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**Assessment of the status of Div.
4TVW Haddock: 2000**

**Évaluation de l'état des stocks
d'aiglefin dans les divisions 4TVW
en 2000**

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Abstract

The current evaluation of the Div. 4TVW haddock stock status was derived from reported landings, shore and at-sea based samples taken from commercial landings for size and age composition, research vessel (RV) surveys conducted in March and July, and a fixed-gear Sentinel Survey conducted in the fall. Indicators of abundance revealed that the number per tow (1-29 cm) from the July RV rose dramatically in 1999 and 2000, reflecting the strength of recent incoming year-classes. Intermediate sized haddock (26-41 cm) have been steadily increasing and the highest value in the series occurred in 2001. The summer RV number per tow of haddock 42 cm + has remained very low throughout the 1990s, and the 2001 estimate is among the lowest observed. Spawning stock biomass has been steadily increasing since closure of the fishery and in 2000 exceeded the 1970-2000 average. The sentinel survey catch rate, which selects for larger haddock, exhibited a declining trend since the initiation of the survey in 1995. Some of the production indicators have been increasing since closure of the fishery. Recruitment at age 1 shows that the 1995 year-class is above the 1970-1998 average while the 1998 year-class appears very strong. Survey estimates at age 1 suggest that the 1999 year-class is also strong. Condition factors have generally been below average since the early 1990s. Growth, based on size at age 7, steadily declined throughout the late 1980s/1990s, which was preceded by a more rapid decline during the mid-1980s. Since closure of the fishery, fishing mortality rates have been low. Prior to the collapse of the fishery, exploitation rates were more than twice the $F_{0.1}$ level of 20%. Currently, Div. 4VW haddock is an early maturing, geographically constricted stock plagued by poor growth (both under-weight and under-length) and high natural mortality that has recently produced good to excellent recruitment. The next few years will be pivotal to this stock given recent strong recruitment and improvement in environmental conditions.

Résumé

Les stocks actuels d'aiglefin dans les divisions 4TVW ont été évalués à partir des débarquements signalés, des échantillons prélevés sur la côte et en mer dans les débarquements commerciaux aux fins de détermination de la taille et de la composition par âge, des relevés par navire de recherche (NR) effectués en mars et en juillet et d'un relevé aux engins fixes par pêche sentinelle réalisé à l'automne. Les indicateurs d'abondance ont révélé que le nombre par trait (1-29 cm) lors du relevé par NR en juillet a augmenté énormément en 1999 et en 2000, reflétant la vigueur des nouvelles classes d'âge. Le nombre d'aiglefins de taille moyenne (26-41 cm) s'est accru de façon soutenue et a été le plus élevé de la série en 2001. Le nombre par trait d'aiglefins de 42 cm + lors du relevé d'été par NR est demeuré très faible tout au long des années 1990, et l'estimation pour 2001 compte parmi les valeurs les plus basses observées. La biomasse du stock reproducteur a augmenté de façon soutenue depuis la fermeture de la pêche et, en 2000, a dépassé la moyenne de 1970-2000. Le taux de capture lors du relevé par pêche sentinelle, qui vise les gros aiglefins, est en déclin depuis le début des relevés en 1995. Certains des indicateurs de production sont en hausse depuis la fermeture de la pêche. Le recrutement à l'âge 1 révèle que la classe d'âge 1995 est supérieure à la moyenne de 1970-1998, tandis que la classe d'âge 1998 semble très forte. Les estimations selon le relevé à l'âge 1 suggèrent que la classe d'âge 1999 est également abondante. Les coefficients de condition ont en général été inférieurs à la moyenne depuis le début des années 1990. La croissance, basée sur la taille à l'âge 7, a diminué de façon soutenue dans les dernières années de 1980 et tout au long des années 1990, après avoir subi un déclin rapide au milieu des années 1980. Depuis la fermeture de la pêche, les taux de mortalité par pêche ont été faibles. Avant l'effondrement de la pêche, les taux d'exploitation étaient plus du double du niveau de $F_{0,1}$ de 20 %. Pour l'heure, les aiglefins dans les divisions 4VW forment un stock précoce, géographiquement confiné, affligé d'une croissance très faible (poids et taille insuffisants) et d'un taux de mortalité naturelle élevé qui a récemment produit un recrutement allant de bon à excellent. Les prochaines années seront critiques pour ce stock étant donné la vigueur récente du recrutement et l'amélioration des conditions environnementales.

Introduction

The eastern Scotian Shelf haddock stock is contained within NAFO Div. 4TVW (Figure 1). Historically, the fishery was very productive but this has not been the case in recent times. The fishery was closed in the fall of 1993 and has remained closed since that time. The last full assessment of this stock was conducted in 1997 (see Frank et al. 1997) with annual updates to 2000 (DFO 2000). Little improvement in the status of the adult component of the stock was noted and the stock has been plagued by poor growth.

FRCC has repeatedly recommend: there be no directed fishery, that closure of the haddock box to all groundfish sectors remain in effect, and that restrictive by-catch measures be maintained in all fisheries directed at other species. All of these measures have been adopted. An evaluation of the haddock box (i.e. the Emerald/Western bank closed area) was conducted in 1998 (Frank and Simon 1998) and its performance is under continual scrutiny. Strict by-catch restrictions have been in existence with a 5% overall cap for mobile gear and a 10% overall cap on fixed gear. A small fish protocol also exists and haddock less than 43 cm are considered to be undersized.

The fishing industry has made an increasing contribution to providing primary data inputs to groundfish stock assessments throughout Atlantic Canada and the eastern Scotian Shelf is no exception. Since 1995 a fixed gear sentinel survey of Div. 4VsW has been in place. This survey represents a joint project of the Fishermen and Scientists Research Society and the DFO's Marine Fish Division. The survey results form an integral part of the Div. 4TVW haddock assessment.

This document contains the most up-to-date primary input data for the Div. 4TVW haddock stock assessment. This includes data derived from the commercial fishery and associated sampling (past and present) and at-sea surveys (industry and DFO). The products derived from this include the commercial and survey age composition. Recent research results as well as a virtual population analysis are also presented.

The Fishery

Landings data by division and country for Div. 4TVW haddock extend back to 1954 (Table 1). Total landings peaked in the mid-1960s and were followed by a rapid decline to the mid-1970s. During this period foreign landings frequently exceeded domestic landings (Figure 2). A second peak in landings occurred in the mid-1980s and once again a decline followed, this time in the early 1990s. Foreign landings have been relatively low since extended jurisdiction to 200 miles in 1977 and were associated with by-catch in the silver hake fishery. Total allowable catches were first imposed in 1976. The decadal average landings since 1960 were approximately 25,000t in 1960-1969, 5,000t in 1970-1979, and 11,500 t in 1980-1989. During the 1990s the fishery for haddock collapsed and has been closed to

directed fishing since the fall of 1993. By-catches in other fisheries have averaged 128 t since 1994. Throughout the modern history of the fishery, landings have generally been derived from Div. 4W with 4Vs as a secondary area.

Canadian landings of haddock by gear type and division are shown in Table 2. Generally, otter trawlers in both divisions have dominated landings. However, in Div. 4W during 1989 to 1993, fixed gear catches exceeded otter trawlers (Figure 3). This was the result of an exemption for fixed gear in the closed area. Geographic locations of landings data are available since 1990. The fishery distribution patterns, for both mobile and fixed gear, prior to the directed fishery closure are shown in Figures 4 and 5. Mobile gear landings have been concentrated around the perimeter of the closed area, the Gully, and Banquereau bank (Figure 4). Fixed gear landings were concentrated inside the closed area and along the edges of Banquereau bank (Figure 5). Since the closure of the directed fishery in 1994, by-catch has been scattered throughout the management unit with some concentrations around the closed area and to the east (Figure 6). The unusual locations of some of the landings data, such as those off the continental shelf and on land represent a very small percentage of the total landings (mobile and fixed gear during 1990-1993 was 0.2% and 2%, respectively; 1994-2000 all gears was 1%). The landings reported from inside the closed area since 1994 amounted to 7.7 t. This was a result of by-catch from the Div. 4W scallop fishery and the removals associated with the conduct of the Div. 4VsW fixed gear sentinel survey.

Commercial catch at age

The commercial catch at age was reconstructed from sampling conducted since the last full assessment in 1997 (Frank et. al. 1997). In general, our objective was to create quarterly age length keys by division. When this stratification (or allocation) scheme was not possible, quarters and divisions were combined in order to provide a sufficient number of aged samples. However, sampling intensity has been quite low during 1997 to 2000 necessitating the use of annual age/length keys. Each key was applied to the combined length frequencies from all gears for each year (see Appendix 1-4). Inter-reader age comparisons (also referred to as age-bias analysis) were conducted for 1998 and 1999. The results showed no bias between the primary and secondary age reader and low CV's (5.4-6.3%). These results are considered to be adequate for this stock.

The historical catch at age (1970 to 1984) used in the previous assessment has remained unchanged. However, in the previous assessment the catch at age constructed for 1985-1989 utilized yearly RV age/length keys due to the lack of ageing information from commercial samples. Re-ageing of otoliths from this time period has been completed and age/length keys based on commercial samples have been constructed as per previous assessments (Appendix 5-9). Age-bias analysis of this re-aged material between the primary and secondary agers revealed low CV's and no bias. CV's were 4.1, 3.1, 4.2, 4.7, and 3.5% for 1985 to

1989 respectively. These results are considered to be very good for this stock.

Landings at age from the foreign small mesh gear fishery (since 1985) were estimated by applying summer research vessel survey age length keys to the length frequency estimates derived from samples of haddock by-catch in the small mesh gear fishery.

The resulting catch at age, from 1970 to 2000, is shown in Table 3. Compared to the previous catch at age used in the last assessment (Frank et al. 1997), the current catch at age is identical from 1970 – 1984 and differs from 1985 to 1996 (Table 4). The reasons for this difference include: 1) Canadian landings were revised from 1986 to present using the Zonal Information File Format or ZIFF, 2) commercial ages were applied to the 1985 – 1989 samples which was not the case in the old catch at age when RV age/length keys were used, 3) minor revisions were made to the allocation blocks from 1990 – 1996, and 4) an updated method (known as CATCH) was used to estimate removals at length from the foreign fishery. Collectively, these changes account for the observed differences.

Resource Status

Industry Survey

A fixed gear sentinel survey, involving 6 commercial long-line vessels, has been in place in Div. 4VsW since 1995 (Figure 7). It is based on a stratified, random survey design, utilizing the same stratification scheme as the DFO July RV survey (see Section on Research Vessels surveys for a stratum map). In addition, three inshore strata shoreward of the 50 fathom isobath were added to the design. Approximately 230 pre-selected set locations are occupied, starting in September of each year (Table 5). Each station consists of 1,500 #12 circle hooks baited with frozen mackerel. Detailed biological sampling protocols are also followed, yielding material for age determination. A commercial index phase has been in place but it has not been financially viable and participation has steadily declined. The amount of haddock (t) captured during the sentinel survey was as follows:

1995	1996	1997	1998	1999	2000
6.4	5.6	3.4	3.7	3.1	3.0t

Abundance trends: In all years, haddock catch rates (kg per 1500 hooks) were generally highest in those strata associated with the closed area (strata 463 – 465). Catch rates were also consistently high in the two strata encompassing Sable Island bank (455-456) and the Gully (451). Catch rates were generally low in the three inshore strata (467-469). Low and variable amounts of haddock were caught in the other strata (Table 6). The stratified mean catch rate, with and without the inclusion of the three inshore strata, revealed a declining trend. Catch

rates were highest in 1995 (> 25 kg/set), declined in 1996, and have remained low (< 15 kg/set) during 1997 to 2000 (Figure 8).

Distribution: The geographic patterns of haddock catches were remarkably consistent from year to year. In the most recent surveys (1999 and 2000), haddock were concentrated within the Emerald/Western bank closed area and around its perimeter (Figure 9). Smaller catches occurred to the east along the flanks of Sable and Banquereau bank and the Gully. Survey results are also shown from 1995 to 1998 (Figure 10). The annual percentage of haddock inside the closed area for each year was as follows:

1995	1996	1997	1998	1999	2000
69%	59%	71%	86%	68%	53%

Length composition: A uni-modal length composition was evident in 1995 and 1996 with catches peaking around 42-46 cm and falling off rapidly at larger sizes (Figure 11). In subsequent years, catches were lower across most sizes. In 2000, the size composition of the catch was skewed towards smaller sizes.

Survey catch rate at age: The stratified mean catch rate at age from the sentinel survey is shown in Table 7. The progression of year-classes is evident in the matrix – notably the 1992 and 1988 year-class. The 1988 year-class was large and its persistence in the population is quite remarkable. Total numbers show a steady decline each year as do the 3+, 5+ and 7+ components of the population.

Industry consultations: Consultation with industry has revealed a concern for the effect of other fisheries and disturbance associated with oil and gas exploration on the well-being of haddock. Other fisheries associated with offshore clam and herring are a concern as these represent potentially important food resources for haddock. Herring spawn (eggs) has been a traditional seasonal food resource for haddock and clams (bivalves) have been recorded as a diet item in haddock. In addition, the recent removal of significant amounts of shrimp and crab is a concern and some have questioned the Department's commitment to an ecosystem approach. Others noted that lack of eye-bait (or krill) and suggested some changes to the food web have occurred. High numbers of worms have been seen in haddock and some speculated that a high worm burden would reduce haddock growth rates. Seismic activity associated with oil and gas exploration is believed to disrupt the behaviour of haddock and fishers are very concerned that it may be having a negative impact on groundfish. Collectively, this information was given in response to the documented reduction in growth and condition of haddock. It was also noted that a traditional "fall run" of haddock essentially disappeared in the fall of 1991 and has not returned. Other historical groups or "runs" of haddock were also noted such as those that occurred in 4Vn. These fish were considered to be slinky and differed from haddock on the offshore banks and from 3Ps and 3NO. There was no disagreement on DFO's perception of the current status of the stock and that of industry.

Research Vessel Surveys

There are two research vessel groundfish trawl surveys utilizing stratified random sampling designs for this stock: the July or summer series that started in 1970 (Figure 12) and a March or spring series that began in 1979. Haddock collected from the March survey have not been routinely aged. However, efforts are underway to do so and when ageing is completed for the March survey, it will be used as an abundance index for this stock. Detailed sampling of haddock has been conducted during March providing information on length-specific maturity schedules and condition.

Summer (July) RV

Abundance trends: The overall abundance of haddock has remained below the long-term average of 42 fish per tow throughout most of the 1990s. However, abundance estimates in 1999 and 2000 rose dramatically and were greater than twice the long-term average. Numbers per tow in 2001 were also well above average (Figure 13). High numbers of small haddock, <14cm in 1999, 18-23 cm in 2000, and 26-31 cm in 2001, were the main contributors to the increase in overall abundance (Table 8). Weight per tow does not show the dramatic increase in 1999 and 2000 as numbers (Figure 13).

Recent increases in abundance of haddock 30 cm and greater were also evident, with above average numbers per tow from 1998-2001 (Figure 13). Weight per tow rose to slightly above average in 1999 and decline to below average in 2001. This size group was considered comparable to the sentinel survey catch rate based on the minimum size of capture. However, the abundance patterns between the two series showed a divergent pattern.

The abundance of haddock 42cm and greater was considered an index of the fishable component of the stock (note: management protocols consider haddock undersized if smaller than 43 cm). Number per tow has remained consistently below the long-term average of 10.6 fish per tow since 1992 (Figure 13). Weight per tow exhibited a near identical trend to numbers.

Length composition: The annual length composition of haddock is presented since the closure of the fishery in 1994. Each year is poly-modal with the entry of new year-classes evident as well as a progression of modal groups through time (Figure 14). Also, a general deficit of larger fish relative to the long-term (1970-2001) average is evident in all years since 1994. There was an unprecedented high abundance of small haddock in 1999 (modal size of 10.5 cm) representing the 1999 year-class. A dominant mode was also evident in 2000 and 2001, presumed to be one and two year-old haddock respectively from the 1999 year-class (Figure 14).

Distribution: Distribution patterns were evaluated for haddock in two size groups from 1995 to 2001: 30cm + and 1-29 cm. Haddock 30cm and greater exhibited consistent annual distribution patterns. Concentrations were evident on Emerald, Western and Sable Island banks. Other important areas included Middle bank, the Gully and edges of Banquereau bank (Figures 15 and 16). This pattern is similar to the September distribution of haddock based on the fixed gear sentinel survey.

Juvenile haddock (1-29 cm group) were concentrated on Emerald, Western, and Sable Island bank similar to the adult distributions. In contrast to the adults, small haddock were more highly concentrated on Sable Island bank and nearer to Sable Island in shallow water. Extremely high numbers per tow were evident in these areas in 1999 –2001. (Figure 17 and 18). In addition, few small haddock were evident in the Gully and areas to the east.

Two indices of spatial distribution were evaluated for each year for all sizes combined: the proportion of non-zero sets and resource concentration. The proportion of annual survey sets where haddock occur is a measure of how widely distributed a stock is throughout the management unit. Peak values (0.6 – 0.7) were evident throughout the 1980s indicating that the stock was widely distributed. This was followed by a decline in the early 1990s (Figure 19). The proportion of non-zero sets has averaged about 0.5 during the past several years. This indicates that the stock is not widely distributed. The proportion of the stock area encompassing 75% of the annually estimated survey abundance is a measure of resource concentration. This index is presently less than the peak values observed during the 1980s, indicating that the resource is somewhat concentrated. It should be noted that the two indices are highly correlated ($r=0.98$, $n=32$, $p<0.001$).

Condition: Predicted weight of haddock at 30 and 45 cm was considered an index of juvenile and adult haddock condition, respectively. Juvenile haddock exhibited no discernable trend in condition throughout the time series, although predicted weights were more variable prior to 1990 reflecting the lower accuracy of spring scales used to weigh haddock (Figure 20). After 1990, electronic scales were in use on the survey resulting in more accurate individual weights. Adult haddock exhibited higher than average weight throughout the 1970s and early 1980s whereas during the remainder of the series weights were generally below average. Since 1993, adult haddock body weight has been below average in seven out of nine years (Figure 20).

Spring (March) RV

Abundance trends: Recent trends in abundance are difficult to discern from the March RV because of missing years (no survey in 1998) and incomplete coverage in some years (1996, 2001). An extremely high level of abundance was recorded in 1981 and this point was omitted when calculating the long-term mean.

The overall abundance of haddock was above average throughout most of the 1980s and somewhat lower and more variable from year-to-year in the 1990s (Figure 21). Numbers per tow in 1999 and 2000 were above average with intermediate (32-39 cm) and small (16-21 cm) haddock being the main contributors respectively (Table 9).

Trends in numbers per tow of 30cm + haddock were nearly identical to the patterns seen among all sizes. The only exception occurred in 2000 when numbers per tow were below average. Numbers per tow of 42cm + haddock were generally above average throughout the 1980s and below average throughout the 1990s to the end of the series in 2001.

Length composition: The length composition from the March survey was distinctly poly-modal with the smallest modal size class occurring between 14 – 21 cm each year. This was the dominant mode in the 2000 survey and was a reflection of the strong 1999 year-class seen as 0-group in the 1999 July survey (Figure 22). This modal size was also above average in 1996 and 1999. In each year since 1994, with the exception of 1999, there was a deficit of fishable sizes (42cm+) relative to the long-term average (Figure 22).

Distribution: Composite distribution patterns of adult (30cm+) and juvenile haddock (1-29 cm) from 1995-2001 were very similar to one another but exhibited a more off-shelf distribution compared to the July RV (Figure 23). Haddock were distributed around Emerald and Western Bank and along the slope edges to the east and in association with the Gully. Few haddock were captured on Sable Island bank and none were collected on Middle bank during this time period (Figure 23). Although not shown, the 1999 distribution was unusual because of the relatively high, on-bank abundance of haddock. This year was unusually warm which may have contributed to the anomalous pattern.

Condition: Similar trends in predicted weights were evident for both juvenile and adult haddock. Generally, length-specific weights were above average during the 1980s and below average throughout the remainder of the time series (Figure 24). The recent pattern of below average adult condition is similar to that seen in the July survey.

Maturities: Maturity at length data has been collected during the March survey since 1979 (Table 10). In most years of the survey, full (100%) maturity was reached by 42 cm. However, 50% maturity has shifted to smaller sizes in the latter years (Figure 25). Adjusting the survey biomass per tow at length data (Table 11) by the proportion mature at length yielded an index of spawning stock biomass, or in the present case, mature female biomass. Mature female biomass has remained below average since 1991 and in 1999 and 2000 rose to near-average levels (Figure 26).

July RV – Age based

The 1997 to 2000 July RV catch at age has been constructed utilizing annual age/length keys. Age bias analyses were conducted for each year. The 1997-1999 analyses revealed no ageing bias and minimal CV's (range: 5.5 – 6.7%). These results are considered to be adequate for this stock. However, the evaluation of primary and secondary ageing information from the 2000 survey revealed an over-ageing by the secondary ager by about 0.5 - 1 year, associated with the younger age groups. In addition, a very high CV of 14.7% occurred. For the present assessment, this discrepancy has not been resolved and the primary agers results are used. The 1970 - 2000 RV stratified mean catch rates at age and biomass per tow at age are shown in Tables 12 and 13.

Recruitment: Number per tow at age 0, 1 and 2 were used to illustrate the development of year-classes in the stock. However, 0-group are not consistently captured by the survey gear and may not provide a meaningful estimate of incoming recruitment. Ages 1 and 2 are considered more reliable indicators of incoming recruitment.

At age 0, numbers per tow were extraordinarily high in 1999 and well-above average in 2000. The 1999 year-class was also extremely abundant at age 1 and the age 1 estimates of abundance for the 1995 and 1998 year-classes were also above-average. (Figure 27). The 1998 year-class, estimated at age 2, was the highest in the time series, and the 1995 and 1997 year-classes were above average as well. A recruitment index, calculated as the average of the abundance estimates at ages 1 and 2 for each year-class, suggests that the 1998 is indeed strong, followed by 1995 year-class. The remaining year-classes since 1988 were either near average or below (Figure 27). This age-based description is entirely consistent with the abundance trends presented earlier based on sizes alone.

Abundance trends (numbers and biomass): Stratified mean numbers per tow and biomass for age 3+, 5+ and 7+ are shown in Figure 28. Numbers per tow of 3+ haddock have increased since 1997 with above average levels of abundance occurring during 1998-2000. Biomass of 3+ haddock rose to above average levels in 1999. A similar trend was seen for 5+ haddock with both recent (1999 and 2000) catch rates and biomass either exceeding or near to the long-term mean. Catch rates of 7+ haddock have generally been above the long-term average since the mid-1980s, suggesting lower mortality in recent times.

Cohort tracking: A concern of any survey is its ability to track the progression of a year-class. The approach used to evaluate cohort tracking was to examine the relationship between year-class estimates at successive ages in the survey. A cross section of plots in Figure 29 show the relationship between ages 1 and 2, ages 2 and 3, ages 3 and 4, and so on. A correlation table (Table 14) contains the full matrix of correlations (r^2 in this case) for all ages. The general conclusion is that the survey does well at tracking year-classes. Also, age 1 catch rates appear

to give a good indication of incoming recruitment, noting the high correlation between age 1 and ages 5, 6 and 7 in Table 14.

Total mortality or Z: Total mortality estimates for adult haddock derived from the summer survey show high, year-to-year variability, particularly in the first half of the time series. A temporal trend was introduced by smoothing the data using a three-year running mean. This revealed two peaks in total mortality, the latter one immediately preceding the closure of the fishery (Figure 30). After closure of the fishery, total mortality was generally quite low and averaged about 0.35. These estimates take on added significance because in a closed fishery they are an approximation of natural mortality.

Population considerations

Growth (size at age): Length at age for the younger age groups of haddock (1 and 2 year old) has remained close to the long-term average of 22 and 31 cm respectively throughout most of the time series (Figure 31). However, age 3 haddock have shown a declining trend in lengths and recent sizes are about 10% lower than the long-term average of 37 cm. The reduction in length at age is even more pronounced in the older age groups (4 years old and greater). For example, a 6 year old haddock was close to 60 cm in the mid-1970s compared to 41 cm during the past several years. Seven year old haddock are currently near 43 cm – a reduction of nearly 20 cm from a peak size in 1978 (Figure 31). Other, older age groups show equally striking changes (Table 15). Haddock are growing older but not larger in this stock. One implication of this finding is that if slow growth persists in this stock then it will take several years for new year-classes to reach fishable sizes.

Fecundity and total egg production: Recent research (Blanchard 2000) has been completed on the length-specific fecundity of haddock on the eastern Scotian Shelf during 1997-1999. The relationship between egg number (E) and body length (L) was

$$E = 0.2156 * L^{3.5334}, r^2 = 0.32, n = 404, p < 0.001 \text{ (Figure 32)}$$

Relative to other haddock stocks in the North Atlantic, length-specific fecundity of these haddock is quite low and highly variable. This data, in combination with the proportion mature at length, permitted an estimate of total egg production. Total egg production increased two-fold from 1997 to 1999 and the 1999 year-class (estimated at age 1) is the strongest ever-observed (Figure 33). This year-class appears to have benefited for increased egg production as well as favorable conditions for early survival.

Temperature: Bottom temperatures in the area of 4V and much of eastern 4W generally increased in 1999 and 2000 to above their long-term (1961-90) means for the first time in over a decade. From the groundfish surveys, there were no

bottom temperatures $<2^{\circ}\text{C}$ in 4VW by 2000 and the lowest observed area with temperatures $<4^{\circ}\text{C}$ since the mid- to late 1980s. However, by 2001 temperatures decreased to fall near to or slightly below their long-term means. The deep basins in 4W such as Emerald have generally been warm except during 1998 when an intrusion of cold slope water from offshore penetrated the Scotian Gulf and flushed the Basin. Surface temperatures throughout much of the Scotian Shelf in 1999 to 2000 were also warm and set or were near their long-term maximum records. In 2001, the surface temperatures declined but in the northeastern half of the Scotian Shelf remained above the long-term mean by upwards of 1°C .

Stock assessment

Estimation of parameters

The traditional age-based population analysis was performed for this stock using ACON software to fit the model, which is described as:

Parameters:

Terminal N estimates -- N_i , 2000, i = ages 1 to 10

Calibration coefficients -- $q_{1,i}$ i = ages 1 to 6 for the July RV survey

-- $q_{2,i}$ i = ages 2 to 8 for the September sentinel survey

Structure imposed:

Error in catch assumed negligible

Partial recruitment fixed for ages 11 and 12 in year 2000

No intercept was fitted

$M = 0.20$ for all ages 1970 to 1984; 0.25 for all ages in 1985; 0.30 for all ages in 1986 and 0.35 for all ages from 1987 to 2000

Input:

$C_{i,t}$ i = 1 to 12; t = 1970 to 2000 Catch at age

$J_{i,t}$, i = 1 to 6; t = 1970 to 2000 July RV index

$S_{i,t}$, i = 2 to 8; t = 1995 to 2000 September sentinel survey

Objective function:

$$\text{Minimize: } \sum \sum \{\ln J_{i,t} - \ln q_{1,i} N_{i,t}\}^2 + \sum \sum \{\ln S_{i,t} - \ln q_{2,i} N_{i,t}\}^2$$

where $N_{i,t}$ is population numbers at age i and year t

Summary:

Number of observations: 228 (186 from July RV and 42 from

Sentinel)

Number of parameters: 23, N's estimated by NLLS, q's algebraically

The main differences between this model formulation and the one used in the previous assessment is the addition of a second tuning index, i.e. the September sentinel survey catch rate at age and the natural mortality assumption. We have now introduced a ramp in natural mortality where $M=0.20$ from 1970 to 1984, climbs to 0.25 in 1985 and 0.30 in 1986, and remains at 0.35 from 1987 to 2000. The justification for this natural mortality pattern is based on Z's from the survey during the period of fishery closure (Figure 30) and the changes in growth and maturity that broadly characterize the stock as one that exhibited larger size-at-age and later maturity during the 1970s/mid-1980s to one of low size-at-age and early maturity thereafter. Body size and natural mortality are generally considered to co-vary in an inverse manner.

Results

The diagnostics from ADAPT are given in Table 16. The coefficients of variation on the population estimates in the terminal year generally range between 20 and 30% with the exception of ages 1 and 2. High CV's associated with these ages stem from the fact that there are few observations available for estimation of these parameters. The CV's associated with the catchability coefficients or q's for the July RV are generally close to 15% which is quite reasonable. The CV's for the q's from the sentinel survey are generally higher (around 36%) and this due to the short time series. Also shown are the bootstrap bias correction results. It should be noted that other model runs were performed with natural mortality assumed to be constant at 0.35 and 0.2. These runs resulted in poorer model fits, having residual mean square errors of 0.7 and 0.9 respectively. The mean square error for the ramp M model was 0.64 (Table 16). Population trajectories were similar for all fitted models.

Table 17 shows the residual pattern from the model for six ages from the July RV and seven ages from the sentinel survey. No strong time trends were evident in the residuals and in most years the average residual variation was less than 0.2. A graphic display of this data reveals some year effects, e.g. 1988 when a band of positive residuals was evident across all ages. Some cohort effects are also evident (diagonal banding pattern) but overall the residual pattern is well-balanced (Figure 34). The residual pattern from the two surveys shows opposite patterns. Another way to judge the fit of the model to the data is to compare the q-corrected survey estimates of abundance to the population numbers from the VPA. When compared to the July RV q-corrected estimates, a close fit was evident between the model and the data with the exception of a few years during the late 1980s/early 1990s. The model did not fit the sentinel survey abundance estimates as well, in part due to the shortness of the time series (Figure 34).

Past assessments of this stock have shown a strong retrospective pattern, where exploitation is under-estimated and population abundance is over-estimated in the current year, relative to when additional data are available in subsequent years. The retrospective pattern in this assessment is reasonably good and represents a significant improvement over past assessments (Figure 35).

The SPA results associated with population number and biomass are shown in Tables 18 and 19. These data represent beginning of the year population estimates corrected for estimated bias. Bias correction was generally less than 3% with the exception of recent years at ages 1 and 2 in 2000 and age 1 in 1999. Recruitment has been improving since the closure of the fishery. The 1995 year-class is above the 1970-1998 average. The 1998 year-class, which takes into account the age 1 estimate in 1999 and age 2 estimate in 2000 from the July RV, appears to be exceptional, exceeding the largest previous year-class in 1981 by about three-fold (Figure 36). The age 1 estimate in 2000 is not reliable given that only one observation is available for estimation. Recruitment estimates were compared to the estimates from the previous assessment conducted in 1997 and to the July RV survey estimates at age 1. Close agreement was evident in both comparisons (Figure 37).

The biomass of haddock has been slowly increasing since closure of the fishery (Table 19). The biomass of haddock ages 5 and older is close to the 1970-2000 average of 17,000 t. A comparison of the 5+ biomass pattern to the 5+ weight per tow from the July RV revealed a closed correspondence (Figure 38).

We attempted to approximate the biomass of 42 cm + haddock from 1970 to present (i.e. the fishable component). This was done in two ways: by making reference to the length at age data from 1970 to 2000 (Table 15) and examining growth models fit to length at age data from the July RV. During 1994 to 2000, the length of a 43 cm haddock corresponded to age 7. During 1970 to 1976, the length of a 43 cm haddock corresponded to age 4 (Figure 39). Because of declining size at age, the age groups contributing to the fishable portion of the population has changed and included ages 4 and older during 1970-1983, ages 5 or 6 and older from 1984-1992, and ages 7 and older from 1993 to present (Table 20). The biomass of 42 cm+ haddock averaged 17,000 mt during the 1970 to 2000 period. Since closure of the fishery, little change has occurred in the biomass of this size component. On the other hand, 3+ biomass has steadily increased since the closure of the fishery but currently remains below the 1970-2000 average of 30,000 t (Figure 40).

Fishing mortality at age is shown in Table 21. The patterns in F coincide with the known exploitation history of the stock. For example, high F 's were evident in the early 1970s when the fishery was unregulated and F rose dramatically when fixed gear effort blossomed during their exemption for the closed area (Figure 41). The total mortality patterns from the SPA and July RV show a reasonably good correspondence (Figure 42).

Exploitation rate has generally been in excess of the $F_{0.1}$ target of 20% and frequently exceeded twice this value. Since closure of the fishery, exploitation rates have been very low (Figure 43).




Long-term trends in SSB and recruitment

Spawning stock biomass and recruitment data are available from previous assessments of the Div. 4TVW haddock stock back to 1948. This information is contained in Mahon et al. (1985) and Zwanenburg et al. (1986). We have taken our recent VPA biomass estimates and adjusted them based on the proportion mature at age (Table 22). The recent SSB time series was then combined with the historical data series to produce a long-term view of SSB and recruitment (Figure 44). SSB was generally in excess of 60,000 t up to the early 1960s and started a steady decline to a minimum in the early 1970s. SSB gradually rose to about 60,000 t in the mid-1980s but declined rapidly thereafter. Annual recruitment frequently exceeds 60 million from 1948 to 1965 but did so only a few times since. The 1999 estimate at age 1 (1998 year-class) is the highest ever observed.

Long-term trends in temperature

Temperature anomalies at 100 m (relative to the 1961-1990 mean) are shown for the Misaine Bank region. Temperature variability at this depth has been shown to be representative of the thermal conditions in the subsurface waters of the northeastern Scotian Shelf (Div. 4Vs) and eastern section of Div. 4W. Anomalies were relatively high in the 1950s, declined into the 1960s, varied during the 1970s but rose to a peak by the early 1980s. At this time a rapid cooling occurred that reached a minimum in the early 1990s after which temperatures increased gradually to above average values (Figure 45). These temperature anomaly trends have generally paralleled changes in size at age with the exception of recent times, when size at age has either continued to decline or remained low while temperatures have risen.

Traffic Light Analysis

The Traffic Light table summarizes the indicators of stock status shown above (Table 23, Figure 46). This table shows the annual values of each indicator as a combination of three lights depending on whether they are among the best values for that indicator, among the worst or in between. For indicators such as stock biomass and recruitment, high values are good and have a green light and low values are bad and have a red light. However, for indicators such as mortality, high values are bad and are assigned a red light  whereas low values are good and receive a green light . Intermediate values (midpoint between red and green) are yellow . A value between red and yellow is expressed as a pie with increasing amounts of red in the pie as the value approaches the red threshold or cut point. Similarly, a value between the midpoint and the green cut point becomes

increasingly green in the pie as the green cut point is approached. Empty cells in the table indicate no observation for that year. Uncertainties about the appropriate cut point resulted in a broad yellow zone.

In the traffic light analysis, indicators are summarised into groups that emphasise specific aspects of the resource. These groupings are called characteristics. The following outlook is cast in terms of these characteristics and each is shown in bold.

Indicators of abundance revealed that the number per tow (1-29 cm) from the July RV rose dramatically in 1999 and 2000, reflecting the strength of recent incoming year-classes. Intermediate sized haddock (26-41 cm) have been steadily increasing and the highest value in the series occurred in 2001. The summer RV number per tow of haddock 42 cm +, the historical fishable size limit, has remained very low throughout the 1990s, and the 2001 estimate is among the lowest observed. Spawning stock biomass (based on the SPA) has been steadily increasing since closure of the fishery and in 2000 exceeded the 1970-2000 average. Recent survey estimates of SSB show a similar increasing trend, although the 2001 estimate was below the 1979-2001 average. The sentinel survey catch rate, which selects for larger haddock, exhibited a declining trend since the initiation of the survey in 1995. Area occupied of 30 cm + haddock is largely restricted to closed area. Annual estimates of the percentage of haddock inside the closed area, derived from the sentinel survey, range from 53 to 86%. Local density of 30 cm+ haddock has not shown a trend since the mid-1980s.

Some of the production indicators have been increasing since closure of the fishery. SPA estimates of recruitment at age 1 show that the 1995 year-class is above the 1970-1998 average while the 1998 year-class appears very strong. Survey estimates at age 1 suggest that the 1999 year-class is also strong. Area occupied of 1-29 cm haddock has been increasing since 1995, and the 1999 to 2001 estimates are comparable to the early 1980s estimates when strong year-classes occurred. Local density of 1-29 cm haddock has been increasing since 1992. Condition factors have generally been below average since the early 1990s. Growth, based on size at age 7, steadily declined throughout the late 1980s/1990s, which was preceded by a more rapid decline during the mid-1980s.

Since closure of the fishery, fishing mortality rates, expressed as exploitation, have been low (less than 2% since 1995). Prior to the collapse of the fishery, exploitation rates were more than twice the $F_{0.1}$ level of 20%.

Temperature anomalies from the Misaine bank region were positive during 1999 to 2001 for the first time since 1985. They provide an indicator of the environment of the eastern Scotian Shelf and have coincided with changes in the productivity of haddock and other stocks in the region. Declining productivity (e.g. poor growth and high natural mortality) has been evident in both haddock and cod in the region

since the initiation of the cooling trend in the mid-1980s. Recent increases in bottom temperature conditions may change this trend in productivity.

Currently, Div. 4VW haddock is an early maturing, geographically constricted stock plagued by poor growth (both under-weight and under-length) and high natural mortality that has recently produced good to excellent recruitment. The next few years will be pivotal to this stock given recent strong recruitment and improvement in environmental conditions. If growth and survival improve, this could lead to a rapid increase in biomass and recovery of historical productivity. If, however, poor growth, early maturity and high natural mortality persist, there will be a slow or negligible increase in biomass and low stock productivity dominated by small fish. At this time, it is uncertain which production scenario the stock will follow. In either case, minimization of removals continues to be appropriate in the short term.

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Table 1. Nominal catches (t) of eastern Scotian Shelf haddock (Div.4TVW) by NAFO Division and country.

Year	4T					4Vn					4Vs					4W					Total	TAC
	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other		
1954	5918	1044			40	5549	405		1058	24						12323	1956			17	28334	
1955	3101	31				3339	450		1183	13						12777	1217				22111	
1956	2861					4899	147		1350	12						18273	1661		354		29557	
1957	1740	1				5869	120		747	9						19960	1533		132		30111	
1958	2599			151		3166	71		1343	6						17572	427		1593		26928	
1959	2996	1		64		1594	159				3456	111		2870		21156	4804		640		37920	
1960	2041					1317	6				1187	18		3926	1	20093	127		1024		29837	
1961	1297			273	2	1055	1		47	1	846			1526	7	22277	23	151	1441	16	28963	
1962	1132			10		1097	1		5	2	1235			1076		15566	51	2567	3224		25966	
1963	1019			46		1213	1	6	64		1061	1		2828	195	11002	60	3295	4915	866	26572	
1964	461			1		958			59	52	677	11		2057	2	9810	42	4391	2884	1889	23294	
1965	432			3	3	402			53	84	1201			1806	47	7007	8	42876	1500	96	55518	
1966	149			1		311		516	30	31	1494			839	9	8259	19	9985	1885	51	23649	
1967	112			9		203		95	26	6	898					7180	5	459	1046	10	10912	
1968	144				4	127			70		1128		59	1702	23	8392		195	1458		13318	
1969	167				3	245				112	726			631	66	8270		235	864	1	11320	
1970	160					395	2		75	1	620		34	830	16	4754	574	636	1332		9429	
1971	151					466			215	1	1133		11	1114		7940	497	464	1477		13469	
1972	60					362	3		136	19	421		3	599	37	2096	70	103	737	102	4748	
1973	21				2	286			76	164	233			431	9	2830	173	76	95	18	4414	
1974	17				14	161			3	1	147		1	174	196	907	6	102	521	78	2357	0
1975	35				2	67			15		107			48	3	1393	20	52	63	59	1868	0
1976	12					40				1	52	1	9		1	1198	31	15			1360	2000
1977	8					189				8	144				1	2845	1	14		38	3248	2000
1978	18					119				3	441		3		38	4949	82	139		109	5901	2000
1979	59					194				11	650				2	2339		104		73	3433	2000
1980	81					188				42	1841					12448		209		31	14840	15000
1981	177					183				25	1796					17684		187		21	20009	23000
1982	47					206				23	2373					12498		53		49	15226	23000
1983	30					299				17	1542			2		7302		149		166	9412	15000
1984	120					598				11	3195				1	3992		168		233	8021	15000
1985	498					898				52	7291			8	42	2862		176		51	11570	15000
1986	465					488				19	8706				2	6170		165		32	16465	17000
1987	425					506				8	1537					991		180		157	3786	0
1988	353					421				2	2022					1175		327		99	4484	0
1989	73					108				3	3113					3580		471		211	7869	6700
1990	29					50					2427					4078		297		118	7060	6000
1991	18					27					972					4001		279		51	5371	0
1992	9					11					776					5261		2		153	6228	0
1993	4					9					435					824				135	1409	0
1994	0					1					35					47				12	103	0
1995	0					1					57					51				26	135	0
1996	0					2					45					154				39	239	0
1997	0					2					24					102				23	151	0
1998	0					2					16					144				15	177	0
1999	0					1					28					47				5	81	0
*2000	1					1					19					48				2	71	0

* Provisional data

Between 1954 and 1958 catches for 4Vn and 4Vs were combined as 4V.
 Canadian landings, 1954-85 NAFO, 1986 to present ZIF
 Foreign landings: 1954-1985 NAFO, 1986 - present Cdn. observers

Table 2. Canadian nominal landings,t of Div 4TVW haddock by gear.

YEAR	4TV					4W					4TVW
	OT	DS/SS	LL/LHS	Misc	Total	OT	DS/SS	LL/LHS	MISC.	Total	Total
1960	3741	27	488	289	4545	18902	6	275	910	20093	24638
1961	2196	51	500	451	3198	21341	29	532	375	22277	25475
1962	2673	51	576	164	3464	14729	57	396	384	15566	19030
1963	2382	92	628	191	3293	10454	97	276	175	11002	14295
1964	1787	38	18	253	2096	9278	49	429	54	9810	11906
1965	1852	27	104	52	2035	6565	49	142	251	7007	9042
1966	1817	55	42	40	1954	7942	13	112	192	8259	10213
1967	1068	27	57	61	1213	6890	55	125	110	7180	8393
1968	1278	16	40	65	1399	7781	110	207	294	8392	9791
1969	903	65	94	76	1138	7774	113	161	222	8270	9408
1970	897	19	152	107	1175	4258	105	32	359	4754	5929
1971	1500	24	166	60	1750	7370	85	34	451	7940	9690
1972	613	85	86	59	843	1589	20	41	446	2096	2939
1973	358	6	43	133	540	2098	35	65	632	2830	3370
1974	226	12	31	56	325	333	16	92	466	907	1232
1975	175	6	16	12	209	446	9	67	871	1393	1602
1976	88	3	9	4	104	305	9	90	794	1198	1302
1977	319	14	6	2	341	1910	17	159	759	2845	3186
1978	543	15	16	4	578	3647	54	177	1071	4949	5527
1979	802	75	19	7	903	974	18	115	1232	2339	3242
1980	1951	116	27	16	2110	11195	151	207	895	12448	14558
1981	1873	97	34	88	2092	15878	400	107	1299	17684	19776
1982	2230	231	129	13	2603	10192	704	127	1475	12498	15101
1983	1497	135	130	16	1778	5582	410	153	1157	7302	9080
1984	3249	174	178	13	3614	2871	348	25	748	3992	7606
1985	7545	583	251	8	8387	2002	247	17	596	2862	11249
1986	8969	702	392	6	10070	4893	472	739	66	6170	16239
1987	1629	502	305	15	2451	427	70	445	49	991	3442
1988	1987	359	516	19	2881	336	123	638	78	1175	4056
1989	2853	288	460	5	3606	1479	184	1877	41	3580	7187
1990	2094	167	300	4	2565	877	295	2860	45	4078	6642
1991	698	50	288	4	1041	1014	54	2896	37	4001	5042
1992	568	92	153	0	813	1704	154	3382	22	5261	6074
1993	247	43	160	0	450	127	10	682	5	824	1275
1994	27	4	14	0	45	18	0	26	3	48	93
1995	27	3	28	1	59	18	0	32	1	51	110
1996	24	4	18	0	46	42	0	110	3	154	201
1997	6	0	17	2	26	23	0	77	1	102	127
1998	6	0	11	1	19	74	0	68	2	144	163
1999	20	0	9	0	29	20	0	26	1	47	76
2000	17	0	4	0	21	12	0	36	0	48	69
*2001	11	0	4	0	15	16	0	40	0	56	71

* landings to Sept. 1/2001

Table 3. Commercial catch at age (thousands of fish) for Div. 4TVW haddock.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	306	268	306	487	59	279	431	213	714	1	332	870	530	497	10	
2	129	667	288	1178	233	61	676	283	433	268	376	318	433	470	360	
3	679	888	671	646	975	470	157	965	811	423	2372	262	1520	1084	1514	
4	1743	2188	751	1467	254	805	249	335	2412	1120	4334	5072	764	3207	4158	
5	1400	2740	924	811	464	282	323	513	436	675	3238	5081	5629	2040	2225	
6	1365	1208	668	723	298	185	189	283	715	159	1702	3010	1957	1677	821	
7	1163	944	345	342	114	63	132	117	203	149	249	1178	1220	530	410	
8	389	1177	191	159	47	30	36	80	61	16	129	139	214	235	90	
9	88	277	159	60	8	8	8	19	23	5	39	105	48	29	30	
10	38	39	9	99	17	4	10	15	8	6	9	30	28	18	5	
11	19	21	18	2	16	1	3	6	2	2	7	10	5	19	2	
12	14	25	0	4	0	1	7	7	0	0	2	5	7	6	1	
13	6	5	0	3	0	1	1	3	1	0	1	4	0	0	0	
14	6	2	0	1	0	0	0	1	1	1	1	4	0	0	0	
15	0	2	0	0	0	0	0	0	0	1	1	0	1	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0
1	111	12	118	305	1973	139	4	7	10	12	22	140	15	15	3	5
2	39	84	83	97	575	561	128	12	17	11	40	48	26	21	3	4
3	313	100	80	45	140	295	731	125	8	4	21	96	27	15	3	2
4	5006	3189	90	117	201	202	1095	1761	94	2	8	96	71	12	4	0
5	4988	9654	743	220	284	148	418	1400	430	17	10	19	9	31	10	3
6	1457	4244	1493	991	263	160	189	589	256	25	21	9	5	33	32	4
7	312	1015	631	1505	1596	411	239	418	89	13	32	15	2	2	9	29
8	323	255	183	696	2430	1640	319	204	46	0	11	18	11	8	2	3
9	257	184	49	175	956	2090	952	246	77	0	2	7	15	27	6	2
10	127	102	37	32	345	525	812	577	88	1	1	0	4	34	6	3
11	47	19	14	24	63	206	292	386	126	3	2	0	2	21	4	3
12	8	24	6	35	37	20	89	196	116	2	3	0	0	5	0	1
13	0	2	0	7	8	10	5	46	36	5	6	0	1	0	0	0
14	1	0	0	6	2	3	1	2	6	1	1	2	1	0	0	0
15	0	0	0	1	2	0	1	0	1	0	0	0	1	0	0	0
16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. Differences observed (000's) between the new catch-at-age and the catch-at-age from the 1997 assessment.

Difference(new-old)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sum	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	0	0	5	1	0	0	0	0	0	0	-	-	-	-
1	-777	-4	35	193	420	119	3	-7	-4	0	-1	-7	-	-	-	-
2	13	-48	5	28	-248	424	55	-2	-5	0	-1	-2	-	-	-	-
3	-199	-852	-12	-3	-85	148	182	-2	-2	1	-1	32	-	-	-	-
4	2059	140	27	-49	-105	19	111	40	0	0	0	56	-	-	-	-
5	494	3978	323	-19	-143	1	39	11	2	0	0	12	-	-	-	-
6	-280	-1108	667	39	-226	12	11	13	2	0	0	6	-	-	-	-
7	-69	-932	-482	311	205	3	16	5	0	0	0	8	-	-	-	-
8	-507	-241	-223	-163	958	16	13	2	0	0	0	9	-	-	-	-
9	-88	-213	-24	-39	-367	82	18	-6	0	0	0	3	-	-	-	-
10	-22	-28	-130	-44	-180	45	23	-12	0	0	0	-1	-	-	-	-
Sum	625	692	186	253	236	872	470	42	-7	1	-1	116				

Table 5. Number of stratified random sets by stratum and year during the Div. 4VsW Sentinel Survey.

Strata	1995	1996	1997	1998	1999	2000
444	13	26	24	29	28	29
446	4	6	6	6	6	5
447	13	11	12	12	12	12
448	9	9	10	9	9	9
449	5	4	4	4	4	4
450	6	7	7	7	7	7
451	4	4	4	4	4	4
452	3	5	4	5	4	4
453	5	5	4	5	5	4
454	6	6	6	6	6	7
455	16	14	13	13	13	14
456	7	6	6	7	6	7
457	4	7	7	6	5	6
458	4	5	5	5	5	5
459	20	19	19	20	20	19
460	12	9	8	10	10	9
461	9	8	7	6	6	6
462	18	14	13	13	14	13
463	5	5	5	5	5	5
464	11	11	12	12	12	13
465	9	14	15	15	14	15
466	1	4	4	4	4	4
467	3	11	10	11	9	11
468	12	11	10	12	12	12
469	20	14	14	11	12	12
Total	219	235	229	237	232	236

Table 6. Catch rate(kg.per set) of haddock by stratum from the fixed gear sentinel survey in Div. 4VsW. Stratified means are also shown with and without the inclusion of three inshore strata (467-469).

Stratum	1995	1996	1997	1998	1999	2000
444	0.0	0.0	0.0	0.0	0.0	0.0
446	3.8	1.3	8.9	0.1	0.6	1.8
447	1.5	2.1	1.1	0.0	1.9	0.0
448	0.1	0.0	0.0	0.0	0.2	0.0
449	13.2	32.1	7.2	3.9	3.5	0.0
450	7.0	11.6	0.2	0.0	0.0	10.6
451	62.5	90.5	49.6	16.7	24.7	4.5
452	0.0	21.6	0.0	0.3	2.4	7.3
453	0.2	1.0	3.8	1.5	10.1	14.7
454	13.2	18.6	3.1	1.8	6.7	25.7
455	51.1	56.6	20.1	8.3	22.1	20.6
456	75.7	52.5	3.0	2.7	11.7	35.9
457	0.3	4.0	0.0	0.8	0.0	0.0
458	0.0	14.3	34.7	0.0	0.0	0.0
459	1.6	5.1	0.3	0.1	0.0	0.1
460	3.8	4.9	1.0	4.9	22.5	6.0
461	0.0	0.0	1.6	0.0	0.3	0.0
462	14.5	9.4	3.7	11.2	8.7	10.0
463	164.4	65.4	116.7	157.1	103.0	90.2
464	236.2	202.5	118.5	141.5	54.3	64.9
465	83.4	41.7	28.7	52.1	67.3	21.6
466	0.0	2.9	29.8	0.0	9.4	64.2
467	0.0	0.0	0.0	0.0	0.0	0.0
468	0.0	0.0	0.0	0.0	0.0	0.0
469	4.4	7.3	2.4	1.7	1.3	1.6
Stratified Mean(444-466)	28.5	23.2	12.9	14.6	13.7	11.0
Stratified Mean(444-469)	26.9	22.0	12.2	13.8	13.0	10.4

Table 7. Sentinel Survey stratified mean numbers at age from 1995 to 2000.

Age	1995	1996	1997	1998	1999	2000
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.32	0.07	0.09	0.02	0.01	0.14
3	3.15	2.72	0.48	0.65	0.50	0.69
4	0.67	4.12	1.99	1.76	1.81	1.89
5	1.21	1.61	2.71	2.45	1.76	3.97
6	3.88	0.73	0.87	1.65	2.26	1.87
7	11.95	3.41	0.80	0.68	1.23	1.70
8	8.19	8.00	1.81	0.30	0.60	1.28
9	2.09	1.97	3.48	1.67	0.62	0.40
10	0.46	0.87	1.21	4.37	1.56	0.08
11	0.09	0.09	0.41	1.20	2.74	0.46
12	0.14	0.15	0.11	0.56	0.42	1.00
13	1.16	0.20	0.02	0.02	0.00	0.14
14	0.13	0.04	0.03	0.11	0.00	0.02
15	0.20	0.11	0.05	0.00	0.03	0.00
16	0.00	0.00	0.04	0.01	0.00	0.00
17	0.00	0.00	0.01	0.00	0.00	0.00
3+	33.31	24.01	14.03	15.44	13.52	13.50
5+	29.50	17.17	11.56	13.03	11.21	10.91
7+	24.40	14.84	7.98	8.93	7.20	5.07
Total	33.63	24.09	14.12	15.46	13.53	13.63

Length(cm)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0.01	0	0	0	0.01	0	0	0.05	0.04	0.01	0.07	0.01	0	0
6.5	0.03	0.04	0.03	0	0	0.02	0.32	0.06	0	0.52	0.89	4.50	0.32	0.10	0.02	0
8.5	0.07	0.02	0.01	0	0.14	0.02	0.25	0.13	0	0.87	0.42	14.31	0.29	0.02	0.26	0.01
10.5	0	0	0	0	0.09	0.03	0.04	0.07	0	0.05	0.12	3.34	0.10	0	0	0
12.5	0	0	0	0	0	0	0	0	0	0	0.01	0.19	0.03	0.02	0	0
14.5	0	0	0	0	0	0	0	0.02	0.04	0	0.02	0.31	1.37	0.29	0.00	0
16.5	0.03	0.02	0.03	0	0	0.03	0.10	0.02	0.53	0	0.04	2.31	7.77	4.16	0	0.02
18.5	0.23	0.15	0.22	0.01	0.03	0.10	0.14	0.09	2.95	0.02	0.59	5.24	5.81	9.84	0.04	0.15
20.5	0.79	0.32	0.52	0.08	0.02	0.22	1.26	0.83	4.03	0.04	1.48	4.78	2.58	8.21	0.26	1.29
22.5	1.23	0.67	0.51	0.21	0.14	0.35	1.04	2.24	1.72	0.02	1.11	2.09	0.74	3.02	0.35	2.35
24.5	0.34	0.48	0.14	0.18	0.10	1.93	0.39	2.22	0.90	0.20	0.39	1.10	1.55	2.12	0.95	0.68
26.5	0.15	0.34	0.19	0.16	0.08	2.38	0.45	1.14	0.49	0.51	0.03	0.59	3.54	2.58	1.85	0.23
28.5	0.04	0.32	0.16	0.26	0.04	0.50	0.35	1.12	0.30	1.62	0.07	1.77	4.46	3.98	3.13	0.31
30.5	0.37	0.95	0.37	0.24	0.13	0.12	0.26	2.03	1.56	2.39	0.02	2.72	3.51	4.20	5.20	0.83
32.5	0.38	1.19	0.36	0.56	0.46	0.03	0.53	3.12	3.44	2.94	0.10	2.59	2.24	5.15	4.55	1.80
34.5	0.19	0.73	0.25	0.37	0.91	0.05	0.71	2.96	4.25	2.54	0.77	1.66	0.97	5.17	4.27	3.37
36.5	0.43	0.39	0.25	0.22	0.75	0.10	0.69	2.08	3.46	1.48	1.88	0.56	1.76	7.83	7.17	4.23
38.5	0.47	0.22	0.20	0.21	0.65	0.11	0.31	1.36	3.21	2.07	4.39	0.31	3.41	9.09	9.95	4.60
40.5	0.69	0.37	0.30	0.17	0.50	0.45	0.08	1.67	4.74	3.41	5.21	0.70	3.72	5.08	10.58	6.28
42.5	0.68	0.63	0.20	0.06	0.69	0.48	0.19	2.45	3.79	3.64	4.43	1.82	2.89	3.33	6.79	6.29
44.5	0.79	0.55	0.17	0.17	0.64	0.95	0.12	2.18	2.96	3.47	5.56	2.39	3.25	2.59	3.95	4.12
46.5	0.53	0.42	0.25	0.15	0.48	0.57	0.26	1.41	2.27	3.03	4.79	2.47	2.40	2.15	2.18	2.75
48.5	0.47	0.38	0.13	0.05	0.23	0.45	0.40	0.53	2.08	2.22	4.69	2.43	2.20	1.81	1.70	1.59
50.5	0.59	0.40	0.34	0.16	0.14	0.44	0.37	0.67	1.27	1.52	3.69	1.77	2.02	1.35	1.04	1.33
52.5	0.50	0.27	0.14	0.17	0.24	0.28	0.31	0.76	0.52	0.83						

Table 9. Catch rate at length of Div. 4VW haddock from the spring RV survey.

Length, cm	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2.5	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
4.5	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
6.5	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
8.5	0.00	0.00	0.02	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
10.5	0.00	0.00	1.88	0.49	0.25	0.00		0.00	0.02	0.00	0.00	0.00
12.5	0.00	0.69	9.16	9.17	2.49	0.64		0.07	0.05	0.07	1.39	0.02
14.5	0.01	3.06	10.33	14.87	6.53	0.97		0.15	1.11	1.50	11.16	0.02
16.5	0.00	1.69	4.83	6.96	4.72	0.10		0.28	1.55	4.12	6.85	0.05
18.5	0.02	0.45	1.38	2.20	1.82	0.30		0.99	0.79	2.26	1.00	0.18
20.5	0.07	0.14	0.07	2.30	2.59	2.27		0.41	0.11	0.64	0.21	0.11
22.5	0.23	0.02	0.57	4.75	4.32	3.27		0.09	0.05	0.15	0.08	0.78
24.5	0.58	0.03	3.67	9.23	5.52	3.72		0.13	0.29	0.88	1.20	3.31
26.5	0.85	0.05	4.45	10.02	3.49	3.63		0.69	0.70	2.58	4.46	4.66
28.5	0.61	0.17	2.64	4.94	2.63	4.65		0.68	0.76	3.09	8.03	2.84
30.5	0.22	0.54	1.38	2.21	4.65	9.27		0.75	0.69	1.28	4.76	0.58
32.5	0.37	1.67	0.50	1.46	10.61	15.56		1.46	1.38	0.49	2.18	2.01
34.5	0.53	2.52	0.12	2.60	13.01	16.26		3.78	2.56	0.94	3.39	3.07
36.5	1.74	3.23	3.14	3.67	8.21	11.27		7.90	3.96	1.50	3.40	2.56
38.5	1.29	2.41	11.40	2.57	6.24	10.49		11.57	5.46	2.11	3.06	1.55
40.5	1.89	1.44	22.09	2.43	7.68	7.28		12.03	8.86	3.50	3.95	2.89
42.5	2.14	0.94	27.89	1.48	6.41	4.14		11.51	9.16	5.85	4.69	3.73
44.5	1.97	0.93	21.77	2.63	5.15	4.63		9.38	8.94	5.43	6.07	5.57
46.5	1.86	1.04	18.37	3.63	3.82	3.28		5.91	7.70	4.88	3.49	5.09
48.5	1.48	0.70	12.95	2.60	3.36	2.49		3.47	4.71	2.87	2.89	4.53
50.5	0.85	0.73	9.94	2.59	3.33	2.48		2.27	2.59	1.86	1.76	3.16
52.5	0.99	0.72	8.28	1.75	2.51	1.58		1.19	1.61	1.24	0.95	1.63
54.5	0.50	0.30	6.22	1.41	2.07	1.36		1.10	0.76	0.70	1.04	0.71
56.5	0.51	0.33	3.13	1.29	1.46	0.91		0.51	0.56	0.34	0.58	0.68
58.5	0.44	0.39	2.87	0.79	0.70	0.61		0.31	0.35	0.23	0.31	0.32
60.5	0.35	0.30	2.37	0.73	0.48	0.31		0.25	0.18	0.27	0.31	0.16
62.5	0.20	0.18	1.12	0.64	0.27	0.36		0.09	0.07	0.09	0.08	0.14
64.5	0.07	0.06	0.37	0.36	0.12	0.22		0.10	0.02	0.10	0.02	0.01
66.5	0.20	0.11	0.37	0.11	0.14	0.11		0.03	0.00	0.03	0.04	0.05
68.5	0.04	0.05	0.08	0.10	0.04	0.04		0.03	0.00	0.00	0.00	0.00
70.5	0.02	0.02	0.00	0.06	0.06	0.13		0.02	0.05	0.00	0.00	0.00
72.5	0.05	0.00	0.00	0.03	0.01	0.02		0.00	0.00	0.01	0.00	0.00
74.5	0.00	0.01	0.02	0.02	0.00	0.01		0.00	0.00	0.00	0.00	0.00
76.5	0.01	0.00	0.00	0.02	0.00	0.01		0.00	0.00	0.00	0.00	0.00
78.5	0.00	0.00	0.00	0.02	0.00	0.01		0.00	0.00	0.01	0.00	0.00
80.5	0.01	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
total	20.11	24.92	193.38	100.10	114.71	112.38		77.13	65.05	49.03	77.32	50.43
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
10.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.01	0.00	
12.5	0.02	0.02	0.00	0.07	0.08	0.00	0.00		0.46	0.88	0.00	
14.5	0.01	0.60	0.12	0.14	1.63	1.66	0.17		1.62	5.33	0.14	
16.5	0.10	0.36	0.92	1.41	1.90	3.90	1.56		3.86	13.27	0.64	
18.5	0.04	0.01	1.54	1.54	0.43	2.23	1.68		3.37	21.31	0.75	
20.5	0.00	0.00	0.61	0.71	0.12	0.80	1.08		0.59	14.72	0.35	
22.5	0.13	0.00	0.00	0.10	0.05	0.31	0.72		0.43	2.79	1.48	
24.5	0.18	0.06	0.00	0.11	0.73	0.70	2.88		4.70	1.10	4.79	
26.5	0.65	0.06	0.04	0.71	1.34	2.78	3.64		5.85	2.32	3.97	
28.5	0.97	0.02	0.00	0.84	1.23	2.44	1.41		2.40	2.69	1.29	
30.5	2.39	0.08	0.06	0.58	0.78	3.79	2.06		4.49	1.28	0.78	
32.5	3.69	0.32	0.43	0.48	1.07	7.52	3.82		11.17	1.18	1.19	
34.5	2.40	0.67	1.06	1.54	0.89	6.36	3.01		11.56	1.55	1.38	
36.5	1.85	1.10	3.56	4.49	0.65	4.16	2.84		11.14	2.30	1.22	
38.5	1.70	0.79	3.43	9.95	0.43	4.04	2.52		8.46	3.08	1.41	
40.5	1.28	1.05	2.57	7.22	0.73	6.08	1.90		6.60	2.27	1.19	
42.5	0.99	0.95	1.24	4.67	0.36	8.19	1.36		4.99	2.11	0.83	
44.5	0.56	0.78	0.88	2.53	0.36	4.51	1.35		3.59	2.05	0.83	
46.5	0.90	0.70	0.42	1.48	0.28	2.37	0.73		3.88	1.52	0.39	
48.5	0.83	0.48	0.24	0.79	0.11	1.29	0.44		1.19	0.89	0.27	
50.5	0.81	0.48	0.06	0.54	0.09	1.15	0.37		1.05	0.71	0.22	
52.5	0.46	0.28	0.07	0.27	0.05	0.24	0.13		0.63	0.34	0.08	
54.5	0.31	0.34	0.04	0.15	0.01	0.21	0.07		0.21	0.11	0.04	
56.5	0.26	0.11	0.02	0.15	0.01	0.02	0.07		0.06	0.03	0.05	
58.5	0.11	0.03	0.07	0.17	0.00	0.02	0.04		0.03	0.02	0.01	
60.5	0.13	0.11	0.01	0.08	0.01	0.01	0.02		0.01	0.01	0.03	
62.5	0.03	0.05	0.01	0.06	0.00	0.00	0.01		0.02	0.01	0.00	
64.5	0.04	0.03	0.01	0.04	0.00	0.00	0.00		0.00	0.00	0.00	
66.5	0.00	0.00	0.00	0.00	0.01	0.00	0.00		0.00	0.00	0.00	
68.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.00	0.00	
70.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.00	0.00	
72.5	0.02	0.00	0.00	0.02	0.00	0.00	0.00		0.00	0.00	0.00	
74.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
76.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
78.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
80.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
total	20.87	9.52	17.40	40.84	13.33	64.78	33.87		92.39	83.89	23.30	

Table 10. Proportion of female haddock mature at length from the spring RV survey. Missing values (bold) were derived from the other time periods. The 1982-1984 average was applied to 1985 and 1986. The 1988 to 1990 average was applied to 1991 and some empty cells in 1992 and 1993. The 1995 to 1997 average was applied to 1998.

Length, cm	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
20.5	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.02	0.00	0.00	0.00	0.00
22.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00
24.5	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26.5	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00
28.5	0.17	0.00	0.17	0.04	0.04	0.00	0.03	0.03	0.00	0.00	0.00	0.08
30.5	0.14	0.00	0.11	0.00	0.05	0.08	0.04	0.04	0.63	0.17	0.10	0.00
32.5	0.33	0.25	0.00	0.25	0.10	0.22	0.17	0.17	0.80	0.50	0.17	0.50
34.5	0.17	0.28	1.00	0.43	0.23	0.33	0.31	0.31	0.68	0.92	0.75	0.15
36.5	0.69	0.16	1.00	0.23	0.45	0.54	0.44	0.44	0.79	0.91	0.83	0.31
38.5	0.92	0.47	1.00	0.36	0.67	0.92	0.70	0.70	0.89	0.92	1.00	0.78
40.5	0.76	0.44	0.08	0.61	0.90	0.95	0.85	0.85	1.00	1.00	1.00	0.86
42.5	0.92	0.60	1.00	0.75	0.79	1.00	0.85	0.85	0.98	0.96	1.00	1.00
44.5	1.00	0.89	0.91	0.80	1.00	0.98	0.98	0.98	1.00	1.00	0.91	1.00
46.5	0.94	0.83	0.93	1.00	1.00	0.94	0.98	0.98	0.98	1.00	1.00	1.00
48.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
50.5	0.96	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
52.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
54.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
56.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
58.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
60.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
62.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
64.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
66.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	1.00	1.00
68.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-
70.5	1.00	1.00	-	1.00	1.00	1.00	1.00	1.00	-	-	-	-
72.5	1.00	-	-	1.00	1.00	1.00	1.00	1.00	-	-	-	-
20.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	0.00	0.00	0.00	0.00	0.33	0.00	0.13	0.15	0.00	0.00	0.00	0.00
24.5	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.05	0.11	0.17	0.00	0.00
26.5	0.00	0.00	0.00	0.00	0.33	0.09	0.00	0.04	0.06	0.17	0.17	0.17
28.5	0.04	0.04	0.04	0.00	0.27	0.00	0.29	0.25	0.43	0.00	0.36	0.36
30.5	0.10	0.00	0.10	0.33	0.33	0.40	0.76	0.58	0.75	0.39	0.54	0.54
32.5	0.40	0.75	0.40	0.63	0.91	0.50	0.71	0.71	0.80	0.67	0.64	0.64
34.5	0.55	1.00	1.00	1.00	0.90	0.71	0.84	0.83	0.79	0.87	0.78	0.78
36.5	0.61	1.00	1.00	0.86	1.00	0.83	0.95	0.94	0.92	0.81	0.76	0.76
38.5	0.88	1.00	1.00	1.00	1.00	0.75	0.95	0.94	0.93	0.92	0.92	0.92
40.5	0.95	1.00	1.00	1.00	1.00	1.00	0.95	0.97	1.00	1.00	0.94	0.94
42.5	0.98	1.00	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
44.5	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	1.00	1.00	1.00
46.5	1.00	1.00	1.00	1.00	1.00	1.00	0.93	0.97	0.95	1.00	1.00	1.00
48.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
50.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
52.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
54.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
56.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
58.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
60.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
62.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
64.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
66.5	1.00	-	-	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
68.5	-	-	-	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00
70.5	-	-	-	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00
72.5	-	-	-	-	-	-	-	-	-	-	-	-

Table 11. Weight (g) per tow at length of haddock from the summer RV survey in Div. 4VW

Length, cm	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
6.5	0.1	0.1	0.1	0.0	0.0	0.1	0.7	0.2	0.0	1.1	1.5	11.6	1.0	0.3	0.0	0.0
8.5	0.4	0.2	0.1	0.0	0.8	0.1	1.3	0.8	0.0	4.4	1.7	83.8	1.9	0.2	1.4	0.1
10.5	0.0	0.0	0.0	0.0	0.9	0.3	0.4	0.8	0.0	0.5	1.0	37.4	1.3	0.0	0.0	0.0
12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	3.6	0.6	0.3	0.0	0.0
14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.0	0.0	0.5	9.4	44.4	8.3	0.1	0.0
16.5	1.1	0.8	1.7	0.0	0.0	1.5	3.8	1.1	21.1	0.0	1.3	103.3	372.4	179.3	0.0	1.0
18.5	13.8	9.5	14.2	0.8	1.6	6.0	8.1	5.6	167.8	1.4	30.3	332.7	390.1	599.0	2.4	9.6
20.5	65.7	27.5	48.0	6.5	1.9	18.8	100.1	74.2	322.7	2.8	105.6	416.0	231.9	684.6	21.1	107.8
22.5	136.5	76.0	58.4	22.8	15.1	43.5	107.6	265.0	182.3	2.5	107.3	242.1	89.3	339.3	36.8	259.3
24.5	49.4	70.1	21.0	26.4	14.2	284.6	54.1	339.4	126.5	25.1	50.4	164.6	238.6	322.9	133.7	96.4
26.5	27.8	63.1	38.5	28.1	14.4	446.4	79.0	214.1	86.9	91.9	5.0	112.2	702.7	481.4	328.5	40.7
28.5	9.8	74.1	36.7	59.0	8.6	117.4	78.4	270.6	71.6	365.9	13.6	422.5	1108.3	909.5	695.5	68.6
30.5	105.3	270.2	110.9	68.7	36.2	35.1	70.5	601.5	431.7	667.0	4.7	801.1	1122.5	1169.6	1421.3	228.0
32.5	138.1	409.5	130.1	191.1	154.5	8.8	183.8	1128.6	1166.2	999.1	33.7	925.7	828.9	1740.3	1511.0	595.4
34.5	81.7	341.7	114.4	153.4	368.6	18.0	284.5	1280.4	1740.8	1041.4	303.0	710.6	408.6	2094.5	1682.2	1327.7
36.5	212.6	189.8	122.2	109.2	362.8	44.0	334.4	1071.5	1688.2	725.9	889.0	285.8	963.0	3764.4	3386.8	1975.4
38.5	280.5	122.8	134.2	118.4	367.1	61.5	169.8	823.1	1854.1	1197.9	2473.2	188.8	2013.8	5140.1	5532.1	2513.7
40.5	492.2	247.6	202.2	111.8	335.1	304.0	54.8	1177.7	3213.8	2295.6	3459.4	489.1	2594.1	3350.3	6877.0	3993.0
42.5	548.9	483.9	163.5	49.8	531.4	381.2	144.4	2003.6	2993.6	2864.0	3447.2	1479.3	2278.1	2523.9	5122.0	4613.2
44.5	738.6	484.6	143.0	158.1	570.9	843.1	105.1	2043.7	2687.6	3153.2	5026.3	2242.6	2949.0	2293.6	3422.8	3467.6
46.5	573.6	420.0	268.9	155.3	487.7	568.0	266.2	1506.2	2390.5	3158.4	5004.3	2649.7	2435.1	2157.2	2166.7	2634.9
48.5	555.7	432.8	163.7	55.2	267.3	525.7	474.2	651.6	2451.2	2645.6	5621.4	2960.7	2555.7	2060.8	1901.8	1733.5
50.5	817.9	488.7	466.1	218.0	187.7	581.6	496.4	963.6	1723.3	2058.2	5050.8	2442.1	2674.5	1736.2	1325.7	1636.3
52.5	783.8	366.2	223.1	254.9	357.3	380.1	475.2	1106.7	795.2	1263.7	2701.9	1620.7	2427.9	1705.8	1531.1	1142.0
54.5	373.7	259.5	231.2	257.7	453.0	777.4	546.7	855.8	281.6	1072.6	2342.6	1037.4	1928.0	1357.3	877.3	653.6
56.5	658.3	321.9	167.3	61.3	397.0	468.4	396.6	847.7	320.1	331.8	851.8	1055.8	1179.5	585.1	833.7	638.5
58.5	540.6	173.9	118.8	315.8	352.6	615.3	150.9	673.1	248.4	197.8	766.2	623.7	964.8	519.4	603.3	459.5
60.5	262.0	125.6	160.2	112.1	148.8	573.9	59.7	771.3	267.5	368.2	586.0	587.7	414.2	202.9	526.8	195.2
62.5	459.5	117.9	239.9	241.8	173.6	335.0	264.4	297.5	283.8	252.8	510.2	238.7	707.5	297.8	308.0	168.7
64.5	730.1	55.1	104.2	0.0	248.4	355.2	229.3	243.8	218.2	150.0	321.1	389.1	473.5	224.8	274.4	78.7
66.5	645.1	305.4	0.0	184.0	29.5	242.7	141.5	53.5	0.0	195.7	165.3	103.9	225.1	294.2	194.9	258.6
68.5	112.9	27.2	162.6	0.0	72.8	100.6	75.6	217.5	110.6	126.3	195.5	113.8	0.0	136.6	213.3	85.0
70.5	175.8	88.9	0.0	0.0	17.7	171.3	0.0	0.0	116.4	73.7	0.0	0.0	63.4	7.1	0.0	79.4
72.5	186.7	0.0	0.0	93.2	62.6	143.4	250.8	134.2	45.8	0.0	0.0	0.0	0.0	92.7	53.8	14.4
74.5	39.5	0.0	0.0	154.8	0.0	0.0	16.4	0.0	0.0	0.0	0.0	0.0	91.2	0.0	25.1	0.0
76.5	42.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.7	0.0
78.5	46.6	0.0	0.0	0.0	0.0	0.0	0.0	158.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9	9.8
82.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Length, cm	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.5	0.2	0.0	0.1	0.0	0.0	0.1	0.0	1.0	0.8	0.1	0.5	0.1	0.1	1.3	0.6	0.0
8.5	0.2	0.3	3.5	0.3	0.0	0.0	0.0	8.4	4.0	1.2	12.9	1.2	3.5	67.2	15.6	1.9
10.5	0.0	0.0	2.7	0.4	0.0	0.0	0.0	13.7	3.8	0.3	19.1	0.7	6.9	476.5	59.0	3.9
12.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.4	0.2	0.0	0.0	0.0	0.9	272.2	17.7	2.3
14.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.6	0.0	1.8	8.7	9.0	0.2
16.5	0.0	7.4	0.0	29.5	0.6	0.0	0.9	0.3	0.0	3.5	4.7	2.9	16.9	3.0	73.6	7.4
18.5	3.3	29.5	4.3	300.9	3.0	1.1	0.5	3.6	3.6	11.7	89.8	13.5	65.7	15.3	303.3	38.7
20.5	13.3	78.2	82.3	440.1	20.8	5.3	28.2	31.0	61.8	93.7	285.2	125.0	95.7	187.6	1251.2	168.7
22.5	44.9	96.3	219.7	170.6	42.9	10.5	34.5	126.0	270.7	205.8	380.1	348.9	40.1	390.1	2198.8	275.7
24.5	63.0	44.5	180.0	78.2	60.9	5.2	20.4	140.0	457.5	110.0	221.2	266.4	10.1	1081.1	1283.9	669.2
26.5	29.8	23.9	47.5	37.8	301.4	12.8	9.2	79.8	180.8	74.2	110.8	520.1	95.3	613.1	367.4	2765.8
28.5	39.3	48.2	78.7	111.8	1337.8	131.6	37.4	50.5	379.1	344.4	247.1	912.5	558.0	711.2	668.1	3520.9
30.5	237.6	140.5	738.9	467.9	1994.5	562.8	124.7	198.9	531.0	731.5	836.4	626.2	1377.4	1085.3	1481.2	1783.2
32.5	498.8	298.5	2735.3	1051.9	1011.2	2607.4	432.4	208.9	311.8	755.1	1255.3	505.3	2482.8	1449.6	1654.3	1719.7
34.5	778.7	364.2	2481.3	680.2	829.4	4762.5	1871.8	393.0	297.9	747.6	1523.6	742.9	2597.3	3002.5	2302.2	1702.5
36.5	1961.1	751.8	1311.5	445.0	1540.7	5016.3	2970.2	1386.5	621.7	658.3	1590.3	1168.3	2189.7	3898.4	2956.9	1908.3
38.5	4128.4	1455.7	2059.3	586.8	1917.9	4868.5	2748.4	2810.3	1632.5	1128.6	1349.1	1096.7	1650.5	3450.9	3253.6	1727.8
40.5	5775.9	3056.5	2829.4	1022.5	1653.3	4191.8	2505.9	2865.7	2541.0	1825.7	1649.7	1170.3	1212.6	2536.2	2296.4	1792.1
42.5	5798.5	4224.0	4112.6	2233.0	1630.9	3884.3	1826.5	2377.1	2081.5	1938.2	1781.9	1463.3	1357.9	1779.9	2350.7	1286.7
44.5	4815.3	4305.2	5446.8	3469.5	2646.1	3490.8	1310.2	1456.1	1303.1	1323.3	1593.7	1344.8	860.8	1408.5	1307.9	705.1
46.5	3603.5	2985.0	4798.3	3706.8	2752.1	3439.5	1123.2	978.0	636.4	666.9	1125.5	899.7	842.0	650.9	1430.2	388.9
48.5	2521.2	2133.8	3507.6	3096.1	2270.7	2847.0	888.6	472.6	411.4	267.1	533.6	534.7	345.9	540.8	961.6	211.2
50.5	1994.2	1015.0	1917.2	1951.7	1870.8	1117.5	683.2	511.2	201.0	100.5	251.2	386.5	417.3	439.2	247.5	165.8
52.5	1099.0	765.8	1083.1	1211.2	874.2	677.6	444.7	220.7	98.9	84.7	84.8	203.2	293.5	164.9	348.6	90.8
54.5	1060.9	313.5	533.2	725.7	489.0	154.2	160.9	102.9	47.5	158.0	110.7	65.1	115.1	67.3	109.5	44.2
56.5	907.9	311.0	362.2	506.3	465.2	130.1	193.7	48.8	35.3	193.7	35.3	0.0	18.4	112.7	10.5	0.0
58.5	620.6	145.1	240.6	143.6	132.4	68.2	22.1	41.3	0.0	136.9	19.6	20.2	61.2	313.4	14.6	0.0
60.5	350.7	73.5	302.1													

Table 12. Stratified mean number per tow of Div. 4VW haddock from the July RV survey.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	0.11	0.06	0.00	0.00	0.23	0.07	0.30	0.19	0.00	1.49	1.44
1	2.74	1.74	1.31	0.53	0.37	4.82	2.78	6.07	9.91	0.10	3.52
2	1.00	3.50	0.95	1.74	2.14	0.95	3.13	11.23	11.04	9.42	0.28
3	1.79	1.20	1.26	0.54	2.84	1.97	0.48	9.06	14.77	9.78	14.95
4	2.12	1.57	0.59	0.47	0.59	1.78	0.95	1.36	8.39	10.27	13.92
5	1.00	0.65	0.50	0.17	0.54	0.48	0.94	1.96	0.50	2.87	8.53
6	0.62	0.37	0.34	0.34	0.26	0.85	0.20	0.73	0.49	0.37	2.08
7	0.62	0.16	0.16	0.08	0.20	0.22	0.23	0.22	0.12	0.31	0.34
8	0.41	0.25	0.11	0.10	0.10	0.10	0.05	0.11	0.01	0.07	0.12
9	0.14	0.01	0.04	0.02	0.05	0.05	0.01	0.00	0.00	0.00	0.02
10	0.04	0.00	0.01	0.05	0.04	0.06	0.01	0.05	0.01	0.04	0.00
11	0.04	0.00	0.00	0.00	0.04	0.00	0.01	0.01	0.01	0.01	0.00
12	0.02	0.00	0.00	0.00	0.00	0.02	0.06	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unknown	0.00	0.00	0.05	0.00	0.01	0.00	0.32	0.10	0.02	0.00	0.05
total	10.64	9.53	5.29	4.03	7.42	11.35	9.49	31.10	45.31	34.76	45.24

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	22.36	0.79	0.14	0.28	0.01	0.14	0.08	1.04	0.10	0.02
1	15.71	18.3	21.29	0.30	4.61	1.20	3.02	4.73	13.65	0.97
2	9.32	15.19	14.68	10.79	1.40	3.25	1.23	12.88	7.64	14.90
3	0.98	12.82	30.15	17.30	8.85	4.16	2.53	6.13	1.93	10.06
4	7.32	2.54	11.72	29.30	10.97	12.77	1.59	4.52	1.39	3.46
5	4.73	7.71	3.00	5.19	12.00	13.49	7.42	3.38	1.81	0.74
6	2.02	3.02	2.77	2.39	3.37	10.09	7.38	9.57	1.73	0.94
7	0.31	0.97	0.95	1.31	0.68	3.22	5.76	6.87	4.69	1.12
8	0.10	0.22	0.27	0.24	1.49	0.81	1.34	5.35	3.71	2.04
9	0.12	0.03	0.08	0.09	0.65	0.80	0.10	0.89	3.40	2.70
10	0.02	0.02	0.03	0.02	0.29	0.32	0.26	0.35	1.03	2.44
11	0.00	0.00	0.00	0.01	0.12	0.10	0.05	0.17	0.18	1.84
12	0.00	0.00	0.04	0.00	0.00	0.11	0.09	0.18	0.23	0.20
13	0.00	0.00	0.00	0.00	0.04	0.02	0.01	0.04	0.02	0.02
14	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.01	0.01	0.13
15	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unknown	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.00
total	62.99	61.62	85.16	67.25	44.46	50.49	30.89	56.15	41.52	41.60

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.02	0.00	2.43	1.36	0.27	4.19	0.36	1.39	71.21	10.29
1	0.13	0.78	2.61	7.02	3.72	9.81	6.59	3.06	15.49	50.29
2	1.88	1.10	1.53	4.49	5.39	6.14	8.6	6.38	7.99	18.96
3	21.61	3.53	1.12	1.19	4.50	8.88	3.65	13.34	9.02	7.31
4	19.87	11.86	3.56	0.89	0.52	4.78	4.46	5.63	11.48	7.1
5	7.11	6.88	9.71	2.25	0.79	0.74	2.27	4.81	6.67	8.41
6	1.52	0.83	3.43	6.93	4.13	0.34	1.02	2.16	3.35	3.13
7	2.37	0.70	0.94	2.81	4.27	1.34	0.28	0.44	2.12	2.67
8	2.01	0.22	0.23	0.24	0.80	3.09	0.48	0.36	0.31	1.11
9	2.19	0.24	0.37	0.19	0.16	1.62	2.01	0.54	0.4	0.45
10	2.29	0.70	0.15	0.09	0.05	0.26	1.4	1	1.12	0.2
11	0.64	0.79	0.48	0.19	0.08	0.05	0.44	0.54	0.87	0.6
12	0.16	0.58	0.27	0.19	0.13	0.02	0.06	0.03	0.3	0.43
13	0.00	0.25	0.23	0.12	0.06	0.02	0.02	0.02	0.06	0.25
14	0.00	0.00	0.01	0.08	0.04	0.09	0	0	0.04	0.02
15	0.00	0.01	0.03	0.00	0.01	0.05	0.03	0	0	0
16	0.00	0.00	0.00	0.00	0.00	0.00	0	0.02	0	0
17	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0	0	0
unknown	0.00	0.01	0.02	0.00	0.00	0.00	0	0	0	0.02
total	61.80	28.48	27.13	28.04	24.92	41.42	31.67	39.73	130.43	111.25

Table 13. Biomass (kg) per tow at age of Div. 4VW haddock from the summer RV survey.

age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001	0.000	0.006	0.004
1	0.281	0.200	0.127	0.063	0.046	0.768	0.251	0.799	0.766	0.009	0.274
2	0.331	1.119	0.253	0.577	0.873	0.215	1.024	4.171	3.911	2.937	0.057
3	1.176	0.772	0.647	0.363	2.061	1.630	0.273	7.074	9.587	6.046	9.221
4	2.092	1.478	0.575	0.529	0.625	2.061	1.077	1.522	8.943	10.152	13.815
5	1.414	0.840	0.645	0.237	0.848	0.813	1.415	3.289	0.774	3.932	11.086
6	1.109	0.590	0.633	0.668	0.544	1.813	0.382	1.387	1.012	0.714	3.770
7	1.351	0.290	0.355	0.173	0.409	0.502	0.560	0.524	0.323	0.732	0.827
8	1.125	0.629	0.216	0.263	0.221	0.254	0.131	0.313	0.023	0.208	0.373
9	0.444	0.027	0.079	0.098	0.102	0.120	0.035	0.000	0.000	0.000	0.059
10	0.122	0.000	0.042	0.193	0.114	0.192	0.020	0.167	0.000	0.132	0.000
11	0.140	0.000	0.000	0.000	0.108	0.000	0.035	0.063	0.000	0.038	0.000
12	0.090	0.000	0.000	0.000	0.000	0.096	0.251	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.000	0.000	0.000
14	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
total	9.743	5.946	3.573	3.164	5.953	8.464	5.455	19.375	25.339	24.908	39.485
5+	5.862	2.377	1.971	1.632	2.347	3.789	2.828	5.806	2.133	5.758	16.115
7+	3.338	0.946	0.692	0.727	0.955	1.163	1.031	1.131	0.346	1.111	1.259

age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.128	0.004	0.000	0.001	0.000	0.000	0.000	0.006	0.001	0.001	0.000
1	1.211	1.097	1.406	0.026	0.489	0.131	0.293	0.516	0.981	0.110	0.013
2	2.867	3.773	2.466	2.542	0.414	1.012	0.394	4.397	2.356	3.841	0.622
3	0.525	8.164	13.684	7.388	3.775	2.285	1.293	2.636	0.995	4.633	9.154
4	6.984	2.223	8.622	18.937	6.989	7.352	0.962	2.710	1.069	2.043	11.017
5	6.005	8.831	3.343	5.058	9.028	9.786	5.339	2.484	1.460	0.600	4.629
6	3.469	4.781	3.780	3.204	3.341	8.597	6.210	7.643	1.530	0.784	1.165
7	0.703	1.854	1.607	2.312	0.818	3.335	5.534	6.920	4.371	1.176	2.267
8	0.235	0.544	0.562	0.562	1.938	1.068	1.474	4.945	4.050	2.095	1.848
9	0.329	0.112	0.218	0.237	0.919	1.221	0.158	1.119	3.637	2.941	2.209
10	0.076	0.054	0.067	0.059	0.561	0.593	0.416	0.390	1.327	2.595	2.444
11	0.000	0.000	0.000	0.042	0.231	0.192	0.091	0.347	0.279	1.913	0.763
12	0.000	0.000	0.119	0.000	0.000	0.189	0.113	0.362	0.331	0.319	0.195
13	0.000	0.000	0.000	0.000	0.110	0.050	0.000	0.079	0.040	0.046	0.000
14	0.000	0.000	0.077	0.000	0.000	0.030	0.000	0.021	0.023	0.148	0.000
15	0.000	0.041	0.000	0.000	0.000	0.000	0.000	0.053	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
total	22.531	31.480	35.951	40.368	28.611	35.843	22.277	34.628	22.449	23.265	36.329
5+	10.816	16.219	9.772	11.474	16.944	25.062	19.335	24.364	17.048	12.637	15.521
7+	1.343	2.607	2.649	3.212	4.576	6.679	7.786	14.236	14.059	11.254	9.727

age	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.000	0.023	0.008	0.002	0.031	0.002	0.011	0.781	0.096
1	0.084	0.344	0.897	0.385	0.953	0.712	0.222	1.993	4.882
2	0.409	0.484	1.094	1.362	1.548	1.789	1.672	1.862	4.241
3	1.557	0.523	0.435	1.732	3.724	1.243	4.852	3.600	2.868
4	6.119	2.073	0.476	0.251	2.311	2.242	2.661	5.380	3.724
5	4.593	5.761	1.400	0.465	0.462	1.363	2.785	3.868	4.833
6	0.678	2.362	4.407	2.898	0.248	0.681	1.507	2.377	2.173
7	0.568	0.747	2.100	3.249	1.095	0.203	0.346	1.477	2.181
8	0.235	0.165	0.242	0.752	2.555	0.377	0.245	0.289	1.009
9	0.274	0.337	0.175	0.143	1.427	1.785	0.553	0.345	0.368
10	0.745	0.147	0.100	0.045	0.214	1.252	1.034	1.051	0.192
11	0.869	0.451	0.179	0.073	0.062	0.449	0.582	0.871	0.659
12	0.680	0.299	0.209	0.151	0.023	0.062	0.040	0.268	0.461
13	0.305	0.212	0.132	0.094	0.041	0.020	0.041	0.086	0.276
14	0.000	0.013	0.099	0.071	0.112	0.000	0.000	0.088	0.033
15	0.016	0.037	0.000	0.011	0.054	0.041	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.000
total	17.133	13.976	11.955	11.685	14.862	12.244	16.577	24.336	27.996
5+	8.964	10.529	9.044	7.952	6.294	6.256	7.159	10.720	12.185
7+	3.693	2.407	3.237	4.589	5.584	4.212	2.867	4.475	5.179

Table 14. Correlation table showing magnitude of correlation (r^2) among year-class estimates at successive ages from the summer RV survey for Div. 4VW haddock

Age	1	2	3	4	5	6	7	8	9
1	-	0.62	0.54	0.45	0.62	0.80	0.74	0.57	0.75
2		-	0.66	0.58	0.84	0.52	0.56	0.45	0.55
3			-	0.74	0.72	0.62	0.58	0.69	0.65
4				-	0.62	0.62	0.54	0.50	0.71
5					-	0.65	0.72	0.66	0.69
6						-	0.81	0.79	0.89
7							-	0.78	0.90
8								-	0.83
9									-

Table 15. Size at age of Div. 4VW haddock from the summer RV survey. A) Length, cm B)Weight, g.

A)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1970	7.92	21.95	31.94	39.73	45.20	50.80	54.58	58.14	62.79	65.08	67.10	70.10	69.30		78.50
1971	7.30	22.59	31.73	40.05	45.43	50.55	54.05	56.99	62.85	60.50					
1972		21.07	29.39	36.49	45.11	49.30	56.00	59.61	57.13	58.81	68.50				
1973		23.18	32.18	40.44	47.84	51.37	57.42	58.07	63.71	72.50	72.14				
1974	9.25	23.48	34.59	41.64	47.14	53.50	58.43	57.91	60.52	59.06	67.16	66.06			
1975	8.57	25.13	28.23	43.23	48.31	54.71	58.98	60.72	63.34	62.20	67.41		72.50		
1976	8.80	21.36	32.20	38.40	47.88	52.44	56.14	61.20	63.23	64.50	54.50	64.50	72.50		
1977	9.18	23.31	32.79	41.87	47.19	53.89	56.06	60.81	64.45		68.50	78.50		78.50	
1978		20.32	32.96	39.95	46.77	52.51	57.64	62.78	56.50		72.50	68.50			
1979	7.74	21.21	31.60	39.33	45.69	50.73	56.49	60.24	64.40		69.54	66.50			66.50
1980	7.48	21.04	28.28	39.61	45.80	49.74	55.10	60.46	64.92	60.50					
1981	8.43	19.71	30.95	37.03	44.77	49.15	54.27	59.25	60.91	63.18	66.20				
1982	7.57	17.80	28.78	39.56	44.05	48.24	53.81	57.35	62.58	72.01	64.50				
1983	6.60	18.99	25.83	35.82	42.00	48.15	51.47	55.24	59.14	64.59	60.63		66.50		72.50
1984	8.37	20.91	29.02	35.27	40.40	46.23	51.32	56.17	61.65	64.04	66.50	74.50			
1985	8.50	22.18	31.30	35.41	40.52	42.85	47.01	50.16	51.51	52.97	58.86	58.74		66.18	
1986	7.25	23.14	32.27	38.63	39.21	42.19	44.40	47.23	50.99	53.41	56.79	57.41	55.43	62.50	66.50
1987	8.18	21.57	31.83	37.06	39.16	41.44	43.61	45.53	47.59	53.56	53.78	56.06	49.70		
1988	8.95	22.74	32.75	35.26	39.22	41.86	42.99	46.30	45.04	49.71	47.84	58.06	57.74	57.45	58.50
1989	9.37	19.95	31.84	37.55	42.70	43.35	44.65	45.41	47.78	47.46	50.39	53.46	52.19	58.15	60.50
1990	14.50	22.66	29.69	35.92	38.98	43.25	43.65	47.08	46.74	47.65	47.28	46.93	54.01	60.98	48.34
1991	6.50	21.48	32.04	34.79	38.06	40.16	42.41	45.67	45.07	46.49	47.37	49.17	49.57		
1992		21.95	33.29	35.23	37.13	40.47	43.30	43.21	47.39	48.44	47.30	47.83	48.87	49.49	60.50
1993	9.18	23.34	31.74	36.42	39.35	39.61	41.74	43.90	42.38	46.05	47.24	46.55	49.32	46.23	52.50
1994	8.61	23.71	29.35	33.56	38.06	40.02	40.31	42.53	46.98	45.61	48.46	45.93	48.30	48.32	50.26
1995	8.39	22.02	29.62	34.07	36.74	39.24	41.60	42.74	45.86	45.04	45.11	45.40	49.21	54.35	56.60
1996	9.25	21.67	29.69	35.14	36.83	40.07	42.21	43.81	43.98	44.91	43.93	50.28	49.33	59.26	50.37
1997	8.38	22.55	27.90	32.75	37.18	39.39	40.78	41.88	42.98	44.74	44.84	46.80	47.02	46.50	
1998	9.50	19.55	29.81	33.19	36.18	38.67	41.12	42.78	40.76	46.65	46.79	47.43	50.90	58.70	
1999	10.56	23.58	28.62	34.10	35.94	38.52	41.14	40.89	44.99	43.84	45.07	46.03	44.33	51.65	59.49
2000	9.99	21.55	28.34	34.08	37.49	38.63	41.11	43.36	44.91	43.38	45.74	47.77	47.41	47.89	54.37
average	8.68	21.80	30.66	37.15	41.82	45.52	48.83	51.53	53.65	54.53	56.62	56.20	54.43	56.41	59.67

B)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1970	4.23	102.80	332.48	657.96	984.90	1419.73	1777.22	2165.76	2756.14	3082.34	3392.21	3889.70	3751.61		5542.17
1971	3.84	114.90	319.37	643.42	940.44	1296.73	1586.34	1860.34	2496.86	2226.54					
1972		96.98	266.41	513.83	977.81	1280.59	1884.73	2278.11	2002.81	2187.04	3474.25				
1973		120.24	331.59	671.82	1129.95	1408.45	1987.95	2057.57	2741.36	4088.42	4026.29				
1974	6.97	123.49	408.67	724.54	1062.64	1570.37	2061.17	2005.21	2298.07	2131.41	3169.28	3012.10			
1975	6.06	159.30	226.85	828.18	1160.64	1693.89	2128.13	2324.46	2642.38	2501.40	3193.42		3983.91		
1976	5.56	90.06	326.97	568.46	1135.92	1511.83	1872.98	2455.99	2720.82	2895.64	1706.21	2895.64	4179.98		
1977	7.75	131.58	371.38	780.85	1122.50	1681.34	1894.84	2426.46	2895.11		3484.92	5272.96		5272.96	
1978		77.25	354.25	649.01	1066.18	1535.08	2057.91	2692.85	1932.79						
1979	3.82	89.58	311.82	618.24	988.32	1371.10	1919.68	2346.77	2891.84		3678.36	3197.61			
1980	2.64	77.94	204.90	616.72	992.45	1299.33	1816.05	2461.44	3105.58	2466.17					
1981	5.70	77.11	307.49	533.10	954.06	1270.10	1720.58	2251.82	2451.09	2741.26	3163.11				
1982	4.77	59.95	248.36	636.84	875.32	1145.43	1583.03	1911.60	2474.04	3749.18	2705.98				
1983	2.67	66.04	168.01	453.87	735.65	1114.26	1364.59	1691.09	2081.06	2719.38	2244.39		2971.71		3863.40
1984	5.32	86.75	235.61	427.02	646.31	974.62	1340.40	1764.52	2343.71	2632.35	2953.12	4175.47			
1985	6.10	105.97	295.19	426.76	637.01	752.10	990.70	1201.66	1299.90	1412.51	1933.26	1922.09		2740.17	
1986	2.79	108.99	311.39	549.34	575.72	725.43	852.07	1035.78	1318.98	1526.73	1852.74	1916.86	1715.88	2506.83	3048.93
1987	4.96	97.08	320.46	511.01	604.74	719.50	841.43	960.78	1099.86	1580.60	1600.84	1818.83	1257.12		
1988	5.92	109.14	341.35	430.02	599.51	734.91	798.65	1007.28	924.30	1257.56	1115.57	2043.75	2008.44	1976.54	2092.22
1989	6.82	71.83	308.35	515.46	769.24	806.38	884.22	932.05	1091.77	1069.67	1288.58	1549.92	1438.14	2013.65	2278.33
1990	29.07	113.24	259.69	460.14	599.36	842.88	832.72	1052.01	1027.29	1088.36	1065.98	1041.42	1595.17	2310.84	1138.77
1991	2.80	100.07	331.09	423.60	554.48	651.11	766.52	956.62	919.49	1008.81	1067.03	1192.59	1221.64		
1992		107.19	372.24	440.99	515.96	667.57	817.18	811.82	1069.72	1142.46	1063.78	1100.20	1173.27	1218.13	2220.48
1993	9.29	131.86	316.13	467.23	582.21	593.30	688.54	794.90	719.04	910.22	978.94	938.64	1106.11	920.33	1321.48
1994	5.98	127.82	243.72	365.43	534.58	622.28	635.98	747.39	1010.19	923.49	1108.99	943.42	1097.89	1099.25	1238.24
1995	5.70	103.62	252.73	384.88	482.92	588.57	701.71	760.94	940.60	891.10	895.33	912.32	1162.94	1567.60	1770.51
1996	7.41	97.18	252.04	419.41	483.46	624.05	730.44	817.37	826.96	880.70	824.31	1239.58	1169.85	2038.05	1246.56
1997	5.17	108.08	208.01	340.47	502.77	600.24	667.97	724.65	784.53	887.85	894.05	1019.49	1034.25	999.61	
1998	8.08	72.61	262.14	363.71	472.56	578.94	697.56	787.25	679.34	1024.52	1034.08	1077.17	1336.01	2061.02	
1999	10.96	128.66	233.02	399.10	468.67	579.90	709.62	696.67	933.44	862.44	938.80	1001.24	892.13	1426.34	2200.42
2000	9.34	97.07	223.66	392.32	524.53	574.62	694.39	816.81	909.21	818.17	961.68	1097.72	1072.66	1105.63	1628.14
average	6.66	101.75	288.56	523.02	763.90	1007.57	1267.91	1509.61	1722.20	1810.94	1993.41	1966.31	1798.35	1950.46	2276.13

Table 16. Diagnostics from ADAPT for the Div. 4TVW haddock stock.

Mean square of the residuals = 0.643983

Age	Parameter	Estimate	SE	CV	Bias
1	popnums	12.5647		0.817367	-0.00146039
2	popnums	10.8649		0.489154	-0.00227728
3	popnums	8.91408		0.385100	-0.00304621
4	popnums	8.91312		0.329261	-0.00370754
5	popnums	9.01557		0.293233	-0.00503732
6	popnums	8.10372		0.268286	-0.00308811
7	popnums	8.09079		0.263614	0.00503127
8	popnums	7.32706		0.261764	-0.01079500
9	popnums	5.90138		0.265859	-0.04220450
10	popnums	5.56646		0.246343	-0.11695700
1	q - July RV	0.000151840	0.000023700	0.156015	-1.20473
2	q - July RV	0.000313950	0.000048100	0.153281	-1.16584
3	q - July RV	0.000494323	0.000075000	0.151819	-1.14791
4	q - July RV	0.000605164	0.000091300	0.150893	-1.14437
5	q - July RV	0.000681081	0.000102414	0.150370	-1.14811
6	q - July RV	0.000781480	0.000117324	0.150131	-1.15997
2	q - sentinel	0.000002900	0.000001090	0.373809	-6.98051
3	q - sentinel	0.000084400	0.000030900	0.366241	-6.67967
4	q - sentinel	0.000252788	0.000091600	0.362307	-6.49511
5	q - sentinel	0.000520110	0.000186708	0.358979	-6.26502
6	q - sentinel	0.000619136	0.000222865	0.359961	-6.49457
7	q - sentinel	0.001124770	0.000407582	0.362370	-6.74624
8	q - sentinel	0.002324730	0.000841334	0.361906	-6.70933

Table 17. Age by age residuals from ADAPT.

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
RV	age											
	1	0.92	1.06	0.16	-0.66	-0.57	0.51	-0.34	0.17	0.58	-3.06	-0.40
	2	-0.37	0.79	0.07	0.13	0.33	-0.08	-0.36	0.60	0.32	0.08	-2.45
	3	-0.44	-0.26	-0.32	-0.51	0.65	0.10	-0.96	0.53	0.67	-0.03	0.36
	4	-0.43	-0.16	-0.66	-0.83	-0.17	0.54	-0.54	0.20	0.67	0.38	0.50
	5	-0.60	-0.81	-0.63	-1.20	-0.02	-0.01	0.31	0.45	-0.45	-0.13	0.53
Sent	6	-0.90	-0.78	-0.50	0.08	0.17	0.94	-0.41	0.51	-0.37	-0.44	-0.01
	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	avg	-0.14	-0.01	-0.14	-0.23	0.03	0.15	-0.18	0.19	0.11	-0.25	-0.11
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
RV	age											
	1	0.42	0.11	0.81	-1.93	1.34	0.22	0.17	0.79	1.18	-1.48	-2.32
	2	0.12	-0.07	-0.58	-0.33	-0.83	0.62	-0.08	1.31	1.00	1.00	-1.13
	3	-1.39	0.25	0.39	-0.63	-0.73	0.11	0.27	1.46	-0.66	1.24	1.33
	4	-0.11	-0.36	0.31	0.45	-1.00	-0.22	-0.71	1.03	0.18	0.10	2.25
	5	-0.03	0.61	0.23	-0.23	-0.17	-0.43	-0.49	0.31	0.45	-0.12	1.12
Sent	6	-0.22	0.14	0.29	0.51	-0.35	0.08	-0.69	0.04	-0.07	0.15	1.00
	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	avg	-0.09	0.05	0.11	-0.17	-0.13	0.03	-0.12	0.38	0.16	0.07	0.17
		1992	1993	1994	1995	1996	1997	1998	1999	2000		
RV	age											
	1	-0.74	-0.51	0.52	-0.12	0.35	0.21	0.14	0.66	1.80		
	2	-0.50	-0.39	-0.28	-0.06	0.06	-0.10	-0.14	0.78	0.55		
	3	-0.58	-0.56	-0.72	-0.37	0.35	-0.54	0.26	0.12	0.61		
	4	1.04	-0.41	-0.64	-1.40	-0.15	-0.18	0.04	0.26	0.03		
	5	2.04	1.21	-0.64	-0.54	-0.82	-0.67	0.13	0.44	0.17		
Sent	6	-0.61	2.20	1.12	0.18	-1.16	-0.28	-0.50	-0.02	-0.11		
	2	0.00	0.00	0.00	1.82	0.31	0.00	-1.04	-1.43	0.34		
	3	0.00	0.00	0.00	1.18	1.07	-0.67	-0.86	-0.87	0.15		
	4	0.00	0.00	0.00	-0.08	0.77	0.09	-0.05	-0.52	-0.22		
	5	0.00	0.00	0.00	0.34	0.40	-0.05	-0.10	-0.45	-0.14		
	6	0.00	0.00	0.00	0.54	0.02	-0.03	-0.35	0.01	-0.20		
	7	0.00	0.00	0.00	1.86	0.17	-0.12	-0.51	-0.89	-0.51		
	8	0.00	0.00	0.00	3.19	1.14	-0.79	-1.42	-0.96	-1.17		
	avg	0.05	0.12	-0.05	0.50	0.19	-0.24	-0.34	-0.22	0.10		

Table 18. Population numbers (thousands of fish) at age of Div. 4TVW haddock from the SPA.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
age											
1	8164	4575	8296	7755	4810	21292	28877	37355	40903	14943	38235
2	5466	6407	3503	6515	5909	3884	17180	23253	30391	32842	12233
3	7161	4358	4642	2608	4268	4627	3125	13454	18782	24490	26647
4	7618	5249	2765	3193	1550	2612	3363	2417	10142	14643	19668
5	4156	4660	2318	1584	1287	1039	1410	2528	1675	6121	10975
6	3322	2136	1336	1061	563	634	596	862	1606	977	4401
7	3385	1485	656	490	215	191	352	317	450	668	656
8	823	1719	362	225	91	73	100	168	154	185	412
9	190	322	342	123	40	32	32	49	66	71	137
10	70	76	13	136	47	26	19	19	23	33	53
11	61	23	27	2	22	23	17	7	2	12	21
12	28	32	0	6	0	4	18	11	0	0	8
sum	40444	31042	24259	23699	18802	34438	55090	80441	104193	94984	113447
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
age											
1	75712	120072	69091	15016	9091	7408	18308	17021	31024	27991	9427
2	31004	61200	97827	56117	12285	6982	5478	12803	11739	20206	19608
3	9676	25096	49715	79669	45619	9533	5100	3791	8941	7789	13768
4	19670	7685	19172	39722	63857	35252	6976	3526	2633	6183	5241
5	12181	11515	5600	12795	28759	45314	23370	4840	2387	1686	4187
6	6056	5376	4334	2739	8462	17996	25260	15845	3226	1443	1064
7	2063	2235	2631	2031	1500	5305	9679	16547	10334	2053	882
8	312	623	726	1674	1292	893	3056	6291	10397	5942	1102
9	220	130	317	382	1289	721	442	2000	3849	5286	2811
10	77	85	63	233	285	777	375	271	1263	1910	1971
11	35	36	45	35	186	110	488	234	164	600	905
12	11	20	25	19	27	104	65	332	145	63	250
sum	157018	234073	249544	210432	172654	130394	98599	83500	86101	81153	61215
	1992	1993	1994	1995	1996	1997	1998	1999	2000		
age											
1	8798	26314	40224	27868	49318	30603	21414	332808	4904274		
2	6639	6194	18535	28335	19620	34637	21553	15077	234523		
3	13710	4669	4350	13052	19934	13785	24386	15171	10622		
4	9088	9556	3283	3063	9180	13967	9692	17172	10688		
5	2774	4926	6855	2312	2152	6388	9783	6820	12098		
6	2600	779	3110	4676	1621	1500	4494	6868	4798		
7	591	1338	335	2171	3277	1134	1052	3139	4813		
8	422	66	868	225	1503	2297	798	740	2205		
9	509	126	8	611	149	1044	1609	555	520		
10	1182	152	24	5	429	99	723	1111	387		
11	707	348	33	16	2	302	66	481	778		
12	392	174	140	21	10	2	212	29	336		
sum	47412	54642	77566	82356	107194	105758	95782	399972	5186042		

Table 19. Population biomass (tonnes) at age of Div. 4TVW haddock from the SPA.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
age											
1	476	267	626	407	314	1940	3211	1657	3280	575	2265
2	1306	1161	613	1168	1310	650	3921	4253	6561	5097	1657
3	3941	2016	1880	1103	2092	2692	1122	6798	9221	11461	11685
4	6539	4129	2193	2433	1310	2396	3262	1930	9254	11728	15406
5	5582	5266	2543	1859	1715	1395	1868	3494	2199	7401	12437
6	5771	3205	2089	1694	960	1159	1061	1460	2987	1677	6945
7	6827	2700	1246	964	429	419	804	675	1017	1467	1426
8	2523	3997	698	561	199	167	251	449	333	516	1112
9	730	797	800	353	97	77	90	109	150	132	365
10	313	189	35	404	168	67	40	61	44	85	101
11	346	60	54	6	77	57	53	20	6	29	58
12	76	86	0	11	0	12	51	26	0	0	18
3+	32648	22445	11538	9388	7047	8441	8602	15022	25211	34496	49553
5+	22168	16300	7465	5852	3643	3353	4217	6294	6734	11307	22463
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
age											
1	2971	5159	2474	525	427	458	1164	881	2014	1061	624
2	4800	8469	9818	7000	1967	1269	1024	2331	2153	2750	3795
3	3198	11106	16691	21339	14463	3841	2034	1407	3750	2935	4550
4	15088	5249	13122	21514	33307	17470	4021	1952	1514	3411	2648
5	13676	12038	5531	10834	20054	30806	15041	3227	1659	1332	2596
6	9055	7623	5419	3348	8318	14409	19735	12011	2601	1184	839
7	4172	4053	4304	3152	1904	5375	8758	15234	8916	1978	788
8	766	1471	1448	3333	1958	1124	3262	5928	10903	5814	1083
9	643	393	821	893	2346	1016	638	2353	3827	5765	2861
10	214	233	182	660	644	1257	587	359	1607	2037	2124
11	70	89	103	107	444	212	895	423	215	694	1019
12	21	38	60	36	74	188	101	634	248	99	281
3+	46903	42293	47681	65216	83512	75698	55072	43528	35240	25249	18789
5+	28618	25936	17867	22364	35741	54388	49018	40169	29977	18902	11592
	1992	1993	1994	1995	1996	1997	1998	1999	2000		
age											
1	456	1642	3901	2533	3277	2033	1486	13489	478570		
2	1281	1140	3323	5093	3171	4925	3628	1961	39783		
3	5239	1947	1479	3998	6490	4038	6708	4907	3212		
4	4249	4842	1641	1287	3960	6413	3888	7090	4890		
5	1688	2726	4006	1297	1181	3441	5278	3570	6278		
6	1896	528	1911	3090	1063	968	2908	4402	3044		
7	466	1078	240	1510	2482	825	763	2189	3664		
8	426	50	778	189	1192	1839	560	634	1755		
9	521	124	6	580	136	895	1443	425	454		
10	1224	161	24	5	368	88	693	1090	352		
11	766	348	32	16	3	277	65	490	790		
12	464	192	142	22	10	2	247	28	348		
3+	16939	11996	10259	11994	16885	18786	22553	24825	24787		
5+	7453	5208	7139	6709	6434	8336	11956	12828	16686		

Table 20. Population biomass (tonnes) at age of Div. 4TVW haddock from the SPA. The shaded part of the matrix highlights cells with haddock greater than 42 cm.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
age											
1	476	267	626	407	314	1940	3211	1657	3280	575	2265
2	1306	1161	613	1168	1310	650	3921	4253	6561	5097	1657
3	3941	2016	1880	1103	2092	2692	1122	6798	9221	11461	11685
4	6539	4129	2193	2433	1310	2396	3262	1930	9254	11728	15406
5	5582	5266	2543	1859	1715	1395	1868	3494	2199	7401	12437
6	5771	3205	2089	1694	960	1159	1061	1460	2987	1677	6945
7	6827	2700	1246	964	429	419	804	675	1017	1467	1426
8	2523	3997	698	561	199	167	251	449	333	516	1112
9	730	797	800	353	97	77	90	109	150	132	365
10	313	189	35	404	168	67	40	61	44	85	101
11	346	60	54	6	77	57	53	20	6	29	58
12	76	86	0	11	0	12	51	26	0	0	18
42cm +	28707	20429	9658	8285	4955	8441	7480	8224	15990	23035	37868

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
age											
1	2971	5159	2474	525	427	458	1164	881	2014	1061	624
2	4800	8469	9818	7000	1967	1269	1024	2331	2153	2750	3795
3	3198	11106	16691	21339	14463	3841	2034	1407	3750	2935	4550
4	15088	5249	13122	21514	33307	17470	4021	1952	1514	3411	2648
5	13676	12038	5531	10834	20054	30806	15041	3227	1659	1332	2596
6	9055	7623	5419	3348	8318	14409	19735	12011	2601	1184	839
7	4172	4053	4304	3152	1904	5375	8758	15234	8916	1978	788
8	766	1471	1448	3333	1958	1124	3262	5928	10903	5814	1083
9	643	393	821	893	2346	1016	638	2353	3827	5765	2861
10	214	233	182	660	644	1257	587	359	1607	2037	2124
11	70	89	103	107	444	212	895	423	215	694	1019
12	21	38	60	36	74	188	101	634	248	99	281
42 cm+	43705	31187	30990	22363	35742	23581	33976	36942	29976	18903	8995

	1992	1993	1994	1995	1996	1997	1998	1999	2000
age									
1	456	1642	3901	2533	3277	2033	1486	13489	478570
2	1281	1140	3323	5093	3171	4925	3628	1961	39783
3	5239	1947	1479	3998	6490	4038	6708	4907	3212
4	4249	4842	1641	1287	3960	6413	3888	7090	4890
5	1688	2726	4006	1297	1181	3441	5278	3570	6278
6	1896	528	1911	3090	1063	968	2908	4402	3044
7	466	1078	240	1510	2482	825	763	2189	3664
8	426	50	778	189	1192	1839	560	634	1755
9	521	124	6	580	136	895	1443	425	454
10	1224	161	24	5	368	88	693	1090	352
11	766	348	32	16	3	277	65	490	790
12	464	192	142	22	10	2	247	28	348
42cm +	5763	1953	1222	2322	4191	3926	3771	4856	7363

Table 21. Fishing mortality at age of Div. 4TVW haddock from the SPA.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
age											
1	0.04	0.07	0.04	0.07	0.01	0.01	0.02	0.01	0.02	0.00	0.01
2	0.03	0.12	0.10	0.22	0.04	0.02	0.04	0.01	0.02	0.01	0.03
3	0.11	0.26	0.17	0.32	0.29	0.12	0.06	0.08	0.05	0.02	0.10
4	0.29	0.62	0.36	0.71	0.20	0.42	0.09	0.17	0.30	0.09	0.28
5	0.47	1.05	0.58	0.83	0.51	0.36	0.29	0.25	0.34	0.13	0.39
6	0.61	0.98	0.80	1.40	0.88	0.39	0.43	0.45	0.68	0.20	0.56
7	0.48	1.21	0.87	1.48	0.88	0.45	0.54	0.52	0.69	0.28	0.54
8	0.74	1.41	0.88	1.52	0.84	0.61	0.51	0.74	0.58	0.10	0.43
9	0.72	3.04	0.72	0.77	0.25	0.32	0.32	0.56	0.49	0.08	0.38
10	0.91	0.83	1.54	1.62	0.52	0.19	0.86	1.96	0.49	0.23	0.21
11	0.43	5.25	1.32	2.90	1.63	0.05	0.21	3.99	2.90	0.21	0.45
12	0.79	1.76	1.05	1.31	0.54	0.37	0.56	1.09	0.52	0.14	0.34
avg 5-7	0.52	1.08	0.75	1.24	0.76	0.40	0.42	0.41	0.57	0.20	0.50
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
age											
1	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.02	0.08	0.01	0.00
2	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.06	0.03	0.01
3	0.03	0.07	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.05	0.07
4	0.34	0.12	0.20	0.12	0.09	0.11	0.02	0.04	0.10	0.04	0.29
5	0.62	0.78	0.52	0.21	0.22	0.28	0.04	0.06	0.15	0.11	0.13
6	0.80	0.51	0.56	0.40	0.22	0.32	0.07	0.08	0.10	0.14	0.24
7	1.00	0.92	0.25	0.25	0.27	0.25	0.08	0.11	0.20	0.27	0.39
8	0.68	0.48	0.44	0.06	0.33	0.40	0.07	0.14	0.33	0.40	0.42
9	0.75	0.53	0.11	0.09	0.26	0.35	0.14	0.11	0.35	0.64	0.52
10	0.57	0.45	0.38	0.02	0.70	0.17	0.12	0.15	0.39	0.40	0.67
11	0.37	0.17	0.64	0.07	0.34	0.22	0.04	0.13	0.61	0.53	0.49
12	0.66	0.48	0.31	0.06	0.43	0.31	0.11	0.13	0.36	0.48	0.54
avg 5-7	0.81	0.74	0.44	0.29	0.24	0.28	0.06	0.08	0.15	0.17	0.25
	1992	1993	1994	1995	1996	1997	1998	1999	2000		
age											
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
3	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00		
4	0.26	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00		
5	0.92	0.11	0.00	0.01	0.01	0.00	0.00	0.00	0.00		
6	0.31	0.50	0.01	0.01	0.01	0.00	0.01	0.01	0.00		
7	1.85	0.08	0.05	0.02	0.01	0.00	0.00	0.00	0.01		
8	0.86	1.82	0.00	0.06	0.01	0.01	0.01	0.00	0.00		
9	0.86	1.31	0.02	0.00	0.06	0.02	0.02	0.01	0.00		
10	0.87	1.17	0.04	0.41	0.00	0.06	0.06	0.01	0.01		
11	1.05	0.56	0.10	0.19	0.04	0.01	0.47	0.01	0.01		
12	0.86	1.43	0.02	0.16	0.02	0.03	0.03	0.01	0.01		
avg 5-7	1.027	0.230	0.020	0.013	0.010	0.000	0.003	0.003	0.003		

Table 22. Proportion of Div. 4VW haddock mature at age. Note: Values for 1970-1978 were based on the average from 1979-1984.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
age											
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.09	0.28
3	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.62	0.89
4	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.92	0.92
5	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.98	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
age											
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.06	0.01	0.00	0.01	0.01	0.01	0.07	0.00	0.00	0.03	0.01
3	0.19	0.21	0.11	0.12	0.14	0.14	0.70	0.22	0.25	0.24	0.24
4	0.64	0.52	0.64	0.73	0.66	0.66	0.79	0.92	0.94	0.48	0.78
5	0.95	0.95	0.90	0.98	0.95	0.95	0.99	1.00	1.00	0.86	0.95
6	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.98	0.91	1.00	0.97
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1992	1993	1994	1995	1996	1997	1998	1999	2000		
age											
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.01	0.01	0.21	0.13	0.00	0.04	0.07	0.06	0.13		
3	0.24	0.24	0.35	0.49	0.41	0.67	0.56	0.66	0.38		
4	0.78	0.78	0.92	0.94	0.77	0.89	0.87	0.85	0.83		
5	0.95	1.00	1.00	1.00	0.75	0.95	0.94	0.93	0.92		
6	0.97	0.88	1.00	1.00	1.00	0.95	0.97	1.00	1.00		
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	1.00		
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00		

Table 23. Rationale table of indicators, their limits, characteristics and weighting factors that went into the table lights for Div. 4TVW haddock.

Indicator	Green	Red	Characteristic & Weighting
Summer RV #/tow (26-41cm)	40 – Top four estimates observed; all preceded by strong year-classes	7 – Lowest observed (1970-76)	Abundance/1.0
Summer RV #/tow (42cm+)	20 – Top three estimates when stock at peak levels during 1980s	7 – Low values that coincide with periods of collapse	Abundance/1.0
Sentinel (kg/set)	35 – Never observed in survey; considered good catch rate	10 – Near to lowest catch rates recorded in past few years	Abundance/1.0
Area occupied(30cm+)	0.6 – Contains top four observations when stock widely distributed in 1980s	0.3 – Encompasses two observations during the early 1970s	Abundance/1.0
Density(30cm+)	3.3 – Contains two highest observations; may be unresponsive indicator	2.4 – Contains estimates associated with 1970-1976	Abundance/1.0
Summer RV #/tow (1-25 cm)	21 -- Contains early 1980's and recent peaks	3 -- Contains lowest observed values in 1970's, 1980's and 1990's	Production/1.0
SPA SSB	50000 – Based on historical series and similarity of mid-1980s SSB to that earlier period	12000 – Captures both mid-1970s and mid-1990s minimum	Abundance/1.0
Area occupied (1-29cm)	0.45 – Captures strong year-classes in early 1980s and recent ones with wide distribution	0.2 – Associated with three lowest values and lowest R estimates	Production/1.0
Density (1-29cm)	2.8 – Contains early 1980s and late 1990s observations	1.2 – Among lowest observed	Production/1.0
SPA Recruitment	50000 – Based on historical series; captures early 1980s and recent strong year-classes	10000 – Among lowest observed	Production/1.0
Summer RV Condition	945 – Contains several observations during 1970s/early 1980s when stock recovered rapidly	860 – Contains one observation	Production/1.0
Summer RV growth age7(length)	60 – Largest body sizes observed during 1970s/early 1980s	45 – Contains most of the data from early 1990s onward	Production/1.0
Spring RV 50% maturity	39.5 – Larger sizes associated with higher fecundity and better egg quality	30 – Small sizes associated with low fecundity and poor egg quality	Production/1.0
Spring RV condition	900 – Among highest observed	808 – Among lowest observed	Production/1.0
Misaine Temperature	0.25 – Captures high values in the late 1970s/early 1980s when condition and size at age were high	-0.25 – Associated with mid-1980s/mid-1990s when capelin and other cold-water sp. flourished	Environment/1.0
Exploitation (%) (ages 5-10)	20 – F0.1 reference level	40 – Twice F0.1 reference level	Fishing Mortality/1.0