A SCUBA technique for collecting live *Sebastes* spp. specimens

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Can. Tech. Rep. Fish. Aquat. Sci. 2309: v + 13 p.

Redfish species (*Sebastes* sp.) are typically found in deep water and are highly vulnerable to decompression damage when brought to the surface. When limited numbers of live specimens are required for experimental work, collection by SCUBA divers in the relatively shallow waters of the St. Lawrence Estuary was shown to be an efficient method that reduced the potential for damage to the fish. Custom made diver-carried cages contributed to limiting the fish's stress. *In situ* decompression was the preferred method for preventing internal damage due to the increased volume of the gas-bladder. Fish densities had to be relatively high for the divers to achieve a reasonable level of success during the 20 to 30 minutes of available bottom time on each dive. Four series of dives were done over a 25 month period. A total of 249 fish were collected, averaging seven to eight fish per dive. Methods to reduce mortality due to decompression and transport are discussed.

RÉSUMÉ

Larocque, R. 2000. A SCUBA technique for collecting live *Sebastes* spp. specimens.
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Les différentes espèces de sébaste (*Sebastes* sp.) se retrouvent généralement en eaux profondes et sont très vulnérables aux dommages dus à la décompression lorsqu'ils sont remontés à la surface. La récolte par des plongeurs en eaux relativement peu profondes de l'estuaire du Saint-Laurent s'est avérée être une méthode efficace lorsqu'un nombre limité de poissons vivants est requis pour des besoins expérimentaux. L'utilisation par les plongeurs de cages spécialement conçues a permis de limiter le stress subi par les poissons. La décompression *in situ* est la méthode privilégiée pour prévenir les dommages internes causés par l'augmentation en volume de la vessie natatoire. Les densités de poissons doivent être relativement élevées pour que les plongeurs aient un succès de capture raisonnable durant les 20 ou 30 minutes de temps de fond allouées lors de chaque plongée. Quatre séries de plongées ont été réalisées sur une période de 25 mois. Un total de 249 poissons furent récoltés à raison d'une moyenne de sept à huit poisson par plongée. Des méthodes visant à réduire la mortalité liée au transport et à la décompression sont discutées.

INTRODUCTION

Redfish, or ocean perch, are common names that refer to a group of species belonging to the *Sebastes* genus (Perciformes, *Scorpaenidae*). Three species of *Sebastes* are present in the northwest Atlantic, *Sebastes mentella* Travin, *S. fasciatus* Storer, and *S. marinus* Linnaeus. *S. mentella* is generally found in deeper waters (350-700 m) than the other two species while *S. marinus* occurs in intermediate depths ranging from less than 300 m to over 370 m. Of the three, *S. fasciatus* inhabits the shallowest depths, ranging from a few meters to more than 500 m. Although mostly found near the bottom, redfish may also be distributed higher in the water column. *S. fasciatus* is probably the species encountered most often in the depths accessible to divers (Scott and Scott, 1988).

While some fish have a connection from the gas-bladder to the oesophagus that permits gas to escape, physoclist species such as *Sebastes* spp. have a completely closed gas-bladder. In physoclist fish, gas exchanges with the blood take place at secretory and resorbent areas of the gas-bladder (Schmidt-Nielsen, 1990). If the ambient pressure is reduced, the gas-bladder expands and the fish gains buoyancy. Physoclist fish brought up from even shallow depths can be damaged by decompression. *Sebastes* seems to be more vulnerable to decompression damage than most other groundfish (Beckman *et al.* 1998). The great difficulties involved in obtaining live specimens explains why experimental data obtained with live *Sebastes* are scarce. An exception to this is the work of Kelly and Barker (1961) in shallow waters off Eastport, Maine, (USA), in which thousands of redfish were captured by hook and line, tagged, and released without any damage to the fish. Beamish and Buerkle (1965) also examined various aspects of redfish biology using live specimens, although the capture sites and methods were not described.

Several attempts have been made to capture fish in the St. Lawrence Estuary using bottom trawls. A small proportion of the fish were brought to the surface without any apparent damage other than an over-inflated gas-bladder. These fish were singled out and had their bladder deflated using a hypodermic needle. Out of the hundreds of fish treated this way, only five survived for more than one month in captivity. Further attempts were made with mid-water trawls, but fish densities were too low to provide enough redfish in good condition. The hook and line method used by other authors (Eldridge *et al.* 1991) was also tried at several sites known for their high abundance of redfish, but again this did not provide the required numbers of live fish. It was then suggested that redfish living in very shallow waters (less than 35 meters) could be hand collected by SCUBA divers. Previous work involving the use of SCUBA diving in the study of redfish and rockfish includes (among others) surveys of *Sebastes spp.* assemblages in the Straight of Georgia, B.C. (Richards *et al.* 1985), abundance estimation around an offshore oil rig (Love *et al.* 1994), and general life history studies of *S. emphaeus* (Beckman *et al.* 1998). None of these involved collecting live fish. The only recent mention of redfish harvesting on the North American east coast involving SCUBA diving is for aquarium purposes off the coast of Maine (Y. Lambert, Maurice-Lamontagne Institute, pers. comm.).

This work was undertaken specifically to optimize the techniques involved in SCUBA fish collecting and to find areas of high fish densities that could be visited over many years without risk of depletion. It is hoped that SCUBA collecting can be used as a routine method to provide live redfish as required by on-going research programs.

The area chosen for this work is located on the North Shore of the St. Lawrence Estuary near Les Escoumins, Québec (48°21'N, 064°24'W). This sector of the lower estuary is characterized by a deep central trough that is the beginning of the Laurentian Channel. Very steep rocky slopes and cliffs are found, dropping to a depth of 100 meters at a distance of approximately 150 meters from shore. The depth in the channel exceeds 300 meters less than 1.5 km offshore. The area has complex current dynamics influenced by the local topography and the freshwater runoff from the Saguenay River (El-Sabh and Silverberg, 1990). The surface waters visited by divers are generally cold and subject to currents that can vary over small spatial and temporal scales. The area is also known for its high biological productivity due in part to the nearby upwelling zones. Significant redfish densities have been reported in this area in the 20 to 40 meter depth range.

MATERIALS AND METHODS

A first series of exploratory dives was done on 8 October 1996. After the success of this first attempt, a more elaborate expedition was undertaken from May 20-26, 1997. A third and fourth series were carried out 17-21 November 1997 and 2-6 November 1998. A total of 68 person-dives were conducted during the four sampling periods. Maximum depths varied between 24 and 33 m with an average of 28.2 m for all dives. All October 1996 dives were done from a single shore location. For the May 1997 dives, a 6.8 meter boat was used to reach sites that were not accessible from shore. Areas along a 2.6 km stretch were visited on this occasion. For the last two periods, a 4.8 meter inflatable boat was used and the diving effort was concentrated on sites where high densities had been found on previous attempts. A map of the area showing the dive sites is presented in Figure 1.

DIVING PROCEDURES

The diving gear used was regular SCUBA equipment including dry exposure suits, back-mounted buoyancy compensators, redundant regulators, and high capacity cylinders (2600 and 2700 liters). One essential piece of equipment was the dive light. High intensity xenon lights with narrow beams were used on all dives. These lights were essential to find the fish in the highly turbid waters encountered. Lights with 50 to 150 watt output were used on 7.0 and 14.0 amp batteries. The 100 watt bulbs were the best compromise between burn time and effective light output.

All dives were done using air except when divers had to do more than two dives per day. On those occasions, EAN30 (enriched air nitrox, 30% O_2) was used as the breathing mixture to

reduce the risk of decompression sickness. The same air schedules were used for air and EAN dives. All dive profiles consisted of a fast descent to the maximum working depth followed by a progressive ascent.

CAPTURE METHODS

On the first series of dives (Oct. 96), the fish were transferred to 30 x 60 cm mesh catch bags. At the end of the dive, the fish were removed from the bag and transferred to a steel-framed cage at a depth of 10 meters. Using this method, valuable time was lost to extricate the fish from the mesh bags and all specimens had to be manipulated twice during the same dive.

Following the fall 1996 dives, an alternative to the catch bags was sought. Small cages that would be carried by the diver were designed (Figure 2). These have an interior volume of 22.5 liters, which is adequate for up to 15 fish of average size. The frame is made of ½ in. CPVC pipes and fittings glued together. A round rubber flap used as a valve was installed in the center of the door under a retaining ring. Two 10 cm loops of nylon rope are attached to opposite corners of the cage. One loop is clipped to a weight while the second one is used for the marker buoy. During the dive, the cage is clipped to the diver which enables the diver to let go of the cage if required but leaves enough room to maneuver the cage when transferring the fish. These small, low-cost cages were a major improvement over the initial method. They reduced the amount of handling time underwater and contributed to reducing the stress to the fish.

The diver carrying the light was responsible for finding the fish. After finding a fish, the diver signaled its position to the second diver who approached with a small hand net to capture the fish. After capture, the fish was inserted head first through the rubber valve of the cage. It was not uncommon to miss a catch, mostly because the fish moved deeper into crevices, out of reach of the divers.

DECOMPRESSION

The greatest challenge was to bring back *Sebastes* specimens that would not suffer significant damage from the expansion of their gas-bladder. Two common approaches used when collecting aquarium fish are to bring the fish up very slowly to allow for decompression or to relieve the pressure by inserting a hypodermic needle through the body wall into the gas-bladder (Taylor, 1978). A combination of both methods was used for this work. It is believed that most fish can survive a twofold increase in volume of their gas-bladder (R. Pyle, Bishop Museum, pers. comm.) without irreversible damage. This is equivalent to going from 30 meters to 10 meters or from 10 meters to the surface. The preferred method was to leave the fish in cages at 10 meters until they were brought to the surface for transport. On the first series of dives (1996), not enough time was available to decompress the fish until equilibrium. The fish were left at 10 meters for as long as possible (3-4 hours) and then brought to the surface where their gas-bladders were deflated using

a 22 ga. needle. On the 1997 and 1998 dives, it was observed that, depending on the capture depth, between 24 and 48 hours were required for the fish to re-establish their buoyancy at 10 m. The fish brought up to the surface on the last day of diving were generally the ones that suffered the most from their increased buoyancy. The gas-bladders of all fish that were still buoyant 24 hours after transport were deflated using the above method.

TRANSPORT

A single 1000 L insulated tank was used to transport captured redfish to the research facility, 5.5 to 6.0 hours from the collection sites. The tank was filled with seawater pumped from 1.5 meters below the surface immediately before transferring the fish. The water temperature in the transport tank was typically ± 1.0 °C of the *in situ* temperature. For the first, third, and fourth sampling periods, the fish were simply put in the tank making sure that the gills were underwater for the fish that were still buoyant. On the second sampling period, fish were transported in their cages in the insulated tank. The tank was overfilled with water and tightly closed after adding the aeration device. A single 2300 L SCUBA tank fitted to a pressure-reducing (4 bars) regulator was used as an air supply for aeration of the transport tank. On all four occasions, methomidate hydrochloride (0.1 mg L^{-1}) was added to the tank as a mild anaesthetic. Upon arrival at the research facility, the fish were immediately transferred to large 7 m^3 enclosures. These are used in an open-circuit mode at salinity and temperature levels similar to those found *in situ* at the time of collection.

RESULTS

All meristic features (e.g., number of anal rays) concur to establish that the captured fish were of the *S. fasciatus* species. Confirmation was obtained using electrophoretic identification of malate dehydrogenase alleles (McGlade *et al.* 1983).

Sebastes specimens were always found deeper than 20 m and were usually resting in crevices or under rocks. The fish densities were highly variable between sites, ranging from three to five fish around a single rock to a fish every ten meters to a single fish on one dive. The bottom was similar at all sites and there was no apparent difference in the composition of the invertebrate fauna between sites. It was observed that dives done in more sheltered areas such as bays and coves tended to yield better captures than those done outside of these areas, directly on the steep slopes of the Laurentian Channel. The very strong tidal currents experienced by the divers may explain in part why *Sebastes* tends to prefer more protected areas.

Data regarding all captures are presented in Tables 1 to 4. The cages for dives S97-09 and S97-13 were lost due to rough seas on the last day of collection (Table 5). A large number of fish died in captivity following the spring 1997 collection (Table 5).

DISCUSSION

A satisfactory level of success was obtained on all four attempts. Other than the losses following the May 1997 collection, mortalities were minimal and sufficient numbers of fish survived to meet the experimental needs. It is suspected that in May 1997, many fish suffered severe stress when left in the cages during transport. The buoyant fish would rub against the hard mesh material of the cages and lose scales. This and other wounds may in turn have promoted the myxo-bacteria infections that led to fish deaths. The use of a soft plastic liner on top of the tank during the last transport appears to have been effective in reducing injuries. A preventive treatment with an anti-bacterial agent such as chloramine T should also be considered for future collections.

Other than transport-related problems, decompressing the fish was also a challenge. The method of choice would be to rapidly deflate the bladders underwater. While it is feasible to use a hypodermic needle in tropical waters where divers can work without heavy gloves, there is no practical way to do this in 4°C water. The method of staged decompression that was used in this study is effective and had little adverse effect on the fish. When not enough decompression time is available, releasing pressure in the gas-bladder using a needle at the surface was found to be effective. However, since this must be done at the surface, it probably subjects the fish to an increase in gas-bladder volume that exceeds the maximum acceptable ratio.

We can only speculate as to why redfish seem to avoid certain areas while aggregating in others. Other than the possible avoidance of strong current in open areas as discussed earlier, it is possible that redfish tend to congregate near well-lit areas such as wharves that attract copepods and amphipods at night. The high densities encountered in Anse-aux-Basques, where fishing and commercial wharves are present, tend to support this hypothesis.

CONCLUSION

When limited numbers of live *Sebastes* specimens are required for experimental work, collection by SCUBA divers was shown to be an efficient method that reduced the potential for damage to the fish. Lightweight diver-carried cages contributed to limiting stress to the fish. In-water decompression is the preferred method to prevent internal damage due to the increased volume of the gas-bladder. When not practical, a hypodermic needle can be used to relieve the pressure. Because of various constraints, the fish densities have to be relatively high for the divers to achieve a reasonable level of success during the 20 to 30 minutes of available bottom time on each dive. The bottom times could be increased significantly by utilizing breathing mixtures other than air and by adapting the SCUBA equipment used. With extended bottom times, the cold temperatures would become the main limiting factor.

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REFERENCES

Beamish, F.W.H. and U. Buerkle. 1965. Pattern of activity in redfish, *Sebastes marinus* (L.), and cod, *Gadus morhua* L., in relation to two photoperiods. Manuscript report series (biological), no. 838, Fish. Res. Board Canada, 16 p.

Beckman, A.T., D.R. Gunderson, B.S. Miller, R.M. Buckey and B. Goetz. 1998. Reproductive biology, growth, and natural mortality of Puget Sound rockfish, *Sebastes emphaeus* (Starks, 1911). Fish. Bull. 96: 352-356.

Eldridge, M.B., J.A. Whipple, M.J. Bowers, B.M. Jarvis and J. Gold. 1991. Reproductive performance of yellowtail rockfish, *Sebastes flavidus*. Env. Biol. Fish 30: 91-102.

El-Sabh, M. I. and N. Silverberg. 1990. The St. Lawrence Estuary: Introduction, p. 1-9. *In* El-Sabh, M. I. and N. Silverberg (eds.) Oceanography of a large-scale estuarine system, the St. Lawrence, Coastal and Estuarine Studies, vol. 39, Springer-Verlag, New York. 434 p.

Kelly, G.F. and A. M. Barker. 1961. Observations on the behaviour, growth and migration of redfish at Eastport, Maine, p 263-275. *In* Trout, G.C. (ed.) ICES/ICNAF redfish symposium, Int. Comm. Atl. Fish., Spec. Publ. 3, Andr. Fred. Høst and sons, Copenhagen. 311 p.

Love, M., J. Hyland, A. Ebeling, T. Herrlinger, A. Brooks and E. Imamura. 1994. A pilot study of the distribution and abundances of rockfishes in relation to natural environmental factors and an offshore and gas production platform off the coast of southern California. Bull. Mar. Sci. 55: 1062-1085.

McGlade, J.M., M. C. Annand and T.J. Kenchington. 1983. Electrophoretic identification of *Sebastes* and *Helicolenus* in the northwestern Atlantic. Can. Bull. Fish. Aquat. Sci. 40:1861-1870.

Richards, L.J., H.I. McElderry and J. Carolsfeld. 1985. SCUBA survey of rockfish assemblages in the Strait of Georgia, B.C. Can. Data Rep. Fish. Aquat. Sci. 586: 112 p.

Schmidt-Nielsen, K. 1990. Animal physiology, adaptation and environment, 4thed. Cambridge University Press, 602 p.

Scott, W.B. and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219, 731 p.

Taylor, L. 1978. Hawaiian fish emigrants. Sea-Front. 24: 91-100.

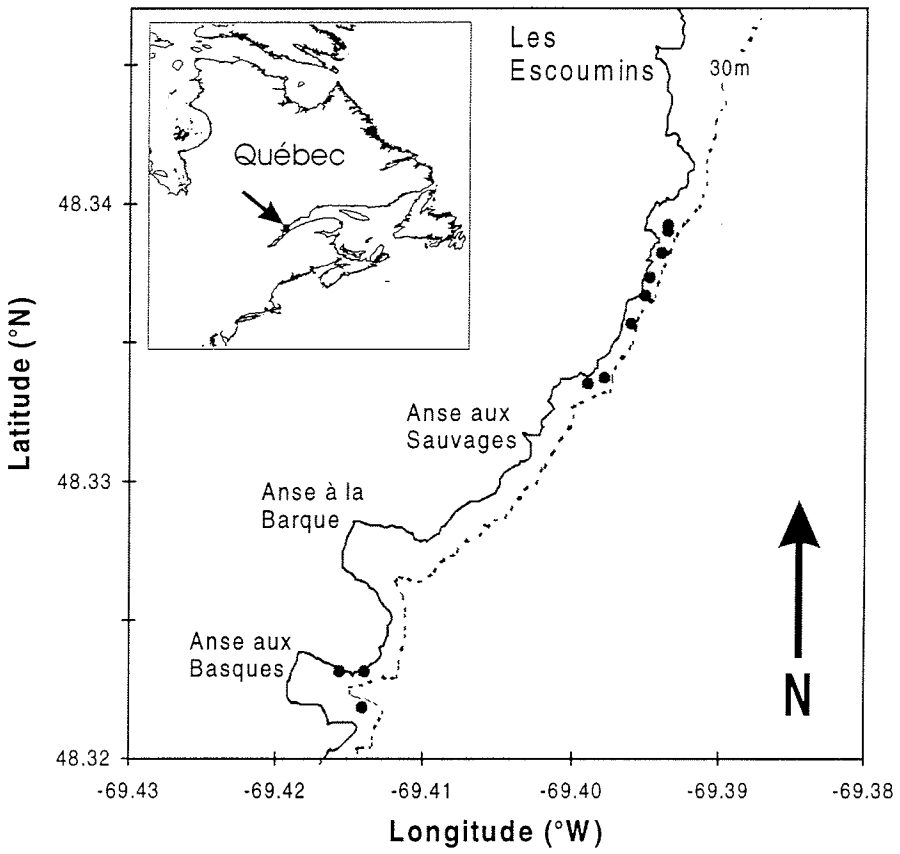

Figure 1. Positions of sampling stations (•) near Les Escoumins, Québec, Canada. Dashed line (------) is the 30 m isobath.

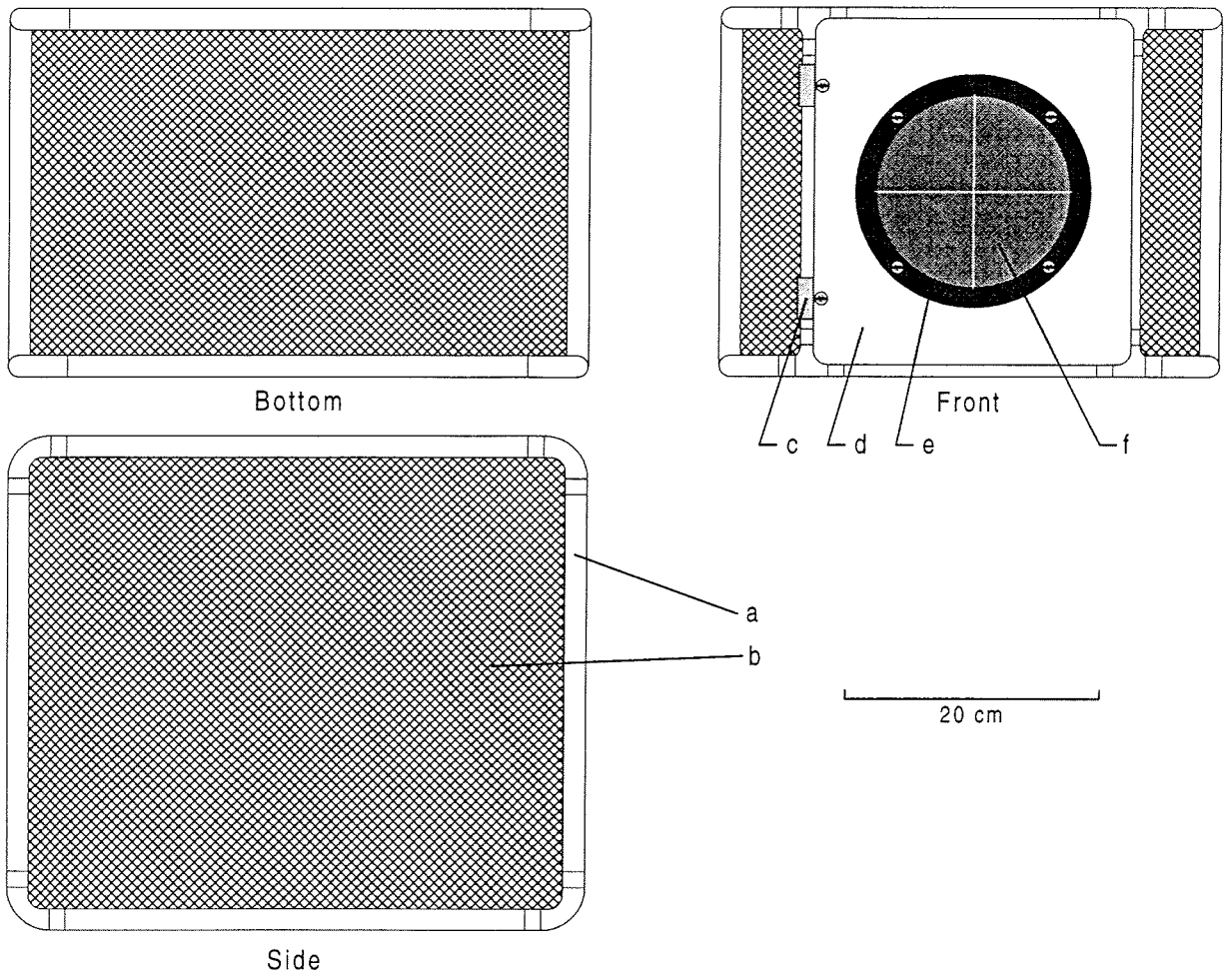

Figure 2. Details of collection cages: a) 1.3 cm dia. CPVC tubing, b) 5.0 mm nylon mesh, c) plastic hinges, d) 3.2 mm HDPE door, e) HDPE retaining ring, f) 3.2 mm rubber flap.

Table 1. Summary of the first series of dives, October 1996.

Dive no.	Date	Position	Total time	Max. depth	Avg. depth	Min. Temp.	Nb. of fish
F96-01	96.10.08	48°19.09'N 069°24.93'W	40 min.	29.6 m	21.0 m	4°C	8
F96-02	96.10.08	48°19.09'N 069°24.93'W	42 min.	28.3 m	17.1 m	4°C	7
F96-03	96.10.08	48°19.09'N 069°24.93'W	35 min.	29.0 m	21.3 m	4°C	10
Average			39 min.	29.0 m	19.8 m	4°C	8.3

Table 2. Summary of the second series of dives, May 1997.

Dive no.	Date	Position	Total time	Max. depth	Avg. depth	Min. Temp.	Nb. of fish
S97-01	97.05.20	48°19.09'N 069°24.93'W	44 min.	24.7 m	17.4 m	4°C	13
S97-02	97.05.21	48°20.05'N 069°23.61'W	46 min.	26.2 m	16.8 m	2°C	0
S97-03	97.05.21	48°20.04'N 069°23.61'W	38 min.	29.6 m	18.6 m	3°C	2
S97-04	97.05.21	48°19.09'N 069°24.93'W	43 min.	25.9 m	17.4 m	2°C	9
S97-05	97.05.22	48°19.99'N 069°23.63'W	41 min.	28.0 m	16.2 m	4°C	5
S97-06	97.05.22	48°19.94'N 069°23.68'W	39 min.	28.3 m	19.8 m	2°C	4
S97-07	97.05.22	48°19.01'N 069°24.84'W	45 min.	27.4 m	17.1 m	5°C	1
S97-08	95.05.23	48°19.90'N 069°23.70'W	42 min.	29.6 m	18.9 m	6°C	6
S97-09	97.05.23	48°19.09'N 069°24.93'W	45 min.	25.9 m	18.3 m	2°C	11
S97-10	97.05.23	48°19.09'N 069°24.83'W	38 min.	25.3 m	18.3 m	6°C	12
S97-11	97.05.24	48°19.84'N 069°23.76'W	42 min.	28.0 m	18.3 m	5°C	4
S97-12	97.05.24	48°19.84'N 069°23.76'W	35 min.	29.9 m	19.8 m	2°C	4
S97-13	97.05.24	48°19.72'N 069°23.87'W	45 min.	26.5 m	18.3 m	3°C	6
S97-14	97.05.25	48°19.74'N 069°23.93'W	45 min.	28.0 m	16.2 m	5°C	2
S97-15	97.05.25	48°19.09'N 069°24.83'W	42 min.	24.7 m	17.7 m	2°C	15
S97-16	97.05.25	48°19.09'N 069°24.83'W	48 min.	25.9 m	17.4 m	3°C	19
Average			42.4 min.	27.1 m	17.9 m	3°C	7.1

Table 3. Summary of the third series of dives, November 1997.

Dive no.	Date	Position	Total time	Max. depth	Avg. depth	Min. Temp.	Nb. of fish
F97-01	97.11.17	48°19.09'N 069°24.83'W	39 min.	27.4 m	19.5 m	3°C	6
F97-02	97.11.18	48°19.09'N 069°24.83'W	37 min.	28.7 m	19.5 m	3°C	4
F97-03	97.11.18	48°19.09'N 069°24.83'W	41 min.	25.9 m	19.2 m	3°C	4
F97-04	97.11.19	48°19.09'N 069°24.83'W	38 min.	28.3 m	19.5 m	4°C	8
F97-05	97.11.19	48°19.09'N 069°24.93'W	39 min.	27.4 m	19.8 m	4°C	9
F97-06	97.11.20	48°19.09'N 069°24.93'W	33 min.	30.5 m	20.7 m	3°C	11
F97-07	97.11.20	48°19.09'N 069°24.93'W	40 min.	33.2 m	19.2 m	3°C	13
Average			38.1 min.	28.8 m	19.6 m	3°C	7.9

Table 4. Summary of the fourth series of dives, November 1998.

Dive no.	Date	Position	Total time	Max. depth	Avg. depth	Min. Temp.	Nb. of fish
F98-01	98.11.02	48°19.09'N 069°24.93'W	41 min.	26.7 m	17.4 m	5°C	1
F98-02	98.11.03	48°19.09'N 069°24.93'W	38 min.	27.0 m	18.9 m	5°C	8
F98-03	98.11.03	48°19.09'N 069°24.93'W	37 min.	27.0 m	18.6 m	5°C	8
F98-04	98.11.04	48°19.09'N 069°24.93'W	37 min.	28.2 m	18.6 m	5°C	11
F98-05	98.11.04	48°19.09'N 069°24.93'W	36 min.	26.4 m	18.3 m	5°C	5
F98-06	98.11.05	48°19.09'N 069°24.93'W	34 min.	28.2 m	18.9 m	5°C	7
F98-07	98.11.05	48°19.09'N 069°24.93'W	36 min.	30.0 m	17.7 m	5°C	8
F98-08	98.11.06	48°19.09'N 069°24.93'W	40 min.	28.2 m	17.7 m	5°C	8
Average			37.3 min.	27.7 m	18.3 m	5°C	7.0

Table 5. Fish mortalities following collection.

Period	Total collected	Loss in transit	Cumulative losses in captivity		
			5 days	10 days	15 days
Fall 1996	25	4	0	0	0
Spring 1997	92 (113)*	1	17	26	37
Fall 1997	55	0	0	0	2
Fall 1998	56	3	0	0	4

* For spring 1997, two cages (21 fish) were lost due to bad weather.