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Estimation of the Labrador component of prefishery abundance of North America Atlantic salmon (*Salmo salar* L.) in 1998

by

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ABSTRACT

For the years 1969-97, the Labrador component of North American prefishery abundance (PFA) including estimates of returns to rivers and spawning escapement was based on the commercial fishery catch data. Since the commercial fishery in Labrador was not open in 1998, and because the PFA is used to provide catch advice to NASCO on North American salmon stocks, an alternate method was required. An alternate use of the abundance estimates was to provide stock status information for Labrador. In total, five options were examined including not providing an estimate for Labrador, removing Labrador from the time series of PFA estimates, providing new estimates based on exploitation rate/habitat model using angling catch data and estimating PFA based either on proportions or regression estimates from the previous time series. After examination of various techniques and their attributes, the proportional method was selected. Raising factors to include estimates of Labrador salmon in the North American PFA were 1.04 to 1.59 for maturing 1SW salmon (potential grilse) and 1.05 to 1.27 for 1SW non-maturing salmon (potential 2SW salmon). There were no counting facilities in Labrador in 1998 and without corroborative evidence it is not recommended that these methods be used to provide stock status information for Labrador salmon.

RÉSUMÉ

De 1969 à 1997, l'élément du Labrador de l'abondance préalable à la pêche (APP) en Amérique du Nord, y compris les estimations des remontes dans les rivières et des échappées de géniteurs, reposait sur les données concernant les prises commerciales. Étant donné que la pêche commerciale du Labrador est demeurée fermée en 1998 et parce que l'APP sert à donner des conseils sur les prises nord-américaines de stocks de saumon à l'OCSAN, il fallait trouver une autre méthode. L'utilisation alternative des estimations de l'abondance permettaient de donner de l'information sur l'état des stocks du Labrador. Au total, cinq options ont été examinées, y compris omettre de fournir une estimation pour le Labrador, enlever le Labrador de la série chronologique des estimations d'APP, fournir de nouvelles estimations reposant sur un modèle de taux d'exploitation/habitat établi à l'aide des données de la pêche à la ligne et déterminer l'APP à partir d'estimations de proportion ou de régression par rapport aux séries chronologiques antérieures. Après examen des diverses techniques et de leurs attributs, la méthode proportionnelle a été retenue. Les facteurs d'extension permettant d'inclure des estimations du saumon du Labrador dans l'APP de l'Amérique du Nord ont été de 1,04 à 1,59 pour le saumon adulte unibermarin (madeleinaux possibles) et de 1,05 à 1,27 pour le saumon non adulte unibermarin (potentiel de saumon dibermarin). Il n'y avait pas d'installation de dénombrement au Labrador en 1998, et sans preuve corroborante, il n'est pas recommandé que ces méthodes soient utilisées pour donner de l'information sur l'état des stocks du saumon du Labrador.

INTRODUCTION

A time series of estimates of prefishery abundance of North American non-maturing salmon has been used since 1993 by the ICES North Atlantic Salmon Working Group (NASWG) to provide advice on catch levels for commercial and recreational fisheries in North America and the commercial fishery at Greenland (Anon. 1998). Prefishery abundance (PFA) which refers to the number of maturing 1SW (grilse) and non-maturing 1SW salmon prior to fisheries exploiting them is estimated by summing returns to freshwater for six major geographical areas comprising all of the North American salmon producing rivers including those of Labrador. The six major geographic areas are: Labrador, insular Newfoundland, Quebec, Scotia-Fundy, Gulf of St. Lawrence and USA. Commercial catches in mixed-stock fisheries in North America and North American origin salmon caught at west Greenland were added to the estimates of returns to freshwater that when corrected for natural mortality provide estimates of the total number of North American salmon. Estimates were made separately for maturing 1SW salmon (potential grilse) and non-maturing 1SW salmon (potential 2SW salmon). In order to maintain PFA estimates in the year of the Greenland fishery, the PFAs for the non-maturing component were lagged by one year which also places the maturing component in the same relative year.

Because of a lack of information on which to directly base returns to Labrador rivers, estimates of returns prior to the commercial fishery were developed using commercial catches in the Labrador fishery corrected for exploitation, origin and sea age class. Returns to freshwater were estimated by subtracting commercial catches and spawners estimated by subtracting angling catches. In 1998, the Labrador commercial fishery was closed effectively ending this time series. The purpose of this paper is to examine alternate methods for determining prefishery abundance of North American maturing and non-maturing salmon to include Labrador return and spawner estimates for 1998.

METHODS

There are five possible options for estimating the Labrador component of North American prefishery abundance (PFA):

- **Option 1** – no estimate;
- **Option 2** – remove Labrador from PFA time series and then develop a new time series without the Labrador component;
- **Option 3A** – adjust for the Labrador component based on proportions of Labrador returns in the 1970-97 time series to the total PFA;
- **Option 3B** – adjust for Labrador component based on regression analysis of Labrador returns in the 1970-97 time series; and,
- **Option 4** – develop a new time series using angling catches, exploitation rates, and estimates of parr rearing habitat to derive new estimates of the Labrador component.

If it is assumed that catch advice must be provided for NASCO then **Option 1** of no catch advice is not possible. This leaves four possible methods remaining for dealing with the missing Labrador data. The first of these, labelled as **Option 2** above, would be to remove Labrador numbers from the time series and have a partial abundance number. Then the partial time series could be used to develop catch advice in the normal way by the NASWG. Removing Labrador completely from the time series will be very difficult because, as part of the calculation of PFA, catches in the mixed-stock fisheries of Newfoundland & Labrador and Greenland were included irrespective of origin. Thus to completely remove Labrador salmon from the PFA estimates will require estimating the proportion of Labrador stocks in these various catches which at the present time cannot be done with accuracy. Also a partial estimate of PFA will only provide a partial estimate of catch advice which may be of little value to managers.

This leaves three other possible options. The first of these options, labelled as **Options 3A&3B,** would be to estimate the missing Labrador returns based on the proportion of Labrador stocks in the PFA estimates in the past. This factor would be used to raise 1998 estimates without Labrador to the total PFA. The difference between **Option 3A and 3B** is that **3B** uses regression techniques to estimate the Labrador returns and spawners while **3A** deals with the Labrador proportion of the total PFA. The final option (**Option 4**) is to develop a new Labrador time series using existing data.

Option 3A

Option 3A is based on developing a raising factor from the time series of Labrador data and North American PFA estimates that could be used to calculate PFA without the Labrador commercial data. This would come as close as possible to leaving our time series of PFA data intact and forecasting of potential current year PFA could then proceed similar to previous years.

Anon. (1998) has documented the PFA estimates and estimates of Labrador total recruits (prior to all fisheries harvesting Labrador salmon except west Greenland). These are repeated in Table 1 of this document. The data on North American PFA comes from Tables 4.2.3.3 for non-maturing 1SW salmon (potential 2SW salmon) labelled NN1 and 4.2.3.4 for maturing 1SW salmon (grilse) labelled MN1 (Anon. 1998). As shown in Tables 4.2.3.1 and 4.2.3.2 of Anon. (1998), catches of salmon in Newfoundland and Labrador and Greenland irrespective of origin are used to determine PFAs. The model was originally constructed this way to avoid the intractable problem of having to determine origin of salmon from the six stock complexes in various mixed-stock commercial fisheries. Assuming that this is still the case, i.e. no new data is available to determine stock origin other than to continent of origin for Greenland, then we cannot partition commercial catches in Labrador, Newfoundland and Greenland to the six stock complexes. Thus, there is no way of determining for each stock complex a complete set of individual PFA estimates. However, for Labrador and Newfoundland there is a time series of data showing estimates of total recruits (or production) prior to commercial fisheries. For Labrador, tag return data from Sand Hill River are used to estimate Labrador origin salmon caught in Newfoundland and Labrador commercial fisheries. Greenland catches of Labrador salmon are estimated from sampling data from Greenland of salmon older than 3 years river age assuming that 70% of these salmon are produced in Labrador. The sum of these estimates of Labrador origin salmon in commercial catches in Labrador plus Newfoundland and Greenland estimate total recruits prior to Greenland fishery. This data on total recruits which are also the PFA data for Labrador salmon were reported in Appendix 5(i) and (ii) of Anon. (1998) (Table 1 in this document). They are labelled as LMN1 for Labrador grilse and LNN1 for Labrador 2SW salmon (equivalent to non-maturing 1SW PFA).

The North American PFA without Labrador is calculated by subtracting MN1 - LMN1 to provide an adjusted PFA labelled as AMN1 for maturing 1SW salmon and NN1 - LNN1 to provide an adjusted PFA labelled as ANN1 for non-maturing 1SW salmon (Table 1). The percent of Labrador PFA of the North American PFA is shown in Table 2 along with a Labrador raising factor (RF). The Labrador raising factor was calculated by dividing the North American PFAs (MN1 & NN1) by the PFAs minus the Labrador total recruits. Equations for the raising factors are as follows:

(1) $RF_{MN1} = MN1/(MN1-LMN1)$

(2) $RF_{NN1} = NN1/(NN1-LNN1)$

Option 3B

Option 3B uses the same data as **Option 3A** but determines the Labrador component by a regression approach instead of proportions. This option was examined based on the relationship between PFA of North American salmon and Labrador recruits. Input parameters were also logged.

Option 4

In 1998, there were no salmon enumeration facilities on rivers in Labrador and thus the only data is the angling catch data. Anderson (1985) lists 81 rivers in Labrador with salmon populations and the author knows of several rivers that have salmon but were not included in Anderson (1985). In 1998, catch data are available for 20 out of 81 rivers and these do not include any rivers in Lake Melville. Angling catch data for Labrador comes almost exclusively from angling camps and until recently did not include catches by local anglers if they were not guests at a camp. The most complete data comes from three rivers of the 20 (Eagle, Pinware & Forteau) which in some years do include estimates of these 'local catches' but in others do not. Therefore, the data vary in quality among rivers and years.

The only way of deriving total returns and spawners to freshwater from angling data would be by assuming exploitation rates and calculating returns and spawners for the 20 rivers and then expanding them proportionate to the watershed area or estimates of parr rearing habitat for Labrador. The rivers with data represent about 10-15% of the watershed area. In order to estimate total returns from angling data an estimate of angling exploitation is also required. There were no counting facilities operational in Labrador in 1998 but data is available in other years to derive estimates of exploitation rates in freshwater although they are few in number (1 year - Big Brook, 8 years - Sand Hill, 1 year - Pinware and 2 years - Forteau) (Reddin et al. 1996; Reddin et al. 1998). Exploitation of salmon in Labrador depends more on the success of the camp operator in attracting business than the number of fish. If an angling camp was non-operational in a given year then there is no data for that river and if only a few guests are attracted then from year to year the exploitation rates can vary considerably depending on the juxtaposition of run timing, angling, number of quests and the length of time they fished. Therefore, using exploitation rates derived from one year for all years and transporting exploitation rates to other rivers may be very inaccurate.

Option 4 was based on estimating a new time series of returns to Labrador rivers using available information on angling exploitation rates and catches. Total returns are then estimated for all Labrador rivers by pro-rating rivers with angling data to rivers without angling data based on estimates of parr-rearing habitat. Out of a total of 81 rivers in Labrador known to have salmon populations, only 21 have angling catch statistics although each river may have no catch data in some years. Exploitation rates are available for two rivers in SFAs 1 & 2 and it then must be assumed that exploitation remains the same in these rivers in 1998 and is applicable to all rivers in SFAs 1 & 2. Total returns to rivers with angling data is then expanded to all Labrador rivers based on estimates of parr-rearing habitat.

For Labrador rivers, Anderson (1985) reported drainage areas including areas that are accessible and inaccessible to salmon, parr-rearing habitat in units (100 m^2) and potential adult production (Table 3). He based his summary on studies of obstructions and habitat surveys from Murphy (1971), Murphy (1972), Murphy (1973), Peet (1971), Murphy and Porter (1974), and Riche (1965). Surveys of the rivers of Labrador date back to Blair (1943) who obtained information directly from fur trappers for his report on obstructions of Labrador rivers. Swollows et al. (1953, 1954) visited several major salmon rivers by boat and canoe and walked the lower sections of many rivers, recording stream velocity, bottom type, surrounding vegetation, and sightings of fish, insects, and mammals. Surveys in 1967 and 1968 by Peet (1968, 1971) were conducted from a fisheries patrol boat and helicopter to categorise different watersheds and pin-point obstructions.

The methods for surveying streams and estimating salmon production are outlined in Riche (1972) and were used as the basis of the surveys by Murphy (1971, 1972, 1973), Murphy and Porter (1974) and further summarized by Anderson (1985). The survey method used required estimating and recording stream widths and bottom substrate compositions on a map while flying over the river at low altitude in a helicopter or in some cases a fixed-wing aircraft. Riche (1972) estimated that the results recorded by an experienced surveyor were 70-80% accurate. Barriers to fish migration were examined from the ground to ensure an accurate assessment of the degree of obstruction. As a result of the information collected, areas of rearing and/or spawning within a watershed are identified and rearing area calculated from stream lengths measured from the 1:250000 scale maps available at the time of the surveys. On the basis of counting fence operations and tagging studies in Labrador, Riche (1972) estimated smolt production in Labrador rivers to be two smolts per rearing unit and adult production to be 15% of smolt production. These values were used by Anderson (1985) to derive estimates of potential adult production.

In Labrador, angling statistics are available for 7 out of 47 rivers in SFA 1, 11 out 31 rivers in SFA 2 (not including any of the Lake Melville rivers), and 3 out of 3 rivers in SFA 14B. However, only 5 rivers of the above have commercial outfitting camps on them that were operational in 1998, viz. Sand Hill River, Eagle River, Big Brook, Big River, and Flowers River. The others either were private camps with perhaps a much lower exploitation rate due to lower usage, had only a small number of local fishermen fishing or were camps not operated in 1998. The available exploitation rates come solely from rivers with commercial outfitting camps, viz. Big Brook and Sand Hill River. The 5 rivers with angling statistics available have 17.7% of the parr rearing habitat in SFAs 1 & 2 (Table 3). Angling exploitation rates are available for Forteau Brook, Pinware River, Sand Hill River, and Big Brook but none for 1998 (Tables 4a&b). Note that rates for Forteau and Pinware are not applicable to other rivers in Labrador, as these rivers are easily accessible by car from the island of Newfoundland while rivers in southern and northern Labrador are not. Exploitation rates are available for both retained salmon and hooked-and-released salmon (Tables 4a&b). Because statistics on the number of hooked and released salmon were generally not recorded prior to 1994, exploitation rates for retained salmon only were used. However, it is unknown if these rates are directly applicable to 1998 and to other rivers for which exploitation rates are unavailable.

Equations used to calculate returns to freshwater for Labrador are as follows:

For small salmon:

(3) $R_S = (AC_S / ER_S)*RF$; where,

R_S = returns of small salmon;
AC_S = angling catch of small salmon (retained only);
ER_S = exploitation rate for retained small salmon; and,
RF = raising factor based on accessible parr-rearing habitat

For large salmon:

(4) $R_L = (AC_L / ER_L)*RF$; where,

R_L = returns of large salmon;

AC_L = angling catch of large salmon (retained only);
ER_L = exploitation rate for retained large salmon; and,
RF = raising factor based on accessible parr-rearing habitat

RESULTS

Option 3A

The time series of raising factors for PFA of non-maturing 1SW salmon ranges at the mid-point from a low of 1.05 in 1990 to a high of 1.27 in 1994 (Fig. 1 and Table 2). The overall mean is 1.16 (1.11 for the minimum and 1.21 for the maximum). The raising factor has been increasing since 1990. The biggest change from one year to the next is about 6%. For maturing 1SW salmon, the raising factor ranges from 1.04 in 1973 to 1.59 in 1997 which is much greater than for 1SW non-maturing salmon. The rate of change between years is also much higher for the maturing than non-maturing salmon, e.g. between 1972 and 1973 it declined by 20% and between 1996 and 1997 it increased by 22%. This raises the possibility that either 1SW maturing salmon could be overestimated in some years or alternately non-maturing salmon could be underestimated.

Accuracy of predicted values is also important. Figure 2 shows predicted and observed values for Labrador grilse and 2SW salmon from mid-point of their range. In most years, predicted values do not coincide with observed values; although predictions for 2SW recruits are considerably better than for 1SW maturing salmon. This suggests that while this may be a suitable procedure for continuing the time series of data for PFA so as to include Labrador salmon, it is not an accurate method of providing estimates of Labrador salmon for assessments.

Option 3B

The correlations between Labrador salmon returns and PFA without Labrador suggests that a regression approach might be used to estimate Labrador returns for inclusion in the PFA. Labrador 1SW salmon returns and maturing component of PFA are significantly correlated at less than 5% level of significance as are Labrador 2SW returns and maturing PFA (Table 5a). Examination of residuals from the relationship of maturing salmon indicates high values in the last couple of years which suggests that their use to derive values for 1998 may be questionable (R^2=0.33, F=12.1, P=0.0019). For the 1SW non-maturing component, residuals are about 50% in the last year suggesting that the regression technique may not be of much practical value for predictive purposes (R^2=0.88, F=169.8, P=0.0001).

Correlations amongst the spawner time series indicates that only lagged 2SW spawners from Labrador, Newfoundland and Quebec are significantly correlated at less than 5% level (Table 5b). This suggests that using various relationships to predict Labrador should include a spawning component. Also, the proportionate technique (**Option 3A**) may not be very useful if spawners producing the returns for PFA in other areas are not correlated.

Option 4

Option 4 is based on exploitation rates for Sand Hill River (1994-96) and Big Brook (1997 only) to adjust angling catches from five rivers with similar outfitting camps to total population size. The five rivers included are Sand Hill River, Eagle River, Big Brook, Big River, and Flowers River. Other rivers in southern and northern Labrador have private camps with possibly much lower exploitation rates or were only lightly exploited in 1998. Population size for all Labrador is derived by raising population sizes from the five rivers to 81 rivers based on estimates of parr-rearing areas. Raising factors to expand population sizes estimated from five to all rivers in Labrador is 5.6531 (Table 3).

In recent years on Sand Hill River and Big Brook, exploitation rates for small salmon (retained only) range from 10 - 14% and 2 - 5% for large salmon (Tables 4a&b). Catches in 1998 for the five rivers were 909 small retained salmon and 187 retained large salmon. A population estimate of 36,588 - 51,223 small salmon is calculated as the quotient of exploitation rate and raising factor. For large salmon, population size would be 21,075 to 52,688.

In order for Option 4 to be viable, the total returns need to be apportioned into virgin 1SW and 2SW categories. For Sand Hill River in SFA 2, which is the only river with recent samples (1994-96), 97% of small salmon (n=485) were virgin grilse and 88% of the large salmon (n=50) were virgin 2SW salmon. For Big Brook in SFA 1, which is the only river with recent samples (1997), 99% of small salmon (n=67) were virgin grilse and 100% of the large salmon (n=3) were virgin 2SW salmon. In any case, there is insufficient data for **Option 4** to be useful with so few samples to determine sea age classes and exploitation rates available for only two out 81 rivers.

DISCUSSION

Options 3A&B and 4 appear to be the only methods for deriving total returns for rivers in Labrador. Both techniques have several flaws, some of which are listed as follows:

For **Option 3A**, the Labrador time series used for these calculations has not been corrected for natural mortality so that numbers of salmon are on a different time scale than PFA. The technique while being straight forward and easy to apply depends very heavily on the accuracy of the Labrador recruit data and PFA estimates. The Labrador recruits are based on an assumed level of fishing mortality adjusted for fishing effort and season length. The numbers generated for Labrador should not be used as a Labrador stock assessment without having some corroborating evidence from angling catches or counting facilities. However, since they are a small component of the North American PFA estimate they may be suitable for correcting PFA to include the Labrador component. They are unsuitable for use as a Labrador assessment because they become 100% of the assessment numbers. Another problem is that if Labrador spawning stocks have been out of phase with mainland stocks then the accuracy of this method for estimating Labrador returns and spawners will not be very good.

Option 3B uses the same data as **Option 3A** and has all of the same assumptions and problems. In addition, because **Option 3B** uses regression techniques, it would result in very wide confidence intervals as the regression statistics are estimated from values that are themselves estimates rather than being absolute. Labrador returns would be estimated by regression and then PFA forecasted also by regression.

Option 4 is rather weak because of a lack of consistent catch and annual exploitation rate information for Labrador rivers. Firstly, only 21 of the 81 rivers have angling catch statistics in some years and for some of these the data is incomplete. This is because angling statistics for Labrador are derived from angling camps and catches by local anglers with the exception of more recent years are not always included. There are exploitation rates and biological characteristics information only from Sand Hill and Big Brook for only a total of four years. The expansion of population estimates to all 81 rivers involves using estimates of parr-rearing habitat that are incomplete for some rivers as not all rivers have been surveyed. The calculations herein were done to provide an example and if used should include a randomization process through bootstrap or Monte Carlo simulation to adjust the PFA.

In summary, it is recommended that none of the methods be used to adjust current year North American PFA estimates to include Labrador without collaborating evidence from salmon counting facilities. There were no counting facilities in 1998. Of the two options presented **Option 3A** would appear to be the best. **Option 3A** may be used for raising PFA up to a total including all North American salmon wherein Labrador is only a small proportion. However it should not be used as an assessment of the status of Labrador salmon stocks where it would be 100% of the value.

At the 1999 meeting, NASWG chose to use **Option 3A** to include Labrador salmon returns in the PFA estimates and then forecast the PFA of North American salmon in 1999. The raising factors chosen come from minimum and maximum values that existed in previous years which for non-maturing 1SW salmon were 1.05 to 1.27 and maturing 1SW salmon was 1.04 to 1.59 (Anon. 1999).

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REFERENCES

Anon. 1998. Report of the Working Group on North Atlantic Salmon. Copenhagen, 14-23 April 1998. ICES, CM 1998/ACFM: 15.

Anon. 1999. Report of the Working Group on North Atlantic Salmon. Copenhagen, 12-22 April 1999. ICES, CM 1999/ACFM: 14.

Anderson, T. C. 1985. The Rivers of Labrador. Can. Spec. Publ. Fish. Aquat. Sci. 81: 389p.

Blair, A. A. 1943. Salmon investigations. 1. Obstructions in Newfoundland and Labrador rivers. Dep. Nat. Resour., St. John's, Newfoundland. Res. Bull. 12: 5 - 16.

Murphy, H. P. 1971. A helicopter reconnaissance survey of Eagle, Paradise and White Bear Rivers, Sandwich Bay, Labrador, August 1970. Fish. Serv. Res. Dev. Branch Nfld. Reg. Prog. Rep. 83: v + 53 p.

Murphy, H. P. 1972. A helicopter reconnaissance survey of 21 Labrador rivers, August-September, 1971. Fish. Serv. Res. Dev. Branch Nfld. Reg. Prog. Rep. 95: xi + 164 p.

Murphy, H. P. 1973. A helicopter reconnaissance survey of 17 Labrador rivers, August 1972. Fish. Serv. Res. Dev. Branch Nfld. Reg. Prog. Rep. 101: xi + 177 p.

Murphy, H. P., and T. R. Porter. 1974. Stream surveys of 31 rivers of Labrador. Vol. 1: English River to Fraser River. Fish. Mar. Serv. Res. Dev. Branch Nfld. Reg. Intern. Ser. No. NEW/1-74-8: vii + 141 p.

Peet, R. F. 1968. A report on a reconnaissance survey and counting trap operation conducted in southeast Labrador during 1966. Dep. Fish. Can. Res. Dev. Branch, Nfld. Reg. Prog. Rep. 48: x + 154 p.

Peet, R. F. 1971. A report on the counting trap and reconnaissance surveys conducted in central coastal Labrador during 1967. Resource Development Branch, Internal Report Series Progress Report No. 68. 283p.

Reddin, D.G., P.B. Short, M.F. O'Connell, and A.D. Walsh. 1996. Atlantic salmon stock status for Sand Hill River, Labrador, 1995. DFO, CSAS Res. Doc. 96/82. 32 p.

Reddin, D.G., P.B. Short and R.W. Johnson. 1998. The stock status of Atlantic salmon (Salmo salar L.) of Big Brook (Michaels River), Labrador in 1997. DFO, CSAS Res. Doc. 98/119.

Riche, L. G. 1965. A preliminary biological survey of the Naskaupi, Kenamu and Lower Churchill Rivers. Dep. Fish. Can. Fish. Cult. Dev. Branch Nfld. Prog. Rep. 30: vi + 82 p.

Riche, L. G. 1972. An outline of methods used in stream surveys and estimation of salmon production with a suggested value for Atlantic salmon sports fish in Newfoundland. Fish. Serv. Res. Dev. Branch Nfld. Reg. Prog. 81: iii + 23 p.

Swollows, G. C., J. A. Dalziel, J. E. Cheeseman, G. H. Huxter and H. V. E. Smith. 1953. Salmon investigations - 1953. Preliminary survey of the rivers and commercial fishery of northern Labrador. Part 1. Dep. Fish. Can. Fish. Cult. Dev. Branch Nfld. Reg. Prog. Rep. 1: 53 p.

Swollows, G. C., J. A. Dalziel, G. Smith, and N. Steele. 1954. Salmon investigations - 1954. Preliminary survey of the rivers and commercial fishery of northern Labrador. Part 2. Dep. Fish. Can. Fish. Cult. Dev. Branch Nfld. Reg. Prog. Rep. 2: 22 p.

Table 1. Prefishery abundance (PFA) of North American 1SW maturing and non-maturing salmon and Labrador salmon recruit estimates.

1SW	North American PFA						Labrador estimates of total recruits						North American PFA without Labrador					
Fishery	Maturing 1SW salmon (MN1)			Non-maturing 1SW (NN1)			1SW recruits (LMN1)			2SW recruits (LNN1)			1SW (AMN1)			2SW (ANN1)		
Year (i)	min (i)	max (i)	mid-pt (i)	min (i)	max (i)	mid-pt (i)	min (i)	max (i)	mid-pt (i)	min (i+1)	max (i+1)	mid-pt (i+1)	min (i)	max (i)	mid-pt (i)	min (i)	max (i)	mid-pt (i)
1971	420912	712450	566681	578954	726699	652826	86754	216884	151819	52893	119725	86309	334158	495566	414862	526061	606974	566517
1972	436665	695903	566284	557788	733183	645486	64934	162335	113634	73966	167424	120695	371731	533568	452650	483822	565759	524791
1973	572545	845730	709138	672661	867737	770199	14208	35520	24864	71398	162441	116919	558337	810210	684274	601263	705296	653280
1974	545936	831088	688512	623992	800812	712402	71142	177856	124499	68093	154087	111090	474794	653232	564013	555899	646725	601312
1975	621925	1004901	813413	710243	904537	807390	141210	353024	247117	78755	177917	128336	480715	651877	566296	631488	726620	679054
1976	615783	984102	799943	610836	826772	718804	98790	246976	172883	69455	157223	113339	516993	737126	627060	541381	669549	605465
1977	477810	790423	634117	506933	667717	587325	87918	219796	153857	55148	124378	89763	389892	570627	480260	451785	543339	497562
1978	303059	513960	408509	288808	371345	330077	42513	106282	74397	31845	71631	51738	260546	407678	334112	256963	299714	278339
1979	453192	721093	587143	630107	831343	730725	57744	144360	101052	74064	167726	120895	395448	576733	486091	556043	663617	609830
1980	642596	1033449	838023	549069	729314	639191	130710	326776	228743	67563	152465	110014	511886	706673	609280	481506	576849	529177
1981	674302	1142626	908464	527384	684484	605934	144859	362147	253503	49819	112558	81189	529443	780479	654961	477565	571926	524745
1982	574585	947257	760921	439898	567062	503480	100357	250892	175624	36217	81727	58972	474228	696365	585297	403681	485335	444508
1983	391398	634776	513087	236420	337375	286897	62452	156129	109291	25777	58281	42029	328946	478647	403796	210643	279094	244868
1984	390487	635136	512811	245426	347472	296449	32324	80811	56567	20666	46517	33591	358163	554325	456244	224760	300955	262858
1985	487890	780575	634232	399007	538538	468772	59822	149555	104688	35253	79537	57395	428068	631020	529544	363754	459001	411377
1986	621046	1002795	811921	435085	575040	505063	90184	225461	157823	46930	106276	76603	530862	777334	654098	388155	468764	428460
1987	648087	1048058	848072	398154	527749	462952	112995	282486	197740	29513	66772	48142	535092	765572	650332	368641	460977	414810
1988	617501	1028800	823151	317613	423435	370524	104980	262449	183715	28800	64945	46873	512521	766351	639436	288813	358490	323651
1989	438950	696489	567719	241518	345953	293735	71351	178377	124864	16386	37057	26721	367599	518112	442855	225132	308896	267014
1990	410314	687314	548814	218190	295743	256967	41718	104296	73007	7817	17792	12804	368596	583018	475807	210373	277951	244163
1991	307174	495922	401548	249690	348471	299080	33812	84531	59171	14756	37045	25901	273362	411391	342377	234934	311426	273179
1992	365334	647945	506640	144482	217310	180896	29632	79554	54593	10242	29482	19862	335702	568391	452047	134240	187828	161034
1993	310947	583413	447180	95572	179827	137699	33382	93231	63307	11396	34514	22955	277565	490182	383873	84176	145313	114744
1994	217187	432964	325075	109457	213387	161422	22306	63109	42708	16520	51530	34025	194881	369855	282367	92937	161857	127397
1995	208824	464291	336558	117752	196643	157197	28852	82199	55525	11814	37523	24669	179972	382092	281033	105938	159120	132528
1996	303287	626639	464963	97940	156563	127251	55634	159204	107419	13167	28647	20907	247653	467435	357544	84773	127916	106344
1997	221206	412691	316949				72138	162610	117374				149068	250081	199575			

Table 2. Raising factors and percentages of Labrador compared to the total North American PFA.

	Percent Labrador recruits of total North American PFA						Labrador raising factor (PFA/(PFA-Labrador))					
1SW	1SW Maturing (Grilse)			1SW Non-maturing (2SW)			1SW Maturing (Grilse)			1SW Non-maturing (2SW)		
Fishery	min	max	mid-pt	min	max	mid-pt	min	max	mid-pt	min	max	mid-pt
Year (i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)
1971	20.6	30.4	26.8	9.1	16.5	13.2	1.26	1.44	**1.37**	1.10	1.20	**1.15**
1972	14.9	23.3	20.1	13.3	22.8	18.7	1.17	1.30	**1.25**	1.15	1.30	**1.23**
1973	2.5	4.2	3.5	10.6	18.7	15.2	1.03	1.04	**1.04**	1.12	1.23	**1.18**
1974	13.0	21.4	18.1	10.9	19.2	15.6	1.15	1.27	**1.22**	1.12	1.24	**1.18**
1975	22.7	35.1	30.4	11.1	19.7	15.9	1.29	1.54	**1.44**	1.12	1.24	**1.19**
1976	16.0	25.1	21.6	11.4	19.0	15.8	1.19	1.34	**1.28**	1.13	1.23	**1.19**
1977	18.4	27.8	24.3	10.9	18.6	15.3	1.23	1.39	**1.32**	1.12	1.23	**1.18**
1978	14.0	20.7	18.2	11.0	19.3	15.7	1.16	1.26	**1.22**	1.12	1.24	**1.19**
1979	12.7	20.0	17.2	11.8	20.2	16.5	1.15	1.25	**1.21**	1.13	1.25	**1.20**
1980	20.3	31.6	27.3	12.3	20.9	17.2	1.26	1.46	**1.38**	1.14	1.26	**1.21**
1981	21.5	31.7	27.9	9.4	16.4	13.4	1.27	1.46	**1.39**	1.10	1.20	**1.15**
1982	17.5	26.5	23.1	8.2	14.4	11.7	1.21	1.36	**1.30**	1.09	1.17	**1.13**
1983	16.0	24.6	21.3	10.9	17.3	14.6	1.19	1.33	**1.27**	1.12	1.21	**1.17**
1984	8.3	12.7	11.0	8.4	13.4	11.3	1.09	1.15	**1.12**	1.09	1.15	**1.13**
1985	12.3	19.2	16.5	8.8	14.8	12.2	1.14	1.24	**1.20**	1.10	1.17	**1.14**
1986	14.5	22.5	19.4	10.8	18.5	15.2	1.17	1.29	**1.24**	1.12	1.23	**1.18**
1987	17.4	27.0	23.3	7.4	12.7	10.4	1.21	1.37	**1.30**	1.08	1.14	**1.12**
1988	17.0	25.5	22.3	9.1	15.3	12.7	1.20	1.34	**1.29**	1.10	1.18	**1.14**
1989	16.3	25.6	22.0	6.8	10.7	9.1	1.19	1.34	**1.28**	1.07	1.12	**1.10**
1990	10.2	15.2	13.3	3.6	6.0	5.0	1.11	1.18	**1.15**	1.04	1.06	**1.05**
1991	11.0	17.0	14.7	5.9	10.6	8.7	1.12	1.21	**1.17**	1.06	1.12	**1.09**
1992	8.1	12.3	10.8	7.1	13.6	11.0	1.09	1.14	**1.12**	1.08	1.16	**1.12**
1993	10.7	16.0	14.2	11.9	19.2	16.7	1.12	1.19	**1.16**	1.14	1.24	**1.20**
1994	10.3	14.6	13.1	15.1	24.1	21.1	1.11	1.17	**1.15**	1.18	1.32	**1.27**
1995	13.8	17.7	16.5	10.0	19.1	15.7	1.16	1.22	**1.20**	1.11	1.24	**1.19**
1996	18.3	25.4	23.1	13.4	18.3	16.4	1.22	1.34	**1.30**	1.16	1.22	**1.20**
1997	32.6	39.4	37.0				1.48	1.65	**1.59**			
Mean	15.22	22.69	19.89	9.97	16.90	14.01	1.19	1.31	1.26	1.11	1.21	1.16
SD	5.65	7.57	6.81	2.48	3.97	3.37	0.08	0.13	0.11	0.03	0.06	0.04

Table 3. Drainage areas, parr habitat and potential adult production for Labrador rivers (Anderson 1985). Drainage area and habitat measured using 1:250 000 scale maps.
Numbers in bold type are estimated from SFA totals. (1) indicates that drainage basin has been re-surveyed and is different than in Anderson (1985).
Rivers in bold italics have angling data for some years but not necessarily all years.

No.	River	SFA	Region	Total Watershed Drainage (km²) Total	Total Watershed Drainage (km²) Accessible	Parr rearing habitat Accessible (units)	Parr rearing habitat Inaccessible (units)	Potential adult production	Comments
1	***Forteau Brook***	14B	Straits shore	389	220	1426	1097	5000	Uses text value of adult production, Anderson (1985) habitat & obstructions survey
2	***Lance aux Loup Brook***	14B	Straits shore	130	94	936	359	281	Anderson (1985) habitat & obstructions survey in 1975
3	***Pinware River***	14B	Straits shore	2627	2133	46691	10808	14007	Anderson (1985) habitat & obstructions survey in 1975
	Subtotal SFA 14B	**14B**	**Straits shore**	**3146**	**2447**	**49053**	**12264**	**19288**	
4	Temple Brook	2	Southern	181	90	2311	***1188***	693	75% estimated inaccessible from fig. 7, Anderson (1985) habitat & obstructions survey
5	St. Peters River	2	Southern	140	16	65	510	20	Anderson (1985) habitat & obstructions survey in 1975
6	***St. Charles River***	2	Southern	311	311	6237	0	1871	Anderson (1985) habitat & obstructions survey in 1975
7	***Mary's Hr River***	2	Southern	414	414	6526	0	1958	Anderson (1985) habitat & obstructions survey in 1975
8	***St. Lewis River***	2	Southern	2590	717	13723	35814	4117	Anderson (1985) habitat & obstructions survey in 1975
9	Notleys Brook	2	Southern	46	46	***598***	***0***	***179***	No habitat or obstructions survey, assumed 100% accessible
10	Bobbys Brook	2	Southern	245	167	1360	641	408	Anderson (1985) habitat & obstructions survey in 1975
11	***Alexis River***	2	Southern	3160	926	8919	21522	2676	Anderson (1985) habitat & obstructions survey in 1975
12	***Shinneys Waters***	2	Southern	313	313	1020	0	306	Anderson (1985) habitat & obstructions survey in 1975
13	***Gilbert River***	2	Southern	642	0	0	3238	0	Murphy (1972a) habitat & obstructions surveys
14	Seven Mile Pond River (Riv	2	Southern	98	98	2128	0	638	Murphy (1972) habitat & obstructions surveys
15	***White Bear Arm River***	2	Southern	233	233	4053	0	1216	Murphy (1972) habitat & obstructions surveys
16	River 16	2	Southern	45	45	833	0	250	Murphy (1972) habitat & obstructions surveys
17	***Hawke River***	2	Southern	1891	1891	46366	0	13910	Murphy (1972) habitat & obstructions surveys
18	Caplin Bay Brook	2	Southern	150	150	1591	0	477	Murphy (1972) habitat & obstructions surveys
19	Partridge Bay Brook	2	Southern	70	70	872	0	262	Murphy (1972) habitat & obstructions surveys
20	Shoal Bay River 20	2	Southern	119	119	1067	0	320	Murphy (1972) habitat & obstructions surveys
21	Shoal Bay Brook	2	Southern	18	18	581	0	174	Murphy (1972) habitat & obstructions surveys
22	River 22	2	Southern	13	13	340	0	102	Murphy (1972) habitat & obstructions surveys
23	Black Bear River	2	Southern	645	645	7921	0	2376	Murphy (1972) habitat & obstructions surveys
24	Open Bay Brook	2	Southern	39	39	360	0	108	Murphy (1972) habitat & obstructions surveys
25	Porcupine Harbour River	2	Southern	155	33	368	1381	110	Murphy (1972) habitat & obstructions surveys
26	River 26	2	Southern	70	70	252	0	76	Murphy (1972) habitat & obstructions surveys
27	Reeds Pond Brook	2	Southern	233	233	3175	0	953	Murphy (1972) habitat & obstructions surveys
28	***Sand Hill River (1)***	2	Southern	1618	1456	***18936***	***2104***	***5681***	No habitat survey, 10% is estimated to be inaccessible from 1997 survey
29	Muddy Bay Brook	2	Southern	337	337	***4382***	***0***	***1315***	No habitat survey, obstructions survey by Peet (1971)
30	Paradise River (1)	2	Southern	5664	5664	56425	0	16928	Murphy (1971) habitat & obstructions surveys
31	***Eagle River***	2	Southern	10824	9793	111516	***5576***	***33456***	No adults listed, prorated from Paradise R, 95% accessible (estimated), habitat & obstructions survey (Murphy 1971, 1972a)
32	Southwest Brook	2	Southern	525	525	***6827***	***0***	***2048***	No habitat or obstructions survey
33	***White Bear River***	2	Southern	1021	1021	22228	0	6668	Murphy (1971) habitat & obstructions surveys
34	North River (1)	2	Southern	2215	2215	***28804***	***0***	***8641***	Peet (1971) obstructions survey, no habitat survey
	Subtotal SFA 2	**2**	**Southern**	**34025**	**27667**	**359785**	**71974**	**107937**	

Table 3. cont'd

35	Flatwater Brook	1	Lake Melville	299	299	***5116***	***0***	***1535***	Peet (1971) obstructions survey, no habitat survey
36	English River	1	Lake Melville	640	33	662	12286	199	Murphy & Porter (1974) habitat & obstructions surveys
37	Kenemich River	1	Lake Melville	699	699	11570	0	3471	Murphy & Porter (1974) habitat & obstructions surveys
38	Kenamu River	1	Lake Melville	4403	4403	***75331***	***0***	16500	No habitat survey, Riche (1965) for adult estimate & obstructions
39	Traverspine River	1	Lake Melville	728	613	19749	3714	5925	Murphy & Porter (1974a) habitat & obstructions surveys
40	Churchill River	1	Lake Melville	93415	1062	***18170***	***1580067***	***5451***	No habitat survey, obstructions surveyed by Nfld Hydro
41	Goose River	1	Lake Melville	3432	1938	33560	25865	10068	Murphy (1973) habitat & obstructions surveys
42	Cape Caribou River	1	Lake Melville	546	546	14922	0	4477	Murphy & Porter (1974) habitat & obstructions surveys
43	Beaver River	1	Lake Melville	1878	1624	46251	7245	13875	Murphy & Porter (1974) habitat & obstructions surveys
44	Susan River	1	Lake Melville	363	363	11166	0	3350	Murphy & Porter (1974) habitat & obstructions surveys
45	Naskaupi River	1	Lake Melville	12691	1269	***21713***	***195417***	***6514***	No habitat survey, 10% inaccessible estimated from Anderson (1985), obstructions surveyed by Riche (1965)
46	Crooked River	1	Lake Melville	2391	2391	46836	0	14051	Murphy & Porter (1974) habitat & obstructions surveys
47	Sebaskachu River	1	Lake Melville	580	580	1893	0	568	Murphy & Porter (1974) habitat & obstructions surveys
48	Mulligan River	1	Lake Melville	1062	1062	9902	0	2971	Murphy (1972) habitat & obstructions surveys
49	***Double Mer***	1	Lake Melville	1425	1425	19502	0	5851	Murphy (1972) habitat & obstructions surveys
50	River 49	1	Lake Melville	855	855	18635	0	5591	Murphy (1972) habitat & obstructions surveys
51	***Tom Luscombe Brook***	1	Lake Melville	1010	1010	***17280***	***0***	***5184***	Peet (1971) obstructions survey, no habitat survey
52	West Brook	1	Lake Melville	149	149	***2549***	***0***	***765***	Peet (1971) obstructions survey, no habitat survey
53	Middle Brook	1	Lake Melville	323	323	***5526***	***0***	***1658***	Peet (1971) obstructions survey, no habitat survey
54	53/54 Pottles Bay River	1	Lake Melville	135	135	***2310***	***0***	***693***	Peet (1971) obstructions survey, no habitat survey
55	55 Byron Bay River	1	Northern	163	163	***2789***	***0***	***837***	No habitat or obstructions surveys
56	***Big Brook (Michaels River***	1	Northern	793	793	22059	0	6618	Murphy (1973) habitat & obstructions surveys
57	Jeanette Bay Brook	1	Northern	67	67	1523	0	457	Murphy (1973) habitat & obstructions surveys
58	River 58	1	Northern	13	13	***222***	***0***	***67***	No habitat or obstructions surveys
59	Tukialik River	1	Northern	47	47	684	0	205	Murphy (1973) habitat & obstructions surveys
60	Pamiulik River	1	Northern	493	493	14882	0	4465	Murphy (1973) habitat & obstructions surveys
61	Stag Bay Brook	1	Northern	155	155	4760	0	1428	Murphy (1973) habitat & obstructions surveys
62	Rattling Brook	1	Northern	285	285	11308	0	3392	Murphy (1973) habitat & obstructions surveys
63	***Big River***	1	Northern	2849	2849	10879	0	3264	Murphy (1973) habitat & obstructions surveys
64	Adlavik River	1	Northern	233	233	7186	0	2156	Murphy (1973) habitat & obstructions surveys
65	River 65	1	Northern	39	39	533	0	160	Murphy (1973) habitat & obstructions surveys
66	River 66	1	Northern	29	29	***496***	***0***	***149***	Murphy obstructions survey (unpublished), no habitat survey
67	Makkovik Brook	1	Northern	111	90	2179	520	654	Murphy (1973) habitat & obstructions surveys
68	Makkovik Rook	1	Northern	259	259	5231	0	1569	Murphy (1973) habitat & obstructions surveys
69	South Brook	1	Northern	399	399	3270	0	981	Murphy (1973) habitat & obstructions surveys
70	Kaipokok River	1	Northern	2499	2242	24006	2756	7202	Murphy (1973) habitat & obstructions surveys
71	English River	1	Northern	326	326	10105	0	3032	Murphy (1973) habitat & obstructions surveys
72	River 72	1	Northern	399	399	840	0	252	Murphy (1973) habitat & obstructions surveys
73	Kanairiktok River	1	Northern	12274	0	0	133109	0	Murphy (1973) habitat & obstructions surveys
74	Little Bay River	1	Northern	244	244	***4175***	***0***	***1252***	No habitat or obstructions surveys assumed 100% accessible
75	River 75	1	Northern	475	475	***8127***	***0***	***2438***	No habitat or obstructions surveys assumed 100% accessible
76	***Adlatok (Ugjoktok) River***	1	Northern	11106	8070	130000	48918	39000	Murphy (1973) habitat & obstructions surveys
77	***Hunt River***	1	Northern	1344	1344	24657	0	7397	Murphy & Porter (1974) habitat & obstructions surveys
78	River 78	1	Northern	338	338	***5783***	***0***	***1735***	No habitat or obstructions surveys assumed 100% accessible
79	***Flowers River***	1	Northern	1443	1443	29084	0	8725	Murphy & Porter (1974) habitat & obstructions surveys
80	Rivers 80/81	1	Northern	310	310	***5304***	***0***	***1591***	No habitat or obstructions surveys assumed 100% accessible
81	Sango Brook	1	Northern	806	685	15561	2745	4668	No habitat or obstructions surveys assumed 100% accessible
	Subtotal SFA 1			**164523**	**42567**	**728285**	**2012642**	**212390**	
	Total			**201694**	**72682**	**1137123**	**2096880**	**339615**	

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Table 4a. Summary of angling exploitation rates on Labrador rivers based on retained plus released salmon from Reddin et al. (1996) and Reddin et al. (1998).

	Sand Hill River		Forteau Brook		Pinware River		Big Brook	
Year	Small	Large	Small	Large	Small	Large	Small	Large
1970	3	1	-	-	-	-	-	-
1971	3	0	-	-	-	-	-	-
1972	11	6	-	-	-	-	-	-
1973	11	0	-	-	-	-	-	-
1994	28	5	71	5	-	-	-	-
1995	22	8	61	16	-	-	-	-
1996	31	14	-	-	-	-	-	-
1997	-	-	61	21	48	71	20	3

Table 4b. Summary of angling exploitation rates on Labrador rivers based on retained salmon from Reddin et al. (1996) and Reddin et al. (1998).

	Sand Hill River		Forteau Brook		Pinware River		Big Brook	
Year	Small	Large	Small	Large	Small	Large	Small	Large
1970	3	1	-	-	-	-	-	-
1971	3	0	-	-	-	-	-	-
1972	11	6	-	-	-	-	-	-
1973	11	0	-	-	-	-	-	-
1994	13	4	67	5	-	-	-	-
1995	10	5	54	13	-	-	-	-
1996	10	5	-	-	-	-	-	-
1997	-	-	44	0	33	0	14	2

Table 5a. Correlations of prefishery abundance without Labrador and Labrador.

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	PFA1_NL	PFA2_NL	LAB1_MID	LAB2_MID
PFA1_NL	1.00000 0.0 27	0.66564 0.00020 26	0.55739 0.00250 27	0.55966 0.00300 26
PFA2_NL	0.66564 0.00020 26	1.00000 0.0 26	0.50496 0.00850 26	0.94325 0.00010 26
LAB1_MID	0.55739 0.00250 27	0.50496 0.00850 26	1.00000 0.0 27	0.47009 0.01540 26
LAB2_MID	0.55966 0.00300 26	0.94325 0.00010 26	0.47009 0.01540 26	1.00000 0.0 26

Table 5b. Correlation analysis for lagged spawners from 6 geographic areas in North America.

Spearman Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	NAL	PFA	LABL	NFL
NAL	1.00000 0.0 19	0.24912 0.3037 19	0.08421 0.7318 19	0.04035 0.8697 19
PFA	0.24912 0.3037 19	1.00000 0.0 26	0.75263 0.0002 19	0.70351 0.0008 19
LABL	0.08421 0.7318 19	0.75263 0.0002 19	1.00000 0.0 19	0.59474 0.0072 19
NFL	0.04035 0.8697 19	0.70351 0.0008 19	0.59474 0.0072 19	1.00000 0.0 19
QL	-0.09649 0.6943 19	0.46842 0.0431 19	0.60526 0.0060 19	0.15789 0.5185 19
GSLL	0.75439 0.0002 19	-0.15263 0.5328 19	-0.44035 0.0592 19	-0.20702 0.3951 19
SFL	0.55263 0.0141 19	-0.11404 0.6420 19	-0.29298 0.2235 19	-0.27544 0.2537 19
USL	-0.32281 0.1777 19	-0.34035 0.1539 19	-0.37895 0.1096 19	-0.34737 0.1451 19

Fig. 1. Percentage Labrador returns prior to commercial fisheries in Newfoundland and Labrador are of total North American prefishery abundance.

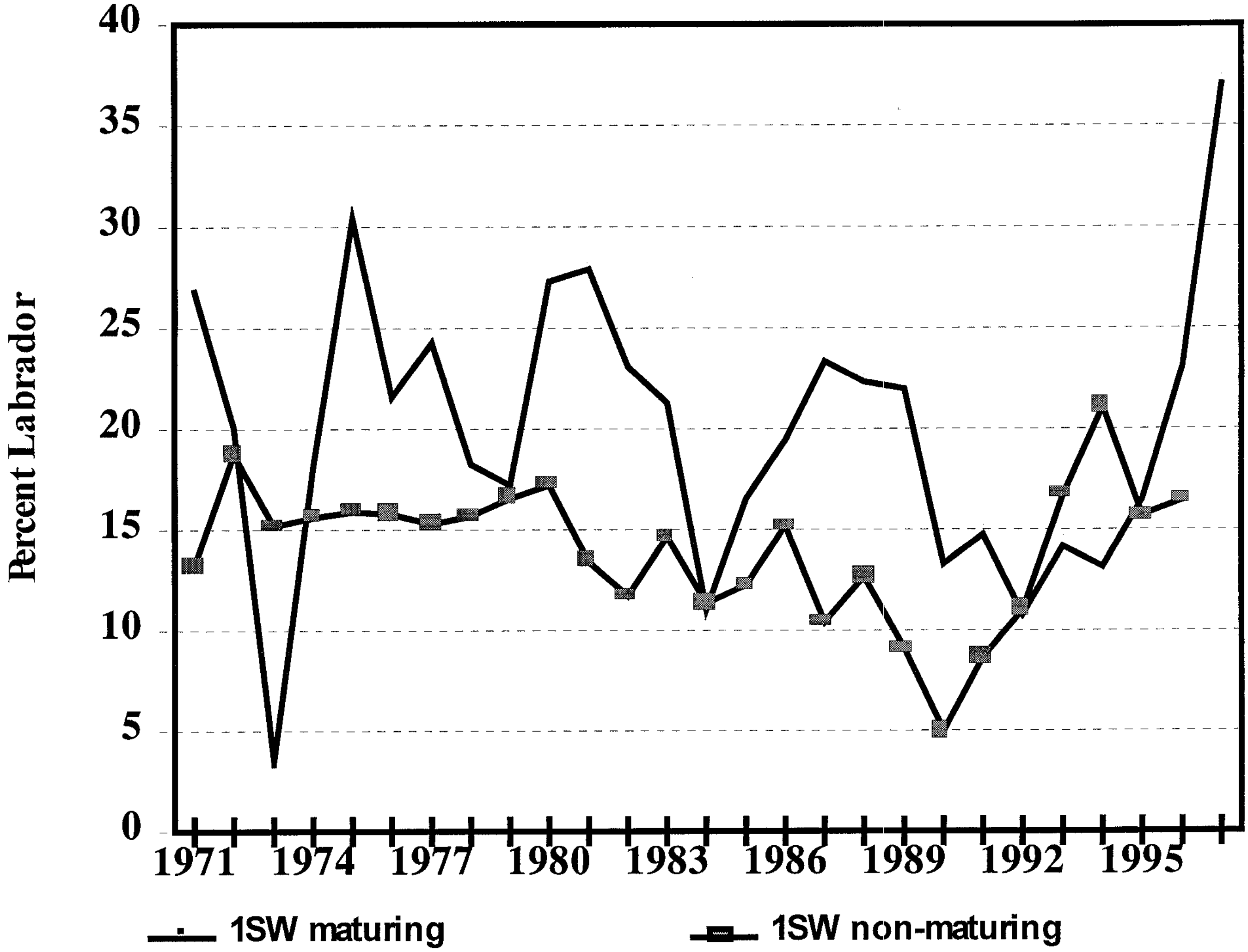

Fig. 2. Predicted and observed Labrador recruits prior to commercial fisheries in Newfoundland and Labrador.