near-terminal stages.

Other required work includes examination of other areas of the coast of B.C. for incidence of BCD, completion of PCR (DNA) diagnostic assay and comparison (validation) to histological examination results, electron microscopy–ultrastructural examination of the cellular features present in *Hematodinium* from WCVI compared to those reported from *Hematodinum* in Alaska and other regions of the world, and molecular anaylsis/DNA comparison of *Hematodinium* from WCVI compared to those reported from *Hematodinum* in Alaska and other regions of the world.

Ecological Considerations

It is apparent by the frequency and consistency in which *C. tanneri* is found in fish stomachs that this species occupies a keystone role in the benthic food chain on the continental slope. Early instars serve to redistribute nutrients from benthic sediments back into the demersal fish community. Trawl surveys over 5 years indicate fairly regular recruitment, especially off WCVI and interannual fluctuations in recruitment of larvae may be relatively minor for this area. It is difficult to evaluate variations in adult abundance given our uncertainty in trawl abundance estimates and lack of success detecting shifts in CPUE at the trap harvest levels to date. However, our impression of this animal from data acquired suggest a more vigorous and dynamic population than was first envisioned. Their resistance to fishing pressure is as yet unknown, however they persist in southern waters despite an intensive slope rockfish trawl fishery. These observations increase the likelihood of a sustainable selective trap fishery if other sources of fishing mortality can be controlled.

Assessment Considerations

Trawl Surveys

A number of factors described above lead us to believe that trawl surveys are the only method of assessment that produce unbiased estimates of population characteristics. Traps are too selective both for size and physiological condition (incidence of acute BCD). Previous surveys were exploratory in nature, and future surveys require more focussed designs and improved data collection, particularly quantification of time the trawl spends fishing on-bottom. Trawl sensor technology is available to report net configuration and document fishing events, but it is expensive (particularly if it is to function at the depths required to survey Tanner crabs).

We strongly support exploration of the correlation between trawl survey estimates of biomass and trap catch rates. This would allow the integration of fishery-independent survey information and fishery-dependent data for a more robust assessment of stock status.

Experimental Fishery

Logistical problems in the last three years did not allow large enough catches to utilize a depletion model to estimate biomass. However, examination of location, catch and effort data led to discussions with the fisher, which revealed behaviour that would result in CPUE hyperstability. We now doubt that an experimental fishery would provide meaningful data for depletion modeling. We do feel that there is value in pursuing an aggressive fishery in one area, in conjunction with independent surveys, to validate population estimates on a general level (Can the fishery remove more crabs than surveys indicate are in the area?).

The experimental fishery also provides a platform for directed studies. We propose to work with fishers on collaborative projects to answer specific questions relating to the fishery, its assessment and management. We would continue to assess stocks in the fishery area and an unharvested control area to examine effects of the fishery on Tanner crab stocks. We would also like to attempt tagging studies to examine mortality rates of discarded crabs and explore the use of tagging to estimate population size. We would also like to work with Industry to evaluate gear modifications with the objective of reducing bycatch of undersize and female crabs by excluding entry from the traps rather than relying on an escape port to release them.

Data Requirements

The primary tool we propose to use to monitor the fishery for assessment purposes is a logbook program. Logbooks will need to report detailed information on location, depth, retained catch and discards by species (discards will have to be categorized by sex and size category for Tanner crabs that are not retained). Use of black box electronic monitoring or video monitoring systems would allow validation of fishing locations and soak times for Stock Assessment purposes, as well as monitoring location and time of fishing for Fish Management and Enforcement purposes. Supplementary observer coverage and coordination by field program staff would be required to collect specialized data or coordinate specific experiments (described further below). If a logbook program fails to collect detailed information required for assessment and management, we will recommend a return to 100% observer coverage.

If commercial CPUE is to be used to monitor fishery performance and develop an index of abundance, then detailed work is required to standardize effort, particularly the effect of soak time. It is possible that this may be achieved through analysis of fishery data, once a sufficient mass of data is available. Alternatively, specific experiments could be designed and carried out with cooperation of Industry to standardize effort.

Equally important is assessment of discard mortality. Mortality of discarded crabs (Tanner or king) could be assessed through a program that tags discards and monitors the fishery for recoveries. DFO field staff would be required to tag crabs and collect tag release data. We would rely on the fishery to provide tag return information. Fishers would be highly motivated to report tag returns, as missing data would be interpreted as higher rates of discard mortality.

Dockside validation of landings must continue, both to track TACs and validate logbook information. Sampling would be required at time of landing to determine count-weight conversion ratios, as logbook data are reported as pieces and TACs are tracked by weight. Validated landings must include data on mortalities at time of landing. Validation would also provide opportunities for collection of biological samples documenting sex, size and condition of the catch.

Future Development Options

Because of our concerns that a depletion model may not perform well under current fishing conditions, development of the fishery cannot be tied to completion of a depletion experiment. However, we still require information on the production potential and effects of an aggressive fishery in a limited area of the coast. Boutillier *et al*. (1998) proposed dividing the coast into three zones: 50% of the available Tanner crab habitat would remain closed to fishing (this would provide conservation refuges and area in which surveys could be carried out to explore dynamics of unexploited populations); 25% of the available habitat would be fished using a fixed exploitation rate (using conservative estimates of fishing mortality and biomass); and 25% of the available habitat would be experimental areas fished at various rates to test initial assumptions. An option to expand the fishery, under conservative limits, into other areas is attractive, as it allows for participation of other fishers and processors based in other centers on WCVI (*e.g.*, Ucluelet). However, it would also require larger and logistically more complex assessment and management frameworks, the cost of which would have to be borne by Industry.

We propose to geographically limit the fishery to WCVI, with PFMA 125 designated as an experimental area to be fished using aggressive harvest rates, under a 100 t TAC, as was intended in the last three years. PFMA represents approximately 8% of the estimated Tanner crab habitat in B.C. (Table 45). If the fishery succeeds in removing 100 t from the area, Industry concerns that we are underestimating biomass would be supported. If the fishery is unable to remove the TAC, without extenuating circumstances, this would increase our confidence in our estimation methods. It is possible that sufficient effort in the area might also result in data robust enough to support depletion modeling, and provide an independent estimate of stock size at the beginning of the fishing season.

PFMA 127 is the area off WCVI that is least affected by the thornyhead fishery. This area would not be fished, and would be used as a control. The area would be regularly monitored to determine if trends in stock status in WCVI were due to fishery effects in PFMA 123-126, or were part of general trends driven by factors other than the fishery.

Other areas of the B.C. continental slope would be set aside as refugia. Tanner crabs stocks in these areas are either poorly known (QCS) or are documented to be at lower levels of abundance (WCQCI). We also are concerned that greater abundance of other species of deep water crab, such as *Paralomis multispina*, *Paralomis verilli* and *Lithodes couesi*, will result in greater bycatch issues if fisheries are pursued in these areas.

The remaining areas of WCVI (PFMA 123, 124 and 126) would be fished under conservative TACs. These areas account for approximately 37% of the estimated habitat area for Tanner crabs in British Columbia (Table 45). These areas would have to be monitored, both in the crab trap fishery and the groundfish trap and trawl fisheries, and when the TACs are achieved the areas would be closed to all sectors of the Industry. Obviously, such monitoring would require management of continental slope resources on an ecosystem basis rather than individual species managed by different sectors; this has been recommended in the past (Stocker and Perry 2000) but has not been enacted to date.

Workman *et al*. (2000) proposed use of conservative 10-20% harvest rates for calculating TACs off WCVI, although the rationale for these rates was not documented. Boutillier *et al*. (1998) discussed using simple production models (with natural mortality, virgin biomass and a scaling factor as input parameters) to calculate conservative harvest levels. They presented a table of estimated mortality rates based on maximum age and a range of scaling factors, but did not endorse a range of harvest rates they felt would be acceptable. In the absence of new information on maximum age and life history strategy, we applied Workman *et al*.'s range of recommended harvest rates to the weighted estimates of biomass to produce a range of conservative harvest levels for PFMAs off WCVI (Table 47).

Conclusions and Recommendations

Although a considerable amount has been learned about the distribution and biology of *C. tanneri* in B.C., the issue of potential production from a sustainable fishery remains unknown. We propose to continue to explore the potential for development of a fishery for offshore Tanner crab by answering specific concerns through a directed, co-operative assessment program with Industry. In support of this proposal, we recommend the following:

1. **Begin annual assessments using trawl gear in the area of the experimental fishery and an unharvested reference area.** Repeated surveys in these areas will be used to develop a time series of indices of abundance. The effects of the fishery can then be examined quantitatively in terms of changes in abundance and shifts in

relative abundance of different sexes and size categories. Included are recommendations to:

- Improve estimates through better quantification of time the gear was fishing and refine measurements of trawl configuration and area swept.
- Explore possible correlations between trawl survey densities and trap catch rates to allow more robust assessment information using two sources of data

2. **Restrict fishery development to the west coast of Vancouver Island.** This would allow continued assessment of potential for development while only placing a portion of the stock at risk. Queen Charlotte Sound and the west Coast of the Queen Charlotte Islands would be considered refugia.
3. **Continue the experimental fishery to examine sustainability and productivity of Tanner crabs in a small area of the coast.** This experimental fishery was designed to provide an independent estimate of abundance for comparison to estimates from fishery-independent trawl surveys. Fishing effort must increase, either through a longer season or more vessels participating, to ensure that the experimental TAC is achieved, whether to compare to lightly fished and unexploited areas or effect sufficient depletion of the resource in the area to generate a signal in a depletion model. We propose:
    - Conducting an experimental fishery in PFMA 125 using aggressive harvest strategies (100 t TAC) to test resource potential and preliminary biomass estimates;
    - Conduct experimental fisheries in PFMA 123, 124 and 126 using conservative TACs;
    - Use PFMA 127 as an unexploited control area to determine if stock trends in other areas are fishery-induced or driven by other factors.
4. **Develop an ecosystem-based management framework for fisheries on the continental slope.** This would entail increased co-operation between Fishery Management and Stock Assessment programs from different sectors. Benefits would include more rational utilization of continental shelf resources and conservation of biodiversity in continental slope ecosystems until this region is better understood.
5. **Examine the feasibility of tagging programs with deepwater crab species.** If tagging can be done effectively, explore the utility of a tagging program to examine mortality rates of undersize male and female Tanner crabs and other crab species. The program could potentially be used to confirm population estimates from trawl and trap surveys, and mortality rates of mature crabs.
6. **Develop effort standardization studies to examine the relationship between soak time and catch rate.** These studies are necessary if fishery-dependent catch data are to be useful within the assessment framework.
7. **Explore gear modifications for exclusion of undersize male and female Tanner crabs.** We are concerned about catch rates of females and undersize males in the experimental fishery, and currently work under the assumption of 100% mortality of discarded crabs. A more pragmatic approach would be to develop traps that exclude these portions of the population, rather than using escape rings to allow small crabs to leave (escape rings also present opportunities for small crabs to enter traps). Considerable time savings in catch processing could be effected by more selective traps, and would result in increased conservation benefits for the stock.

8. **Complete trawl survey off the west coast of the Queen Charlotte Islands.** All other areas of the coast have had initial assessments to examine relative abundance, distribution and biological characteristics of Tanner crabs and associated fauna. Completion of the WCQCI trawl survey will finish the coast-wide exploratory phase of data gathering.

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References

Adams, A.E. 1985. Some aspects of reproductive biology of the crab *Chionoecetes bairdi*: Final project report. Alaska Sea Grant report 85-06, University of Fairbanks, Alaska.

Biron, M., M. Moriyasu, E. Wade, P. DeGrace, R. Campbell and M. Hebert. 1999. Assessment of the 1998 snow crab fisheries off Eastern Nova Scotia (Areas 20 to 24 (and 4X)), Canada. CSAS Res. Doc. 99/12. 58 p.

Boutillier, J.A., R.B. Lauzier, A.C. Phillips and L. Barton. 1998. Framework for a Tanner crab (*Chionoecetes tanneri* and *C. angulatus*) fishery in waters off the west coast of Canada. CSAS Res. Doc. 98/125. 29 p.

Bower, S.M, G.R. Meyer, A. Phillips, G. Workman and D. Clark. 2003. New host and range extension in bitter crab syndrome in *Chionoecetes* spp. caused by *Hematodinium* sp. Bull. Eur. Assoc. Fish. Pathol. 23(2): 82-86.

Dawe, E., G.D.M. Taylor, P.J. Veitch, H.J. Drew, P.C. Beck and P.G. O'Keefe. 1997. Status of Newfoundland and Labrador snow crab in 1996. CSAS Res. Doc. 97/07. 30 p.

Donaldson, W.E. and A.E. Adams. 1986. An ethogram and description of mating behaviour for the Tanner crab, *Chionoecetes bairdi* M.J. Rathbun. .Alaska Dept. of Fish and Game Information leaflet No. 256. 30 p.

Donaldson, W.E. and A.E. Adams. 1989. Ethogram of behaviour with emphasis on mating for the Tanner crab *Chionoecetes bairdi* Rathbun. J. Crust. Biol. 9: 37-53.

Eaton, W.D., D.C. Love, C. Botelho, T.R. Meyers, K. Imamura and T. Koeneman. 1991. Preliminary results on the seasonality and life cycle of the parasitic dinflagellate causing bitter crab disease in Alaskan Tanner crabs (*Chionoecetes bairdi*). J. Invertebr. Pathol. 57: 426-434.

Haist, V., R. Hilborn and M. Wyeth. 2001. Sablefish stock assessment for 2001 and advice to managers for 2002. CSAS Res. Doc. 2001/135.

Hart, J.F.L. 1982. Crabs and their relatives of British Columbia. B.C. Prov. Mus. Handbook 40. 267 p.

Hebert, M., E. Wade, P. DeGrace, M. Biron and M. Moriyasu. 1999. The 1998 assessment of snow crab, *Chionoecetes opilio*, stock in the southern Gulf of St. Lawrence (Areas 12-25/26, 18, 19, E and F). CSAS Res. Doc. 99/11. 69 p.

Hughes, S.E. 1981. Initial U.S. exploration of nine Gulf of Alaska seamounts and their associated fish and shellfish resources. Mar. Fish. Rev. 43(1): 26-33.

Jadamec, S.L., W.E. Donaldson and P. Cullenberg. 1999. Biological field techniques for *Chionoecetes* crabs. Univ. of Alaska, Alaska Sea Grant, AK-SG-99-02. 80 p.

Jamieson, G.S. 1990. Development of a fishery for *Chionoecetes tanneri* on the continental slope off British Columbia: management implications. p. 587-592. *In*: Proceedings of the International Symposium on king and Tanner crabs. Univ. of Alaska, Alaska Sea Grant, AK-SG-90-02.

Jamieson, G.S., G.D. Heritage and D. Noakes. 1990. Life history characteristics of *Chionoecetes tanneri* off British Columbia. p. 153-162. *In*: Proceedings of the International Symposium on king and Tanner crabs. Univ. of Alaska, Alaska Sea Grant, AK-SG-99-02.

Love, D.C., S.D. Rice, D.A. Moles and W.D. Eaton. 1993. Seasonal prevalence and intensity of bitter crab dinoflagellate infection and host mortality in Alaskan Tanner crabs *Chionoecetes bairdi* from Auke Bay, Alaska, USA. Dis. Aquat. Org. 15: 1-7.

Love, D., R. Thomas and A. Moles. 1996. Bitter crab hemolymph studies: Indications of host physical condition. Proc. Int. Symp. High Latitude Crabs. Alaska Sea Grant 96-02: 549-562.

McCallum, B.R. and S.J. Walsh. 1997. Groundfish survey trawls used at the Northwest Atlantic Fisheries Center, 1971 to present. NAFO Sci. Counc. Stud. 29: 93-104.

Meyers, T.R., C. Botelho, T.M. Koeneman, S. Short and K. Imamura. 1990. Distribution of bitter crab dinoflagellate syndrome in southeastern Alaska Tanner crabs *Chionoecetes bairdi*. Dis. Aquat. Org. 9: 37-43.

Meyers, T.R., T.M. Koeneman, C. Botelho and S. Short. 1987. Bitter crab disease: a fatal dinoflagellate infection and marketing problem for Alaskan Tanner crabs *Chionoecetes bairdi*. Dis. Aquat. Org. 3: 195-216.

Meyers, T.R., J.F. Morado, A.K. Sparks, G.H. Bishop, T. Pearson, D. Urban and D. Jackson. 1996. Distribution of bitter crab syndrome in Tanner crabs (*Chionoecetes bairdi, C. opilio*) from the Gulf of Alaska and Bering Sea. Dis. Aquat. Org. 26: 221-227.

Moriyasu, M., and G.Y. Conan. 1988. Aquarium observations on mating behaviour of snow crab, *Chionoecetes opilio*. Int. Counc. Explor. Sea C.M. K:9.

Pereya, W. 1966. The bathymetric and seasonal distribution and reproduction of adult Tanner crabs, *Chionoecetes tanneri* Rathbun, off the northern Oregon coast. Deep-Sea Res. 13: 1185-1205.

Perry, R.I., C.J. Walters and J.A. Boutillier. 1999. A framework for providing scientific advice for the management of new and developing invertebrate fisheries. Rev. Fish Biol. Fish. 9: 125-150.

Pestal, G.P, D.M. Taylor, J.M. Hoenig, J.D. Shields and R. Pickvance. 2003. Monitoring the prevalence of the parasitic dinoflagellate *Hematodinium* sp. in snow crabs *Chionoecetes opilio* from Conception Bay, Newfoundland. Dis. Aquat. Org. 53: 67-75.

Phillips, A.C. and R. Lauzier. 1997. Biological background for the development of a new fishery for the grooved Tanner crab (*Cionoecetes tanneri*) of British Columbia. CSAS Res. Doc. 97/148. 81 p.

Rathbun, M.J. 1893. Catalogue of the crabs of the family Majidae in the U.S. National Museum. Proc. U.S. Natl. Mus. 16: 63-103, pl. 3-8.

Rathbun, M.J. 1925. The spider crabs of America. Bull. U.S. Natl. Mus. 129. 613 p. + 283 pl.

Sainte-Marie, B. and F. Hazel. 1992. Moulting and mating of snow crabs, *Chionoecetes opilio* (O. Fabricius), in shallow waters of the northwestern Gulf of St. Lawrence. Can. J. Fish. Aquat. Sci. 49: 1282-1293.

Schnute, J.T., N. Olsen and R. Haigh. 1999. Slope rockfish assessment for the west coast of Canada in 1998. CSAS Res Doc. 99/16. 79 p.

Somerton, D.A. 1982. Bipartite breeding: a hypothesis of the reproductive pattern in tanner crabs. Proc. Int. Symp. on the Genus *Chionoecetes*. Alaska Sea Grant Rep. 82-10 : 283-292.

Somerton, D.A. and W. Donaldson. 1996. Contribution to the biology of the grooved and triangle Tanner crabs, *Chionoecetes tanneri* and *C. angulatus*, in the eastern Bering Sea. Fish. Bull. (U.S.) 94: 348-357.

Starr, P.J. 2001. Assessment of the Canadian longspine thornyhead () for 2001. CSAS Res Doc. 2001/136. 57 p.

Stevens, B.G., J.A. Haaga, and W.E. Donaldson. 1994. Aggregative mating behaviour of tanner crabs, *Chionoecetes bairdi*. J. Fish. Aquat. Sci. 51: 1273-1280.

Stocker, M and I. Perry [eds.]. 2000. Report of the Invertebrate Subcommittee meeting, June 19-22, 2000. CSAS Proc. Ser. 2000/011. 40 p.

Taylor, D.M. and R.A. Khan. 1995. Observations on the occurrence of *Hematodinium* sp. (Dinoflagellata: Syndinidae), the causative agent of bitter crab disease in Newfoundland snow crab (*Chionoecetes opilio*). J. Invertebr. Pathol. 65: 283-288.

Taylor, D.M., G.P. Pestal, J.M. Hoenig and J.D. Shields. 2002. Sensitivity and specificity of macroscopic criteria for diagnosing *Hematodinium* sp. infections in snow crabs. CSAS Res. Doc. 2002/002. 15 p.

Tester, P. and A. Carey. 1986. Instar identification and life history aspects of juvenile deep water spider crabs, *Chionoecetes tanneri* Rathbun. Fish. Bull. (U.S.) 84: 973-980.

Walsh, S.J. and B.R. McCallum. 1997. Performance of the Campelen 1800 shrimp trawl during the 1995 Northwest Atlantic Fisheries Center autumn groundfish survey. NAFO Sci. Counc. Stud. 29: 105-116.

Workman, G.D., A.C. Phillips, F.E. Scurrah and J.A. Boutillier. 2000. Development of a fishery for Tanner crab (*Chionoecetes tanneri*) off the coast of British Columbia. CSAS Res. Doc. 2000/169. 71 p.

Workman, G.D., J.A. Boutillier, A.C. Phillips, G.E. Gillespie, W.-G. Park, D. Clark and B. Pennell. 2001. Results of a bottom trawl survey of grooved Tanner crab, *Chionoecetes tanneri* Rathbun, stocks off the west coast of Vancouver Island, July 21-August 3, 1999. Can. Manuscr. Rep. Fish. Aquat. Sci. 2568. 79 p.

Workman, G.D., A.C. Phillips, F.E. Scurrah and J.A. Boutillier. 2002. A new fishery for grooved Tanner crab (*Chionoecetes tanneri*) off the coast of British Columbia, Canada. p. 439-456. *In*: Crabs in cold water regions: biology, management and economics. Univ. of Alaska, Alaska Sea Grant, AK-SG-02-01.

Table 1. Dates, areas and number of trawl sets completed during DFO surveys, CCGS W.E. RICKER, 1999-2003.

Year	Dates	Area	# Sets
1999	Jul 22 – Aug 8	West Coast Vancouver Is. North	40
2000	Aug 26 – Sep 4	Queen Charlotte Sound	30
		West Coast Queen Charlotte Is. South	
2001	Aug 25 – Sep 9	West Coast Vancouver Is. South	41
2002	Sep 1- Sep 4	West Coast Queen Charlotte Is. North	15
2003	Apr 3 – Apr 18	West Coast Vancouver Is. North	36

Table 2. Dates, areas and number of traps fished during DFO surveys, CCGS W.E. RICKER, 1999-2001.

Year	Dates	Area	# Traps
1999	Jul 22-Aug 8	West Coast Vancouver Is. North	90
2000	Aug 26-Sep 4	Queen Charlotte Sound	90
		West Coast Queen Charlotte Is. South	30
2001	Aug 25-Sep 9	West Coast Vancouver Is. South	135

Table 3. Dates, areas, number of strings and number of traps fished during Industry trap surveys, 1999-2003.

Survey	Sets	Number of traps	Start	Finish
1999/2000 WCVI	290	5,094	December 19, 1999	January 25, 2000
2000 WCQCI	60	1,035	March 5, 2000	April 27, 2000
2003 WCQCI	144	2,677	February 1, 2003	March 14, 2003

Note: Start date is the first day traps were deployed and finish date is the last day traps were retrieved.

Table 4. Dates, number of strings and number of traps fished during Industry experimental fisheries off WCVI, 1999-2003.

Season	Sets	Number of traps	Start	Finish
1999/2000	64	3,650	January 24, 2000	March 30, 2000
2000/2001	81	5,071	February 3, 2001	March 31, 2001
2001/2002	162	9,923	December 14, 2001	April, 15, 2002
2002/2003	17	1,031	November 24, 2002	January 17, 2003

Note: Start date is the first day traps were deployed and finish date is the last day traps were retrieved.

Table 5. Depth strata used to categorize survey and fishery data, 1999-2003.

Stratum	Depths (m)
1	400-599
2	600-799
3	800-999
4	1,000-1,199
5	1,200-1,399
6	1,400-1,599
7	≥1,600

Table 6. Mean density (kg/km^2) and standard error (SE) of Tanner crabs, *Chionoecetes tanneri*, off WCVI from DFO trawl surveys, by year and depth stratum.

All Sexes and Sizes

	1999 (PFMA 124-126, fall)			2001 (PFMA 123-124, fall)			2003 (PFMA 123-127, spring)		
Stratum	Density	SE	n	Density	SE	n	Density	SE	n
1	37.9	55.5	9	100.1	102.9	5	178.5	96.2	3
2	175.9	183.1	10	911.1	828.3	6	969.7	592.6	5
3	390.1	736.0	9	1,057.4	492.1	6	792.0	925.7	11
4	255.2	102.4	4	421.1	385.0	7	681.4	837.3	5
5	218.9	309.5	2	30.5	38.3	3	295.1	187.5	3

Males ≥112 mm CW

	1999 (PFMA 124-126, fall)			2001 (PFMA 123-124, fall)			2003 (PFMA 123-127, spring)		
Stratum	Density	SE	n	Density	SE	n	Density	SE	N
1	35.3	47.6	9	100.1	103.0	5	164.9	73.4	3
2	118.3	79.7	10	752.0	541.7	6	618.9	456.4	5
3	97.3	115.3	8	449.4	280.9	6	545.5	767.5	11
4	108.9	81.5	4	263.8	205.4	7	518.0	677.5	5
5	0.0	-	1	0.0	0.0	3	116.6	97.0	3

Table 7. Mean density (kg/km^2) and standard error (SE) of Tanner crabs, *Chionoecetes tanneri*, in QCS from the 2000 DFO trawl survey, by depth stratum.

All Sexes and Sizes

	2000 (PFMA 130 and 142)		
Stratum	Density	SE	n
1	-	-	0
2	94.1	82.0	3
3	42.2	61.0	4
4	0.0	-	1
5	3.5	7.9	5

Males ≥112 mm CW

	2000 (PFMA 130 and 142)		
Stratum	Density	SE	n
1			0
2	88.7	76.9	3
3	41.8	60.4	4
4	0.0	-	1
5	3.1	6.9	5

Table 8. Mean density (kg/km^2) and standard error (SE) of Tanner crabs, *Chionoecetes tanneri*, off WCQCI from the 2002 DFO trawl survey, by depth stratum.

All Sexes and Sizes

	2002 (PFMA 101 and 142)		
Stratum	Density	SE	n
1	0.0	0.0	3
2	88.9	-	1
3	206.0	-	1
4	24.6	28.9	6
5	-	-	0

Males ≥112 mm CW

	2002 (PFMA 101 and 142)		
Stratum	Density	SE	n
1	0.0	0.0	3
2	77.3	-	1
3	144.2	-	1
4	27.6	30.6	6
5	-	-	0

Table 9. Mean catch rate (crabs/trap) of Tanner crabs, *Chionoecetes tanneri*, from DFO trap surveys off WCVI, by sex, size category and depth stratum, 1999 and 2001.
Means for males ≥112 mm CW could only be calculated by string, thus SD represents variance between strings only, not between traps in a string.

1999

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	30	2.73	3.25	0.00	0.00	2.70	3.72
2	15	6.13	2.34	3.87	4.73	5.53	-
3	30	20.30	13.69	32.20	32.88	4.24	3.73
4	0	-	-	-	-	-	-
5	15	0.00	0.00	0.00	0.00	0.00	-

2001

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	15	5.20	3.67	0.00	0.00	5.20	-
2	45	2.31	3.32	0.18	0.53	2.13	2.18
3	30	1.67	1.81	0.30	0.70	0.89	0.66
4	15	1.87	1.68	0.13	0.35	1.80	-
5	30	0.40	0.86	0.13	0.35	0.20	0.28

Table 10. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from DFO trap surveys off WCVI, 1999 and 2001.

1999

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
6	90	8.70	11.71	11.38	24.02	4.85	3.03

2001

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
1	15	0.27	0.46	0.00	0.00	0.27	-
2	120	2.24	2.91	0.46	1.15	2.03	1.88

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 11. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from DFO trap surveys off WCVI, 1999 and 2001.

1999

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
124	30	15.80	17.45	31.00	35.35	0.40	0.47
125	60	5.15	4.30	1.98	3.53	4.47	3.07

2001

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
123	105	2.29	3.06	0.41	1.18	2.17	1.99
124	30	1.10	1.42	0.40	0.72	0.63	0.33

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 12. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, from the DFO trap survey in QCS and southern WCQCI, by sex, size category and depth stratum, 2000.

Queen Charlotte Sound

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	0	-	-	-	-	-	-
2	20	2.10	2.79	0.15	0.37	1.85	2.33
3	20	2.55	2.48	0.20	0.52	2.30	2.69
4	10	0.10	0.32	0.00	0.00	0.00	-
5	10	1.10	1.20	0.10	0.32	0.60	-
6	10	0.00	0.00	0.00	0.00	0.00	-
7	20	0.00	0.00	0.00	0.00	0.00	0.00

Southern Queen Charlotte Islands

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	0	-	-	-	-	-	-
2	10	1.60	1.17	0.60	1.90	1.40	-
3	0	-	-	-	-	-	-
4	10	0.80	1.03	0.20	0.42	0.60	-
5	0	-	-	-	-	-	-
6	10	0.00	0.00	0.00	0.00	0.00	-
7	0	-	-	-	-	-	-

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 13. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from DFO trap surveys of QCS and off the southern WCQCI, 2000.

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
2 (QCS)	30	2.70	2.91	0.13	0.43	2.57	2.25
3 (QCS)	20	0.00	0.00	0.00	0.00	0.00	0.00
4 (QCS)	20	0.90	1.07	0.05	0.22	0.50	0.14
5 (QCS)	20	0.30	0.47	0.15	0.37	0.10	0.14
2 (QCI)	30	0.80	1.10	0.27	1.11	0.67	0.70

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 14. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from DFO trap surveys of QCS and off the southern WCQCI, 2000.

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
102	20	0.30	0.47	0.15	0.37	0.10	0.14
130	70	1.41	2.29	0.07	0.31	1.24	1.81
142	30	0.80	1.10	0.27	1.11	0.67	0.70

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 15. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and depth stratum, from Industry trap surveys off WCVI, 1999/2000.

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	1,413	1.46	3.49	0.02	0.31	1.37	2.35
2	1,474	3.54	5.04	0.44	1.34	3.36	3.46
3	1,000	2.48	6.65	0.80	3.07	2.02	2.38
4	150	1.35	2.55	0.05	0.25	1.22	1.60
5	37	0.54	1.19	0.00	0.00	0.53	0.45

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 16. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chinoecetes tanneri*, by sex, size class and latitudinal block, from the Industry trap survey off WCVI in 1999/2000.

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
1	168	0.52	1.01	0.05	0.37	0.51	0.51
2	254	1.07	2.04	0.17	0.48	0.94	1.46
3	278	1.23	2.52	0.25	2.52	1.09	2.05
4	262	1.66	2.44	0.35	1.05	1.42	1.20
5	335	2.66	4.68	0.62	1.76	2.23	3.77
6	311	2.80	4.15	2.03	5.17	2.21	2.48
7	317	2.26	3.74	0.50	1.13	1.84	2.38
8	389	3.00	9.44	0.22	1.00	2.51	1.88
9	279	2.34	3.32	0.05	0.33	2.32	2.38
10	289	4.26	6.64	0.14	0.73	4.02	4.79
11	315	2.92	4.42	0.14	0.70	2.86	2.96
12	262	2.32	3.50	0.10	0.51	2.26	2.20
13	302	4.41	7.26	0.13	0.67	4.34	4.75
14	313	1.46	2.35	0.10	0.76	1.43	1.29

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 17. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chinoecetes tanneri*, by sex, size class and PFMA, from the Industry trap survey off WCVI in 1999/2000.

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
123	458	0.85	1.70	0.11	0.42	0.80	1.18
124	955	2.09	3.69	0.76	3.02	1.67	2.46
125	1,129	2.63	6.41	0.47	1.59	2.08	2.19
126	715	3.29	5.20	0.14	0.69	3.28	3.61
127	817	2.79	5.13	0.10	0.58	2.78	3.39

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 18. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and depth stratum, from Industry trap surveys off WCQCI, 2000 and 2003.

2000

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	401	0.34	1.08	0.02	0.14	0.33	0.66
2	515	0.88	1.62	0.05	0.24	0.88	0.95
3	132	1.83	2.02	0.07	0.28	1.71	0.80
4	0	-	-	-	-	-	-
5	0	-	-	-	-	-	-

2003

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	419	0.13	0.48	0.01	0.11	0.11	0.20
2	538	1.12	1.69	0.10	0.37	1.03	0.92
3	513	1.26	1.93	0.22	0.71	1.12	0.84
4	717	0.66	1.12	0.15	0.60	0.51	0.38
5	490	0.27	0.88	0.04	0.24	0.19	0.48

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 19. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from Industry trap surveys off WCQCI, 2000 and 2003.

2000

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	121	0.55	1.07	0.03	0.18	0.64	0.42
9	227	1.22	2.01	0.00	0.07	1.18	1.37
10	65	1.69	2.58	0.00	0.00	1.69	0.83
11	165	0.90	1.46	0.01	0.11	0.88	0.79
12	172	0.80	1.48	0.04	0.21	0.77	0.93
13	91	0.69	1.24	0.18	0.51	0.68	0.68
14	139	0.12	0.46	0.02	0.15	0.10	0.11
15	68	0.24	0.52	0.09	0.29	0.21	0.21

Note: The 2000 survey was incomplete, including only the northern half of WCQCI and depth strata 1-3.

2003

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
1	56	0.63	1.29	0.05	0.30	0.51	0.46
2	169	0.17	0.49	0.01	0.08	0.13	0.12
3	140	0.91	1.59	0.06	0.26	0.81	0.94
4	37	0.73	1.10	0.14	0.48	0.54	0.01
5	0	-	-	-	-	-	-
6	197	0.71	1.61	0.16	0.45	0.62	1.01
7	182	0.34	0.67	0.22	0.87	0.25	0.30
8	319	0.73	1.37	0.13	0.42	0.57	0.63
9	404	0.74	1.18	0.08	0.34	0.68	0.55
10	210	0.90	1.52	0.12	0.43	0.75	0.82
11	114	0.96	1.31	0.09	0.28	0.91	0.65
12	194	0.82	1.48	0.19	0.65	0.62	0.65
13	325	1.03	2.00	0.11	0.55	1.03	1.21
14	207	0.42	0.96	0.04	0.23	0.31	0.34
15	123	0.59	1.53	0.18	0.83	0.47	0.51

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 20. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from Industry trap surveys off WCQCI, 2000 and 2003.

2000

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
101	370	0.39	0.96	0.08	0.33	0.37	0.51
142	678	1.02	1.78	0.01	0.11	1.01	1.03

2003

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
101	732	0.75	1.65	0.10	0.52	0.68	0.92
142	1,945	0.70	1.30	0.12	0.47	0.58	0.66

Note: Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 21. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and depth stratum, from the experimental fishery off WCVI, 1999/2000 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	34	16.82	13.52	0.09	0.29	15.33	-
2	576	12.67	12.63	0.71	2.69	12.30	6.33

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	93	10.23	7.13	2.33	5.51	10.12	5.07
2	388	13.02	11.32	5.47	8.91	12.90	7.53

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 22. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from the experimental fishery off WCVI, 1999/2000 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
10	366	11.78	11.10	0.29	1.67	10.96	4.35
11	244	14.57	14.66	1.25	3.53	14.15	7.54

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
10	280	9.11	8.32	2.20	5.02	9.27	4.79
11	201	17.16	11.82	8.58	10.59	16.55	7.81

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 23. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from the experimental fishery off WCVI, 1999/2000 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	0	-	-	-	-	-	-
126	610	12.90	12.70	0.68	2.62	12.55	6.10

Subsampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	0	-	-	-	-	-	-
126	481	12.48	10.69	4.87	8.45	12.23	6.74

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 24. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and depth stratum, from the experimental fishery off WCVI, 2000/2001 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	0	-	-	-	-	-	-
2	1,290	17.13	11.92	2.50	3.98	17.13	5.78

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	16	10.50	6.85	1.56	2.56	10.50	2.60
2	612	10.94	7.81	0.30	1.26	10.76	5.37

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 25. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from the experimental fishery off WCVI, 2000/2001 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	202	12.33	9.70	2.24	3.65	12.30	3.81
9	1,088	18.02	12.08	2.54	4.04	17.96	5.72

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	167	9.65	7.10	0.29	1.23	9.57	4.63
9	461	11.40	7.97	0.35	1.35	10.99	5.36

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 26. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from the experimental fishery off WCVI, 2000/2001 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	202	12.33	9.70	2.24	3.66	12.30	3.81
126	1088	18.02	12.08	2.54	4.04	17.96	5.72

Subsampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	314	10.03	7.04	0.31	1.28	9.76	5.32
126	314	11.84	8.38	0.36	1.36	11.43	4.96

Note: “All sampled” data include catch by trap for every trap on each string. “Subsampled” data represent trips where catch was recorded for only a subsample of traps on each string. “Subsampled” data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 27. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and depth stratum, from the experimental fishery off WCVI, 2001/2002 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	124	8.32	9.77	0.64	1.78	7.72	9.69
2	1,394	10.51	9.73	0.44	1.71	10.26	5.66

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	190	6.22	6.58	4.69	8.85	5.86	4.26
2	929	10.31	8.28	2.79	6.10	10.07	5.45
3	10	9.60	2.91	0.00	0.00	9.40	-

Note: “All sampled” data include catch by trap for every trap on each string. “Subsampled” data represent trips where catch was recorded for only a subsample of traps on each string. “Subsampled” data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 28. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from the experimental fishery off WCVI, 2001/2002 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	174	8.89	6.82	0.97	3.68	8.59	2.27
9	975	11.39	10.04	0.47	1.31	11.04	5.89
10	369	8.20	9.73	0.20	1.04	8.03	6.79

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	46	7.02	6.42	1.04	3.57	6.55	2.71
9	759	9.32	7.64	3.65	7.31	8.53	4.84
10	324	10.69	9.25	2.04	5.01	9.63	5.75

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 29. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from the experimental fishery off WCVI, 2001/2002 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	441	7.89	7.17	0.57	2.46	7.51	2.93
126	1,077	11.33	10.47	0.41	1.30	11.19	6.45

Subsampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	159	8.95	7.08	1.59	4.05	8.58	4.29
126	970	9.73	8.28	3.33	6.96	8.78	5.18

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" data represent trips where catch was recorded for only a subsample of traps on each string. "Subsampled" data are catch from sampled traps only. Standard deviations for males ≥112 mm CW represent the variance between strings only, and do not include variance between traps on each string.

Table 30. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and depth stratum, from the experimental fishery off WCVI, 2002/2003 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	0	-	-	-	-	-	-
2	663	12.41	9.14	9.30	13.52	11.95	5.38

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	0	-	-	-	-	-	-
2	60	5.88	3.25	8.98	8.00	5.79	1.34

Total Catch by String

		All Males		All Females		Males ≥112 mm CW	
Stratum	# Traps	Mean	SD	Mean	SD	Mean	SD
1	0	-	-	-	-	-	-
2	366	5.51	1.08	11.28	9.40	5.49	1.09

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" and "Total catch by string" data represent trips where catch was recorded for only a subsample of traps on each string, and a total count for the string was collated. "Subsampled" data are catch from sampled traps only. "Total catch by trap" data are all crabs caught on a string divided by the number of traps on that string. SD for "All sampled" and "Subsampled" include variance between traps, SD for "Total catch by string" includes only variance between strings.

Table 31. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and latitudinal block, from the experimental fishery off WCVI, 2002/2003 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	221	10.05	6.91	0.00	0.07	9.39	3.31
9	308	11.95	8.99	15.30	14.90	11.82	5.54
10	134	17.38	10.75	10.84	13.07	17.38	6.93

Subsampled

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	0	-	-	-	-	-	-
9	40	6.58	3.43	11.25	10.73	6.43	1.01
10	20	4.50	2.35	4.45	0.21	4.50	0.99

Total Catch by String

		All Males		All Females		Males ≥112 mm CW	
Block	# Traps	Mean	SD	Mean	SD	Mean	SD
8	0	-	-	-	-	-	-
9	241	5.61	1.09	11.99	10.73	5.59	1.11
10	125	5.29	1.48	4.85	0.21	5.29	1.48

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" and "Total catch by string" data represent trips where catch was recorded for only a subsample of traps on each string, and a total count for the string was collated. "Subsampled" data are catch from sampled traps only. "Total catch by trap" data are all crabs caught on a string divided by the number of traps on that string. SD for "All sampled" and "Subsampled" include variance between traps, SD for "Total catch by string" includes only variance between strings.

Table 32. Mean catch rate (crabs/trap) and standard deviation (SD) of Tanner crabs, *Chionoecetes tanneri*, by sex, size class and PFMA, from the experimental fishery off WCVI, 2002/2003 season.

All sampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	279	10.15	6.65	4.50	11.78	9.51	2.88
126	384	14.05	10.29	12.79	13.68	13.97	6.35

Subsampled

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	0	-	-	-	-	-	-
126	60	5.88	3.25	8.98	8.00	5.79	1.34

Total Catch by String

		All Males		All Females		Males ≥112 mm CW	
PFMA	# Traps	Mean	SD	Mean	SD	Mean	SD
125	0	-	-	-	-	-	-
126	366	5.51	1.08	11.28	9.40	5.49	1.09

Note: "All sampled" data include catch by trap for every trap on each string. "Subsampled" and "Total catch by string" data represent trips where catch was recorded for only a subsample of traps on each string, and a total count for the string was collated. "Subsampled" data are catch from sampled traps only. "Total catch by trap" data are all crabs caught on a string divided by the number of traps on that string. SD for "All sampled" and "Subsampled" include variance between traps, SD for "Total catch by string" includes only variance between strings.

Table 33. Landings (kg) of Tanner crab, *Chionoecetes tanneri*, from the experimental fishery off WCVI, by season and month.

Month	Season			
	1999/2000	2000/2001	2001/2002	2002/2003
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	1,040	4,881
1	3,417	-	30,733	3,650
2	8,424	13,582	16,727	
3	23,095	27,879	16,122	
4	-	3,966	7,038	-
Total	34,936	45,427	71,661	8,532

Note: Landings in 1999/2000 do not include approximately 4,000 kg of crabs that were permitted to be landed from the Industry trap survey.

Table 34. Total number of Tanner crab, *Chionoecetes tanneri*, landed in experimental fisheries off WCVI, by sex, size category and season.

Season	Total Catch (n)		
	Males ≥ 112 mm CW	Females	Males < 112 mm CW
1999/2000	N/A	N/A	N/A
2000/2001	57,692	4,422	N/A
2001/2002	96,207	26,594	N/A
2002/2003	10,184	9,741	65

Note: Observers did not report piece counts in 1999/2000. Female catch in 2000/2001 and 2001/2002 are estimates based on subsamples and catch by trap for entire strings. Number of females was difficult to collate because different observers collected data using different methods.

Table 35. Total catch (number of animals) by trap gear from experimental fisheries off WCVI, by species and season.

Species		Total Catch (n)			
Scientific Name	Common Name	1999/2000	2000/2001	2001/2002	2002/2003
Chionoecetes tanneri	Grooved Tanner crab	N/A	62,114	122,801	19,990
Lithodes couesi	Scarlet king crab	121	1,033	1,020	129
Echinacea	Sea urchins				345
Gastropoda	Snails			1,576	197
Ophiurea	Brittle stars			29	100
Holothuroidea	Sea cucumbers			2	25
Atelostemata	Heart urchins			1,573	8
Octopoda	Octopus		15	18	15
Porifera	Sponge		1		
Bivalvia	Bivalve			1	
Aphrodita sp.	Sea mouse			1	
Anoplopoma fimbria	Sablefish	27	43	55	3
Sebastolobus alascanus	Shortspine thornyhead	2	1	6	
Sebastolobus altivelis	Longspine thornyhead		2	1	3
Coryphaenoides acrolepis	Pacific grenadier		1	1	
Microstomus pacificus	Dover sole		2	2	1
Anotopterus nikparini	Daggertooth			1	
Chauliodus macouni	Pacific viperfish			1	
Pisces	Unident. fish		2	6	1
	Unident. organic matter		6		
Number of strings		64	81	162	17
Number of traps		3,650	5,071	9,923	1,031

Note: Number of Tanner crabs caught in 1999/2000 were not recorded consistently.

Table 36. Mean catch rate (crabs/trap) and standard deviation of scarlet king crabs, *Lithodes couesi*, by latitudinal block, from the Industry trap survey off WCVI, 1999/2000.

		Catch Rate (n/trap)	
Block	# Traps	Mean	SD
1	168	0.02	0.04
2	254	0.00	0.00
3	278	0.00	0.00
4	262	0.01	0.02
5	335	0.03	0.04
6	311	0.01	0.05
7	317	0.02	0.04
8	389	0.03	0.05
9	279	0.04	0.13
10	289	0.05	0.16
11	315	0.13	0.20
12	262	0.19	0.28
13	302	0.26	0.46
14	313	0.43	0.49

Note: Standard deviations (SD) represent the variation between strings only, and do not include variance on each string.

Table 37. Mean catch rate (crabs/trap) and standard deviation of scarlet king crabs, *Lithodes couesi*, by latitudinal block from the DFO trap survey off QCS, 2000.

		Catch Rate (n/trap)	
Block	# Traps	Mean	SD
1	0	-	-
2	30	0.30	0.28
3	20	0.00	0.00
4	20	0.95	0.49
5	20	0.00	0.00

Note: Standard deviations (SD) represent the variation between strings only, and do not include variance on each string.

Table 38. Mean catch rate (crabs/trap) and standard deviation of scarlet king crabs, *Lithodes couesi*, by latitudinal block from the Industry survey off WCQCI, 2003.

		Catch Rate (n/trap)	
Block	# Traps	Mean	SD
1	56	1.68	1.28
2	169	1.11	1.66
3	140	1.18	1.53
4	37	1.66	0.23
5	0	-	-
6	197	0.63	0.74
7	182	0.21	0.20
8	319	0.24	0.32
9	404	0.90	1.16
10	210	1.20	2.13
11	114	0.66	0.85
12	194	0.44	0.43
13	325	0.78	1.29
14	207	0.26	0.27
15	123	0.24	0.29

Note: Standard deviations (SD) represent the variation between strings only, and do not include variance on each string.

Table 39. Total catch (number of animals, kg) by species from the 1999/2000 Industry trap survey off WCVI.

Species		Total Catch	Total Weight
Scientific Name	Common Name	(n)	(kg)
Chionoecetes tanneri	Grooved Tanner crab	11,505	10,540
Lithodes couesi	Scarlet king crab	364	200.5
Anoplopoma fimbria	Sablefish	228	490.4
Sebastolobus alascanus	Shortspine thornyhead	10	2.01
Pisces	Fish	6	10.6
Sebastolobus altivelis	Longspine thornyhead	25	3.99
Coryphaenoides acrolepis	Pacific grenadier	12	23.50
Paralomis multispina		28	18.9
Paralithodes cammtschatica	Red king crab	2	2.00
Bathyraja interupta	Sandpaper skate	2	2.4
Solaster stimpsoni	Sun starfish	6	12
Microstomus pacificus	Dover sole	9	10.9
Octopus sp.	Octopus	1	0.5

Note: Data are from 290 strings totalling 5,094 traps. Weights were not reported consistently.

Table 40. Total catch (number of animals, kg) by species from the 2000 Industry trap survey off WCQCI.

Species		Total Catch	Total Weight
Scientific Name	Common Name	(n)	(kg)
Chionoecetes tanneri	Grooved Tanner crab	872	N/A
Lithodes couesi	Scarlet king crab	666	240
Anoplopoma fimbria	Sablefish	134	273
Sebastolobus alascanus	Shortspine thornyhead	1	1
Pisces	Fish	2	-
Sebastolobus altivelis	Longspine thornyhead	1	1
Coryphaenoides acrolepis	Pacific grenadier	1	1

Note: Data are from 60 strings totalling 1,035 traps. Weights of Tanner crabs were not collected consistently.

Table 41. Total catch (number of animals, kg) by species from the 2003 Industry trap survey off WCQCI.
Total catch is the total number of animals encountered. Weights in kilograms are best estimates. Data are from 144 strings totalling 2,677 traps.

Species		Total Catch	Total Weight
Scientific Name	Common Name	(n)	(kg)
Chionoecetes tanneri	Grooved Tanner crab	2,215	1,701.5
Lithodes couesi	Scarlet king crab	1,933	1,275.7
Paralomis multispina		513	321.3
Gastropoda	Snails	452	22.6
Anoplopoma fimbria	Sablefish	424	688.3
Chionoecetes angulatus	Triangle Tanner crab	329	230.3
Macrouridae	Grenadiers	275	428.9
Asteriodea	Starfish	180	40.5
Echinacea	Sea urchins	124	2.1
Ophiurae	Brittle stars	71	0.7
Porifera	Sponge	34	2.25
Paralithodes brevipes	Brown king crab	15	9.4
Sebastes aleutianus	Rougheye rockfish	14	25.8
Atheresthes stomias	Turbot	13	24.5
Coryphaenoides acrolepis	Pacific grenadier	11	21.8
Octopoda	Octopus	9	17.2
Solaster stimpsoni	Sun starfish	7	0.8
Microstomus pacificus	Dover sole	6	3.4
Sebastolobus alascanus	Shortspine thornyhead	5	2.6
Scyphozoa	Jellyfish	4	1.0
Sebastolobinae	Thornyhead rockfish	4	0.9
Hippoglossus stenolepis	Pacific halibut	3	15.0
Rajidae	Skates	2	1.4
Sebastes babcocki	Redbanded rockfish	2	2.7
Anthozoa	Coral	2	Trace
Paguridae	Hermit crabs	2	Trace
Sebastinae	Rockfish	1	2.3
Pleuronectidae	Right-eye flounder	1	0.5
Decapoda	Unident. crab	1	Trace
Actiniaria	Anemone	1	Trace

Table 42. Catches (kg) of Tanner crabs, *Chionoecetes tanneri*, by the Canadian groundfish trawl fishery by PFMA and year.

	Year							
PFMA	1996	1997	1998	1999	2000	2001	2002	Total
101			28	34	3,275	2,887	2,467	8,692
102	1	39	8	8	55	102	2	216
103							1	1
104		132	6		231		3	373
105		15		0	2			17
106							0	0
107	0	0			6	2	5	14
108	2					139	10	151
109	1	2		0		1	1	5
110		7			46	0		53
111	5		5	0	0	0	0	11
121	9	10			5	0	1	25
123	585	4,321	5,203	2,387	3,533	9,136	11,084	36,249
124	18,543	16,765	27,161	32,748	27,569	42,702	49,367	214,854
125	6,740	5,553	25,643	35,803	21,956	22,655	39,038	157,388
126	3,656	19,220	13,474	55,374	54,429	14,982	27,537	188,673
127	4	14	18	117	6,118	1,488	124	7,882
130	96	187	489		7,423	3,040	1,257	12,493
142		136	136	184	1,412	2,084	2,236	6,188
Total	29,643	46,401	72,172	126,658	126,061	99,318	133,217	633,469

Source: PacHarvTrawl database, Pacific Biological Station.

Table 43. Encounter rates (ER) and total catch (kg) of Tanner crab, *Chionoecetes* sp., from observed commercial sablefish trips, 2000-2002.

		Tanner Crab		
Date of Trip	# Strings	# Strings	ER	Estimated Catch (kg)
Sep-Oct, 2001	17	9	52.9%	33.4
Dec 2001-Jan 2002	72	29	40.3%	68.9
May 2002	63	62	98.4%	341.8
Jun 2002	31	31	100.0%	221.2
Nov 2002	50	23	46.0%	80.3

Source: PacHarvSable database, Pacific Biological Station, Nanaimo.
Note: Includes only strings where either start or end depth exceeded 450 m.

Table 44. Encounter rates (ER) and average catch of Tanner crabs, *Chionoecetes* sp., from DFO sablefish trap surveys, by year.

		Tanner Crab			
Year	# Strings	# Strings	ER	Est. Catch (n)	Catch/String (n)
1990	23	10	43.5%	45	4.5
1991	32	11	34.4%	42	3.8
1992	32	13	40.6%	30	2.3
1993	37	21	56.8%	52	2.5
1994	41	22	53.7%	71	3.2
1995	43	23	53.5%	69	3.0
1996	37	17	45.9%	67	3.9
1997	29	19	65.5%	81	4.3
1998	35	23	65.7%	208	9.0
1999	40	28	70.0%	122	4.4
2000	62	27	43.5%	86	3.2
2001	66	38	57.6%	130	3.4
2002	92	31	33.7%	186	6.0
Total	569	283	49.7%	1,189	4.2

Source: GFBio database, Pacific Biological Station, Nanaimo.
Note: Includes standardized survey strings where mean depth exceeded 450 m.

Table 45. Estimated habitat area (km²) for Tanner crabs, *Chionoecetes tanneri*, off the coast of British Columbia, by PFMA and depth stratum.

	Stratum (Depth range in m)					
	1	2	3	4	5	
PFMA	(400-600)	(600-800)	(800-1,000)	(1,000-1,200)	(1,200-1,400)	Total
101	230	137	185	514	181	1,246
102	92	79	45	10	0	226
123	242	227	239	269	185	1,162
124	360	352	355	420	657	2,145
125	155	189	243	241	166	1,193
126	298	396	257	191	151	1,293
127	193	245	351	521	658	1,969
130	608	568	522	451	484	2,633
142	561	699	563	883	899	3,605
Total	2,739	2,891	2,761	3,499	3,580	15,470

Table 46. Preliminary biomass estimates (t) of Tanner crabs, *Chionoecetes tanneri*, off the coast of British Columbia by PFMA (Workman *et al*. 2000).

All Sexes and Sizes

PFMA	Biomass	95% CL	
		Lower	Upper
101	250	136	450
102	41	23	73
123	241	129	456
124	367	199	689
125	227	114	442
126	255	146	468
127	330	172	637
130	494	272	928
142	634	361	1,157
Total	2,839	1,552	5,300

Males ≥112 mm CW

PFMA	Biomass	95% CL	
		Lower	Upper
101	95	60	141
102	18	13	24
123	89	64	126
124	138	98	194
125	78	55	114
126	106	77	148
127	114	76	167
130	189	139	263
142	249	174	351
Total	1,075	754	1,528

Estimates were produced by expanding density estimates (kg/km^2) from the 1999 DFO trawl survey in PFMA 124 and 125 over estimates of Tanner crab habitat (km^2) in other PFMAs.

Table 47. Preliminary weighted biomass estimates (t) and hypothetical harvest levels of Tanner crabs, *Chionoecetes tanneri*, off the coast of British Columbia by PFMA (Workman *et al*. 2000).

Males ≥112 mm CW

PFMA	Biomass (t)	Weighting Factor	Weighted Biomass (t)	Harvest (t) F=0.10	Harvest (t) F=0.20
101	95	0.42	40		
102	18	0.06	1		
123	89	0.48	43	4.3	8.6
124	138	0.92	127	12.7	25.4
125	78	1.17	89	8.9	17.8
126	106	2.01	213	21.3	42.6
127	114	1.76	200		
130	189	0.76	143		
142	249	0.35	87		
Total	1,075		943		

Note: Estimates were produced by expanding density estimates (kg/km^2) from the 1999 DFO trawl survey in PFMA 124 and 125 over estimates of Tanner crab habitat (km^2) in other PFMAs. The estimates were then weighted using CPUE estimated from the Industry trap surveys in each PFMA.

Table 48. Comparison of sensitivity and specificity of macroscopic diagnosis and microscopic histological examination of Bitter Crab Disease (BCD) in Tanner crabs, *Chionoecetes tanneri*, from the DFO trawl survey off WCVI, April 2003.

Crabs <30 mm CW

Source	Mic +	Mic -	Total	Mic + (%)
Mac +	64	7	71	90.14%
Mac -	15	80	95	15.79%
Total	79	87	166	47.59%

Crabs ≥30 mm CW

Source	Mic +	Mic -	Total	Mic + (%)
Mac +	19	1	20	95.00%
Mac -	2	58	60	3.33%
Total	21	59	80	26.25%

All Crabs

Source	Mic +	Mic -	Total	Mic + (%)
Mac +	83	8	91	91.21%
Mac -	17	138	155	10.97%
Total	100	146	246	40.65%

Notes: Mac = macroscopic diagnosis, Mic = microscopic histological examination, + = positive for BCD, - = negative for BCD.

Table 49. Estimated prevalence of Bitter Crab Disease (BCD) in Tanner crabs, *Chionoecetes tanneri*, from the DFO trawl survey of WCVI, April 2003.

Tow	Catch (n)	Infected (n)	Prevalence
1	220	8	3.6%
4	112	1	0.9%
5	83	2	2.4%
7	17	1	5.9%
8	110	14	12.7%
9	186	2	1.1%
11	229	21	9.2%
12	85	5	5.9%
13	~670	37	~5.5%
14	53	6	1.1%

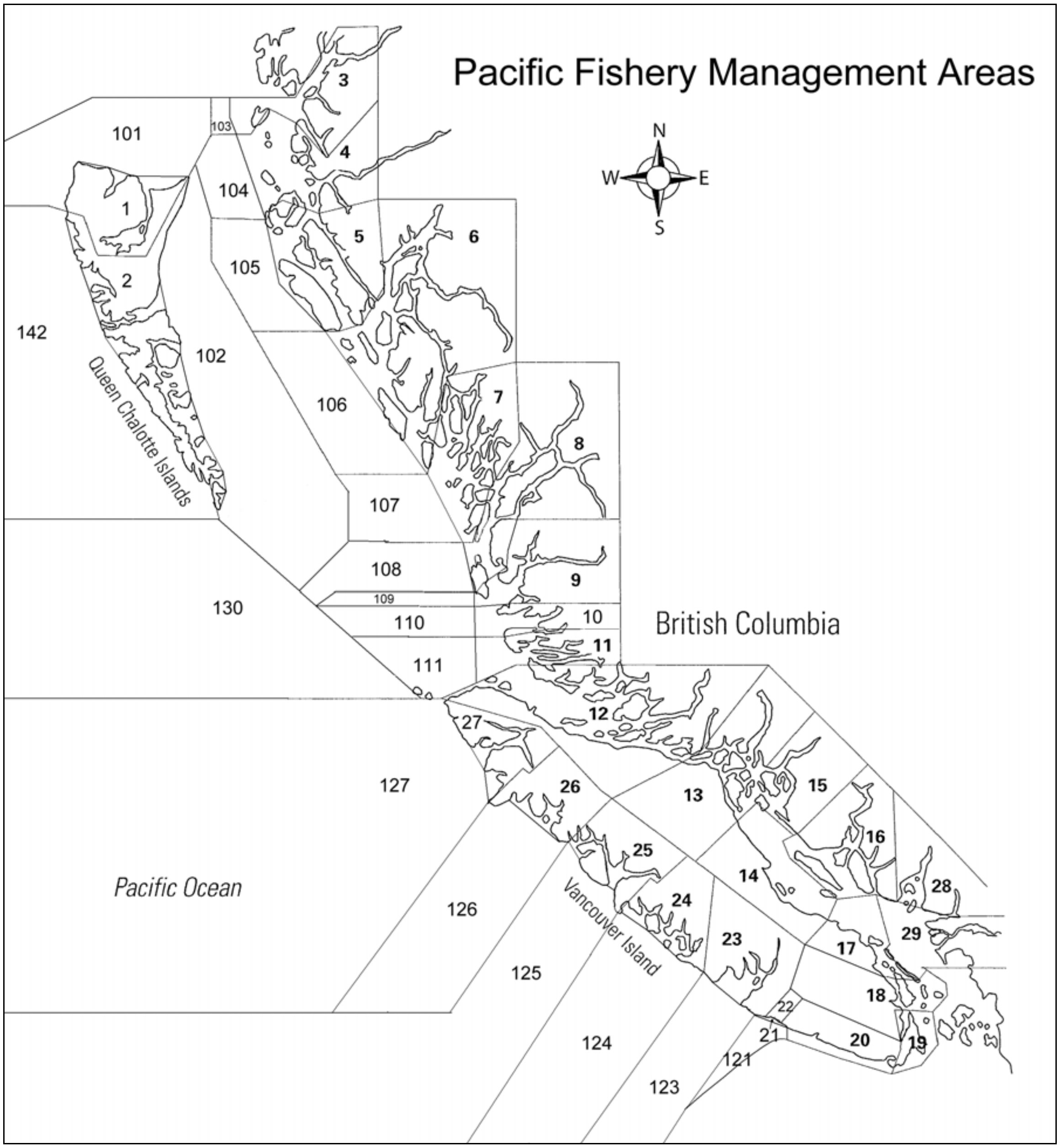


Figure 1. Pacific Fishery Management Areas for British Columbia.

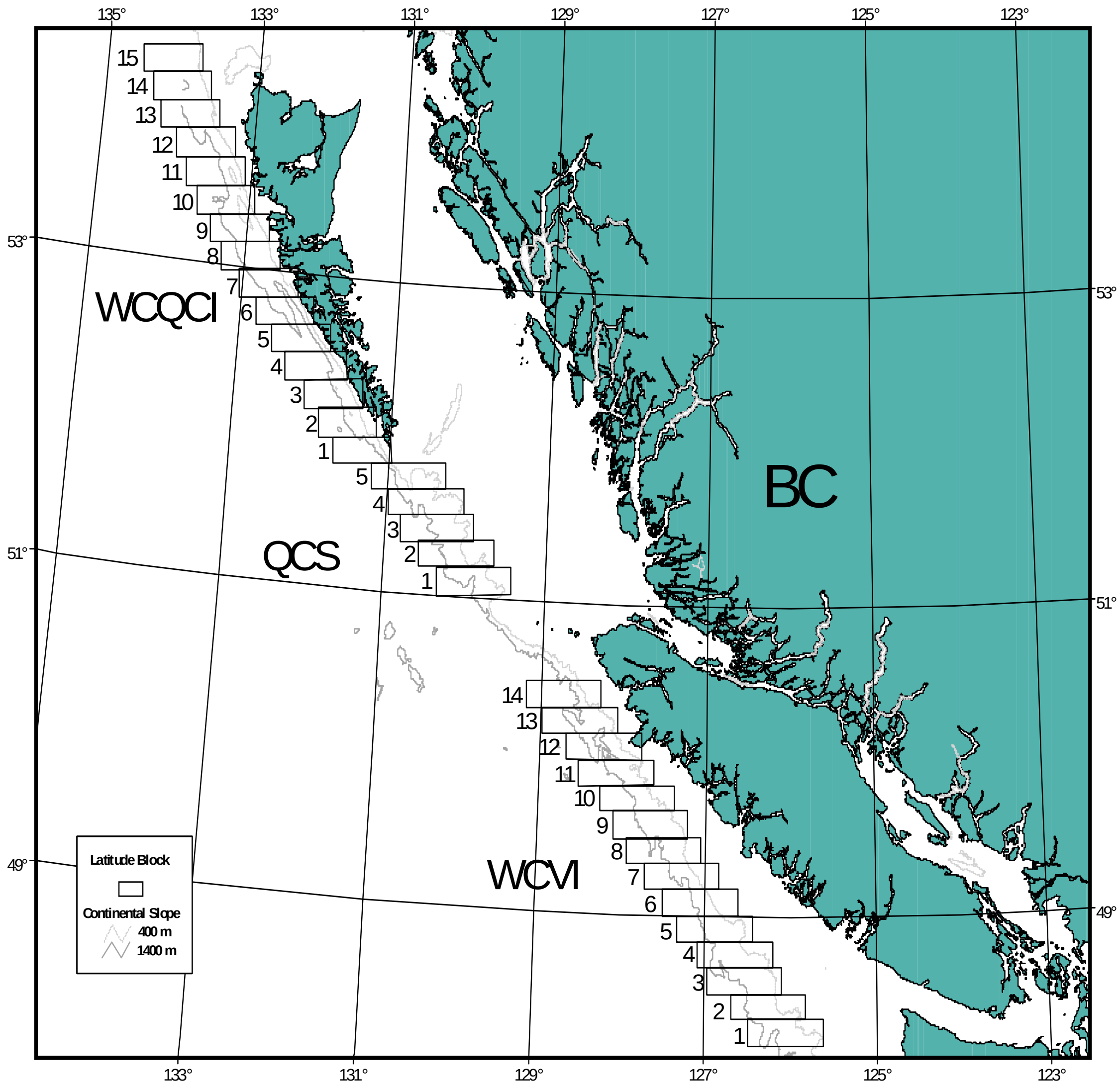


Figure 2. Latitudinal blocks used to summarize catch rates from trap surveys and experimental fisheries in British Columbia.

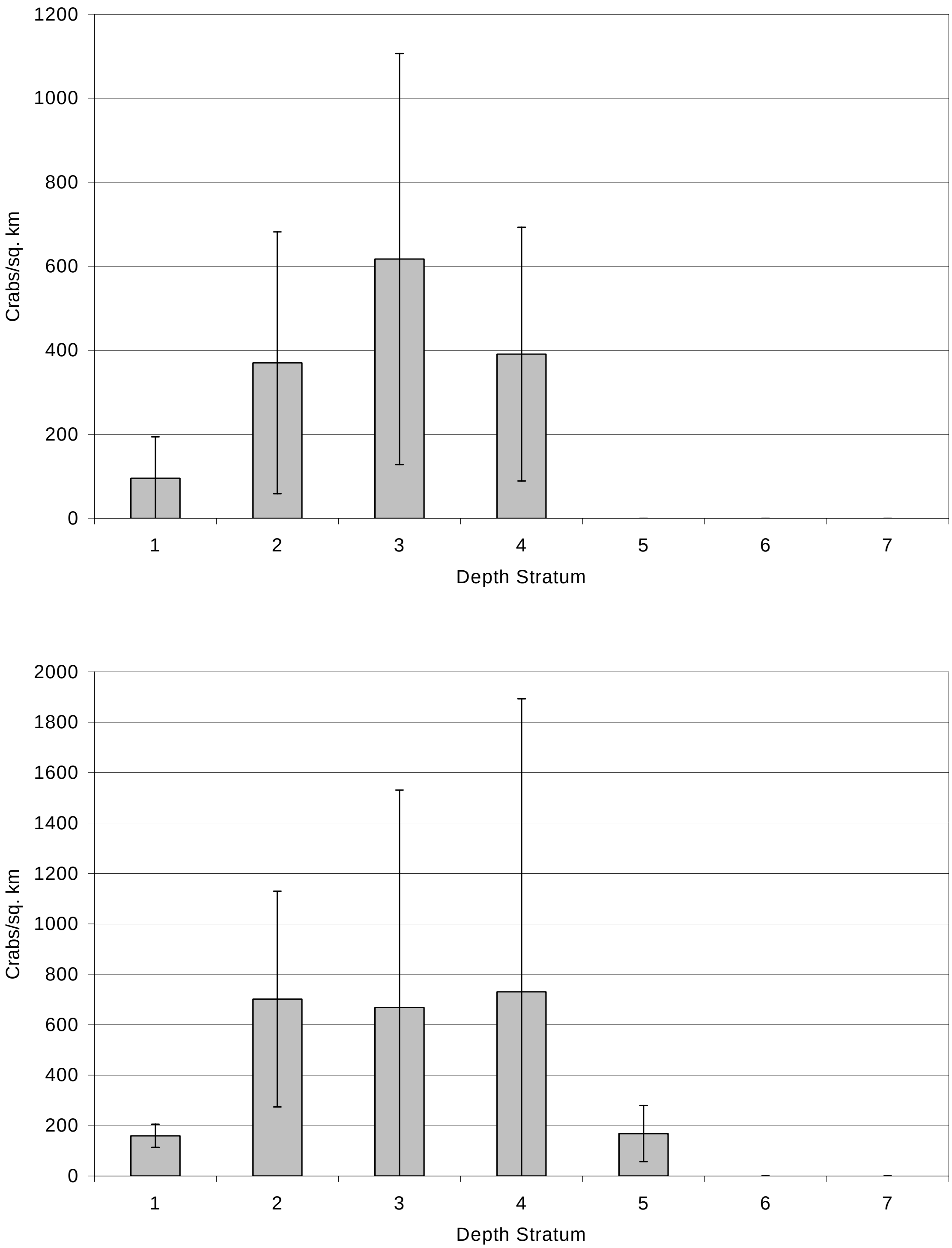


Figure 3. Distribution of legal-size Tanner crab, *Chionoecetes tanneri*, by depth from DFO trawl surveys off WCVI, Fall 2001 (upper panel) and Spring 2003 (lower panel).

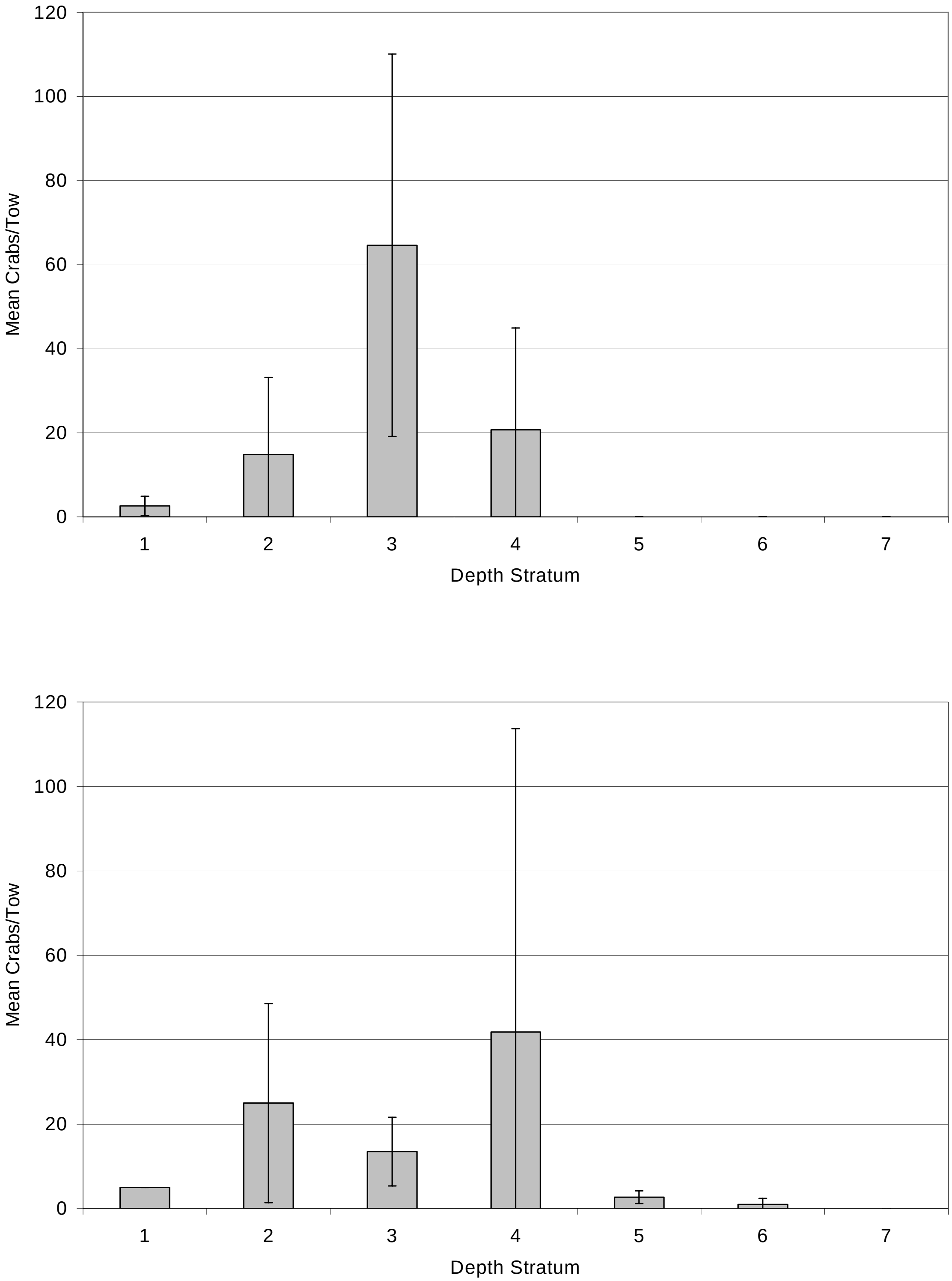


Figure 4. Distribution of adult male Tanner crabs, *Chionoecetes tanneri*, by depth from DFO trawl surveys off WCVI, Fall 2001 (upper panel) and Spring 2003 (lower panel).

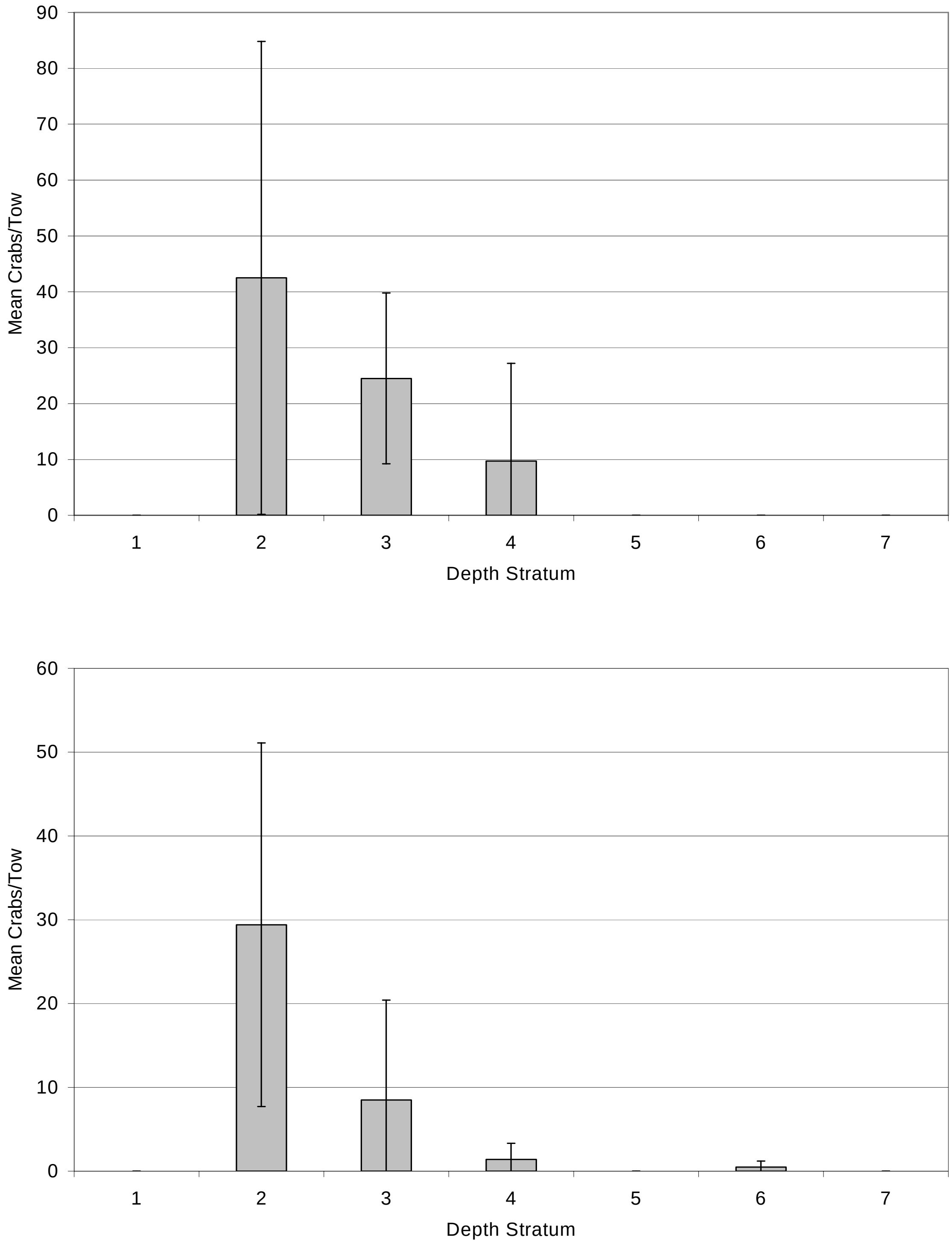
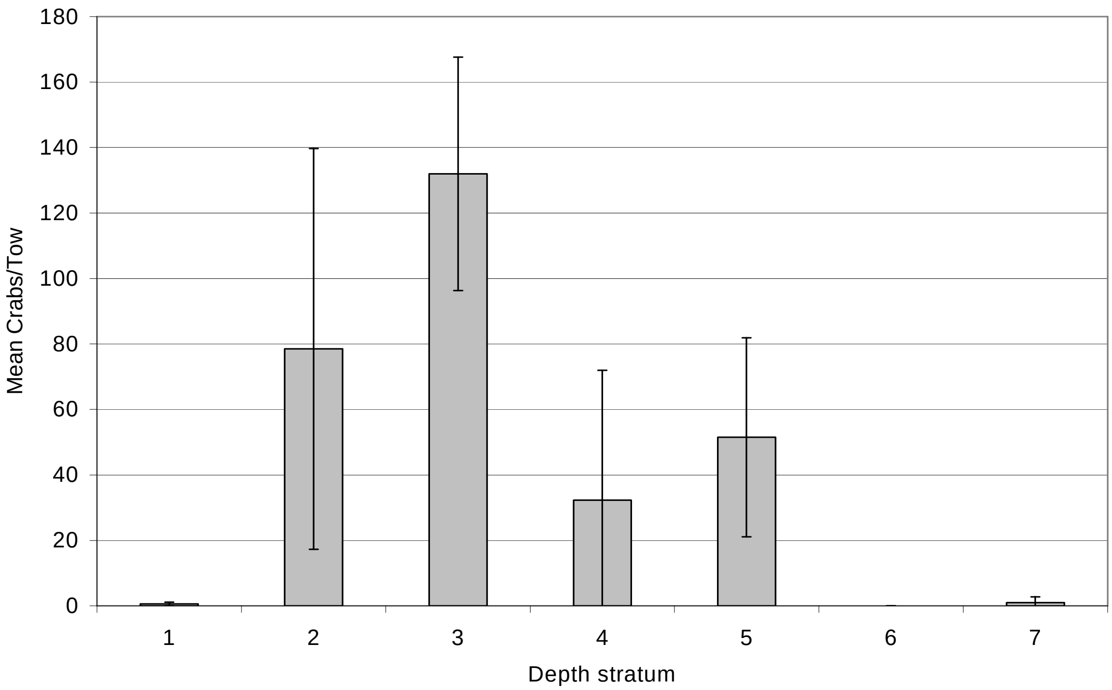


Figure 5. Distribution of adult female Tanner crabs, *Chionoecetes tanneri*, by depth from DFO trawl surveys off WCVI, Fall 2001 (upper panel) and Spring 2003 (lower panel).



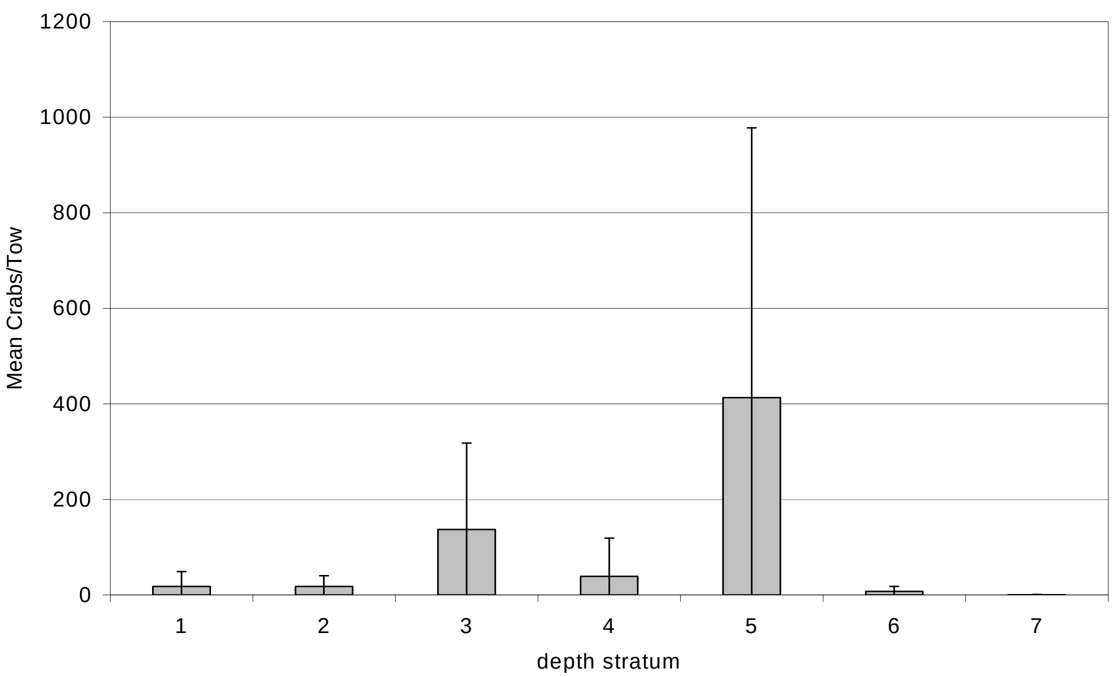


Figure 6. Distribution of juvenile Tanner crab, *Chionoecetes tanneri*, by depth from DFO trawl surveys off WCVI, Fall 2001 (upper panel) and Spring 2003 (lower panel).

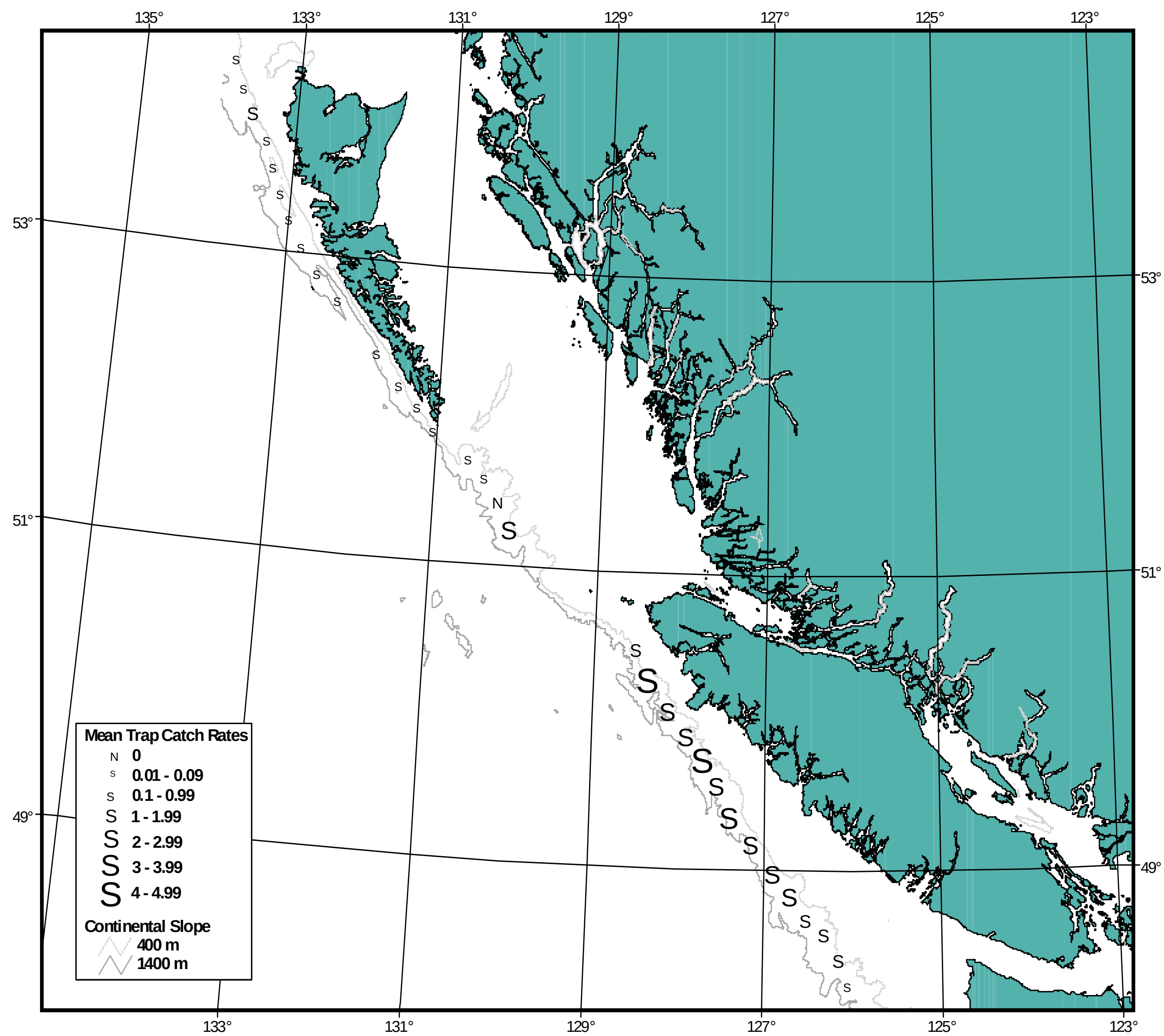


Figure 7. Mean catch rates of Tanner crab, *Chionoecetes tanneri*, off the coast of British Columbia from trap surveys, 1999-2003.

Note: Data for WCVI is from the 1999/2000 Industry trap survey, for QCS is from the 2000 DFO trap survey and from WCQCI is from the 2003 Industry trap survey.

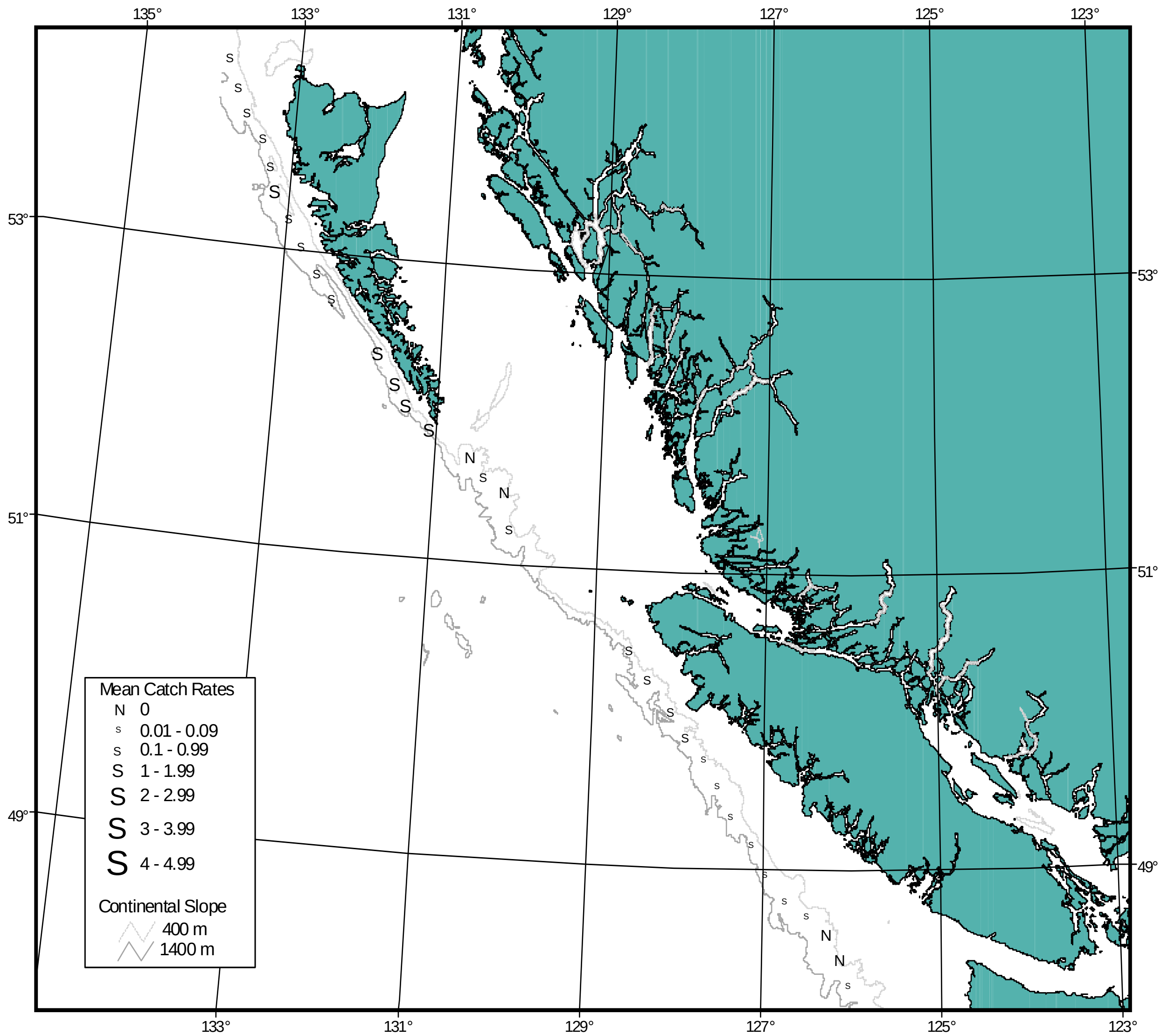


Figure 8. Mean catch rates by latitudinal block of scarlet king crab, *Lithodes couesi*, off the coast of British Columbia from trap surveys, 1999-2003.

Note: Data for WCVI is from the 1999/2000 Industry trap survey, for QCS is from the 2000 DFO trap survey and from WCQCI is from the 2003 Industry trap survey.

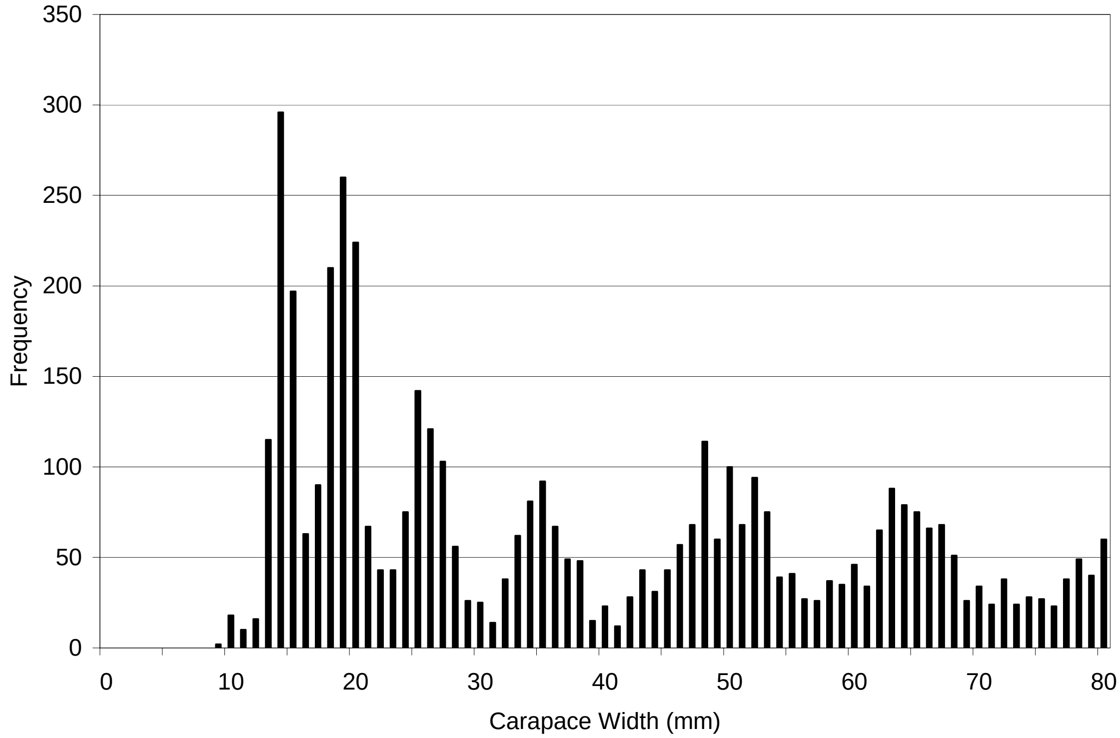


Figure 9. Size distribution of juvenile Tanner crabs, *Chionoecetes tanneri*, sexes combined, from DFO surveys off WCVI, 1999-2003.

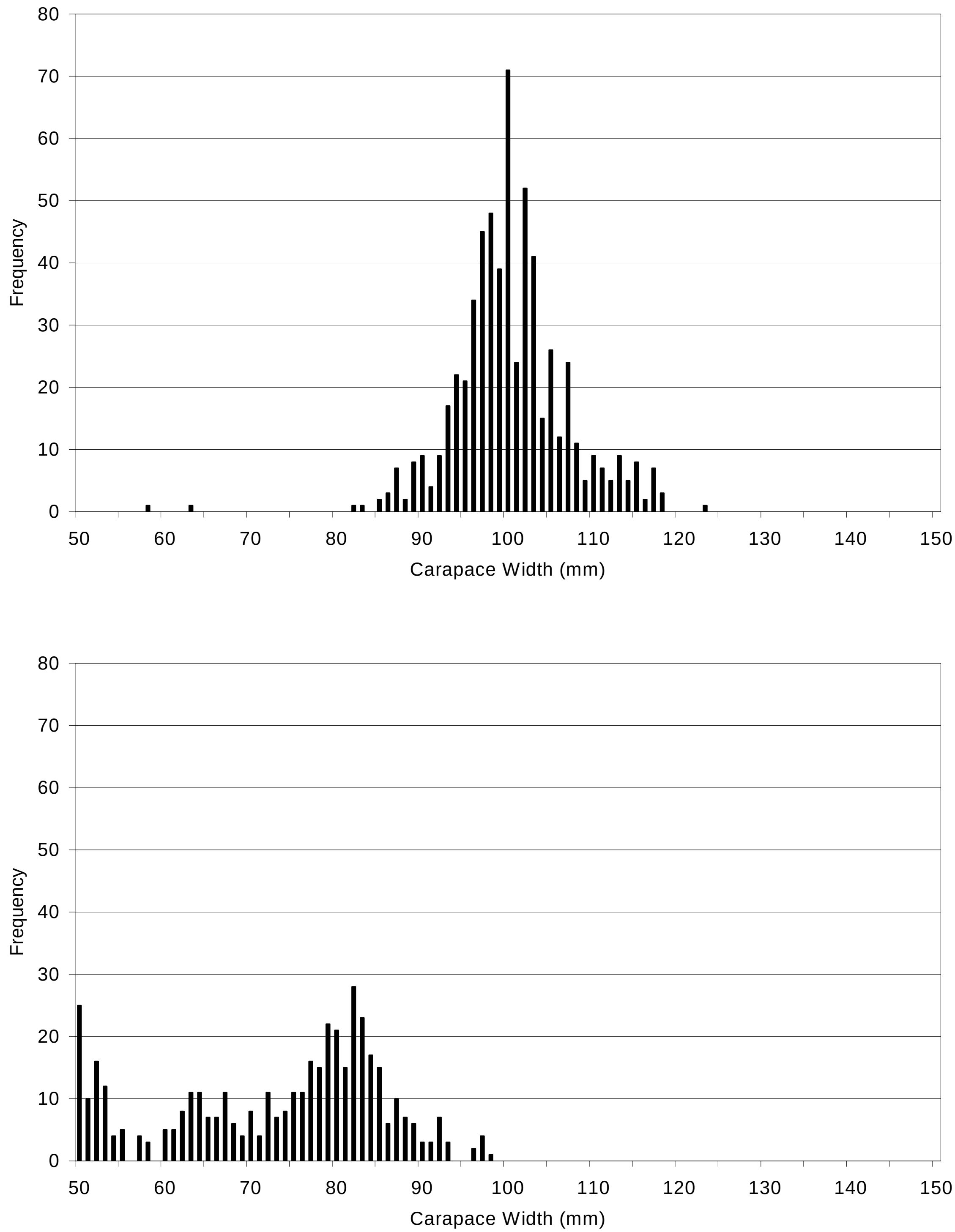


Figure 10. Size distribution of mature (upper panel) and immature (lower panel) female Tanner crabs, *Chionoecetes tanneri*, from DFO surveys off WCVI, 1999-2003.

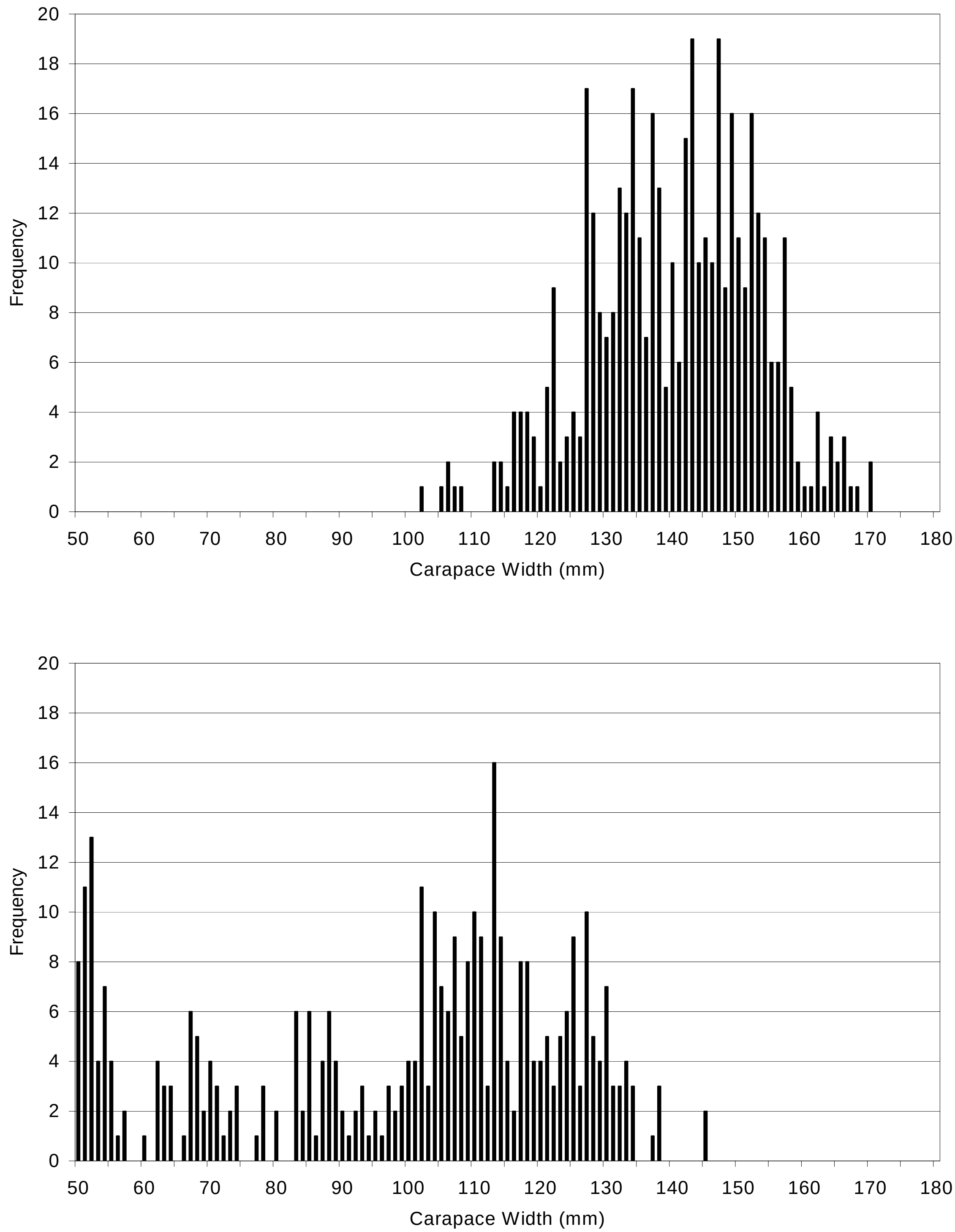


Figure 11. Size frequency of mature (upper panel) and immature (lower panel) male Tanner crabs, *Chionoecetes tanneri*, from DFO surveys off WCVI, 1999-2003.

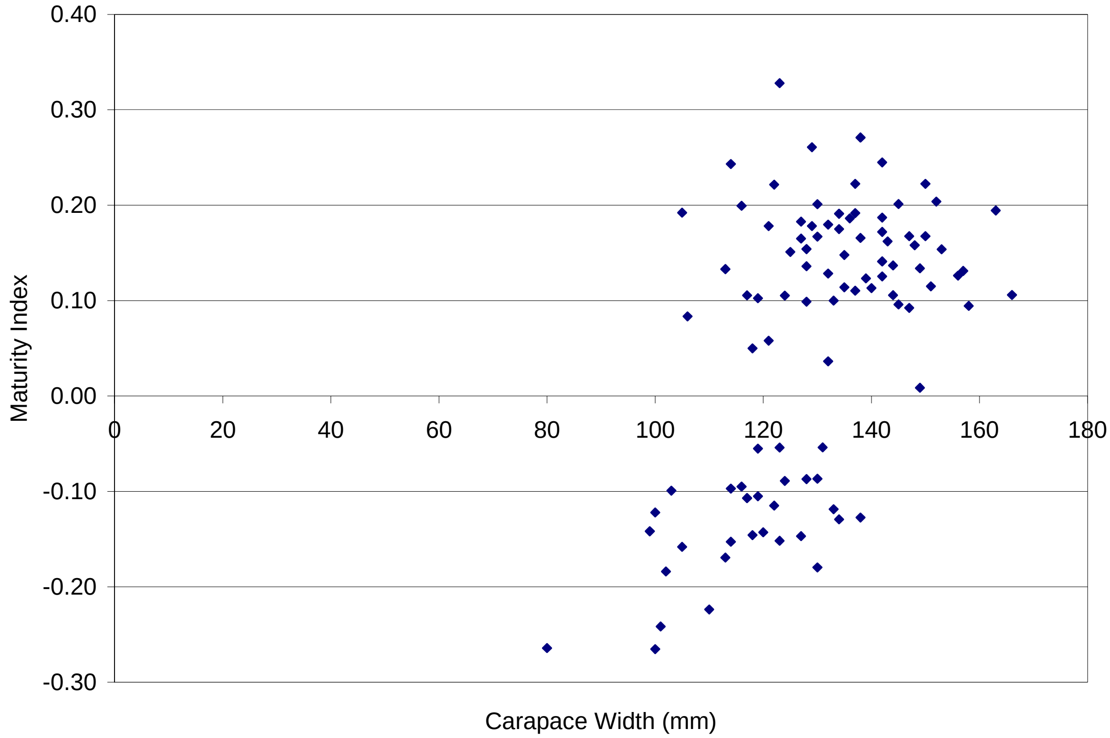


Figure 12. Distribution of male maturity index values determined from chela length and carapace width for Tanner crabs, *Chionoecetes tanneri*, from DFO surveys, 1999-2002. Positive index values indicate morphometric maturity.

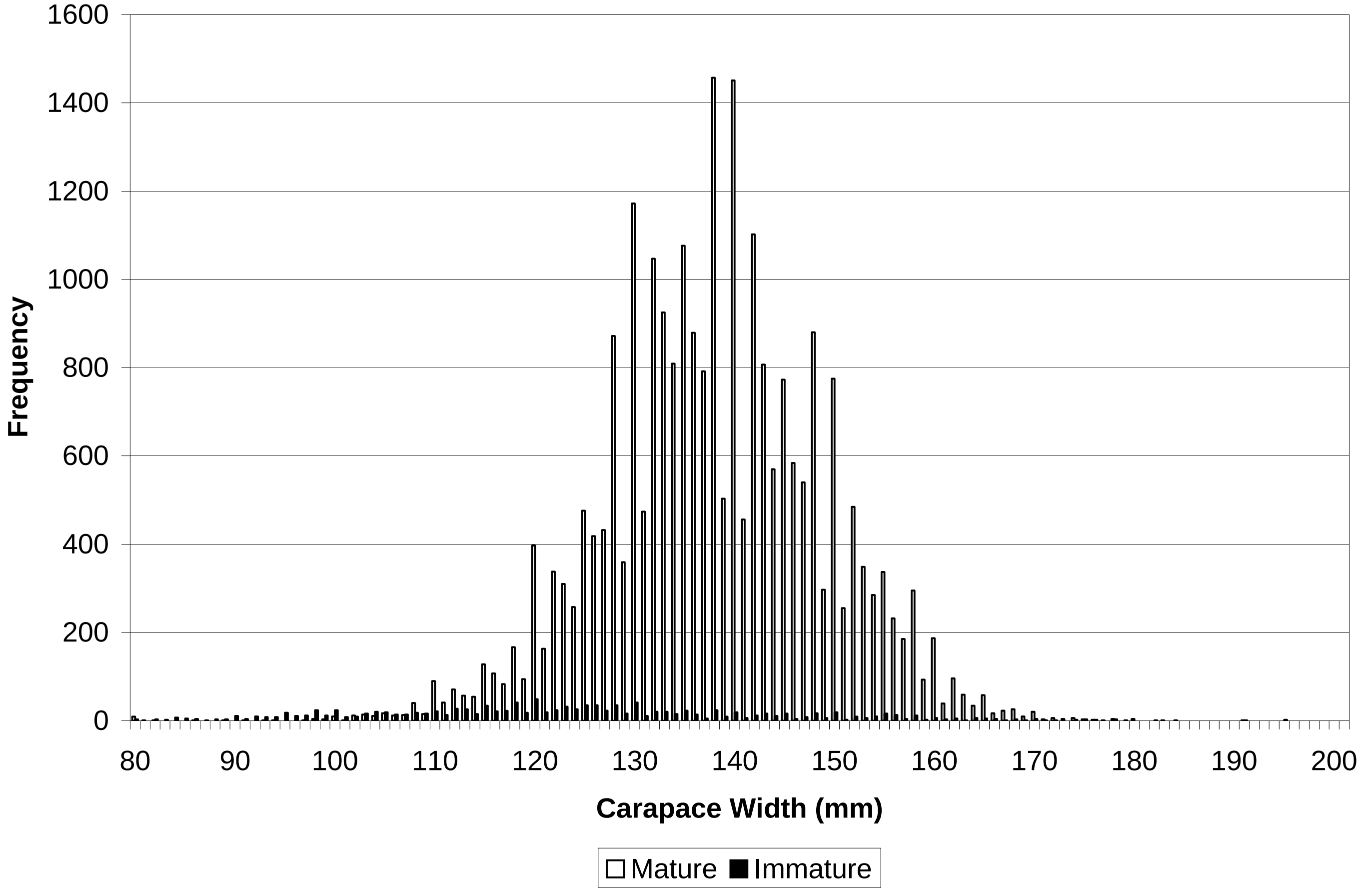


Figure 13. Carapace width frequency distribution of male Tanner crabs, *Chionoecetes tanneri*, by maturity stage, from experimental fisheries off WCVI , 1999/2000 to 2002/2003.

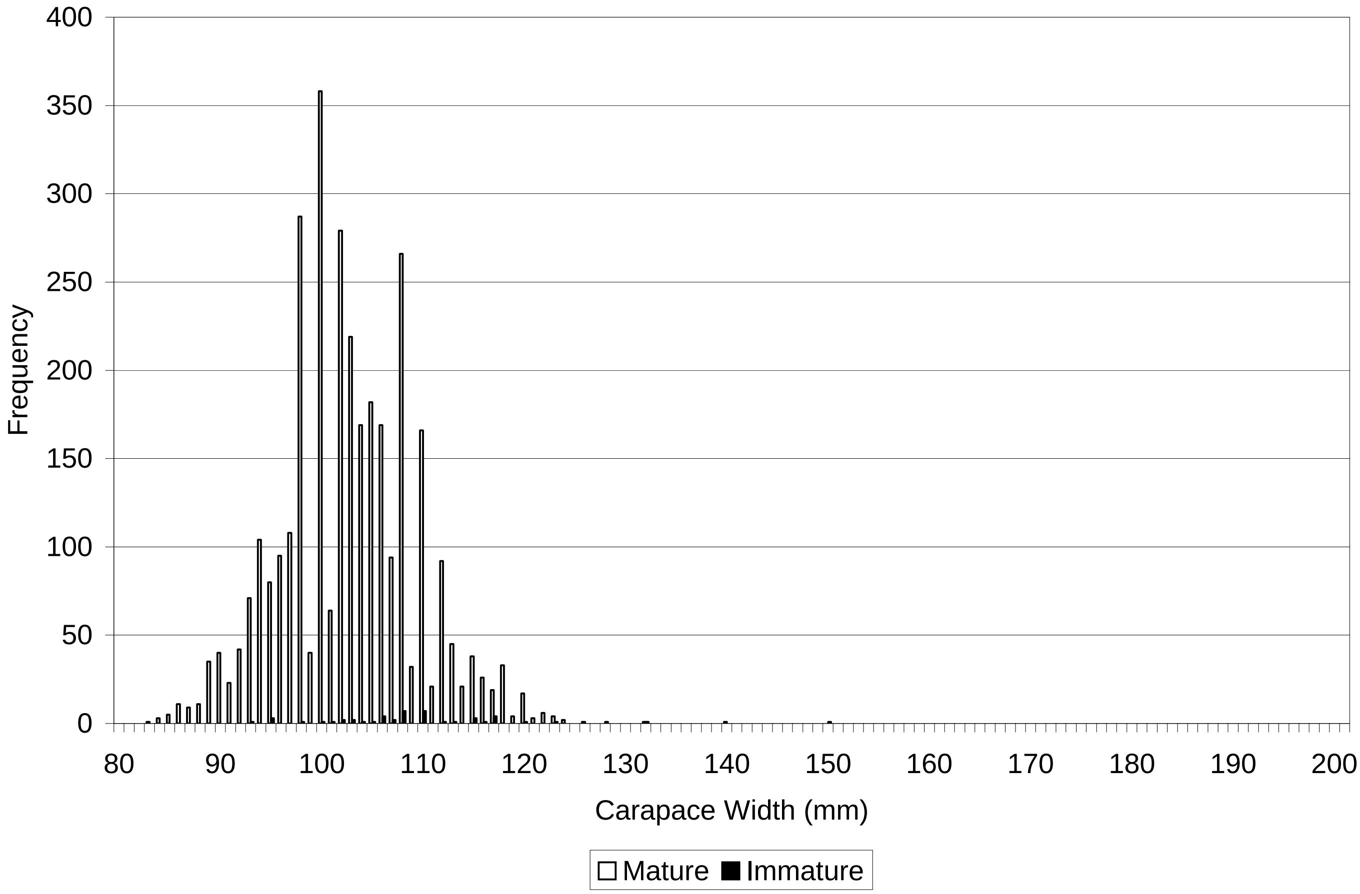


Figure 14. Carapace width frequency distribution of female Tanner crabs, *Chionoecetes tanneri*, by maturity stage, from experimental fisheries off WCVI, 1999/2000 to 2002/2003.

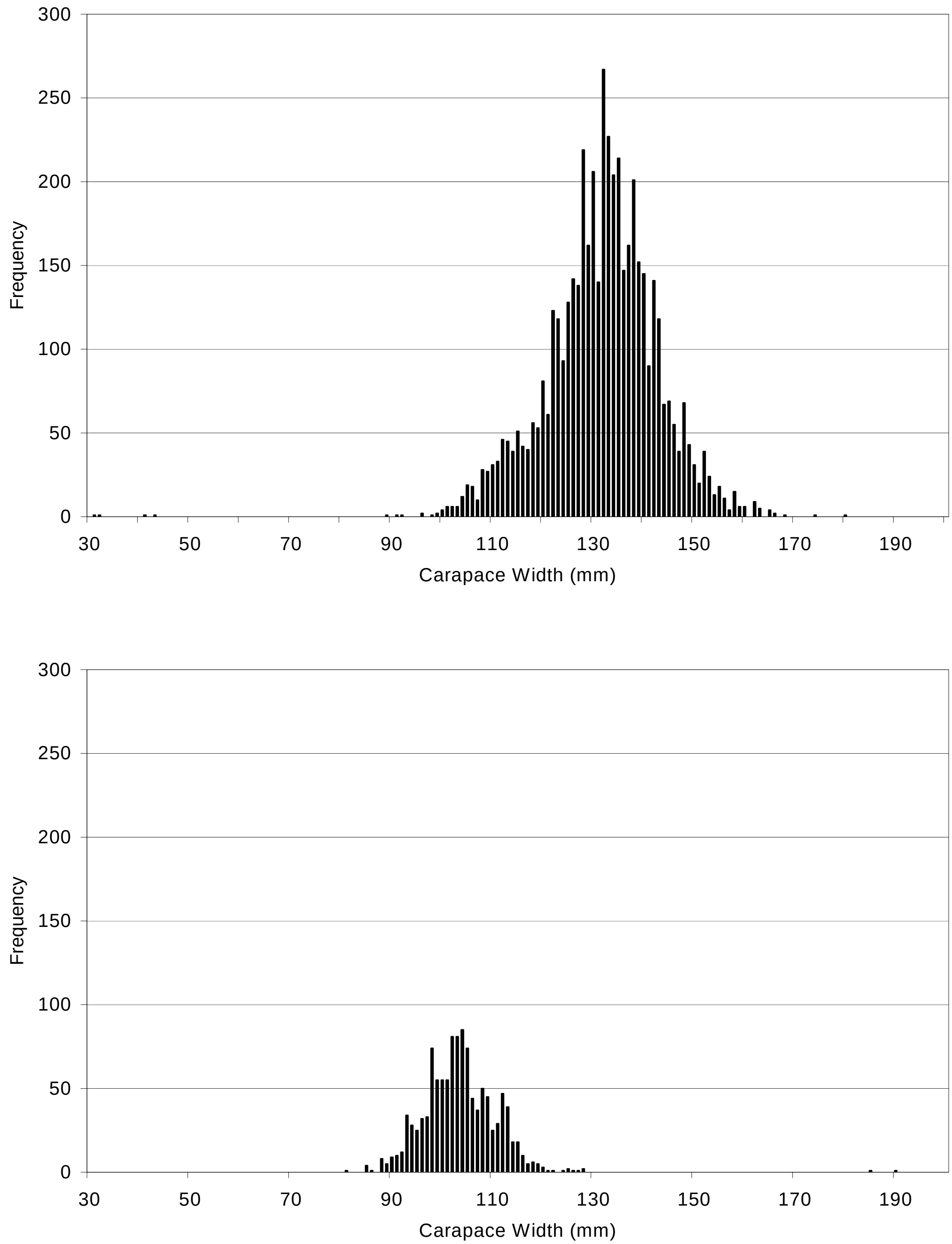


Figure 15. Size distribution of male (upper panel) and female (lower panel) Tanner crabs, , from the experimental fishery off WCVI, 1999/2000.

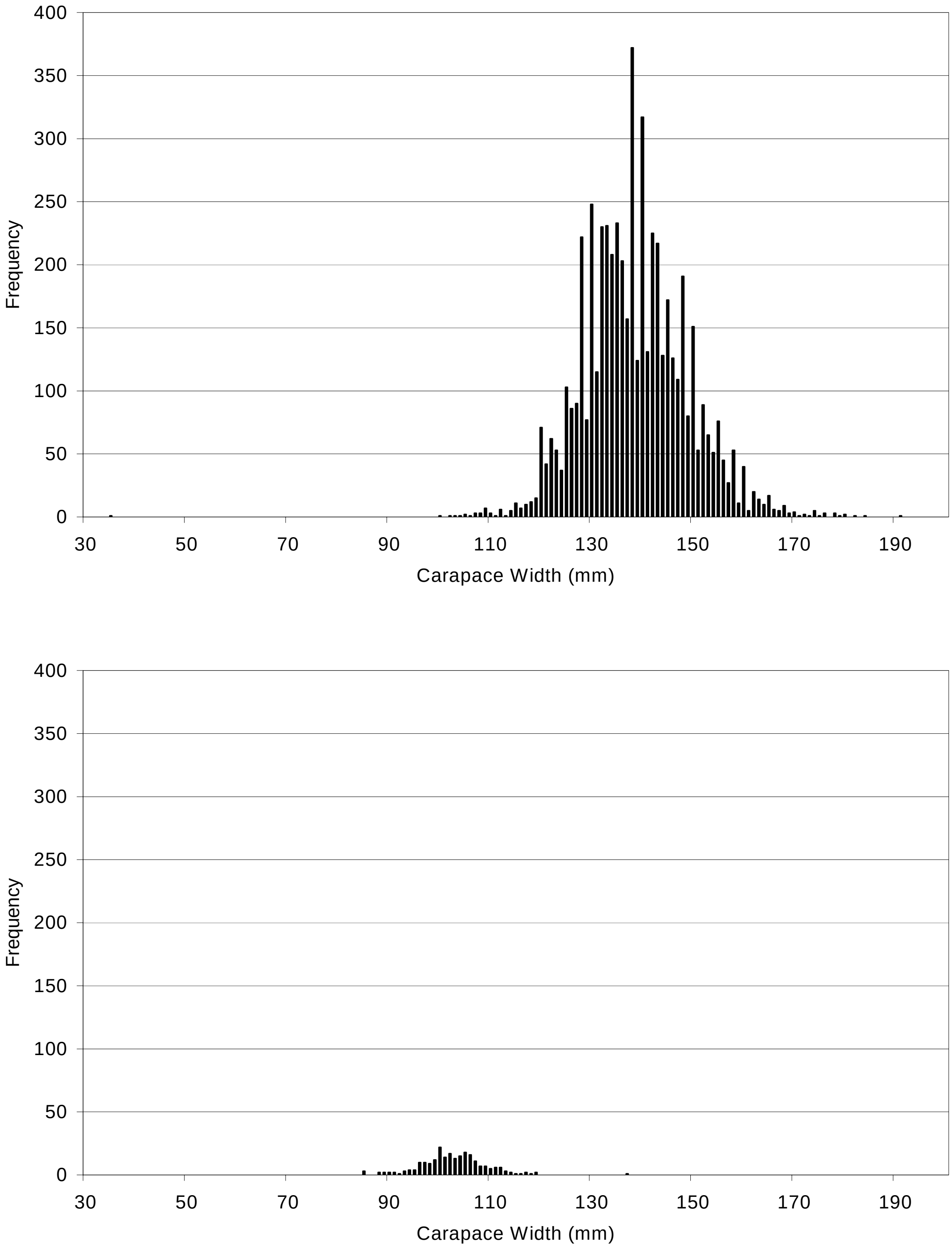


Figure 16. Size distribution of male (upper panel) and female (lower panel) Tanner crabs, *Chionoecetes tanneri*, from the experimental fishery off WCVI, 2000/2001.

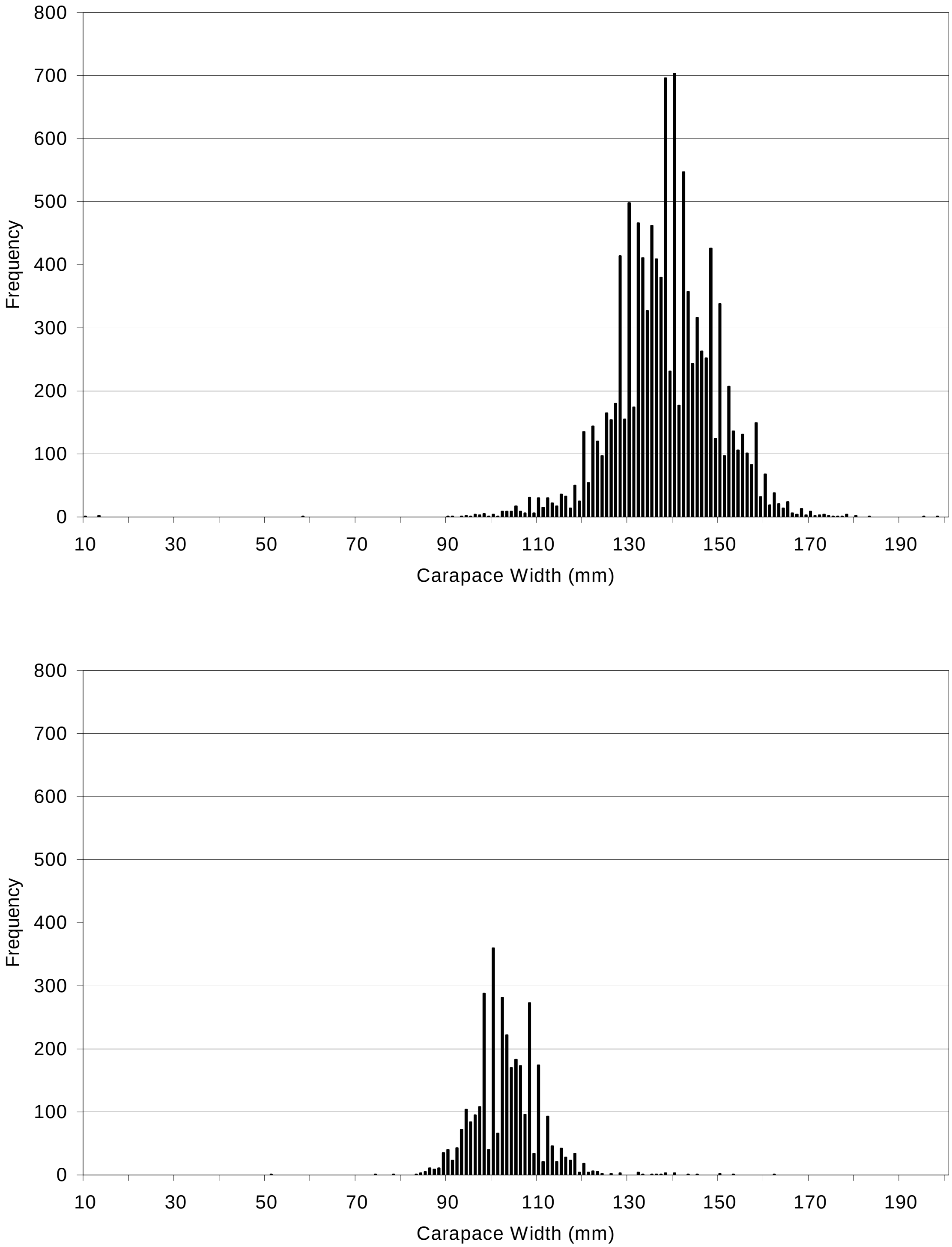


Figure 17. Size distribution of male (upper panel) and female (lower panel) Tanner crabs, *Chionoecetes tanneri*, from the experimental fishery off WCVI, 2001/2002.

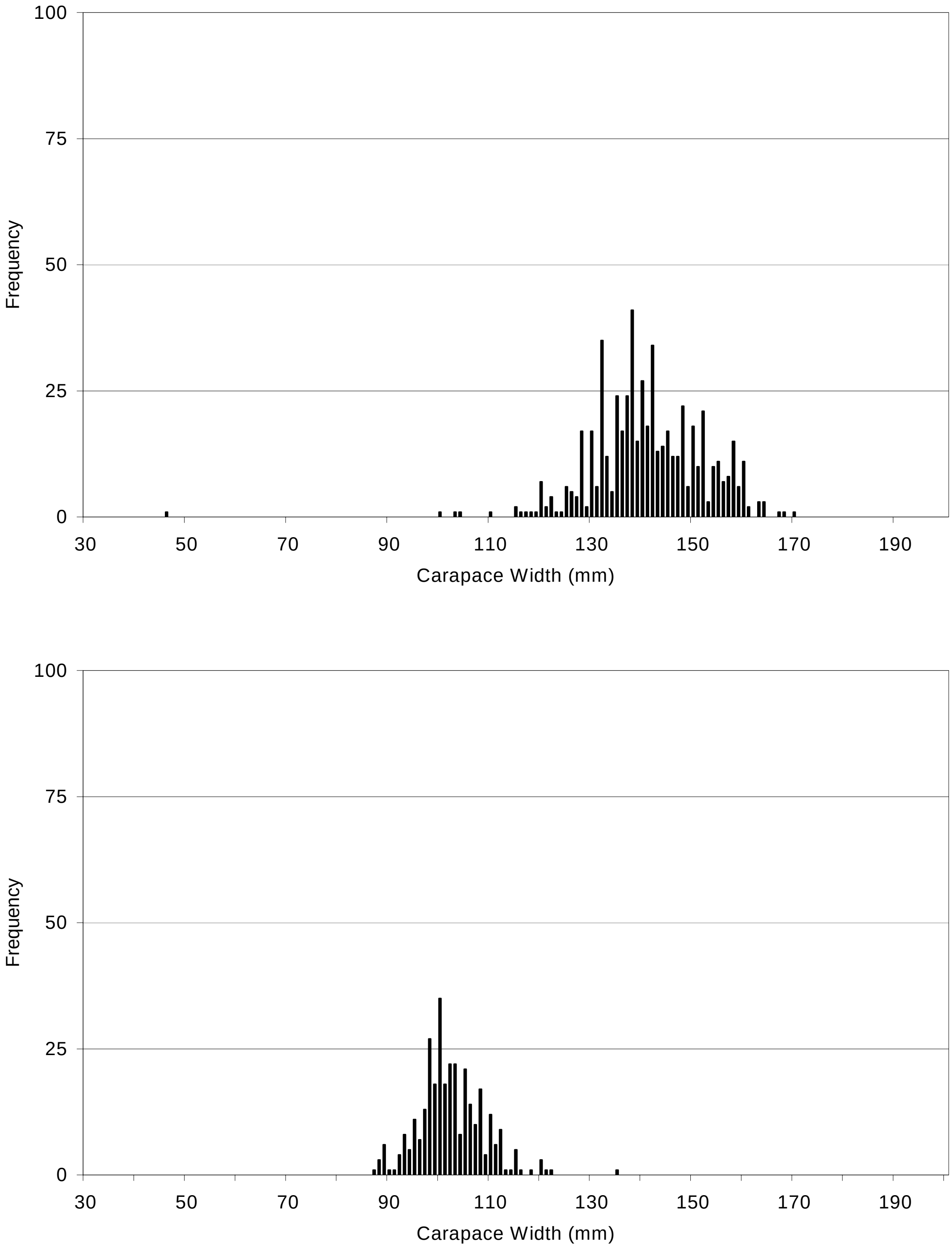


Figure 18. Size distribution of male (upper panel) and female (lower panel) Tanner crabs, *Chionoecetes tanneri*, from the experimental fishery off WCVI, 2002/2003.