



Massachusetts Division of Marine Fisheries
Technical Report TR-10

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Abstract

Throughout the 2001 fishing season (April–November), DMF personnel collected biological data (length and age) on scup through sea sampling and port sampling from both the recreational and commercial fisheries in the Commonwealth. Biological data were collected from five different fisheries that target scup and from one fishery (spring small-mesh otter trawl) that targets *Loligo sp.*, in which scup is a bycatch. In addition, DMF personnel collected length, weight, and age data from seafood dealers that process scup caught from local fishermen. Data collected were used to characterize landings and discards by length, age and ratios of discards-to-landings for each fishery. Length frequency distributions and age keys were constructed for both landed and discarded catches of scup.

Age data analyses indicated landings in each fishery were comprised mainly of age-3 and age-4 scup, whereas the majority of discards were comprised of age-2 fish. These results agree with those of the NEFSC 31st Stock Assessment Review Committee that predicted strong 1997, 1998, and 1999 year classes. Sea sampling results also suggested that discarding of scup was not a significant problem in the spring small-mesh otter trawl fishery. Discards-to-landings ratios generated from the commercial pot, hook and line, and recreational fisheries were used to determine future sampling intensities using bootstrapping and other statistical techniques.

State and federal seafood dealer transaction forms were collected and reviewed to determine level of fishing effort (total landings, number of permit holders and number of trips prosecuted in each fishery). Weirs constituted the majority of landings during spring, whereas the commercial hook and line fishery was the dominant fishery during summer and autumn seasons contributing over fifty percent of total landings of scup for the year. In addition, landings generated from seafood dealer transaction forms were compared to landings reported to DMF (via the IVR system) and to the National Marine Fisheries Service. Differences in landings estimates and reporting requirements were analyzed and discussed. Recommendations for improving reporting requirements are provided.

Introduction

Scup is the target of important commercial and recreational fisheries in southeastern Massachusetts.

The commercial fishery landed about 700,000 lbs. in 2002 with an ex-vessel worth approaching \$1 million. The recreational fishery landed about 1 million scup in 2002 and this species has long been a staple among the party/charter and private boat fleet in southeastern Massachusetts. Despite their importance, these fisheries have historically been poorly scientifically sampled and characterized. The lack of basic information has created problems with managing this species in a scientifically-sound manner.

Although scup are managed coast-wide by a quota system, an analytical assessment necessary for proper quota setting has been repeatedly rejected by the Stock Assessment Review Committee (SARC) owing to insufficiencies in the input data, principally the inability to characterize commercial and recreational removals by age and the inability to accurately estimate discards. Both the Atlantic States Marine Fisheries Commission (ASMFC 1997) and SARC (Northeast Fishery Science Center 2000) have strongly recommended expanded age sampling of scup from commercial and recreational catches and the collection of discard information.

This study was undertaken to fully characterize the Massachusetts scup fisheries both for biological parameters (catch-at-age, discard rates) and for social/economic attributes (participants, fleet characteristics). Biological data were collected through intense sea sampling on commercial boats and party/charter boats and through market sampling. The commercial data were collected for each fishery type separately (weir, spring *Loligo* trawl, hook and line, pot, and autumn directed trawl). Although collected from Massachusetts, these data can likely be used to characterize similar fisheries on a broader geographic scale. This study provides the first information on the age structure of recreational discards and landings in Massachusetts and the first estimates of discard to landings (D/L) ratios for all Massachusetts scup fisheries. Further, this study provides estimates of variability in biological parameters that can be used to determine future sampling intensities. Data are compatible with the Atlantic Coast Cooperative Statistics Program (ACCSP) protocols and this study serves as a first implementation of the ACCSP biological sampling and sea sampling/discard modules.

Life History

Scup (*Stentomus chrysops*) is a temperate species that occurs primarily from Cape Cod, Massa-

Table 1: Annual landings of scup by gear type in Massachusetts, 1981 - 2000. Source: The National Marine Fisheries Service Fisheries Statistics & Economics Division.

Year	Hook & Line	Pound Nets	Pots & Traps	Otter Trawl	Haul Seines	Paired Trawls	Other	Unknown	Total Landings (pounds/year)
1981	61,000	342,800	104,000	471,500	0	171,200	2,500	0	1,153,000
1982	97,700	337,900	0	532,500	2,500	230,200	500	0	1,201,300
1983	72,900	725,500	16,500	426,000	100	239,800	0	0	1,480,800
1984	39,400	576,500	15,600	288,100	100	269,000	3,000	0	1,191,700
1985	51,600	450,200	2,900	347,500	0	0	1,300	0	853,500
1986	737,016	669,845	12,548	282,321	183	227,610	0	0	1,929,523
1987	616,044	387,035	59,920	210,720	198	346,990	9,175	0	1,630,082
1988	639,802	99,959	96,250	53,740	107	290,570	652	0	1,181,080
1989	679,938	159,609	107,776	131,390	46	198,460	306	0	1,277,525
1990	617,749	79,165	276,799	116,962	0	439,850	2,934	0	1,533,459
1991	586,579	17,490	249,238	57,463	73	308,070	221	0	1,219,134
1992	715,846	110,400	300,659	103,272	624	206,990	6,891	0	1,444,682
1993	679,988	40,348	192,540	122,011	1,704	101,110	86,924	0	1,224,625
1994	542,468	113,464	32,532	90,906	210	0	658	312	780,550
1995	403,046	86,241	57,812	68,824	7,398	0	16,538	44,084	683,943
1996	719,624	2,696	202,443	31,802	0	0	2,541	2,891	961,997
1997	1,014,427	8,692	173,485	293,830	138	0	230	768	1,491,570
1998	727,351	702	151,327	72,781	5	0	7,178	175	959,519
1999	244,770	51,323	66,411	151,360	24	0	1,414	146,279	661,581
2000	125,601	76,562	29,302	50,042	202	0	875	72,819	355,403
Totals	9,372,849	4,336,431	2,148,042	3,903,024	13,612	3,029,850	143,837	267,328	23,214,973

* Gears in the "Other" category include: fyke nets, gill nets, longlines, beam trawls, and scallop dredge.

** Gears in the "Pots & Traps" category include fish pots, conch pots, and lobster pots (inshore and offshore).

*** Gears in the "Haul Seines" category include Danish and Scottish seines.

**** Gears included in the "Hook & Line" category include: rod and reels, common handlines, and troll lines.

achusetts to Cape Hatteras, North Carolina. The general life history is reviewed in Collette and Klein-MacPhee (2002). It is a schooling species that undergoes seasonal migrations (during spring and autumn) in association with water temperature changes. When water temperature rises in the spring, scup migrate north and inshore to spawn. Larger fish arrive off southern New England by early May, followed by schools of sub-adults (Sisson 1974). Larger scup are found during summer near the mouth of larger bays and in the ocean within the 20-fathom contour; smaller scup are found in shallow areas of bays (Morse 1978).

As inshore water temperatures decline below 9°C in the autumn, scup migrate to warmer waters on the outer continental shelf south from the Hudson Canyon off New Jersey to Cape Hatteras, North Carolina in depths ranging from 75 – 185m (Morse 1978; Bowman *et al.* 1987). Their winter distribution appears to be limited by the 7°C isotherm, their

lower preferred limit (Neville and Talbot 1964; Steimle *et al.* 1999).

Tagging studies and meristic analyses (Neville and Talbot 1964; Cogswell 1960, 1961; Hamer 1970, 1979; Finkelstein 1971, and Sisson 1974) have suggested the possibility of two distinct stocks, one in southern New England and another extending south from New Jersey to Cape Hatteras. However, Pierce (1981) reviewed tagging and meristic studies in detail and found the data inconclusive as to the existence of one or two separate stocks of scup. Lack of definitive tag return data in conjunction with distributional data from the NEFSC bottom trawl surveys support the concept of a single unit stock extending from Cape Hatteras north to New England (Mayo 1982; NEFSC 2000).

A detailed summary describing the size and growth rate of scup is described by Steimle *et al.* (1999). Scup can attain a maximum fork length (FL) of about 40cm and a maximum age of about

Table 2: Percentages of scup landed by gear type in Massachusetts, 1981 - 2000. Source: The National Marine Fisheries Service Fisheries Statistics & Economics Division.

Year	Hook & Line	Pound Nets	Pots & Traps	Otter Trawl	Haul Seines	Paired Trawls	Other	Unknown
1981	5%	30%	9%	41%	0%	15%	<1%	0%
1982	8%	28%	0%	44%	<1%	19%	<1%	0%
1983	5%	49%	1%	29%	<1%	16%	0%	0%
1984	3%	48%	1%	24%	<1%	23%	<1%	0%
1985	6%	53%	<1%	41%	0%	0%	<1%	0%
1986	38%	41%	1%	15%	<1%	12%	0%	0%
1987	38%	24%	4%	13%	<1%	21%	1%	0%
1988	54%	8%	8%	5%	<1%	25%	<1%	0%
1989	53%	12%	8%	10%	<1%	16%	<1%	0%
1990	40%	5%	18%	8%	0%	29%	<1%	0%
1991	48%	1%	20%	5%	<1%	25%	<1%	0%
1992	50%	8%	21%	7%	<1%	14%	<1%	0%
1993	56%	3%	16%	10%	<1%	8%	7%	0%
1994	69%	15%	4%	12%	<1%	0%	<1%	<1%
1995	59%	13%	8%	10%	1%	0%	2%	6%
1996	75%	<1%	21%	3%	0%	0%	<1%	<1%
1997	68%	6%	12%	20%	<1%	0%	<1%	<1%
1998	76%	<1%	16%	8%	<1%	0%	1%	<1%
1999	37%	8%	10%	23%	<1%	0%	<1%	22%
2000	35%	22%	8%	14%	<1%	0%	<1%	21%
Total	40%	19%	9%	17%	<1%	13%	<1%	1%

* Gears in the "Other" category include: fyke nets, gill nets, longlines, beam trawls, and scallop dredge.

** Gears in the "Pots & Traps" category include fish pots, conch pots, and lobster pots (inshore and offshore).

*** Gears in the "Haul Seines" category include Danish and Scottish seines.

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20 years (Dery and Reardon 1979). Crecco *et al.* (1981) characterized scup as slow-growing and relatively long-lived fish. Young-of-the-year fish put on considerable growth after they leave the bays, indicating that they feed and grow for at least a month or two before the winter mark, or annulus, is formed (New Jersey Div. Fish & Game 1962).

In southern New England, young-of-the-year scup grew to 5 – 10 cm FL by November (Gottshall *et al.* 2000), with returning juveniles measuring 10 – 13 cm FL in the spring (Michelman 1988; Able and Fahay 1998). Growth is curvilinear between 10 – 38 cm FL corresponding to ages between 1 – 13 years, with rapid growth between 10 – 15 cm FL and declining with increasing age (Penttila *et al.* 1989). Age at 50% sexual maturity in both males and females is two years at a total length (TL) of 15.5 cm (6.1 inches) (Finkelstein 1969a) and is completed at age 3 at 21 cm TL (8.3 inches) (Terceiro 2001).

Description of the Fisheries

Annual landings of scup in Massachusetts by gear type and the corresponding percentages for the years 1981 – 2000 are described in Table 1 and Table 2, respectively. Annual landings peaked in 1986 at over 1.9 million lbs., and in 1997 at almost 1.5 million lbs. (constituting 8% and 6%, respectively to the total landings during this period). Annual landings were lowest in 2000 (355,403 lbs.), which constituted only 2% of the total landings during this period. This information is based on the best available data and must be regarded with caution (see *Reporting Requirements: Discrepancies and Challenges* in Discussion for detailed review of past reporting problems).

Hook & Line Fishery

The commercial hook and line fishery contributed the majority of Massachusetts landings from 1981 – 2000. Over 9 million pounds of scup were



Figure 1: Weirs are designed to intercept and capture migrating fish inside the the bowl, where they are harvested. Photo by Brian Kelly.

landed by commercial hook and line fishermen, thus accounting for 40% of total landings during this period. Landings peaked in 1997 (1,014,427 lbs.), constituting 68% of total landings that year. Landings were lowest in 1984 (39,400 lbs.), which accounted for 3% of total landings that year.

Little information describing the nature of this fishery exists. A study by Finkelstein (1969*b*) describing the age structure of the catches in the hook and line fishery in Long Island Sound showed that scup catches in June 1965 were dominated by age 2 and 3, while in June 1966, ages 3 and 4 were dominant. The Massachusetts hook and line fishery operates primarily out of New Bedford and surrounding towns. During the summer management period (May – October) this fishery accounted for 70% of Massachusetts scup landings and 39% of coastwide landings in 1999.

Pound Net (Weir) Fishery

This is a small fishery that occurs along the south side of Cape Cod during April and May. A concise study documenting the evolution of the trap fishery and its regulations is provided by Pierce (1981). This fishery historically takes a large amount of scup when the stock is at higher levels.

Pound nets are stationary and limited to a depth of about 60 feet or less with the net held in place by poles set in the bottom (Morse 1978). This gear is designed to intercept and capture migrating fish (Figure 1). Once fish encounter the leader, they usually move seaward through the wings and funnels and are trapped in the bowl or parlor (Sissenwine and Saila 1974).

Pound nets rank second (4,336,431 lbs.), accounting for 19% of the total landings during 1981-2000. Landings in the commercial pound net fishery peaked in 1983 (725,500 lbs.), constituting almost 50% of the total landings for that year. Landings were lowest in 1998 (702 pounds), accounting for less than 1% of the total landings for that year.

Otter Trawl Fishery

Prior to 1930, fixed gear such as pound nets and floating traps were the primary means of harvesting scup. Since then, otter trawls have increased in importance and are now the predominant gear used to catch scup commercially nation-wide (ASMFC 1996). The otter trawl fishery ranked third in total landings (3,903,024 lbs.), thus contributing 17% of the total landings for 1981-2000. Landings in the otter trawl fishery peaked in 1982 (532,500 lbs.),

44% of the total landings for that year. Landings in the otter trawl fishery were lowest in 2000 (50,042 lbs.), 14% of the total landings during this period.

Spring Small-Mesh Otter Trawl Fishery (Loligo)

A seasonal spring (May/early June) fishery targeting long-finned squid (*Loligo pealeii*) using otter trawls exists in which scup is taken as bycatch. The impact of this fishery on local abundance of scup and other fishery resources has become an issue of concern in recent years. As predicted by Wilk and Brown (1980), one of the causes of mortality for young scup is thought to be incidental bycatch and subsequent discarding of this species from demersal trawlers that target other species, particularly squid (Kennelly 1999).

Studies of the inshore squid fishery by McKiernan and Pierce (1995) and Cadrin *et al.* (1995) showed discarding of scup in Vineyard and Nantucket Sounds. However, they concluded that trawling effort throughout the region and offshore had a greater influence on the abundance of scup rather than the small effort of the inshore trawl fleet (Eklund and Targett 1990). It was recommended that an examination of discard rates in the offshore autumn trawl fishery be conducted to determine the impact of this fishery on undersized scup as well as research into gear modifications to reduce the bycatch of scup in this fishery.

One such study conducted by Glass *et al.* (1999) assessing the level of scup bycatch using a separator trawl found that a high degree of separation occurs with squid being caught in the upper codend and scup and flatfish in the lower codend. Further analysis of catch data for the inshore squid fishery indicated that the proportion of scup in the overall catches in 1997 was found to be much lower than in previous years. While these results imply that scup bycatch is not a significant problem in the inshore squid fishery, it was suggested that there may be an overall decline in the biomass of scup in Nantucket Sound, and that the patchy nature of scup distribution results in a wide range of variability in capture rates from year to year (Glass *et al.* 1999).

Scup Directed Trawl Fishery

Otter trawls are the primary means of harvesting scup during winter months when scup are wintering in offshore waters. The winter trawl fishery for scup is confined principally to general offshore regions of Cape May, New Jersey to Cape Hatteras, North Carolina, in depths from 20 to 100 fathoms (Neville

and Talbot 1964). Trawls account for 93% of scup landings during these months. In Massachusetts, there is a small scup-directed trawl fishery operating primarily out of New Bedford that targets scup in November as fish leave inshore waters and migrate south and offshore.

Size compositions of scup catches in the winter trawl fishery in Virginia studied by Smith and Norcross (1968) revealed increasing percent contributions of small scup in total catches from 24% in 1957-58 to 69% in 1966-67. Inconclusive age analyses in this study suggested that catches were composed primarily of age-1 and age-2 fish. A similar study conducted by Finkelstein (1969b) on scup catches by otter trawls in eastern Long Island during the summer revealed that age composition was influenced by mesh size. In this study, age-2 scup was the dominant age group caught by trawls in June and July, 1964. However, during the same time period, and in the same locations, otter trawls using small-mesh liners caught almost entirely age-1 scup.

Kennelly (1999) using NMFS sea sampling data observed high discard rates of scup in the commercial scup trawl fishery in various NMFS statistical areas in the northwest Atlantic. However, high discard rates of scup were seldom consistent in particular areas and times. Neville and Talbot (1964) noted sharp changes in size compositions of scup catches in the winter trawl fishery and attributed these fluctuations to changes in hydrographic conditions.

Scup Pot Fishery

Pot and trap fisheries ranked fifth in the total landings (2,148,042 lbs.), which contributed 9% of total landings during this period. Landings peaked in 1992 (300,659 lbs.), 21% of the total landings for that year. Landings in this fishery were lowest in 1985 (2,900 lbs., less than 1% of the total landings in 1985), and in 1982 (no reported landings). Total landings in this category are composed of five different fisheries (fish pots, conch pots, inshore lobster pots, offshore lobster pots, and other). Fish pots comprised the majority of the total landings (93%) with 1,862,670 pounds. Landings in the fishery "other" contributed to 6% of the total landings with 127,818 lbs. while conch, inshore lobster, and offshore lobster pots combined for 1% of the total landings with 21,454 pounds.

Table 3: Annual total catch (discards and landings) of scup from all modes of recreational fishing in Massachusetts state waters from 1981 - 2000. Source: Marine Recreational Fisheries Statistics Survey Database. Type of catch: **TOTAL CATCH (TYPE A + B1 + B2)**

Year	Number of individual fish landed and discarded by mode				% Landings by
	Shore	Party/Charter	Private Rental	Total	Party/Charter
1981	427,500	835,074	892,692	2,155,266	39%
1982	612,102	996,021	2,939,689	4,547,812	22%
1983	587,798	655,939	1,250,716	2,494,453	26%
1984	409,020	165,636	995,083	1,569,739	11%
1985	449,016	123,462	145,326	717,804	17%
1986	336,029	1,505,399	10,144,409	11,985,837	13%
1987	577,922	61,926	6,133,149	6,772,997	1%
1988	513,414	509,862	1,517,882	2,541,158	20%
1989	158,963	315,907	1,833,137	2,308,007	14%
1990	197,506	684,100	1,011,761	1,893,367	36%
1991	325,107	1,348,093	2,363,075	4,036,275	33%
1992	160,057	183,210	903,842	1,247,109	15%
1993	179,849	1,438,359	826,806	2,445,014	59%
1994	71,588	427,572	755,897	1,255,057	34%
1995	42,420	301,700	947,665	1,291,785	23%
1996	41,922	183,179	1,208,631	1,433,732	13%
1997	216,146	287,598	707,985	1,211,729	24%
1998	123,419	177,378	443,623	744,420	24%
1999	25,790	584,480	939,511	1,549,781	38%
2000	176,922	1,081,507	800,202	2,058,631	53%
Totals	5,632,490	11,866,402	36,761,081	54,259,973	
Percentage of overall total catch	10%	22%	68%	100%	
Mean % from party and charter vessels (1981 - 2000)					26%

Recreational Fishery

Since 1979, the National Marine Fisheries Service has conducted annual Marine Recreational Fishing Statistical Surveys (MRFSS). The purpose of MRFSS is to establish a reliable database for estimating impact of recreational fishing on marine resources. This survey is designed to expand interview data on catch and angler effort from both on site creel census and telephone surveys to state and regional levels (ASMFC 1996). This survey quantifies recreational catches and landings using three categories. Category Type A are fish that are available for identification and measurement. Type B1 comprise fish that are filleted or discarded dead, and type B2 is fish released alive. Total recreational catch comprises the summation of category types A, B1, and B2 whereas category types A and B1 combined constitute total recreational landings.

MRFSS (2002a) estimated annual total catch, including discards and landings (Type A + B1 + B2), of scup from all modes of recreational fishing in Massachusetts state waters from 1981 – 2000 is

shown in Table 3. During this period, it was estimated that over 54 million fish were caught by all modes combined. Total catch peaked in 1986 (over 11 million fish), whereas total catch was lowest in 1985 (almost 718,000 fish). The majority of the catch came from private and rental vessels at over 36 million fish caught (68% of the total overall catch for this period). Total catch in this mode peaked in 1986 at over 10 million fish caught. Total catch from private and rental vessels was lowest in 1985 (over 145,000 fish caught). Party and charter vessels ranked second in total catch (almost 12 million fish, 22% of the overall total catch during this period). Total catch in this mode peaked in 1986 at over 1.5 million fish caught; however, total catch was lowest in 1987 at over 61,000 fish caught. Mean percentage of total catch from party and charter vessels during this period is 26%.

Estimated annual total landings of scup (Type A + B1) from all modes of recreational fishing in Massachusetts state waters from 1981 – 2000 is described in Table 4 (MRFSS 2002b). Estimated total

Table 4: Annual total landings of scup from all modes of recreational fishing in Massachusetts state waters from 1981 - 2000. Source: Marine Recreational Fisheries Statistics Survey Database. Type of catch: **HARVEST (TYPE A + B1)**

Year	Number of individual fish landed and discarded by mode				% Landings by Party/Charter
	Shore	Party/Charter	Private Rental	Total	
1981	396,162	677,145	429,956	1,503,263	45%
1982	548,431	947,555	2,928,071	4,424,057	21%
1983	239,835	631,378	1,166,867	2,038,080	31%
1984	227,324	155,943	747,277	1,130,544	14%
1985	147,250	87,717	23,349	258,316	34%
1986	314,869	1,330,939	7,371,979	9,017,787	15%
1987	352,347	61,926	5,171,005	5,585,278	1%
1988	409,516	472,206	1,350,960	2,232,682	21%
1989	121,556	293,311	1,727,771	2,142,638	14%
1990	92,470	549,688	782,653	1,424,811	39%
1991	252,937	1,298,977	2,087,757	3,639,671	36%
1992	87,384	135,279	861,036	1,083,699	12%
1993	114,277	1,329,681	723,163	2,167,121	61%
1994	47,163	376,550	619,841	1,043,554	36%
1995	20,176	137,116	589,496	746,788	18%
1996	14,107	126,910	583,020	724,037	18%
1997	73,779	220,691	515,913	810,383	27%
1998	17,554	138,913	166,020	322,487	43%
1999	11,541	425,719	591,830	1,029,090	41%
2000	56,531	777,821	500,413	1,334,765	58%
Totals	3,545,209	10,175,465	28,938,377	42,659,051	
Percentage of					
overall total catch	8%	24%	68%	100%	
Mean % from party and charter vessels (1981 - 2000)					29%

landings by all combined fishing modes during this period is over 42.6 million fish. Total landings peaked in 1986 at over 9 million fish, and total landings were lowest in 1985 at over 258,000 fish. The majority of the landings were from private and rental vessels at almost 29 million fish (68% of the overall total landings during this period). Total landings for this mode peaked in 1986 at over 7.3 million fish, and was lowest in 1985 at over 23,000 fish. Party and charter vessels ranked second in total landings at over 10 million fish (almost 25% of the overall total landings during this period). Landings peaked in 1986, 1991 and 1993 at around 1.3 million for each year. Landings were lowest in 1985 and 1987 at over 87,000 and almost 62,000, respectively. Mean percentage of total landings from party and charter vessels during this period is 29%.

Current Status of the Stock

Prior to this study, the 31st Northeast Regional Stock Assessment Workshop (31st SAW)(NEFSC 2000) considered the stock overfished and that

overfishing was occurring. This was based on indices of spawning stock biomass (SSB) per tow developed from the NEFSC spring offshore strata series for use as minimum biomass indices for stock rebuilding in response to Sustainable Fisheries Act (SFA) considerations (NEFSC 1998). SSB index (1998-2000 average = 0.10 SSB kg/tow), was less than 5% of the biomass threshold for scup (2.77 SSB kg/tow) established by Amendment 12 to the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan (FMP). The current status of the scup stock described in 35th SAW (NEFSC 2002) suggests that the stock is beginning to recover. Current average SSB index (2000-2002) is 3.20 SSB kg/tow, which exceeds the threshold biomass index.

Amendment 12 defined overfishing for scup to occur when the fishing mortality rate (F) exceeds the threshold fishing mortality of $F_{max} = 0.26$ (NEFSC 1998). Although an estimate of fully recruited F is not available, catch curve analyses of

Table 5: Target sampling level in gear specific fisheries (based on estimated 2000 trips).

Fishery	2000 Total Trips	Target Sampling Level (No. trips and % sampling coverage)
	Recreational	
Headboat	1,200	60 (5%)
	Commercial	
Pound Net (Weir)	38	3 (8%)
Otter Trawl (<i>Loligo</i>)	677	34 (5%)
Hook & Line	630	32 (5%)
Fish Pots	146	10 (7%)
Scup Directed Otter Trawl	30	6 (20%)

fishery-independent survey indices indicate that F for ages 0-3 exceeds 1.0 and is considerably above F_{\max} (NEFSC 2000). These estimates were variable and considered imprecise because lack of older scup in these surveys affects catch curve analyses, therefore total mortality (Z) is overestimated. Indices of recruitment have declined in recent years, except for a strong 1997-year class and moderately strong 1998 and 1999 year classes. Though the relative exploitation rates have declined in recent years, the absolute magnitude of F cannot be determined, which impedes obtaining accurate stock projections. It was recommended by the SARC to continue efforts to further reduce fishing mortality rates and minimize fishery discards to rebuild the stock (NEFSC 2002).

It was concluded by the Stock Assessment Review Committee (SARC) that the current stock assessment for scup is insufficient due primarily to inadequate estimates of total catch and discard data. Limited data available from sea sampling indicates that commercial discards from 1989 – 1999 may have equaled or exceeded commercial landings during this period. Furthermore, the lack of reliable discard estimates has created inaccurate reference points from the yield-per-recruit analysis, thus preventing the use of VPA and production models to assess this stock.

Methods

Sampling Protocol

Throughout the fishing season (April – November 2001), DMF samplers collected biological information (length and age data) on scup through sea sampling and port sampling from both recreational and commercial fisheries in the Commonwealth.

DMF samplers collected data from four different commercial fisheries that target scup (weir, scup pot, hook and line, and scup-directed otter trawl) and from one fishery (spring small-mesh otter trawl) that targets *Loligo* squid, in which scup can be a by-catch. In addition, DMF samplers collected data on headboats, which comprise a large percentage of recreational catches for scup in Massachusetts waters. Finally, DMF personnel collected length, weight, and age data from seafood dealers that purchase scup caught from local fishermen.

All sea sampling and biological sampling was conducted in accordance with protocols and minimum data elements of the appropriate Atlantic Coastal Cooperative Statistics Program (ACCSP) modules. For biological sampling, targets were set at 25 scales per sample (trip) and 100 lengths measured as center-line length (CL) to the nearest cm (however, because local management is based on total length in inches, we present the data in this format throughout the report). For sea sampling, the target level was set at 5% of total number of trips taken in 1999. To estimate the total number of trips in 1999, the number of trips in the vessel trip report (VTR) data was raised based on the ratio of total reported landings to the landings reported in VTRs. This method took into account the considerable number of directed scup trips taken by individuals who do not possess a federal fishing permit. Target number of sampling trips for each fishery is presented in Table 5.

Pound Net (Weir) Fishery

Due to the small number of trips made and reported to DMF in 2000 (38), target sampling intensity was raised to 8% (3 trips). DMF sea samplers collected data aboard vessels tending pound nets

during the spring scup season. Amounts of scup landed and discarded were recorded. In addition, a minimum of 100 length measurements and 25 scale samples were collected from scup in both landed and discarded categories. Landings of other species besides scup were obtained from catch logs filled out by weir owners. All discarded scup were measured at sea and released alive.

Spring Small-Mesh Otter Trawl Fishery (Loligo)

Target sampling level in this fishery was set at 34 trips. Gear characteristics were recorded onto logs provided by the National Marine Fisheries Service Fisheries Observer Program. Descriptive information included the construction material of the net body, the cod-end, ground cable, bridles, foot-rope, use of trawl doors, and floats. Length measurements were made on the head-rope, foot-rope, ground cable, as well as the type and size of mesh used in both the fishing circle and the cod-end.

Information regarding hauls was recorded onto NMFS trawl haul logs. The information recorded onto these forms included date, time, location (latitude/longitude) of the beginning and end of each haul, as well as depth of the beginning of the haul, and all species landed and discarded. DMF samplers recorded the amounts of all species that were landed and discarded in each haul. A minimum of 100 length measurements and 25 scale samples were taken from scup in both landed and discarded categories. Length measurements were taken on other species when time allowed.

Scup Pot Fishery

Minimum number of sampling trips in this fishery was set at 10 trips (7% of total number of trips reported in 1999). Gear characteristics were recorded onto NMFS lobster, crab, and fish pot gear characteristics logs. The number, shape, dimensions (inches), and side construction material of the pots used by each fisherman were recorded. Additionally the number, location, sizes (inches) and shape of entrances and escape vents as well as use of bait and biodegradable panels were recorded.

NMFS lobster, crab and fish pot haul logs were used to record the types and amounts of all species that were landed and discarded for each haul. In this fishery, a haul consisted of a number of pots set in a particular location. Number of pots that were set, hauled, and lost in each haul were recorded, as well as depth, time and location (lat/long) for the beginning and end of each haul. For each haul, the esti-

mated soak duration (in hours) was recorded. The condition in which the pots were set (i.e. temperature, tidal or current patterns, bottom contours), was also noted. A minimum of 100 length measurements and 25 scale samples were taken from scup in both landed and discarded categories as well as length measurements taken from other species time permitting.

Hook & Line Fishery

Based on total trips reported in 2000, minimum sampling intensity in this fishery was set at 32 trips. Information describing gear used in this fishery was recorded using NMFS long-line gear characteristics logs. These gear logs were modified by filling in only relevant fields, because many long-line features such as floats, light sticks, radio beacons, radar reflectors, and drop-lines, are not applicable to the hook and line fishery. The relevant fields included were number, size, and patterns of hooks used, as well as number, material and test of gangions used. In addition, the material and test of the mainline and leaders was also recorded. The method of fishing, either rod and reel or common hand-line was noted in the comment section of the gear log.

NMFS long-line haul logs were used to record the types and amounts of all species landed and discarded for each haul. For these trips, a haul was defined as the amount of time spent fishing in a particular location (marked by latitude and longitude). Date, time, and depth for the beginning and end of each haul were recorded. Additional notes were taken on number of hooks set, lost, tended, and rebaited, as well as type of bait used and weight of additional line weights. The method in which hooks and lines were set (i.e. temperature, tidal or current patterns, bottom contours), was also noted. A minimum of 100 length measurements and 25 scale samples were taken from scup in both landed and discarded categories as well as length measurements taken from other species as time permitted.

Scup Directed Trawl Fishery

Due to the low number of trips reported in 2000 (30), minimum sampling target was raised to 6 trips (20%). Information regarding characteristics of trawl gear and hauls were recorded onto the same NMFS forms that were used to describe the spring *Loligo* otter trawl fishery. DMF samplers followed the same sampling protocol used in the spring otter trawl fishery recording amounts of all species that were landed and discarded in each haul. A mini-

num of 100 length measurements and 25 scale samples were taken from both landed and discarded scup per trip. When time permitted, length measurements of other species were recorded.

Recreational Fishery

The initial sampling target was 60 trips based upon 5% of the number of estimated party boat trips taken in 2000. The vessel sampling target was further divided into a desired three trips per week for the time period May 1 – October 15, corresponding to the time period that scup are known to inhabit Massachusetts waters. Since the season ended by regulation on October 6, no trips were made after that date. No trips were made during 2001 in the first two weeks of May since fish were not available to the fishery and there was no participation by the fleet.

Trips were made aboard party and charter boats operating out of ports in southeastern Massachusetts and on Cape Cod (from New Bedford to Harwich, and including Martha's Vineyard). These samples are also representative of the recreational fishing activity from private/rental boats, which occurs at similar times and locations. Together, the two fishing modes comprised greater than 98% of recreationally-caught scup in MA waters and greater than 93% coastwide in 1999 (Personal communication from the NMFS, Fisheries Statistics and Economics Division).

Trips were randomized as much as possible between available boats. Initially, the study began with twelve boats, but decreased to five by the end of the fishing season. When a trip could not be made on a vessel due to booking to capacity, not fishing for bottom fish or poor weather, arrangements to sample another vessel were made if possible. Sampling by geographic area was also randomized as much as possible.

Vessels were assigned rail positions based upon the positions of the hours on a clock, with 12 o'clock representing the bow and 6 o'clock position representing the stern (Figure 2). A random number generator computer function was used to generate lists of up to 20 random numbers from 1-12, with replacement. A different list was used for each trip.

Anglers were sampled according to their position at the rail spot corresponding to the rail position on the list of random numbers for that trip. If an angler had been previously sampled on that trip, the next angler to the right or left was chosen if not

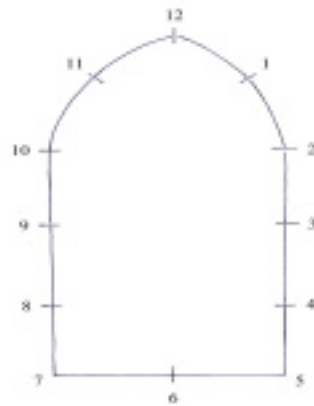


Figure 2: Clock positions on a recreational fishing vessel for random sampling purposes.

previously sampled. If that angler had been previously sampled, another rail position and corresponding angler was chosen. In some trips all available anglers were sampled at least once. In those instances, re-sampling occurred based again upon a randomly picked rail position.

The catch of each observed angler was sampled for a 10, 15 or 20 minute sampling period of available fishing time. Time spent steaming to and from the fishing grounds and between areas, or during anchor resetting was not counted as fishing time. The sampling period remained the same within each trip.

In addition to vessel and trip data (date, times, location, etc.) each angler's data were recorded separately and marked with an appropriate identifying name. Number and size of kept and discarded scup, as well as all other species caught was recorded. Scup centerline lengths were recorded to the nearest cm, and scale samples were taken from at least three scup per cm interval of length per trip. If remarkably small or large fish were noted in other angler's catches, those fish were sampled for length and scales as well.

Market Sampling

DMF samplers obtained length data and scale samples according to ACCSP protocol from local

seafood dealers that purchase scup caught by local fishermen. DMF maintains a comprehensive listing of state licensed seafood dealers, and DMF issues authorizations to purchase scup and other quota-managed species. Federally licensed seafood dealers are listed in the NMFS Northeast Region Permit Database. Sampling was conducted according to gear type due to the local nature of the fishery (this is generally known to the dealers), and by market category. While there was no specified number of port sampling trips, sampling was stratified temporally throughout the summer fishing season.

Length and weight data for individual fish were collected to construct a length-weight relationship. In addition, measurements of centerline length (CL) and total length (TL) were also recorded from sampled scup in order to construct center-line length – total length, and total length – center-line length conversion formulas. Length (CL) data were also collected on scup that were culled into different market categories.

Data Analysis & Management

Data were entered into a spreadsheet database after each trip. All catch composition, length frequency, and trip data were entered and maintained in a separate spreadsheet from the age sampling data. Data collected from trip haul logs were coded for entry into the NMFS Commercial Fisheries Database (CFDBS), as well as the ACCSP Data Module.

Scale samples were placed onto cellulose acetate slides (77.2 x 26.4 x 0.2mm) and pressed using plastic cover slips. Imprinted slides were then placed underneath a Micron Reader and scales were aged using 24X and 48X magnification lenses. Age sampling data were routinely sorted and counted within length bins to track sample numbers so that scale sampling could be redirected to needed fish sizes to attain minimum sample number targets. Age data were also grouped by fishery from which samples were collected in order to create age keys for each respective fishery.

In each commercial fishery, total landings and discards for all species were recorded in pounds. Ratios of discards-to-landings (D/L) of scup (by weight and by number of individual fish) were created from these data, except in the recreational fishery where only the latter (discard rates by number) were recorded. Length frequency distributions were constructed from length data for landed and discarded scup. In cases where sub-samples were taken,

length frequency data were “weighted” to reflect total catches for all sampled trips. For the recreational fishery, length frequency distributions were created as proportions per cm group and were grouped into two-month intervals according to season (Spring: May – June; Summer: July – August; Autumn: September – October). This separation by season was done to monitor changes in size and age compositions of catches.

Scale samples were collected from each sampling trip to construct age distributions of landings and discards for each fishery. The age of each sample was correlated with its respective length to form an age-length key. These keys were separated into seasonal intervals (Spring: May – June; Summer: July – August; Autumn: September – November) to account for changes in growth rates. Length frequency data for landings and discards in each fishery were applied to its respective age-length key (the season in which the fishery occurred). Data were arranged as proportions-at-age to describe total landings and discards in all combined sampling trips in each fishery.

Catch rates in the recreational fishery were studied in further detail by calculating mean CPUE's in total catch (TCPUE) and mean CPUE's for scup retained per trip (RCPUE). CPUE was defined as the total number of scup caught and/or retained per angler per hour. Mean TCPUE's and mean RCPUE's were separated by their respective seasonal intervals to analyze seasonal trends in angler catch rates. Overall mean CPUE's and variances were calculated for all trips in each season. Individual angler CPUE (for both total catches and landed catches) were calculated, log-transformed, then grouped into two-month intervals in accordance with mean CPUE seasonal analysis. Single factor ANOVA was calculated for CPUE's (total catch and landed catch), to determine if there was a significant difference in catch rates among the time intervals. Tukey's Studentized Range (HSD) and Scheffe's Tests were used for multiple comparisons between time intervals.

Two methods were used to estimate appropriate sample sizes (number of sea sampling trips in each fishery) for future sampling efforts in order to provide statistically sound estimates of D/L ratios. These methods are both based on the variance around the estimates provided from the present study.

In the first method (Bootstrap Method), the D/L

ratios (ln transformed) from individual trips were randomly drawn with replacement 1000 times with sample sizes ranging from 2 to 60. A coefficient of variation (CV) was calculated from the 1000 draws at each sample size. For this modeling exercise, it was assumed that no further improvement of the CV would occur above a sample size of 60. The relationship between sample size and CV was fitted to an exponential function using least squares regression. The maximum reduction in CV that could be achieved was calculated as the CV at a sample size of 2 minus the CV at a sample size of 60. The target for sampling was then arbitrarily set at the sample size that would achieve 90% of the maximum possible reduction.

The second method (Variance Method) was based on the formula in Zar (1996):

$$n = (s^2)(t^2_{\alpha(2), (n-1)}) / d^2$$

where s^2 is the sample variance, estimated with $v = n - 1$ degrees of freedom, d is the half-width of the desired confidence interval, and $1 - \alpha$ is the confidence level for the confidence interval. In order to use this formula, geometric mean discards-to-landings (GMDL) ratios for all sampled trips in each fishery were calculated. Hence, the sample variance was obtained for use in this formula. Minimum target sample size was estimated at the 95% confidence interval. The desired confidence interval was set at equal to the mean.

Analysis of Effort and Landings by Fishery

Research also concentrated on determining the level of fishing effort (the number of trips made, and the total landings for 2001) in each of the aforementioned fisheries. State dealer transaction forms (sent to DMF via the state licensed seafood dealers at the end of the year), and federal dealer transaction forms were acquired from NMFS regional port agents, whom local federal dealers must submit transaction forms. From these forms, state permit numbers were queried into the DMF permit database in order to identify the gear type. Total landings per trip, and the number of trips were calculated once the gear type was identified.

Fleet composition for all fisheries was classified using the U.S. Department of Commerce (1993) scheme which classifies vessels according to gross registered tons of displacement (GRT). Vessel classification is as follows: Class 1 vessels are less than 5 GRT. Class 2 vessels (5 – 50 GRT) comprise most inshore vessels up to 60 feet in length. Class 3

(51 –150 GRT) and Class 4 (151 – 500 GRT) are larger vessels capable of operating further from shore, and often fish multi-day trips.

In the recreational fishery, telephone interviews were conducted with party and charter boat captains, to determine the number of trips that each company made targeting scup. To further describe this fishery, additional questions asked included the peak business periods, as well as the demographics of the fishing clientele (the percentage of in-state, and out-of-state customers, as well as the percentage of repeat customers).

Once the level of fishing effort was estimated for each fishery, the percentage of trips covered by observers could be determined. Target sample sizes (number of trips) estimated by bootstrapping were compared to the estimated number of trips made in 2001 in each fishery. Comparisons were also made between the number of trips covered by observers and the estimated target sample sizes. The purpose of making these comparisons was to determine whether the number of trips sampled in each fishery reflected an accurate representation of the landings and discard rates for each fishery.

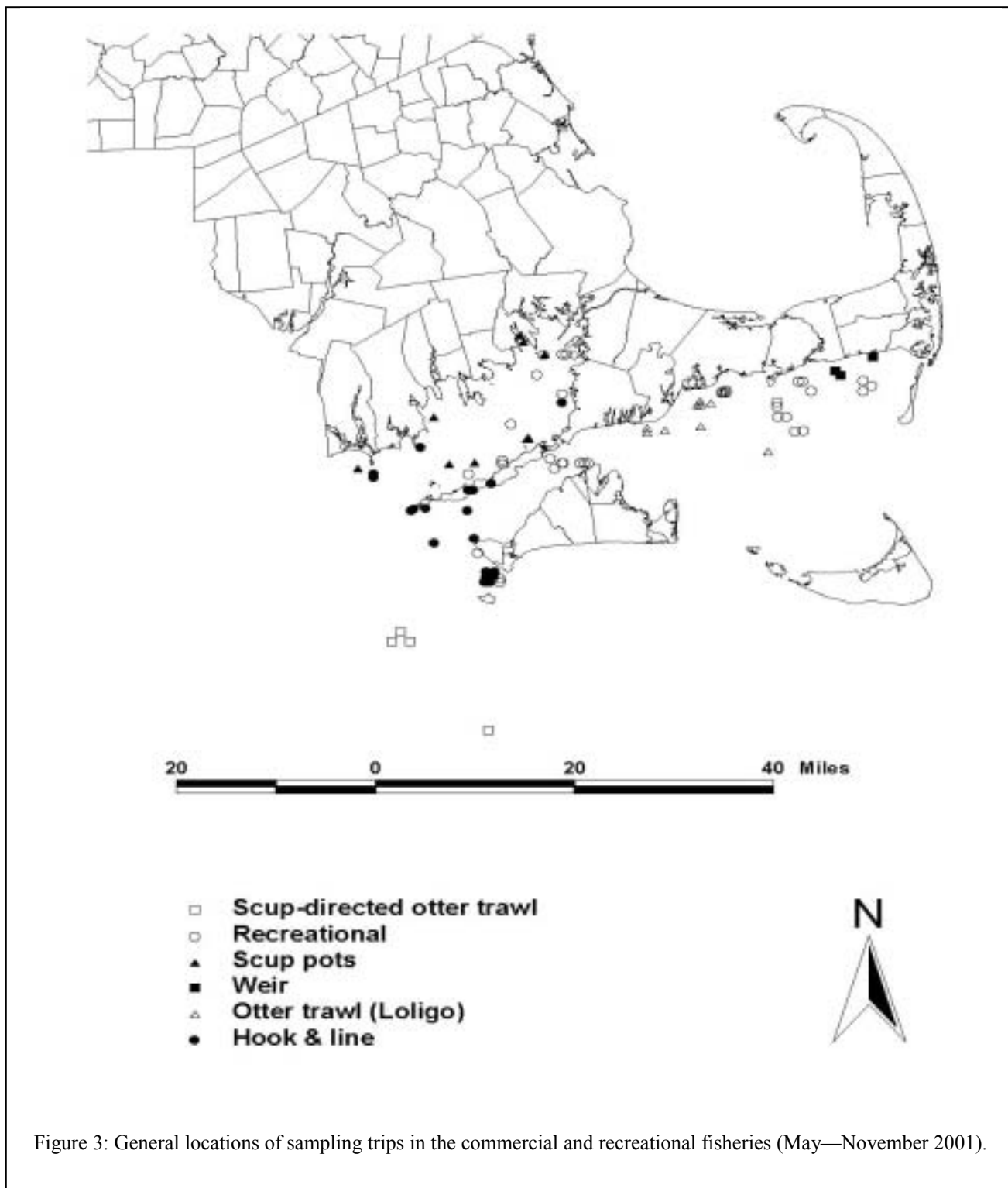
Results

Description and Analysis of Catch Data by Fishery

The number of trips conducted by DMF observers in each fishery and their approximate locations are shown in Figure 3. DMF observers covered thirty-eight trips in the recreational fishery. In the commercial fishery, all of the targets were met or exceeded with the exception of the commercial hook and line fishery (in which 27 of the 32 trips were made), and in the scup directed otter trawl fishery (4 of 6 trips were conducted).

Pound Net (Weir) Fishery

DMF personnel conducted their sampling trips on weirs owned by two companies. The characteristics of the weirs employed by these two companies are almost identical. Both companies used weirs composed of three main sections: a leader, heart, and one bowl (Figure 4). The leaders measured 1,500 feet long with 18-inch mesh size, while the heart measured 60 feet wide with 6-inch mesh size. In both weir types the bowl measured 60-feet in diameter. One company used a 1.75-inch mesh size at the top of the bowl which tapered to 1.5 inches at the bottom, whereas the bowl mesh size used by the other company was uniform at 1.75 inches.



Four sampling trips were made by DMF observers during the spring (5/10/01 – 5/17/01). Sampling was conducted at three weirs (two were located in the inshore area near Dennisport, and one was located inshore near Harwich). Total species landings for all trips combined totaled almost 23,000 lbs. (Table 6). Mackerel was the dominant species landed (over 12,000 lbs.), comprising 54% of the

total catch. Squid ranked second in total landings (over 9,500 lbs.), 42% of the total catch. Scup ranked third (697 lbs. landed), with 260 lbs. sub-sampled by observers. The catches in these four trips ranged from 13 lbs. to 500 lbs (Table 7). A combined total of 10 lbs. of scup was discarded, with two (50%) of these four trips producing no discards. Consequently, the D/L ratios, by weight

Table 6: Summary of landings in four sampled trips by commercial weir fishermen (5/10/01 - 5/17/01). All landings recorded in pounds.

Trip Date	Pockets Operating	Pockets Lifted	Bluefish	Squid	Summer Flounder	Mackerel	Scup	Black Sea Bass	Trip Totals
5/10/01	3	3	0	3,800	82	9,085	500	0	13,473
5/11/01	3	3	0	1,485	0	3,100	47	0	4,638
5/14/01	4	4	30	2,520	0	0	137	0	2,695
5/17/01	3	3	0	1,760	0	0	13	140	1,919
Species Totals	-	-	30	9,565	82	12,185	697	140	22,725
Percent Totals	-	-	< 1%	42%	< 1%	54%	3%	1%	100%

Table 7: Number and percentage of scup landed and discarded by commercial weir fishermen during the spring fishery (5/10/01 - 5/17/01). Included are estimated totals for landed and discarded categories and calculations of D/L ratios for each trip.

Gear type: Weir	Trip Date			
	5/10/01	5/11/01	5/14/01	5/17/01
Total Catch (lbs)	508	49	137	13
Total Landed (lbs)	500	47	137	13
Percentage	98	97	100	100
Subsample Weight (lbs)	65	46	137	13
Percentage	13	97	100	100
No. fish in subsample	71	51	127	18
Estimated No. fish landed	550	53	127	18
Total Discarded (lbs)	8	2	0	0
Percentage	2	3	0	0
Subsample Weight (lbs)	8	2	0	0
Percentage	100	100	0	0
No. fish in subsample	22	5	0	0
Estimated No. fish discarded	22	5	0	0
Discard Ratio (discards/landings)				
by weight	0.02	0.04	0	0
by number	0.04	0.1	0	0
Arithmetic mean D/L Ratio				
by weight	0.015			
by number	0.035			

and by number, in these four trips were low (the mean ratio by weight = 0.02, and the mean ratio by number = 0.04). All discarded scup were immediately returned alive and in good condition.

The weighted length frequency distribution of scup landed and discarded by commercial weir fishermen for these four sampling trips is shown in Figure 4 (N = 716). The average size of scup landed

was 27.4 cm CL (12.1 in. TL). The length frequency for scup discarded was not weighted because all discarded scup in these four trips were measured (N = 27). The average size of discarded scup was 19.8 cm CL (8.8 in. TL). The majority of the sampled catch in the weir fishery (Table 8) was comprised of age-4 fish (43%). The age-length key was constructed combining both landed and discarded scup because of the amount of discarded

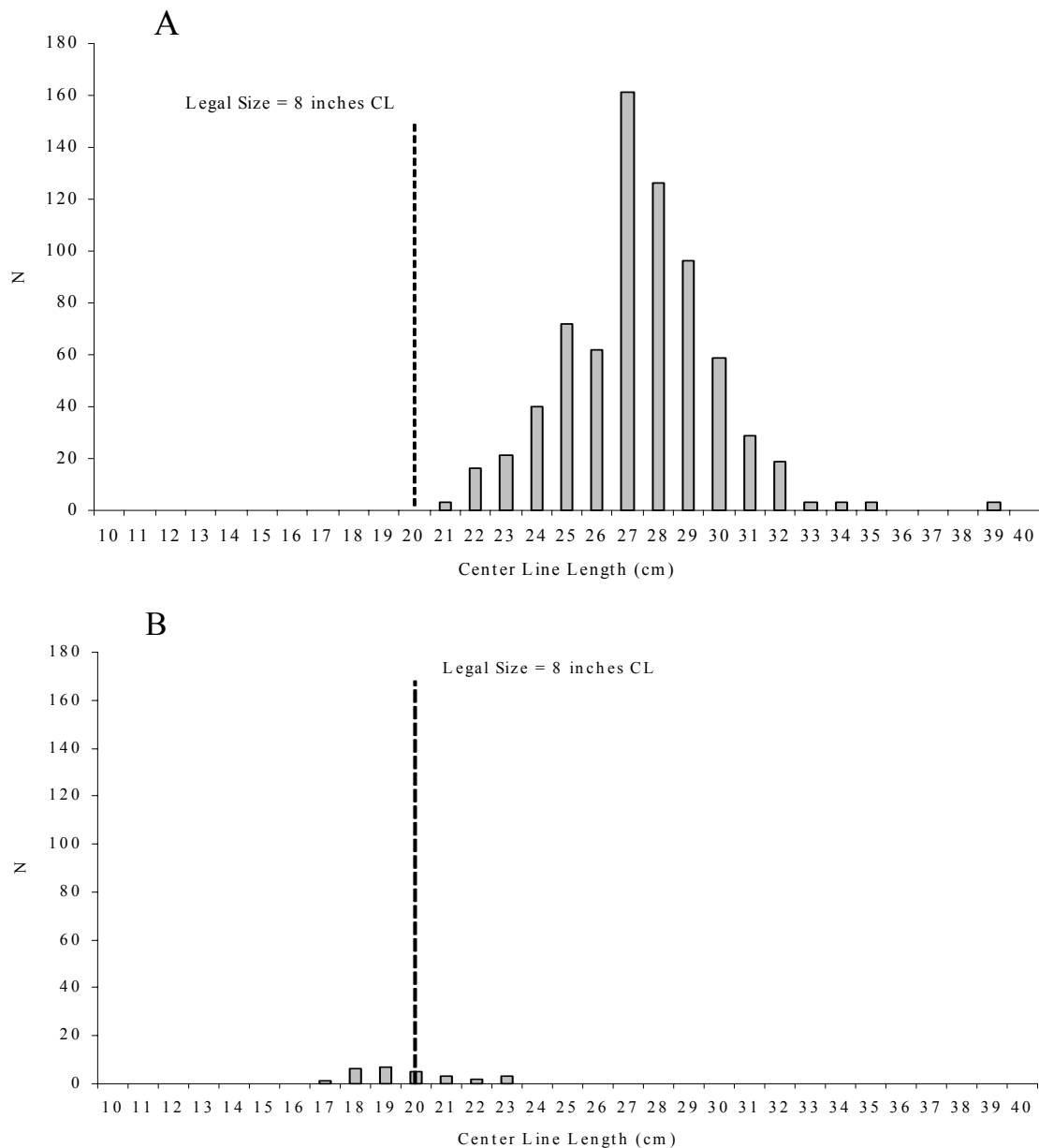


Figure 4: Length frequency distribution of scup landed (A) and discarded (B) by commercial weir fishermen during the spring fishery (5/10/01 - 5/17/01).

scup was so low that it did not warrant the construction of a separate key.

Spring Small-Mesh Otter Trawl Fishery (Loligo)

Sampling trips were made aboard inshore draggers (Class 2 vessels) deploying trawl nets with similar characteristics (Figure 5). Trawl net bodies were constructed mainly of polyethylene or a combination of spectra and polyethylene material with mesh sizes ranging between 1 - 6 inches. Codends were constructed primarily of polyethylene material with mesh sizes ranging between 1.5 - 6 inches.

Codends with larger mesh sizes were fitted with $1\frac{7}{8}$ - 2 inch mesh liners. Metal doors ranged in weight between 200 - 454kg, which were towed using wire ground cable. Footropes used were primarily rock-hoppers as well as chain, wire, and rope. The headropes were fitted between 14 - 35 floats (8-inch diameter). No excluder or separator devices were used in these trawl nets.

Ten sampling trips were conducted from April 23 - May 15, 2001. The trips occurred primarily in inshore areas of Nantucket Sound between Succon-

Table 8: Catch at age (proportion at age) of sampled scup caught in commercial weir catches (5/10/01 - 5/17/01).

CL (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17		0.0003	0.0011									0.0013
18		0.0012	0.0064	0.000403								0.0081
19		0.0009	0.0056	0.0019	0.0009							0.0094
20		0.0003	0.0047	0.0013	0.0003							0.0067
21			0.0044	0.0031	0.0006							0.0081
22			0.0077	0.0143	0.0022							0.0242
23			0.0048	0.0203	0.0071							0.0322
24			0.007	0.0258	0.0204							0.0532
25			0.0116	0.0513	0.0319	0.0019						0.0967
26				0.0433	0.0375	0.0033						0.0841
27				0.0908	0.1017	0.0238						0.2163
28				0.0508	0.0745	0.0389	0.0051					0.1693
29				0.0193	0.0787	0.031						0.129
30					0.042	0.0341	0.0024	0.0024				0.0808
31				0.0047	0.0109	0.0218	0.0016					0.039
32					0.0056	0.0156	0.0043					0.0255
33						0.0012	0.0028					0.004
34							0.0024	0.0016				0.004
35							0.0017	0.0023				0.004
36												
37												
38												
39											0.004	0.004
40												
41												
42												
Proportion	0	0.0028	0.0535	0.3273	0.4143	0.1717	0.0203	0.0063	0	0	0.004	1
Percent	0	0	5	33	41	17	2	1	0	0	0	100

nesset Shoal and Collier Ledge. In total, thirty-eight tows were made for a total fishing time of forty hours (Appendix A). *Loligo* was the most common species landed (11,475 lbs. 88%). Scup ranked 12th in the total catch with 50 lbs. (0.4% of the total catch), but ranked fourth of all species kept (39 lbs. landed, Table 9). The D/L ratios from these observed trips (Table 10) were low (mean ratio by weight = 0.07, and the mean ratio by number = 0.08). No length-frequency or age distributions were constructed due to the small sample size. However, age samples were collected on the small amount of scup that were caught in order to form the spring age-length key.

The number of trips that landed scup and the amount landed during the Spring *Loligo* fishery (from VTR data) is shown in Table 11. Of the 205

reported trips that landed squid, 103 (50%) did not land any scup. Eighteen trips (9%) reached the maximum allowable bycatch limit of 100 lbs. per day. Nine trips (4%) produced catches in excess of the 100-lbs. limit. It must be noted that these data do not take into account the number of multi-day trips and therefore, this does not necessarily imply that illegal harvesting (exceeding the possession limit) was taking place.

Analysis of fleet composition shows the otter trawl fleet targeting *Loligo* during the spring 2001 was comprised mainly of Class 2 vessels (over 60% of the entire fleet, N = 29), Class 3 vessels (33%, N = 16) and Class 4 (2%, N = 2). All Class 2 vessels operate out of Massachusetts homeports. Three of the Class 3 vessels originate from homeports in other states (two from Rhode Island, one from Con-



Figure 5: An otter trawl fisherman targeting *Loligo* inspects his catch. Photo by John Sheppard.

Table 9: A listing of all species landed and discarded from observed commercial squid sampling trips (Spring 2001). All weights recorded in pounds.

Species	Total	Total	Combined	
	Landed	Discarded	Totals	Percentage
<i>Loligo</i>	11,475	0	11,475	88%
Northern sea robin	0	310	310	2%
Winter flounder	0	288	288	2%
Summer flounder	113	17	130	1%
Spider crab	0	122	122	1%
Striped sea robin	0	105	105	1%
Striped bass	0	104	104	1%
Alewife	0	99	99	1%
Tautog	73	5	78	1%
Butterfish	12	43	55	0.42%
Little skate	0	51	51	0.39%
Scup	39	11	50	0.38%
Horseshoe crab	4	23	27	0.21%
Windowpane	0	24	24	0.18%
Black sea bass	21	1	22	0.17%
Atlantic herring	6	9	15	0.12%
Bluefish	4	8	12	0.09%
Winter skate	0	8	8	0.06%
Conch	4	2	6	0.05%
American lobster	0	6	6	0.05%
Lady crab	0	2	2	0.02%
Whelk	1	0	1	0.01%
Rock crab	0	1	1	0.01%
Sand eel	0	1	1	0.01%
Totals	11,752	1,240	12,992	100%

Table 10: Number and percentage of scup landed and discarded by commercial trawl fishermen during the spring *Loligo* fishery (4/23/01 - 5/15/01). Included are estimated totals for landed and discarded categories and calculations of the D/L ratios for each trip.

Gear: Otter Trawl (Spring <i>Loligo</i> Fishery)	Trip Date									
	4/23/01	4/25/01	4/27/01	4/30/01	5/1/01	5/2/01	5/4/01	5/7/01	5/8/01	5/15/01
Total Catch (lbs)	0	0	0	0	19	2	1	0	2	26
Total Landed (lbs)	0	0	0	0	19	2	1	0	2	15
Percentage	0	0	0	0	100	100	100	0	100	58
Subsample Weight (lbs)	0	0	0	0	19	2	1	0	2	15
Percentage	0	0	0	0	100	100	100	0	100	100
No. fish in subsample	0	0	0	0	19	3	2	0	3	27
Estimated No. fish landed	0	0	0	0	19	3	2	0	3	27
Total Discarded (lbs)	0	0	0	0	0	0	0	0	0	11
Percentage	0	0	0	0	0	0	0	0	0	42
Subsample Weight (lbs)	0	0	0	0	0	0	0	0	0	11
Percentage	0	0	0	0	0	0	0	0	0	100
No. fish in subsample	0	0	0	0	0	0	0	0	0	21
Estimated No. fish discarded	0	0	0	0	0	0	0	0	0	21
Discard Ratio (discard/landings)										
by weight	0	0	0	0	0	0	0	0	0	0.73
by number	0	0	0	0	0	0	0	0	0	0.77
Aritmetic mean D/L Ratio										
by weight	0.073									
by number	0.077									

Table 11: Frequency of occurrence as to the number of trips which landed scup and the amount landed during the Spring *Loligo* fishery 2001.

Range of scup landed (lbs)	N Trips	Percentage
0 lbs	103	50%
1 - 10 lbs	13	6%
11 - 20 lbs	13	6%
21 - 30 lbs	6	3%
31 - 40 lbs	4	2%
41 - 50 lbs	8	4%
51 - 60 lbs	4	2%
61 - 70 lbs	2	1%
71 - 80 lbs	3	2%
81 - 90 lbs	1	1%
91 - 99 lbs	21	10%
100 lbs	18	9%
*101 lbs +	9	4%
Total	205	100%



Figure 6: A scup pot fisherman unloads his catch. Photo by Brian Kelly.

necticut). One of the Class 4 vessels hails from New York.

Scup Pot Fishery

Sampling trips were made with commercial pot fishermen using “inshore lobster” (Class 1) vessels. Two types of pots were used: cube pots (24 in. L x 24 in. W x 24 in. H), and rectangular pots (42 in. L x 24 in. W x 13.5 in. H). Both types were constructed of coated wire (Figure 6). Fishermen deployed between 6 – 40 pots per sampling trip (50 pots maximum allowable limit). Pots included two square entrances (2.5 in.²) and 1 – 2 escape vents which were either square (2.25 in.²) or circular (3.1 inch diameter) in shape. As required, pots were also fitted with ghost panels secured with biodegradable fasteners. The pots were baited with clam bellies stored in either bait bags or built-in compartments.

Ten sampling trips were conducted from July 17 to August 6, 2001 (Appendix B). All trips were conducted within Buzzards Bay. Scup was the dominant species caught (2,641 lbs.) which accounted for 75% of all species caught in these trips (Table 12). In addition, scup was the top species landed (1,562 lbs.), comprising 91% of all species landed. However, undersized scup also accounted for 59%

of all species discarded (1,079 lbs.) in these trips. Therefore, the average D/L ratios in these sampled trips (Table 13) were high (0.58 by weight, and 1.3 by number). Observations indicate that all discarded scup were immediately released alive and in good condition.

The weighted length frequency distribution of scup landed (Figure 7a, N = 556) indicates a mean size of 24.7 cm CL (10.9 in. TL). The sampled landings consisted of age-3 (46%) and age-4 (43%) scup (Table 14a). The weighted length frequency distribution of scup discarded is shown in Figure 7b (N = 846). The mean size of scup discarded in these trips is 19.0 cm CL (8.5 in. TL). Over two-thirds (68%) of the sampled scup discarded in this fishery were age-2 fish (Table 14b).

Hook & Line Fishery

The hook and line fishing fleet tended to operate in two main areas: Vineyard Sound near the islands of Gosnold (from Robinson’s Hole to the west of Cuttyhunk Island), and to the west of Martha’s Vineyard (from Devil’s Bridge west of Aquinnah to Squibnocket Point and Nomans Island). Some trips were conducted within Buzzards Bay (inshore areas of West Falmouth to Westport). The fleet consisted

Table 12: Summary of all species landed and discarded in the commercial scup pot fishery (7/18/01 - 8/6/01). All weights recorded in pounds.

Species	Total Landed	Percent Landed	Total Discarded	Percent Discarded	Combined Totals	Percentage
Scup	1,562	91.4	1,079	59.2	2,641	75
Black sea bass	140	8.2	311	17.1	451	13
Spider crab	0	0	381	21	381	11
Striped bass	0	0	26	1.4	26	0.7
American lobster	4	0.2	8	0.4	12	0.3
Toadfish	0	0	10	0.5	10	0.3
Tautog	0	0	4	0.2	4	0.1
Channeled whelk	4	0.2	0	0	4	0.1
Bluefish	0	0	2	0.1	2	0.05
Puffer fish	0	0	1	0.05	1	0.03
Mummichog	0	0	1	0.05	1	0.03
Total Catch	1,710	100	1,823	100	3,533	100

Table 13: Number and percentage of scup landed and discarded by commercial pot fishermen during the summer fishery (7/17/01 - 8/6/01). Included are estimated totals for landed and discarded categories and calculations of D/L ratios for each trip.

Gear Type: Scup Pot	Trip Date									
	7/18/01A	7/18/01B	7/18/01C	7/19/01A	7/19/01B	8/1/01A	8/1/01B	8/2/01A	8/2/01B	8/6/01
Total Catch (lbs)	329	855	125	239	288	122	125	317	47	194
Total Landed (lbs)	230	240	110	200	220	83	73	234	45	127
Percentage	70	28	88	84	76	68	58	74	96	65
Subsample Weight (lbs)	230	240	110	100	111	83	73	117	45	127
Percentage	100	100	100	50	50	100	100	50	100	100
No. fish in subsample	293	372	233	118	179	108	101	130	89	183
Estimated No. fish landed	293	372	233	236	355	108	101	260	89	183
Total Discarded (lbs)	99	615	15	39	68	39	52	83	2	67
Percentage	30	72	12	16	24	32	42	26	4	34
Subsample Weight (lbs)	99	138	15	39	68	39	52	83	2	67
Percentage	100	22	100	100	100	100	100	100	100	100
No. fish in subsample	280	414	130	111	223	130	197	234	6	179
Estimated No. fish discarded	280	1,845	130	111	223	130	197	234	6	179
Discard Ratio (discards/landings)										
by weight	0.43	2.56	0.14	0.2	0.31	0.47	0.71	0.35	0.04	0.53
by number	0.96	4.96	0.56	0.47	0.63	1.2	1.95	0.9	0.07	0.98
Arithmetic mean D/L Ratio										
by weight	0.58									
by number	1.29									

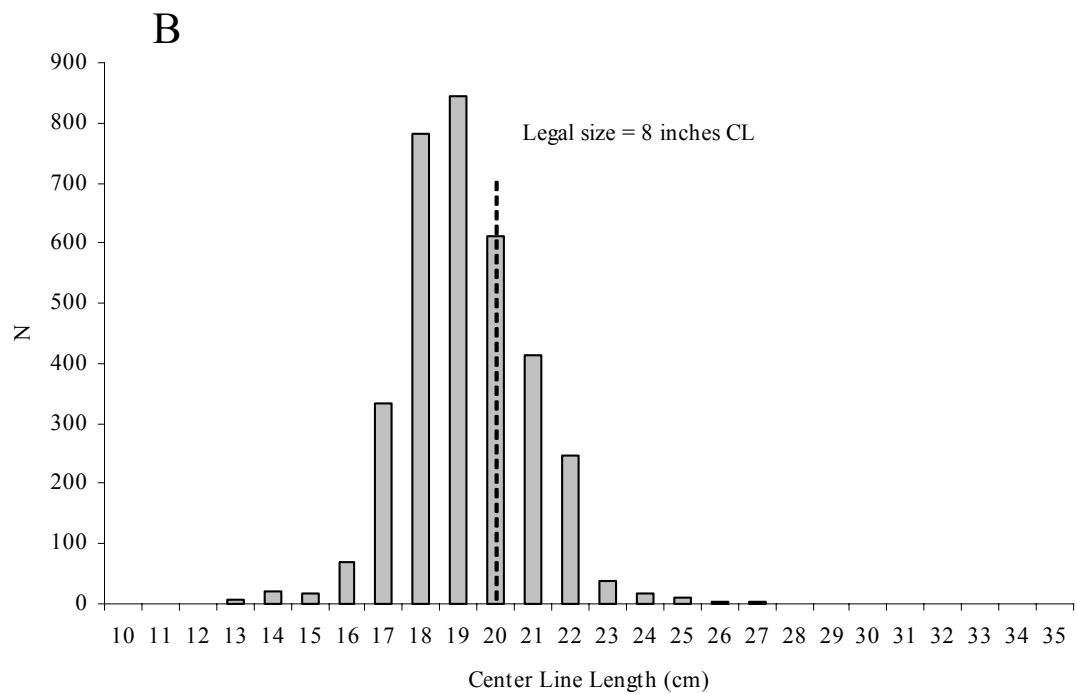
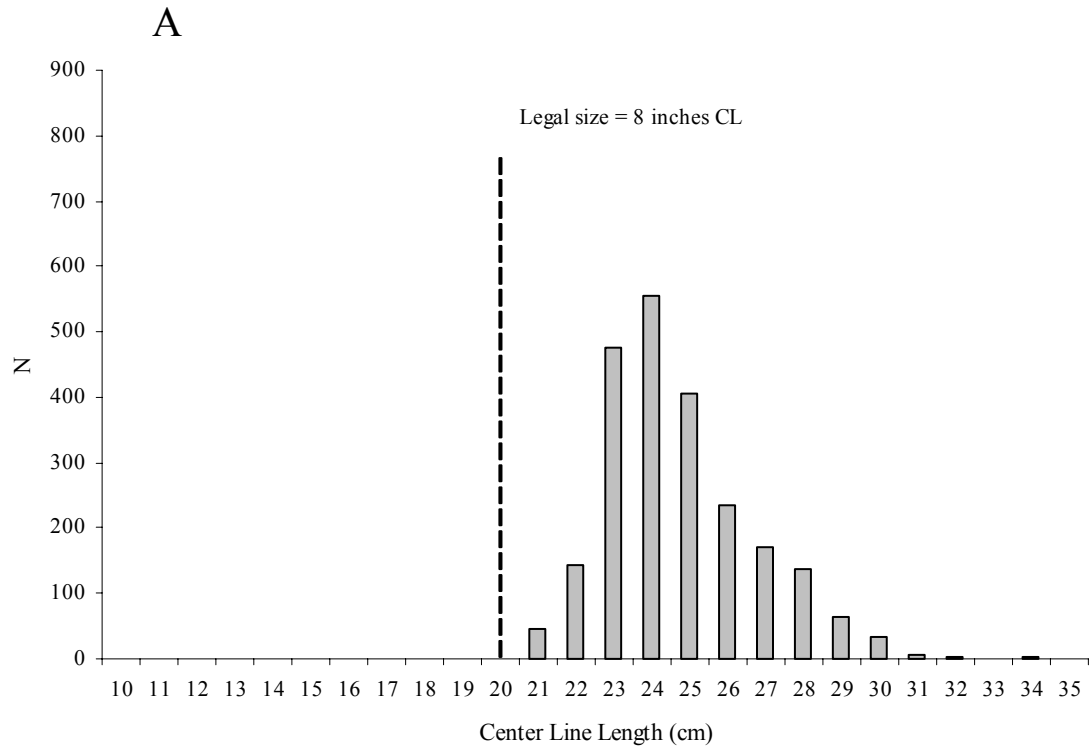


Figure 7: Length frequency of scup landed (A) and discarded (B) by pot fishermen during the summer fishery (7/18/01—8/6/01).

Table 14: Catch at age (proportion at age) of scup landed (A) and discarded (B) in the commercial pot fishery (7/18/01 - 8/6/01).

A. Landings												
C L (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	T o t a l
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21			0.0109	0.0091	0.0006							0.0206
22			0.0162	0.0398	0.0056	0.0006						0.0622
23			0.025	0.1166	0.0666							0.2082
24			0.0171	0.1438	0.0828							0.2436
25			0.0036	0.0767	0.0963	0.0018						0.1784
26			0.0021	0.0379	0.0564	0.0051	0.001					0.1025
27				0.0226	0.0497	0.003						0.0754
28				0.0091	0.0472	0.0042						0.0605
29				0.0042	0.0154	0.007	0.0014					0.028
30				0.0003	0.0083	0.0061	0.0001					0.0149
31					0.0006	0.0015	0.0006					0.0026
32					0.0002	0.0009	0.0005	0.0001				0.0018
33					0.00004	0.0002	0.0002	0.0001				0.0004
34						0.0001	0.0006	0.0002				0.0009
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0	0.0747	0.46	0.4299	0.0305	0.0045	0.0003	0	0	0	1
Percent	0	0	7	46	43	3	0	0	0	0	0	100

B. Discards												
C L (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	T o t a l
5												
6												
7												
8												
9												
10												
11												
12												
13		0.0016	0.0004									0.0021
14		0.0059										0.0059
15		0.0026	0.0017	0.0004								0.0047
16		0.001	0.0176	0.0018								0.0205
17		0.0029	0.0829	0.0117								0.0976
18		0.0069	0.1902	0.0321								0.2291
19		0.0025	0.1983	0.0471								0.2479
20		0.0036	0.1056	0.0662	0.0036							0.179
21			0.064	0.0531	0.0036							0.1207
22			0.0187	0.0461	0.0065	0.0007						0.0721
23			0.0013	0.0062	0.0036							0.0111
24			0.0003	0.0028	0.0016							0.0047
25			0.0001	0.0011	0.0014	0.00003						0.0026
26			0.00003	0.0005	0.0008	0.0001	0.00001					0.0015
27				0.0002	0.0004	0.00002						0.0006
28												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0.0270	0.6812	0.2695	0.0215	0.0008	0.00001	0	0	0	0	1
Percent	0	3	68	27	2	0	0	0	0	0	0	100



Figure 8: Commercial hook and line fishermen harvesting scup using common handlines. Photo by Brian Kelly.

Table 15: Summary of all species landed and discarded in the commercial hook and line fishery (7/18/01 - 8/20/01). All weights recorded in pounds.

Species	Total Landed	Percent Landed	Total Discarded	Percent Discarded	Combined Totals	Percentage
Scup	4,285	90.7	179	44.5	4,464	87.1
Striped bass	350	7.3	44	11	394	7.7
Black sea bass	48	1	113	28.1	161	3.1
Smooth dogfish	0	0	53	13.2	53	1
Summer flounder	41	1	1	0.2	42	0.8
Tautog	0	0	5	1.2	5	0.1
Bluefish	0	0	5	1.2	5	0.1
Triggerfish	0	0	2	0.5	2	0.04
Total Catch	4,724	100	402	100	5,126	100

of small boats (Class 1), each vessel having 2 – 5 anglers using rod and reels or common handlines with baited hooks (Figure 8). Mainlines ranged from 20 – 40 lbs. test monofilament (heavier lines were deployed using handlines). Anglers used two hooks (Mustad sizes 1-2), that were connected to the mainlines with 12 – 40 lbs. test leaders ranging between 1 – 4 feet. Clams and squid strips were commonly used for bait, and it was deployed on the

bottom using 2 – 6 oz. lead weights depending on current speed.

Twenty-six sampling trips were conducted by DMF observers in this fishery (7/20/01 – 8/20/01). These trips amounted to 107 hours total fishing time and a total of 79 anglers sampled (Appendix C). Scup was the dominant species caught (4,464 lbs.), accounting for 87% of all species caught (Table 15).

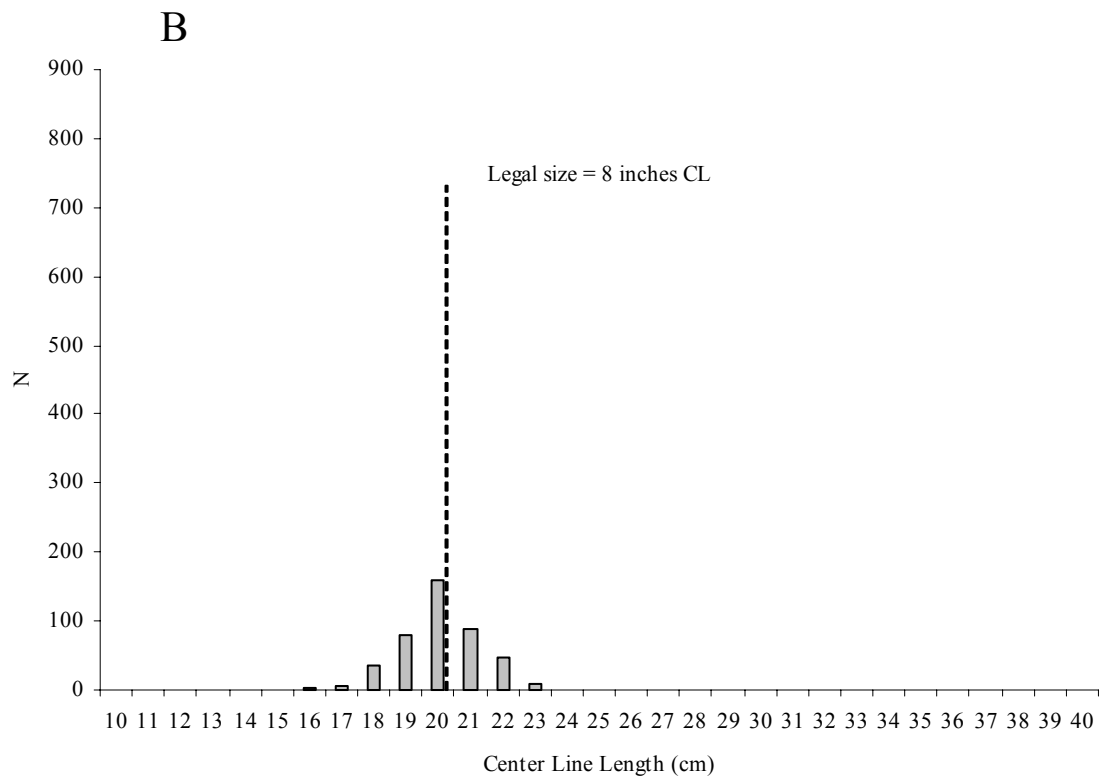
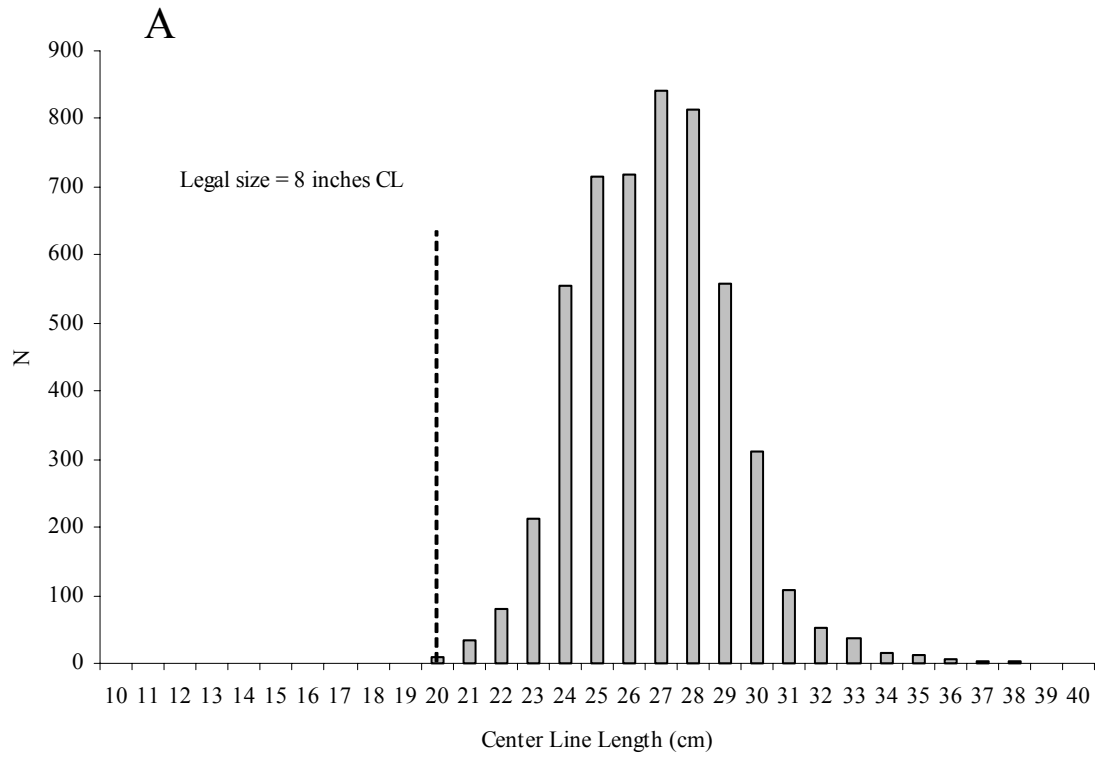


Figure 9: Length frequency of scup landed (A) and discarded (B) by hook and line fishermen during the summer fishery (7/20/01 - 8/20/01).

Table 16: Catch at age (proportion at age) of scup landed (A) and discarded (B) in the commercial hook and line fishery (7/18/01 - 8/20/01).

A. Landings												
C.L. (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20		0.00003	0.0009	0.0006	0.00003							0.0016
21			0.0035	0.0029	0.0002							0.0067
22			0.0041	0.0101	0.0014	0.0002						0.0157
23			0.0051	0.0236	0.0135							0.0421
24			0.0076	0.0644	0.0371							0.1092
25			0.0028	0.0604	0.0759	0.0014						0.1405
26			0.0028	0.0523	0.0777	0.0071	0.0014					0.1413
27				0.0496	0.1092	0.0066						0.1655
28				0.0240	0.1249	0.0112						0.1602
29				0.0165	0.0604	0.0274	0.0055					0.1098
30				0.0012	0.0343	0.0251	0.0006					0.0612
31					0.0047	0.0119	0.0047					0.0213
32					0.0015	0.0054	0.0032	0.0003				0.0104
33					0.0007	0.0026	0.0032	0.001				0.0075
34						0.0003	0.0021	0.0007				0.0031
35						0.0004	0.0011	0.0007				0.0022
36						0.0002	0.0006	0.0002				0.001
37								0.0004				0.0004
38						0.0004						0.0004
39												
40												
41												
42												
Proportion	0	0.00003	0.0269	0.3057	0.5415	0.1002	0.0224	0.0033	0	0	0	1
Percent	0	0	3	31	54	10	2	0	0	0	0	100

B. Discards												
C.L. (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12		0.0023										0.0023
13												
14												
15		0.0013	0.0008	0.0002								0.0023
16		0.0002	0.004	0.0004								0.0047
17		0.0004	0.0119	0.0017								0.014
18		0.0024	0.0656	0.0111								0.0791
19		0.0018	0.147	0.0349								0.1837
20		0.0074	0.2182	0.1368	0.0074							0.3698
21			0.1109	0.0921	0.0063							0.2093
22			0.029	0.0714	0.01	0.0011						0.1116
23			0.0028	0.013	0.0074							0.0233
24												
25												
26												
27												
28												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0.0159	0.5902	0.3617	0.0312	0.0011	0	0	0	0	0	1
Percent	0	2	59	36	3	0	0	0	0	0	0	100



Figure 10: Unsorted catch taken in the scup-directed trawl fishery (autumn 2001). Photo by John Sheppard.

Scup was the top species landed (4,285 lbs.) accounting for 91% of the total landings. Scup was also the most common species discarded (45%) in these sampled trips (179 lbs.). Average D/L ratios in these sampled trips (Appendix D) were low (0.06 by weight, and 0.12 by number).

The weighted length frequency distribution of the scup landed in these trips is shown in Figure 9a (N = 841). The average size of scup landed was 26.8 cm CL (11.8 in. TL). Over half (54%) of the sampled landings was comprised of age-4 scup, and almost one-third (31%) of the catch consisted of age-3 fish (Table 16a). For the scup that were discarded in these trips (Figure 9b) the length frequency distribution indicates an average size of 20.0 cm CL (8.9 in. TL). All discarded scup were measured on these trips (N = 159), and therefore, the length frequency distribution did not have to be adjusted. The majority of the sampled scup discarded in this fishery (Table 16b) consisted of age-2 (59%) and age-3 fish (36%).

Scup Directed Trawl Fishery

Sampling trips were made aboard a Class 3 offshore dragger (60 GRT), deploying trawl nets with

similar characteristics to those used by the inshore draggers in the spring *Loligo* fishery (Figure 10). Trawl net bodies and codends were constructed of polyethylene material with mesh sizes ranging from 5-inch square mesh to 6-inch diamond mesh in the net body, and 4.5-inch diamond to 6.5-inch square mesh in the codend. Metal doors (227 kg) were towed using wrapped wire ground cables with a 1-inch nylon footrope (used for towing over smooth sandy bottoms). The headrope was fitted with nine 8-inch diameter floats. No excluder device, separator device, fish outlet or chafing gear was used in these trawl nets.

DMF observers conducted four sampling trips from November 1, to November 14, 2001 (Appendix E). The sampling locations were located outside of Massachusetts territorial waters. Three sampling trips were located in Rhode Island Sound southwest of the Southwest Shoal, and one trip was located in the EEZ east of Cox Ledge. In total, twenty-eight hauls were conducted for a total fishing time of 27.5 hours (range: 0.5 – 1.5 hours/haul). Spiny dogfish (9,720 lbs.) was the most common species caught and discarded comprising 33% of all species caught and 42% of all species discarded

Table 17: Summary of all species caught (landed and discarded) in the commercial otter trawl fishery (11/1/01 - 11/14/01). All weights recorded in pounds.

Species	Total Landed	Percent Landed	Total Discarded	Percent Discarded	Combined Totals	Percentage
Spiny dogfish	0	0	9,720	42	9,720	33.2
Little skate	0	0	9,421	41	9,421	32
Scup	5,874	97	362	1.6	6,236	21.3
Winter skate	0	0	924	4	924	3.2
Summer flounder	0	0	768	3.3	768	2.6
Winter flounder	75	1.2	537	2.3	612	2.1
Monkfish	0	0	412	1.8	412	1.4
Torpedo Ray	0	0	230	1	230	0.8
Black sea bass	90	1.5	118	0.5	208	0.7
Smooth dogfish	0	0	207	1	207	0.7
Windowpane	0	0	146	0.6	146	0.5
Striped bass	0	0	101	0.4	101	0.3
Striped sea robin	0	0	83	0.4	83	0.3
Yellowtail flounder	0	0	79	0.3	79	0.3
Fourspot flounder	0	0	39	0.2	39	0.1
Bluefish	0	0	25	0.1	25	0.1
Rock crab	0	0	21	0.1	21	0.1
Tautog	12	0.2	3	0.01	15	0.05
Conger eel	0	0	10	0.04	10	0.03
Atlantic cod	8	0.2	0	0	8	0.03
<i>Loligo</i>	0	0	7	0.03	7	0.03
Sea Raven	0	0	5	0.02	5	0.02
Silver hake	0	0	5	0.02	5	0.02
Total catch	6,059	100	23,223	101	29,282	100

Table 18: Number and percentage of scup landed and discarded by commercial otter trawl fishermen during the autumn fishery (11/1/01 - 11/14/01). Included are estimated totals for landed and discarded categories and calculations of the discards/landings ratios for each trip.

Gear type: Otter Trawl	Trip Date			
	11/1/01	11/8/01	11/12/01	11/14/01
Total Catch (lbs)	2,472	785	1,540	1,439
Total Landed (lbs)	2,357	757	1,460	1,300
Percentage	95	96	95	90
Subsample Weight (lbs)	377	95	225	310
Percentage	16	13	15	24
No. fish in subsample	514	123	303	406
Estimated No. fish landed	3,214	971	1,966	1,703
Total Discarded (lbs)	115	28	80	139
Percentage	5	4	5	7
Subsample Weight (lbs)	38	28	80	106
Percentage	31	100	100	75
No. fish in subsample	198	104	178	300
Estimated No. fish discarded	599	104	178	393
Discard Ratio (discards/landings)				
by weight	0.05	0.04	0.05	0.11
by number	0.14	0.11	0.09	0.23
Arithmetic mean D/L Ratio				
by weight	0.06			
by number	0.14			

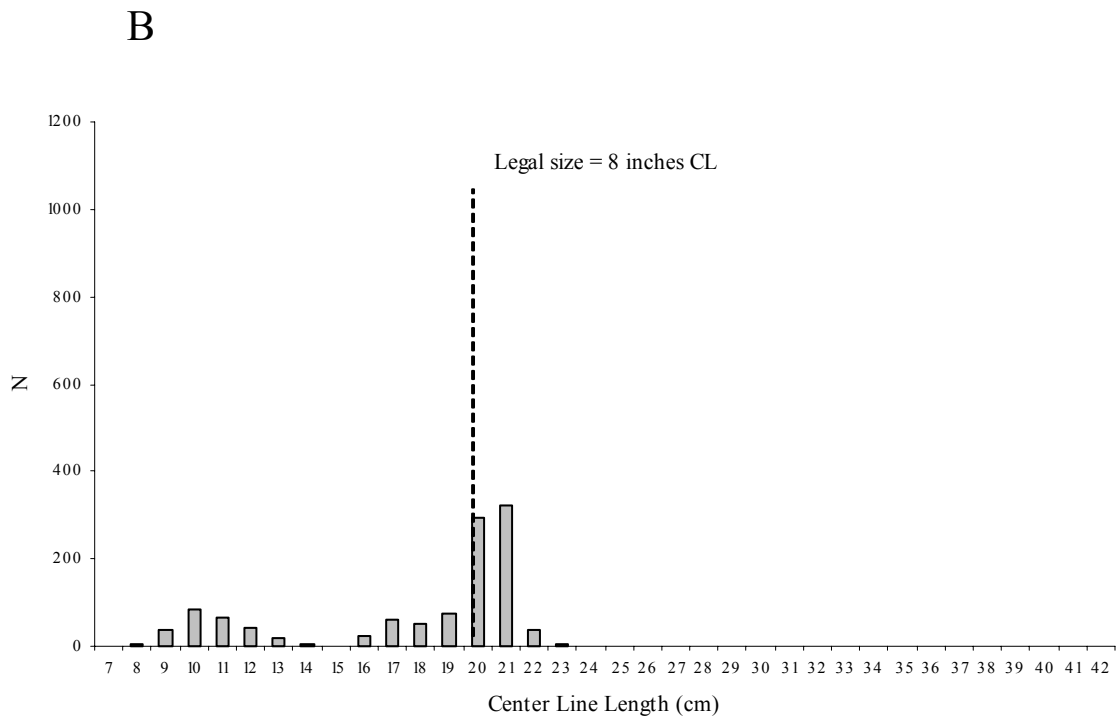
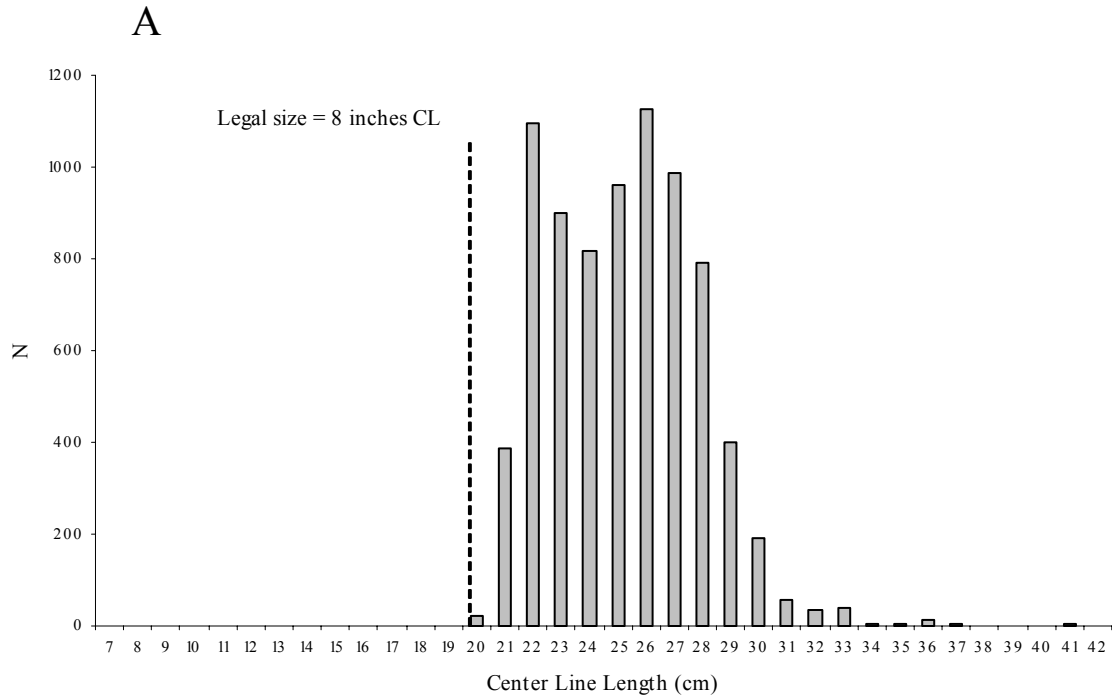


Figure 11: Length frequency of scup landed (A) and discarded (B) by otter trawls during the autumn fishery (11/1/01 - 11/14/01).

Table 19: Catch at age (proportion at age) of scup landed (A) and discarded (B) in the scup directed trawl fishery (11/1/01 - 11/14/01).

A. Landings												
C.L. (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20			0.0021	0.0008	0.0001							0.0029
21			0.0216	0.0255	0.002							0.049
22			0.021	0.102	0.0168							0.1397
23			0.0127	0.0904	0.0114							0.1145
24				0.0791	0.025							0.1041
25				0.0466	0.0551	0.0208						0.1225
26				0.0416	0.1018							0.1434
27				0.0226	0.103							0.1256
28					0.0768	0.0242						0.101
29				0.0026	0.0271	0.0215						0.0512
30					0.0108	0.0117	0.001	0.001				0.0245
31					0.0016	0.0058						0.0074
32						0.0045						0.0045
33					0.0013	0.0013	0.0013	0.0007	0.0006			0.0052
34							0.0008					0.0008
35								0.0008				0.0008
36								0.0008	0.0008			0.0015
37							0.0008					0.0008
38												
39												
40												
41										0.0008		0.0008
42												
Proportion	0	0	0.0573	0.411	0.4327	0.0899	0.0038	0.0032	0.0014	0.0008	0	1
Percent	0	0	6	41	43	9	0	0	0	0	0	100

B. Discards												
C.L. (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8	0.0063											0.0063
9	0.0349											0.0349
10	0.0742											0.0742
11	0.0517	0.0064										0.0581
12	0.0297	0.0061										0.0358
13	0.0102	0.0068										0.017
14												
15		0.0013	0.0004									0.0018
16		0.0175	0.0022									0.0197
17		0.0186	0.0378									0.0564
18		0.0094	0.0353									0.0447
19			0.049	0.0181								0.0671
20			0.1835	0.0681	0.0105							0.2621
21			0.1259	0.1488	0.0114							0.2862
22			0.005	0.0242	0.004							0.0331
23			0.0003	0.0021	0.0003							0.0027
24												
25												
26												
27												
28												
29												
30												
31												
32												
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41												
42												
Proportion	0.207	0.0661	0.4393	0.2614	0.0262	0	0	0	0	0	0	1
Percent	21	7	44	26	3	0	0	0	0	0	0	100



Figure 12: A recreational party vessel fishing in Vineyard Sound. Photo by Paul Caruso.

(Table 17). Scup ranked third (6,236 lbs.) of all species caught (21%) and ranked highest (97%) of the total landings with 5,874 lbs. Scup accounted for less than 2% (362 lbs.) of all discarded species. Average D/L ratios in these sampled trips were low (Table 18). Mean D/L ratio was 0.06 by weight, and 0.14 by number.

The length frequency distribution of landed scup is shown in Figure 11a (N = 7,851). Average size of scup landed in these four sampling trips was 25.2 cm CL (11.2 in. TL). Age composition of the landings (Table 19a) consisted mainly of age-3 (41%) and age-4 (43%) fish. The length frequency of discarded scup (Figure 11b, N = 1,121) indicates an average size of 17.8 cm CL (7.9 in. TL). The majority of discards (Table 19b) were age-2 (44%) and age-3 (26%) fish. Approximately 28% of the catch consisted of scup age-0 and age-1 (21% and 7%, respectively).

Fleet composition was determined for all vessels landing scup during this season. In contrast to the spring *Loligo* fishing fleet, the otter trawl fleet targeting scup during the autumn 2001 season was less numerous, and was comprised of Class 3 (50% of the entire fleet, N = 4), Class 2 (38%, N = 3) and Class 4 (12%, N = 1) vessels. Of the eight vessels

participating in this fishery, five had homeports in Massachusetts, and three had homeports in Rhode Island.

Scup Recreational Fishery

DMF observers conducted thirty-eight sampling trips in the recreational fishery between May 9, 2001 and October 3, 2001. Trips were made aboard charter and party boats (Figure 12) operating out of ports in southeastern Massachusetts and Cape Cod (from New Bedford to Harwich, and including Martha's Vineyard). Vessels with homeports west of Cape Cod operated in localities within Buzzards Bay and Gosnold, but also conducted trips on the Southwest Shoal off Martha's Vineyard. Vessels operating out of Falmouth, Hyannis, Harwich, and Martha's Vineyard conducted trips within Vineyard and Nantucket Sounds. The charter and party vessels provided customers with equipment similar to that used by the hook and line fishery (rod and reel with two hooks connected to the mainline by leaders), however, some patrons brought their own equipment. Bait was usually squid, but clams, sea-worms and green crabs were sometimes used.

A summary of the total amount of species landed and discarded by recreational anglers sampled by

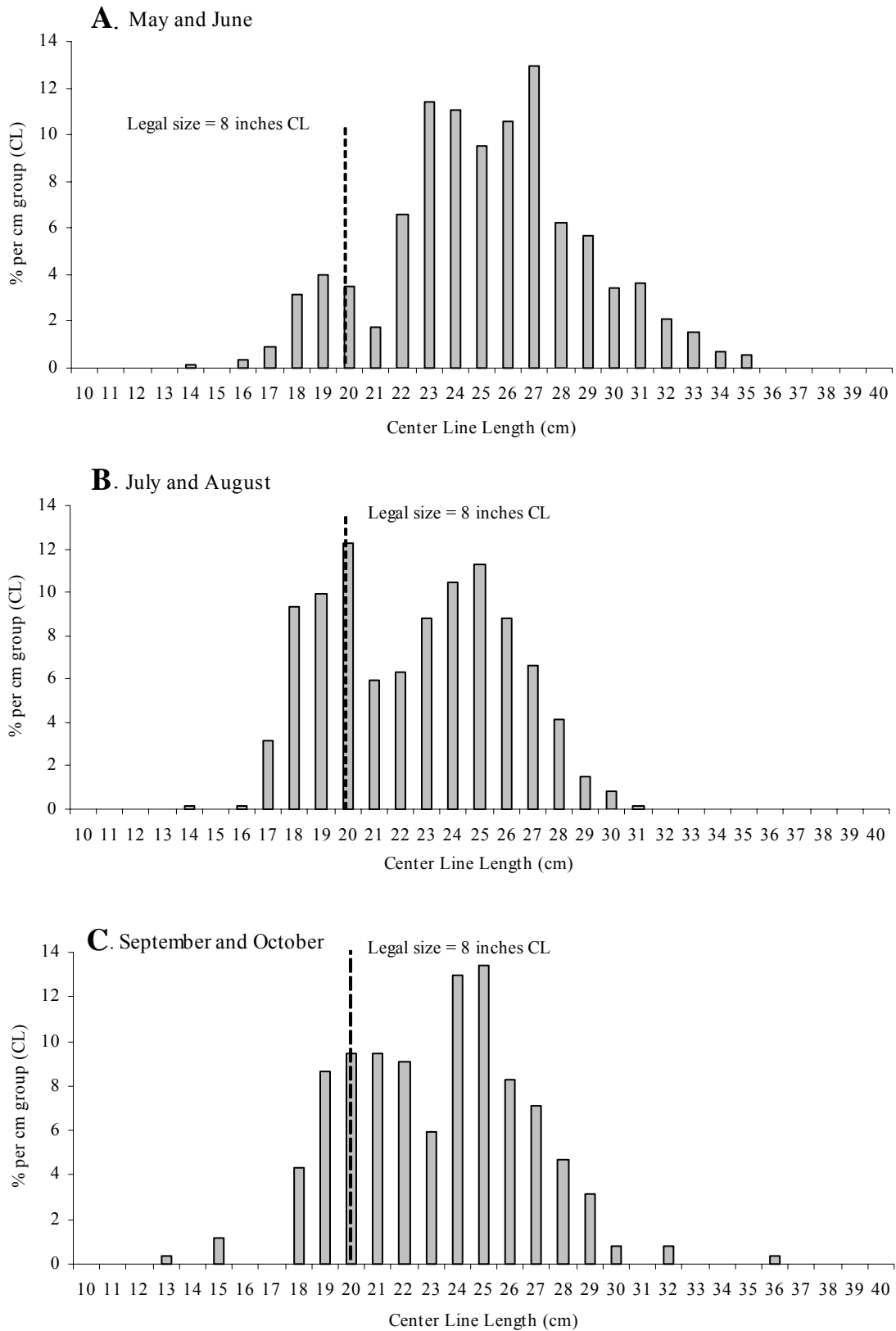


Figure 13: Percentage (per cm group) of scup caught by recreational anglers during the spring (A), summer (B), and autumn (C) seasons.

Table 20: Catch at age (proportions at age) of scup landed (A) and discarded (B) in the spring recreational catches (May and June 2001).

A. Spring Landings

C.L. (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20		0.0001	0.001	0.0003	0.0001							0.0014
21			0.0076	0.0053	0.001							0.0139
22			0.0222	0.0409	0.0062							0.0694
23			0.0189	0.0796	0.0278							0.1263
24			0.0168	0.062	0.049							0.1278
25			0.0132	0.0581	0.0362	0.0022						0.1096
26				0.065	0.05621	0.005						0.1262
27				0.0612	0.0685	0.016						0.1457
28				0.0212	0.0311	0.0163	0.0021					0.0708
29				0.01	0.0406	0.016						0.0666
30				0	0.0213	0.0173	0.0012	0.0012				0.0411
31				0.0052	0.012	0.0241	0.0017					0.043
32					0.0055	0.0152	0.0042					0.025
33						0.0056	0.0124					0.018
34							0.005	0.0033				0.0083
35							0.003	0.004				0.0069
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0.0001	0.0797	0.4087	0.3556	0.1177	0.0297	0.0085	0	0	0	1
Percent	0	0	8	41	36	12	3	1	0	0	0	100

B. Spring Discards

C.L. (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16		0.0059	0.0176									0.0234
17		0.0125	0.05									0.0625
18		0.0316	0.1688	0.0105								0.211
19		0.0266	0.1594	0.0531	0.0266							0.2656
20		0.0113	0.1586	0.0453	0.0113							0.2266
21			0.0215	0.0148	0.0027							0.0391
22			0.015	0.0277	0.0042							0.0469
23			0.007	0.0295	0.0103							0.0469
24			0.001	0.0038	0.003							0.0077
25			0.0019	0.0083	0.0052	0.0003						0.0156
26												
27				0.0164	0.0184	0.0043						0.0391
28				0.0047	0.0069	0.0036	0.0005					0.0156
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0.0879	0.6008	0.2142	0.0885	0.0082	0.0005	0	0	0	0	1
Percent	0	9	60	21	9	1	0	0	0	0	0	100

Table 21: Catch at age (proportions at age) of scup landed (A) and discarded (B) in the summer recreational catches (July - August 2001).

A. Summer Landings												
C L (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20		0.0012	0.0366	0.0229	0.0012							0.062
21			0.0397	0.033	0.0022							0.0749
22			0.0242	0.0595	0.0084	0.0009						0.093
23			0.0152	0.0709	0.0405							0.1266
24			0.0103	0.0869	0.0501							0.1473
25			0.0035	0.0756	0.0949	0.0018						0.1757
26			0.0026	0.0478	0.0711	0.0065	0.0013					0.1292
27				0.0295	0.06481	0.0039						0.0982
28				0.0081	0.04233	0.0038						0.0543
29				0.0035	0.01279	0.0058	0.0012					0.0233
30				0.0003	0.00724	0.0053	0.0001					0.0129
31					0.00057	0.0014	0.0006					0.0026
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0.0012	0.1321	0.438	0.3961	0.0294	0.0032	0	0	0	0	1
Percent	0	0	13	44	40	3	0	0	0	0	0	100

B. Summer Discards												
C L (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14		0.0046										0.0046
15												
16		0.0002	0.004	0.0004								0.0046
17		0.0026	0.0748	0.0106								0.088
18		0.0078	0.2152	0.0363								0.2593
19		0.0028	0.2222	0.0528								0.2778
20		0.0046	0.1366	0.0856	0.0046							0.2315
21			0.0196	0.0163	0.0011							0.037
22			0.0024	0.0059	0.0008	0.0001						0.0093
23			0.0022	0.0104	0.0059							0.0185
24			0.0019	0.0164	0.0094							0.0278
25												
26			0.0003	0.0051	0.0076	0.0007	0.0001					0.0139
27				0.0028	0.0061	0.0004						0.0093
28				0.0028	0.0144	0.0013						0.0185
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0	0.0227	0.6792	0.2454	0.0501	0.0025	0.0001	0	0	0	0	1
Percent	0	2	68	25	5	0	0	0	0	0	0	100

Table 22: Catch at age (proportion at age) of scup landed (A) and discarded (B) in the autumn recreational catches (September - October 2001).

A. Autumn Landings

CL (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20			0.0352	0.0131	0.002							0.0503
21			0.0369	0.0436	0.0034							0.0838
22			0.0134	0.0653	0.0107							0.0894
23			0.0081	0.0574	0.0073							0.0727
24				0.1401	0.0442							0.1844
25				0.0679	0.0804	0.0304						0.1788
26				0.0324	0.0793							0.1117
27				0.0181	0.0825							0.1006
28					0.0467	0.0147						0.0615
29				0.0022	0.0237	0.0188						0.0447
30					0.0025	0.0027	0.0002	0.0002				0.0056
31												
32						0.0112						0.0112
33												
34												
35												
36								0.0028	0.0028			0.0056
37												
38												
39												
40												
41												
42												
Proportion	0	0	0.0935	0.4401	0.3827	0.0778	0.0002	0.003	0.0028	0	0	1
Percent	0	0	9	44	38	8	0	0	0	0	0	100

B. Autumn Discards

CL (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
5												
6												
7												
8												
9												
10												
11												
12												
13	0.008	0.0053										0.0133
14												
15		0.03	0.01									0.04
16												
17												
18		0.0308	0.1159									0.1467
19			0.2141	0.0792								0.2933
20			0.14	0.052	0.008							0.2
21			0.0528	0.0624	0.0048							0.12
22			0.014	0.0681	0.0112							0.0933
23			0.003	0.0211	0.0027							0.0267
24												
25				0.0101	0.012	0.0045						0.0267
26				0.0039	0.0095							0.0133
27												
28					0.0101	0.0032						0.0133
29												
30					0.0059	0.0064	0.0005	0.0005				0.0133
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												
41												
42												
Proportion	0.008	0.0661	0.5498	0.2968	0.0641	0.0141	0.0005	0.0005	0	0	0	1
Percent	1	7	55	30	6	1	0	0	0	0	0	100

observers is shown in Appendix F. A total of 1,922 fish were caught by 339 observed anglers in 38 sampling trips for a total of over 140 hours of fishing time. Scup was the dominant species caught and landed ($N = 1,289$) which comprised 67% of all species in the total catch. Discarded scup ($N = 413$) contributed to 21% of the total catch. The remaining catch was comprised of mostly black sea bass (7%) and tautog (2%).

The length frequency data was divided into three different time intervals, spring (May-June), summer (July-August), and autumn (September-October). The length frequency of scup sampled during May and June (Figure 13a) had three modes present. Two modes appear to be present in July and August (Figure 13b), and in September and October (Figure 13c), two modes were present. The average size of scup caught by sampled anglers during the spring (25.2 cm CL, 11.2 in. TL), was larger than the average size of scup caught by anglers sampled during the summer (22.6 cm CL, 10 in. TL) and autumn (23.3 cm CL, 10.3 in. TL).

The length frequency data collected in this fishery during the different seasons were incorporated into the appropriate age-length key. The majority of the landings during the spring (Table 20a) were comprised of age-3 (41%) and age-4 (36%) scup and 16% of the landings were age-5 and older. Approximately 60% of the discarded catch was comprised of age-2 scup (Table 20b). Age-3 and age-4 scup comprised 30% of the discarded catch (21% and 9%, respectively). The recreational landings during the summer (Table 21a) consisted mostly of age-3 (44%) and age-4 (40%) scup. Over two-thirds (68%) of the scup discarded were age-2 fish (Table 21b). In the autumn (Table 22a), the majority of the recreational landings were age-3 (44%) and age-4 (38%) fish. The scup discarded (Table 22b) were mainly age-2 (55%) and age-3 (30%) fish.

TCPUE for the months of May and June are shown in Figure 14a. Seventeen trips were sampled during this period (one trip was sampled where no observed anglers caught fish, and therefore this trip was excluded from the analysis). Mean TCPUE for anglers sampled during these two months was 15.7. Mean RCPUE during this period (Figure 14b) was 13.0. Thirteen sampling trips were conducted during the months of July and August. Mean TCPUE during this period (Figure 14c) was 14.8, and the mean RCPUE (Figure 14d) was 9.3. Eight sampling trips were conducted during the months of September and October (one trip in which anglers did not

retain fish was excluded). Mean TCPUE (Figure 14e) was 4.1, and the mean RCPUE (Figure 14f) was 2.9.

Differences in mean TCPUE among seasons were examined using ANOVA. Results from ANOVA ($F = 26.9$, $p < 0.05$) were significant, indicating that a difference existed in mean catch rates among these seasons. Tukey's Standardized Range (HSD) and Scheffe's Test ($\alpha = 0.05$, $df = 311$) indicate the mean catch rates in September and October were significantly lower than those in the spring (May and June) and the summer (July and August). The same series of tests were used to determine differences in mean retained catch rates among seasons. Results from ANOVA ($F = 21.7$, $p < 0.05$) were significant, and the results from Tukey's and Scheffe's Tests ($\alpha = 0.05$, $df = 311$) also indicated that mean RCPUE scores during the autumn season were significantly lower than those of the spring and summer seasons.

Market Sampling

The market-sampling period began July 17 and ended on August 20, 2001. While there was no specified number of market-sampling trips, sampling was distributed throughout the summer fishing season. Length data was collected on scup that were culled into different size categories. Three size categories were studied: "large", "jumbo", and "mixed". Large scup (Figure 15a) ranged in size from 20 cm – 28 cm with an average size of 24.1 cm CL (9.4 in. TL). Jumbo scup (Figure 15b) ranged in size from 24 cm – 34 cm with a mean size of 27.5 cm CL (10.6 in. TL). Scup in the mixed size category (Figure 15c) ranged from 23 cm – 32 cm with a mean size of 26.1 cm CL (10.2 in. TL).

Lengths and weights were collected on a sample of 300 fish in order to construct the following length-weight relationship:

$$W = 0.0000209CL^{3.001438} (r^2 = 0.95)$$

where W is the weight in grams, and CL is the centerline length in millimeters. When the length-weight relationship was applied to the length frequency data collected for each market category, the calculated mean weight of "large" scup was 0.7 lbs. ($N = 586$). Mean weight for "jumbo" scup ($N = 529$) was 0.98 lbs. For scup in the "mixed" size category, the mean weight was 0.8 lbs. ($N = 92$).

In addition, measurements of center line length (CL) and total length (TL) were taken from a sample of 198 individual scup to form the following

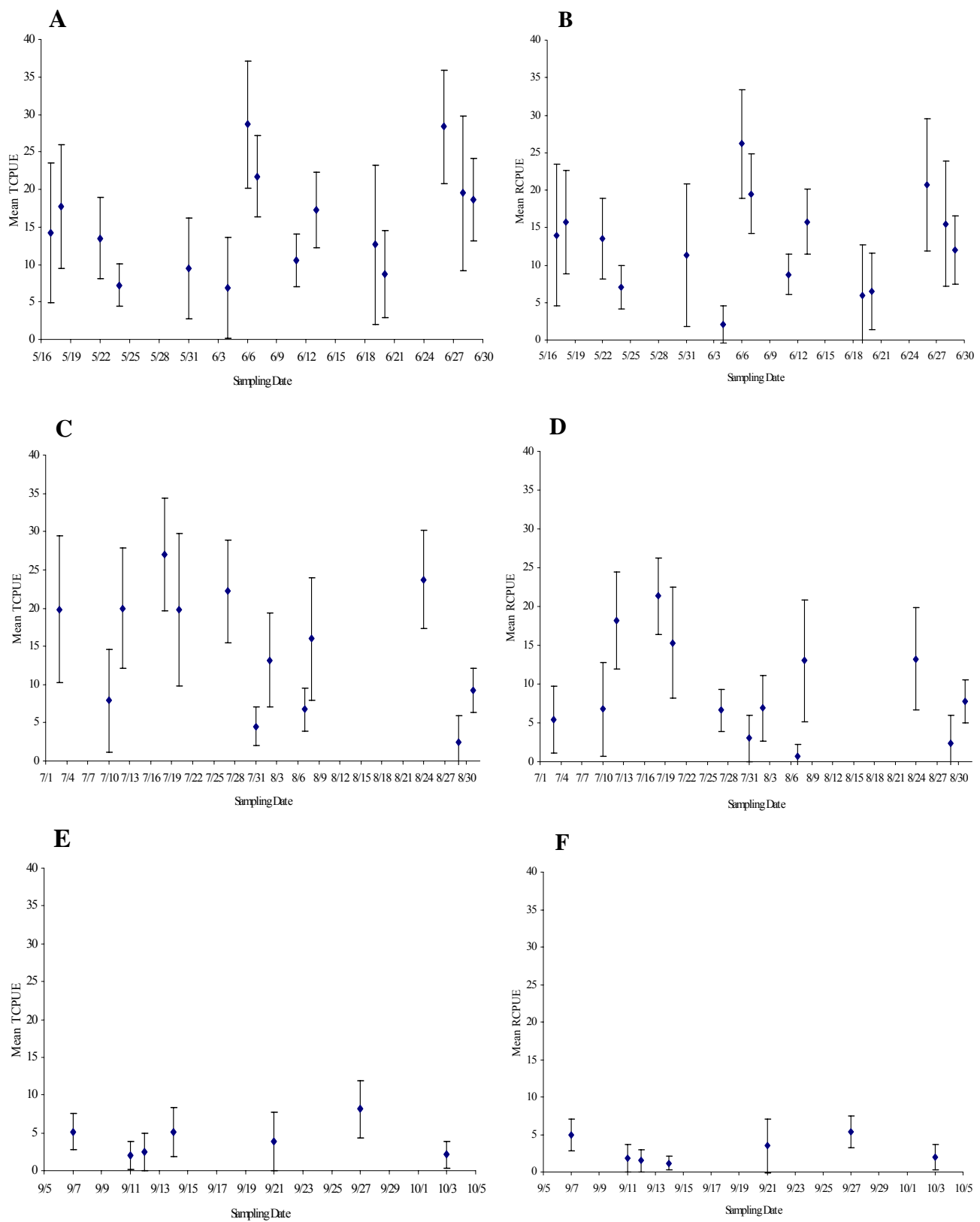


Figure 14: Mean (and 95% C.I.) TCPUE and RCPUE scores in the recreational fishery during the spring (A and B), summer (C and D) and autumn (E and F).

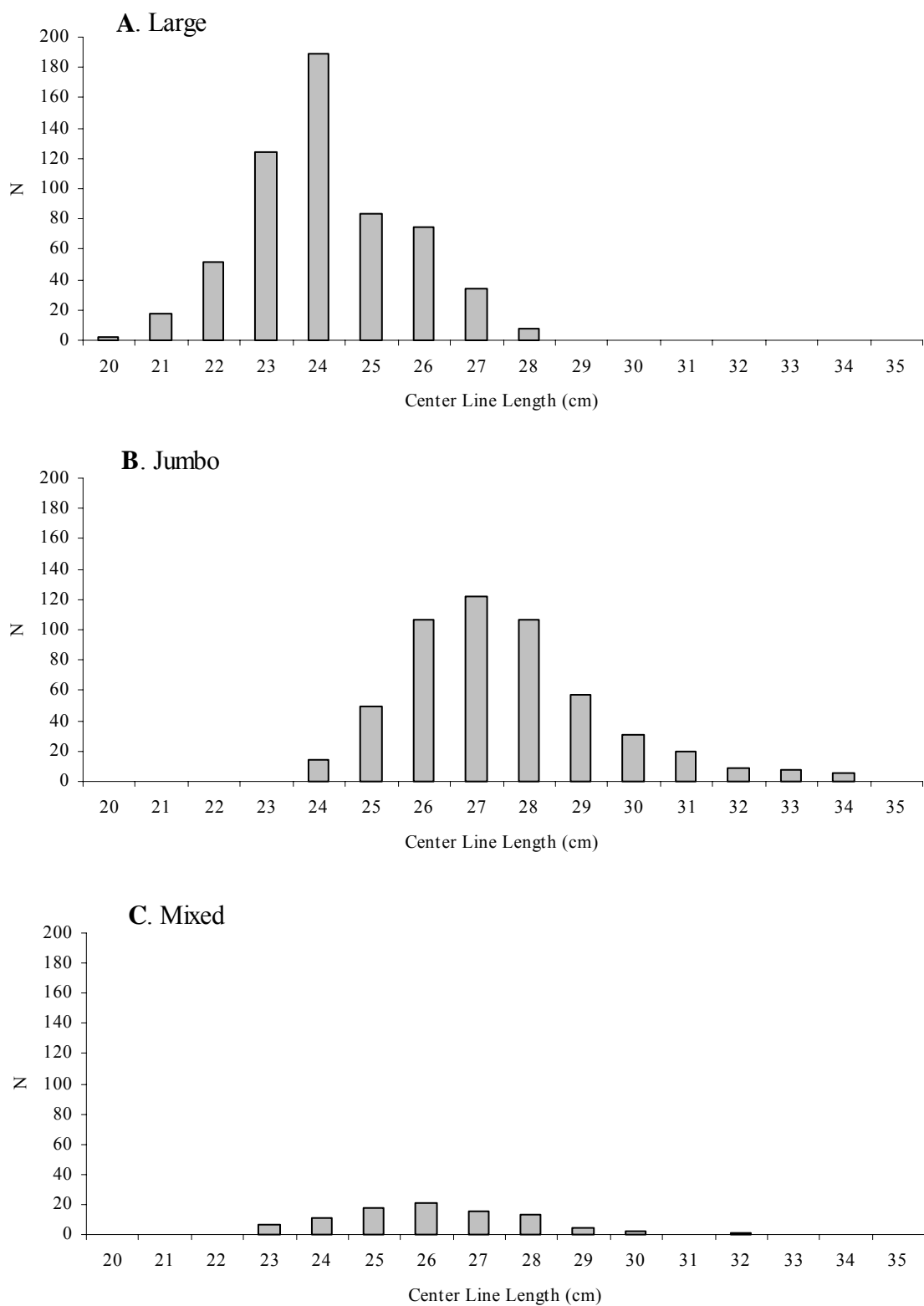


Figure 15: Length frequency of scup culled into large (A), jumbo (B), and mixed (C) size categories by seafood dealers during the summer fishery.

center line length – total length, and total length – center line length conversion formulas:

$$TL = 1.093306(CL) + 0.7978822 \ (r^2 = 0.99)$$

$$CL = 0.890831(TL) - 0.09027 \ (r^2 = 0.99)$$

Age samples were collected to determine the dominant age groups in each size category. Sixty-eight age samples were collected from scup culled into the size category “large” (Figure 16a). The majority of scup culled into this size category were age-3 fish (55%, N= 34). Ninety-two age samples were collected from “jumbo” scup. Age-4 fish (55%, N= 51) was the dominant age class in this market category (Figure 16b). Thirty-six age samples were collected from scup culled into the “mixed” size category (Figure 16c). The majority of sampled scup in this category were age-3 and age-4 fish (42%, N = 15, and 50%, N = 18, respectively).

Analysis of 2001 Landings and Effort by Fishery

A summary of monthly landings by gear type and the number of permit holders is shown in Table 23. Monthly landings, the number of trips and permit holders for all fisheries is described in Appendix G. Total annual landings reported to NMFS from weigh-out data for all gears combined was 474,458 lbs. The commercial hook and line fishery contributed the majority of the annual landings (56%) with over 264,000 lbs. Weirs ranked second in annual landings (15%) with over 70,900 lbs. The scup pot fishery (over 68,000 lbs.) ranked third (14%) and otter trawls (44,300 lbs.) ranked fourth at 9% of the annual landings.

Landings were highest during the summer (7/18/01 – 8/20/01) with over 319,000 lbs. reported by state and federal dealers. The commercial hook and line fishery contributed most of these landings with over 216,000 lbs. (68% of the total landings during this period). The scup pot fishery ranked second (over 62,300 lbs.) constituting approximately 20% of the summer landings. The commercial otter trawl fishery ranked third (over 22,700 lbs.) accounting for 7% of the summer landings. The spring fishery (4/23/01 – 5/31/01) produced the second highest landings for the 2001 season with 85,000 lbs. The weir fishery was dominant constituting 83% of the total landings during this period. The otter trawl fishery which is targeting *Loligo* squid during this time and landing scup as bycatch ranked second with over 5,000 lbs. (6% of the total spring landings). The autumn fishery (11/1/01 – 11/20/01) ranked third in annual landings with al-

most 64,000 lbs. The commercial hook and line fishery contributed 64% of the autumn landings with over 40,800 lbs. Otter trawls (over 15,000 lbs.) ranked second during this period constituting 24% of the November landings. The scup pot fishery (over 6,000 lbs.) attributed approximately 10% of the November landings. Some landings occurred outside the regulated fishing seasons with over 1,000 lbs. landed from January through March and over 5,000 lbs. landed during the month of September.

A summary of total landings, number of trips and permit holders by season for each fishery is shown in Table 24. The weir fishery is a short fishery that occurs only during the month of May, and it is the dominant fishery in the spring landing almost 71,000 lbs. in 51 trips by eight federal permit holders. The otter trawl fishery targeting *Loligo* squid and scup as bycatch also occurs at this time and over 5,000 lbs. of scup was landed by 48 permit holders in 205 trips (of which 34 permit holders actually landed scup in 101 trips.) The hook and line fishery was the dominant fishery during the summer season with over 216,000 lbs. of scup landed by 260 distinct permit holders (256 state and 4 federal) conducting 1,475 trips. The commercial pot fishery ranked second in total landings during the summer season landing over 71,000 lbs. Scup pot fishermen contributed to the majority of these landings with over 62,000 lbs. landed in 422 trips by 51 distinct permit holders. As in the summer fishery, commercial hook and line fishermen contributed to the majority of the landings in November with over 40,000 lbs. landed in 73 trips by 34 distinct permit holders. Commercial otter trawlers ranked second in total landings in November with over 15,000 lbs. landed by eight permit holders conducting 23 trips.

The estimated number of trips conducted for each of the aforementioned fisheries from the analysis of weigh-out data and the percent observer coverage is shown in Table 25. The 2001 MRFSS study (MRFSS 2002c) estimated that over 1.7 million scup were caught by recreational anglers in Massachusetts waters (of which over 931,000 fish were landed, and over 815,000 fish were discarded). The number of trips made by charter and party boats (obtained via telephone interviews with the captains) for the year 2001 was estimated at 1,474 trips. Thus, observer coverage accounted for 3% of all trips. In the commercial fisheries, the 5% minimum sampling intensity level was reached or exceeded for both the spring and autumn fisheries. However,

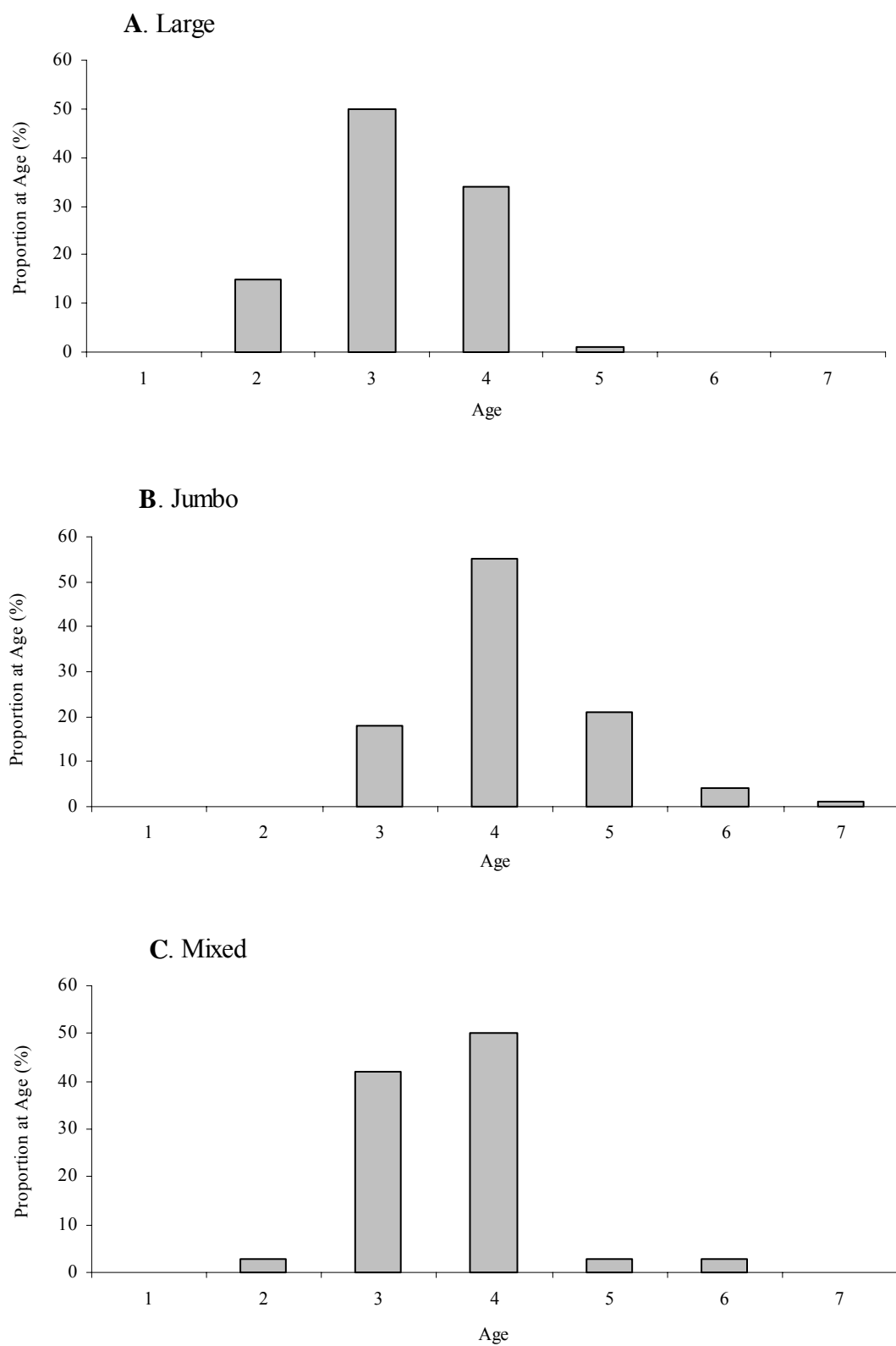


Figure 16: Proportion at age of scup culled into large (A), jumbo (B), and mixed (C) size categories by seafood dealers during the summer fishery.

Table 23: Summary of the total monthly landings of scup by each gear type during the 2001 fishing season. Highest monthly values are indicated in bold. All landings in pounds.

Gear type	Monthly Landings (lbs.)												Total
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	
Line Trawl						4,739							4,739
Hook & Line					252	2,125	80,229	135,951	4,895		40,834		264,286
Otter Trawl	887	2		125	5,016	450	18,833	3,916		142	15,027		44,398
Gill Net		139		41									180
Scallop Dredge				1,250									1,250
Pound Net					70,910								70,910
Pots (Other)					100		268	2,814			358		3,540
Pots (Fish)							30,803	31,548			6,097		68,448
Pots (Off. Lobster)							192				7		199
Pots (Coast. Lobster)							1,820	3,840					5,660
Scottish Seine					217	95		3					315
Other Gear							2,586	2,515			990		6,091
Unknown							1,779	1,939			765		4,483
Grand Totals	887	141	0	1,416	76,495	7,409	136,510	182,526	4,895	142	64,078	0	474,499

Table 24: Summary of scup landings and the number of trips made by state and federal permit holders during the primary fishing seasons in 2001 (all areas combined). Landings from state permit holders were derived from state and federal seafood dealer weigh-out transaction forms. Landings from federal permit holders were obtained from the National Marine Fisheries Service Commercial Fisheries Database. All landings in pounds.

Fishery	Fishing Season								
	Spring (May)			Summer (July-August)			Autumn (November)		
	No. Permits	Trips	Landings	No. Permits	Trips	Landings	No. Permits	Trips	Landings
Hook & Line (State Permitted)	3	4	248	256	1,448	215,479	33	70	40,082
Hook & Line (Federal Permitted)	<u>2</u>	<u>3</u>	<u>4</u>	<u>4</u>	<u>27</u>	<u>701</u>	<u>1</u>	<u>3</u>	<u>32</u>
<i>Totals</i>	5	7	252	260	1,475	216,180	34	73	40,114
Fish Pots (State Permitted)	0	0	0	51	422	62,351	3	5	5,771
Fish Pots (Federal Permitted)	0	0	0	0	0	0	3	13	326
Pots, Other (State Permitted)	1	2	100	1	1	200	1	6	141
Pots, Other (Federal Permitted)	0	0	0	3	43	2,882	3	7	217
Coastal Lobster Pots (State Only)	<u>0</u>	<u>0</u>	<u>0</u>	<u>8</u>	<u>43</u>	<u>5,660</u>	<u>0</u>	<u>0</u>	<u>0</u>
<i>Totals</i>	0	2	100	63	509	71,093	10	31	6,455
Pound Net (Federal Only)	<u>8</u>	<u>51</u>	<u>70,910</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
<i>Totals</i>	8	51	70,910	0	0	0	0	0	0
Otter Trawl (State Permitted)	*1	1	175	*	170	12,083	0	0	0
Otter Trawl (Federal Permitted)	<u>47</u>	<u>204</u>	<u>4,841</u>	<u>26</u>	<u>138</u>	<u>10,666</u>	<u>8</u>	<u>23</u>	<u>15,027</u>
<i>Totals</i>	48	205	5,016	*26	308	22,749	8	23	15,027

Cumulative Totals by Season	Spring (May)			Summer (July-August)			Autumn (November)		
	61	263	76,278	*345	2,248	310,022	48	114	61,596

* The number of state permit holders were estimated due to unidentified entries into the NMFS commercial fisheries database.

Table 25: Percentage of observer coverage in gear specific fisheries (based on estimated 2001 trips).

Fishery	2001 Total Trips (weigh-out data)	No. Trips Observed	(% sampling coverage)
	<i>Recreational</i>		
*Headboat	1,474	38	3%
	<i>Commercial</i>		
Pound Net (Weir)	51	4	8%
Otter Trawl (<i>Loligo</i>)	205	10	5%
Hook & Line	1,528	26	2%
Fish Pots	422	10	2%
Scup Directed Otter Trawl	23	4	17%

*The estimated number of trips reported by vessel captains and owners in recreational survey.

these targets were not met in the summer fisheries.

Determining Future Sampling Intensities

D/L ratios, CV's, and associated parameters necessary for estimating appropriate sample sizes for future studies are listed in Appendix H. The relationship between the CV and sample size (from the Bootstrap Method) for the D/L ratios in the pot fishery asymptotes at a CV of about 12 (Figure 17a). The calculated target sample size was 27 trips and 18 trips by the Bootstrap Method and Variance Method, respectively.

In the commercial hook and line fishery, the relationship asymptotes at a CV of about 18 (Figure 17b). The calculated target sample size was 23 trips by the Bootstrap Method and 6 trips by the Variance Method.

In the recreational fishery, the D/L ratios were separated into two groups (spring and summer combined; autumn) based on ANOVA results. For the spring-summer period, the relationship reached an asymptote at a CV of about 18 (Figure 18a), and the target sample sizes were 27 trips by the Bootstrap Method and 29 trips by the Variance Method. In the autumn (Figure 18b), the curve reached an asymptote at a CV of about 12, and the target sample sizes were calculated at 21 trips by the Bootstrap Method and 23 trips by the Variance Method.

Discussion

Pound Net (Weir) Fishery

Small numbers of scup discarded in these sampling trips combined with the corresponding low D/L ratios indicate that the discard level in this fishery is low. Of the individuals that were discarded, one-third were of legal size. This suggests that fishermen may have selected larger individuals to be landed for the market. Because of this, an inherent bias in discard rates exists in this fishery. This bias appears to be due to culling practices rather than a gear selectivity issue. These results also tend to support the hypothesis that larger scup are first to enter the sounds during spring. However, it is difficult to say this with certainty with these results being based on four sampling trips. Increasing the number of sampling trips should increase the precision of D/L ratios as well as data on size and age composition of landed and discarded catch.

Three additional scup pound net trips were made (two in May, and one in July after closure of the scup season) to document large catches of scup occurring in weirs and to procure additional length frequency and age data (Appendix I). There were no scup landings these latter dates. Catches of scup in two trips conducted in May were not landed because one of these trips occurred on a Friday (5/18)

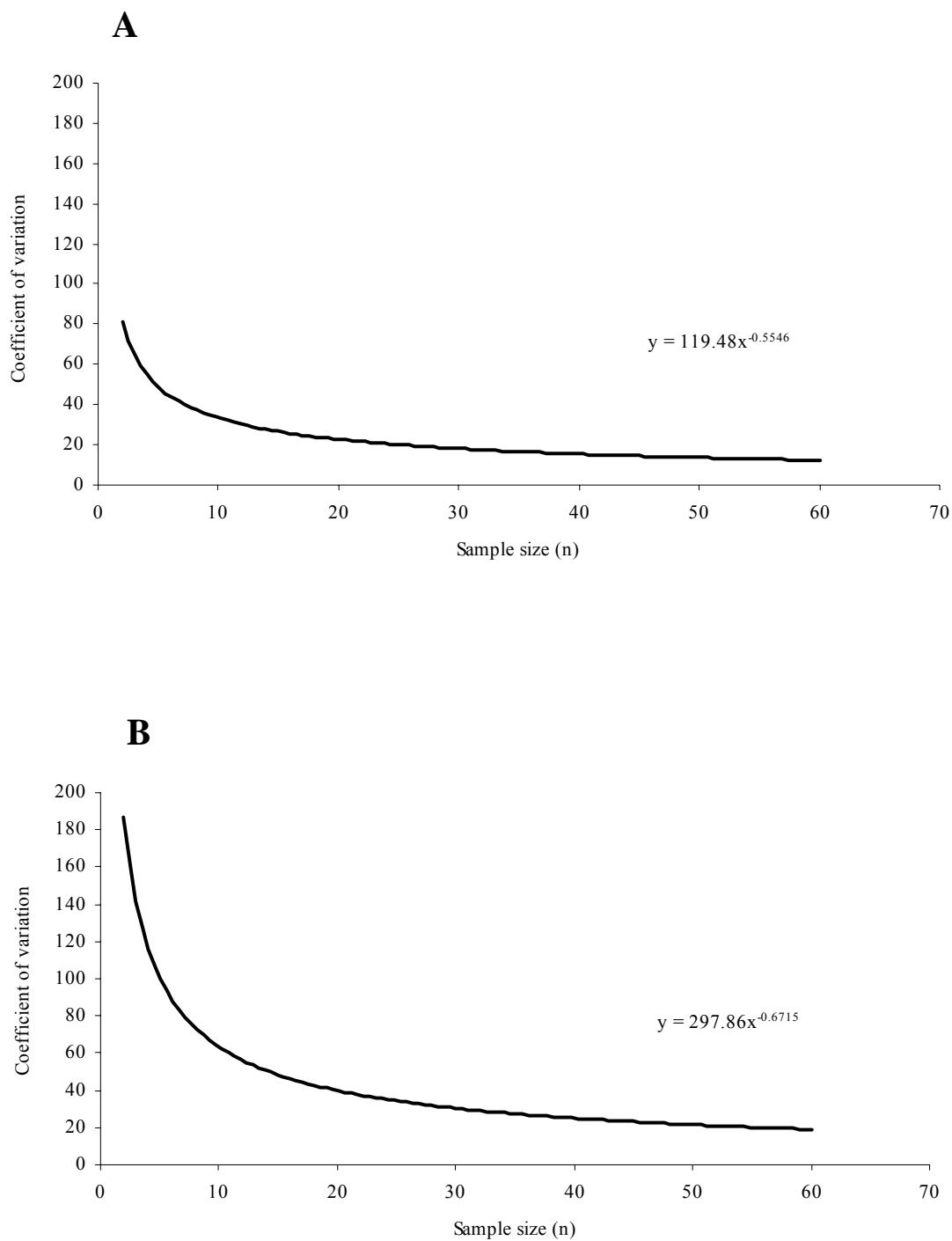


Figure 17: The relationship between variation in D/L ratios and sample size using bootstrapping to determine minimum sampling intensities in the commercial pot (A) and hook and line (B) fisheries.

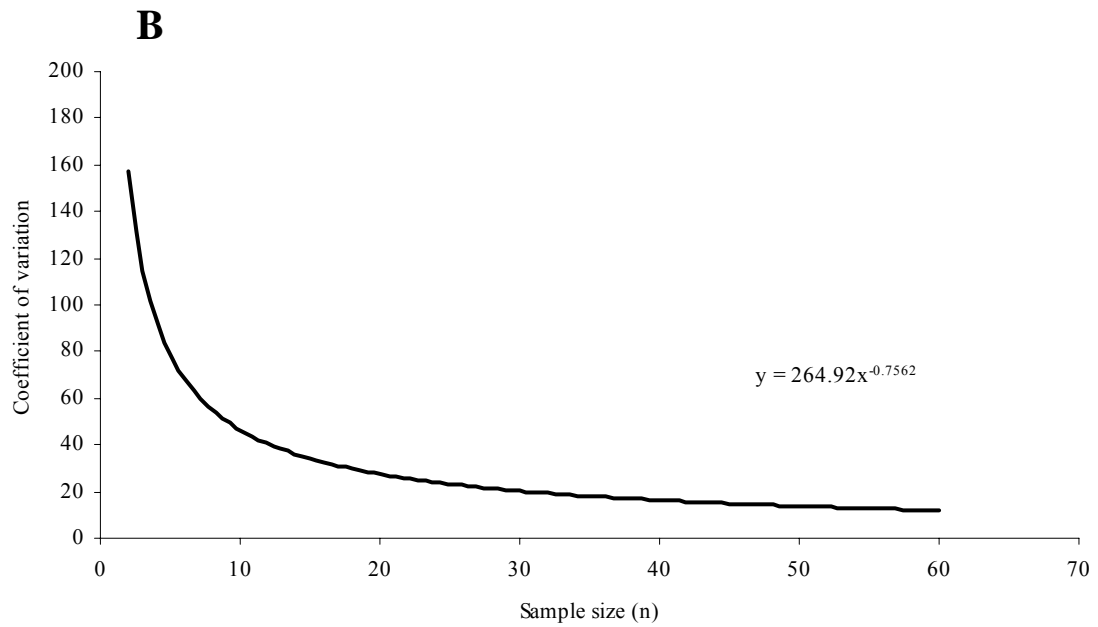
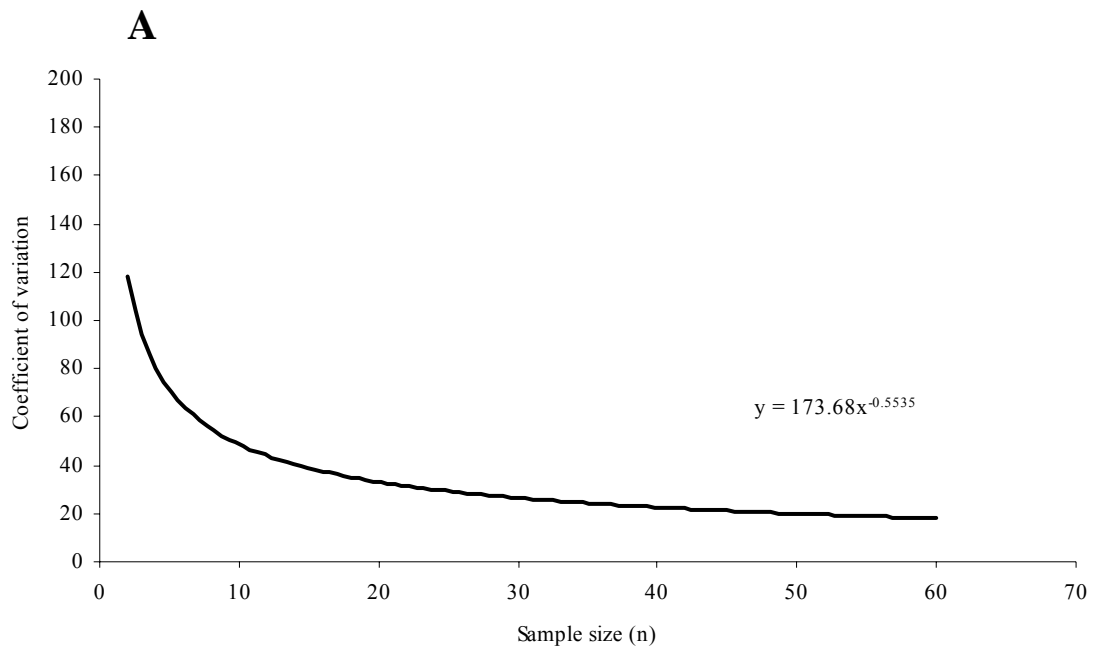


Figure 18: The relationship between variation in D/L ratios and sample size using bootstrapping to determine minimum sampling intensities in the recreational fishery during the spring and summer (A) and the autumn (B).

in which there is no open market. Unlike the other scup fisheries, weir fishermen generally sell their catches to a fresh market that occurs Monday to Thursday. The other sampling trip (5/30) was conducted after the quota was reached. Therefore, all scup caught on these two days were released.

Over 60,000 lbs. was estimated between these three trips, and it suggests that scup catches in the weirs increased after the above sampling trips were conducted. Scup may have arrived in larger numbers later in Nantucket Sound than in previous years. However, Pierce (1981) noted that weather patterns such as prolonged northeast or southwest winds influence scup behavior and their movements within the Sound that often results in variable catches among traps. This variability was observed among catches and landings of sampled trips conducted in this study. Whether this is due to weather patterns, temperature patterns, or the patchy and schooling nature of the species or a combination of said factors remains unknown.

Age data collected from two trips in May were combined with age data collected during the open weir season and were compared to the lone trip conducted in July to monitor any changes in age structure of catches. During May, catch was dominated by age-4 scup, whereas catch in July was dominated by age-2 fish. Lengths collected from these three trips also showed a similar trend. Sampled catches in May were composed mainly of scup larger than 26 cm CL, whereas the sampled catch in July was comprised primarily of scup ranging in size between 18 – 20 cm CL. Length data collected in two trips in May were not combined with data collected during the open season because all scup were released despite the fact that the majority of the sampled catch was above legal size. While these results are only based on one sampling trip conducted during the summer, it does suggest that a shift in the size and age structure from older to younger scup occur in nearshore waters of Nantucket Sound from spring to summer. However, this result must be regarded with caution due to lack of sampling trips made in the summer.

Small-Mesh Otter Trawl Fishery (Loligo)

All sampling trips in the small-mesh otter trawl fishery (and weir fishery) were conducted during the last week of April and the first half of May. Effort was focused in areas such as Collier Ledge, a popular fishing location that is only open from April 23 – April 30. Seventy-seven trips were re-

ported to NMFS during this one-week period in which over 202,000 lbs. squid was landed. In three of these trips targeting squid, 121 lbs. scup was reportedly landed. Effort declined sharply in the second week because the closure was enacted, and fishermen had to search greater distances to find squid.

The catch of scup was variable. However, none of these sampled trips reached the maximum allowable bycatch limit of 100 pounds. Landings on 10 observed trips showed low levels of scup bycatch (range: 0 – 26 lbs.), with 50% of these trips not catching any scup. Only one trip that caught scup actually discarded fish, therefore all other trips had a discard ratio of zero. This has severely skewed the mean discard ratios (weight: 0.07, and number: 0.08). Based on these sampling trips, results suggest that there was not a significant amount of scup discarded in this fishery.

Low catch levels in this fishery may be due to two other factors. First, scup may have arrived later in Nantucket Sound, as is evidenced by the increased catches in the weirs after their quota was reached. This is further supported by the fact that party and charter boats out of Hyannis and Harwich did not make any trips during the first two weeks of May. Second, catches and discards observed in these sampling trips may not have been representative of the fishery as a whole. Average landings of scup reported to NMFS (48 lbs.) was slightly higher than the average amount of scup caught in trips observed by DMF (5 lbs. in ten sampled trips). In addition, during the second half of the season, more trips were reportedly landing scup (as is evidenced by increasing mean ratio of trips producing scup in Table 26). In particular, during the last two weeks of the season (5/20 – 5/31), all reported trips targeting squid (24) landed scup.

Scup Pot Fishery & Hook & Line Fishery

The pot fishery and hook and line fishery occur within the same temporal scale. However, these two fisheries tend to operate in two discrete geographic areas with little overlap. The pot fishery operates within nearshore areas of Buzzards Bay whereas the hook and line fishery operates mostly in outer state territorial seas of Vineyard Sound and Marthas Vineyard (within the three nautical mile limit). In the hook and line fishery, scup was the primary species targeted in these trips, but some trips targeted striped bass, summer flounder, and black sea bass in conjunction with scup. The main areas in which the

Table 26: Summary of weekly landings of *Loligo* and scup during the spring otter trawl fishery (4/23/01 - 5/31/01). Included are the number of trips, the mean ratio of trips which landed scup and squid together, and the average amount of scup landed per week. Source: NMFS CFDBS.

Species: <i>Loligo</i>			Species: Scup			Mean Ratio (Scup:Squid/Trip)	Mean Weight Scup Landed (lbs)
Period	Landed (lbs)	No. trips	Period	Landed (lbs)	No. trips		
4/23 - 4/30	202,234	77	4/23 - 4/30	121	3	0.04	40
5/1 - 5/6	67,527	26	5/1 - 5/6	143	6	0.23	24
5/7 - 5/12	220,547	70	5/7 - 5/12	2,658	54	0.77	49
5/13 - 5/19	17,770	17	5/13 - 5/19	760	14	0.82	54
5/20 - 5/26	22,628	10	5/20 - 5/26	392	*11	1.00	39
<u>5/27 - 5/31</u>	<u>3,185</u>	<u>5</u>	<u>5/27 - 5/31</u>	<u>1,053</u>	<u>*13</u>	<u>1.00</u>	<u>81</u>
Totals	533,891	205	Totals	5,127	101	0.64	48

* Some trips reportedly landed scup only.

hook and line trips were conducted (Quick's Hole, Cuttyhunk Island, Squibnocket Point) are popular fishing areas for striped bass which ranked second in trip landings (350 lbs.)

Pot fishermen tended to operate in areas closer to shore for economic reasons. They often use larger vessels than hook and line fishermen, and they incur greater overhead costs such as fuel for larger motors, pots which are fished in greater numbers and are occasionally damaged or lost, and bait, which is bought and used in larger volumes. On many observed trips in the pot fishery, fishermen also used pots designed to catch black sea bass, conch, and lobster. These pots were deployed in areas separate from the sites of the scup pots. Therefore, it is common practice for both commercial pot fishermen and commercial hook and line fishermen to have endorsements to fish for multiple species not only to cover overhead costs, but to also maximize revenues.

Scup landings in the hook and line fishery were dominated by age-4 fish (and to a lesser extent, age-3 fish). These results are consistent with those of Finkelstein (1969b). Sampled landings in the pot fishery consisted mainly of age-3 and age-4 scup in more even proportions. While the sampled scup discarded in both fisheries were dominated by age-2 scup, the discard level (e.g. the estimated number of fish discarded) in both of these fisheries (Table 13 and Appendix D, respectively), must be noted. The estimated number of scup discarded in the commer-

cial pot fishery (N = 3,335), is an order of magnitude higher than the actual number of scup discarded in the commercial hook and line fishery (N = 428).

D/L ratios (by weight and by number) appear to be lower in the hook and line fishery than in the scup pot fishery. D/L ratios in these two fisheries were compared to each other because they occur on the same temporal scale while using different methods to harvest scup in different locations. Single factor ANOVA based on D/L ratios from these fisheries are significant ($F = 12.7$, $p < 0.01$), which suggests that hook and line fishermen tend to focus their effort on areas consisting primarily of larger fish. Four hook and line trips were conducted inside Buzzards Bay, and these trips produced higher than average D/L ratios (both weight and number). The wide range of D/L ratios derived from pot sampling trips suggest that there is a high degree of variation from trip to trip, and that the magnitude of scup discarded in these trips are high (over 50% as is evidenced by the mean D/L ratios for scup in weight and in numbers). Despite this, the relatively good condition of observed discards suggests that discard mortality in this fishery is minimal.

These results support the findings of Morse (1978) that smaller, younger scup tend to inhabit inshore areas of estuaries, bays and harbors, whereas the larger adults tend to leave inshore waters in spring and aggregate in coastal waters farther from shore during summer. This concept is further

supported by the large proportion of smaller, younger scup caught in the weir trip conducted in July. Results suggest the possibility that scup may distribute themselves by age structure on a spatial (geographic) scale.

Scup Directed Trawl Fishery

Total landings from these trips resulted in less than 5% by-catch by weight of most of the state's other managed species such as summer flounder (768 lbs., 2.6%), winter flounder (611 lbs., 2.1%), monkfish (412 lbs., 1.4%) and black sea bass (207 lbs., 0.7%). However, these trips did land spiny dogfish (9,720 lbs., 33% of the total catch by weight). Large volumes of dogfish and skates seem to decrease the selectivity of the trawl net as is evidenced by the presence of several scup less than 15 cm (CL), which would normally pass through a net with 4.5-inch mesh. Very few scup in this size range have been observed in the other fisheries.

Mean D/L ratio (by weight) for all trips was low (6%), thus suggesting that despite the presence of smaller scup in the trawls, the majority of scup caught were of legal size. A similar mean ratio was observed in the summer commercial hook and line fishery. The majority of sampled landings (ages-3 and 4) and discards (ages-2 and 3) contrast those of Smith and Norcross (1968) and Finkelstein (1969b). However, the large number of small fish appears to have skewed the average size of the scup discarded in the weighted length frequency distribution. The average size (17.8 cm) lies between two modes where larger and smaller fish occur. In an ideal fishery, ages 0-1 fish would not be captured and the mean size of discarded scup would shift toward the larger mode on the length frequency distribution.

Scup Recreational Fishery

Age composition of recreational landings and discards remained relatively uniform throughout the entire 2001 fishing season. Landings were dominated by age-3 and age-4 scup, whereas the majority of discards consisted of age-2 fish. These results contrasted those of Crecco *et al.* (1981) who determined that age-2 and age-3 scup were most frequently represented in Connecticut recreational landings. The average size of the catches was highest in the spring (25.2 cm CL), lowest in the summer (22.6 cm CL) and increased in the autumn (23.3 cm CL). These results are consistent with those of Briggs (1968) who observed similar trends in size composition of scup catches.

A dynamic shift in the nature of the fishing clientele appears to take place in the recreational fishery as the seasons change from spring to summer and from summer to autumn. The spring appears to be comprised mostly of "serious" anglers from other states and are gradually succeeded by "casual" out-of-state anglers during the summer. In turn, these anglers are succeeded by mostly in-state anglers during the autumn (Appendix J).

For vessels with homeports not on Cape Cod, the fishing season ran from May to October with peak periods running between May and June. Their clients were almost all out-of-state and almost all were repeat customers. They tended to focus primarily on the spring run when larger fish are closer to shore. The fishing season for vessels with homeports on Cape Cod also ran from May – October. Some companies (private charters), only fished for scup from May to June, then focus their efforts on other species such as bluefish and striped bass during the summer. After Labor Day weekend in September, there is a substantial decrease in effort, and this is largely due to a decrease in tourists after the summer season ends. In comparison to off-cape charters, the clientele for on-cape charters is comprised mostly of out-of-state customers during spring and summer. However, during the autumn, the few remaining vessels conducting fishing trips report that the majority of customers are in state.

Catch rates and discard rates in this fishery are highly variable throughout the entire fishing season (May – October). This appears to be a function of the time of year (season), angler skill and angler choice (as to whether they choose to retain or release their catch). For these reasons, it makes estimating the level of catches and discards in this fishery very difficult. In the spring, catch rates are high, and most caught fish are retained. During the summer, when the casual anglers and tourists arrive in larger numbers, the catch rates remain high, but there is a noticeable decline in scup retained per angler. During the autumn season, there is a substantial decline in both total catch and retained catch rates. This may be due to angler skill, choice, and the availability of the stock as fish begin to migrate from Massachusetts waters south to their wintering grounds.

Market Sampling

The mode shown in the "large" market category (24 cm CL), is consistent with the mode shown in the weighted landed catch of scup in the commer-

cial pot fishery. This, along with the calculated average size of scup landed in this fishery (24.7 cm CL), indicate the majority of the catches in the pot fishery lie within this size category. The mode shown in the “jumbo” market category (27 cm CL), is consistent with the mode shown in the weighted landed catch of the commercial hook and line fishery. The calculated average size of scup landed in this fishery (26.8 cm CL), indicate the majority of the catches in the commercial hook and line fishery are within this size category.

Market price of scup is influenced by size category. In general, “jumbo” sized scup will demand a higher market price than “large” scup. However, some seafood dealers do not cull fish by size and instead will sell them as a “mixed” size category (especially at times where there is a minimal difference in market price). Overall, the weight is equal in all size categories, but in some cases the price can be less per unit value if the catch is culled (Frank Pieroni, L.J. Fisheries, *pers. comm.*). Certain dealers may mix all sizes together because it may increase the total value of the catch than if culled. This can allow fishermen to increase the value per unit of the large scup they catch if dealers sell them as mixed.

For future market sampling, it is recommended that the gear be identified for all samples so that generated length frequency analyses can be used to obtain more accurate descriptions of catches in these two fisheries. It is also recommended that market sampling be expanded to include sampling during the spring and autumn seasons. This will help develop a better assessment as to which market size categories the weirs and otter trawls are targeting. In addition, length frequency graphs generated from all fisheries may show seasonal changes in size and age structure of landed scup. This in turn can be compared to seasonal changes in size and age compositions of scup caught in the recreational fishery.

Age Analysis & Age Key Formation

Scales were aged using standardized criteria established by the NMFS Northeast Fisheries Science Center Age and Growth Unit at Woods Hole. The medium in which the scale samples were mounted was the same as that used by Smith and Norcross (1968), Finkelstein (1969b), Hamer (1970), and Pierce (1981). Scup scale samples were aged using January 1 (established by Campbell *et al.* 1979) as the scup birth date. The use of this date is an inter-

nationally accepted convention for most North Atlantic demersal species and is done to minimize uncertainty in determining the year class and to insure that all data are comparable (Williams and Bedford 1974).

Although scales could be aged with confidence, at times, problems arose in determining ages of scup at certain age ranges. In general, the first annulus was distinguishable making it easy to identify age-0 and age-1 fish. Some of the age samples 2 – 3 years were difficult to identify because the second annulus was less apparent. In comparison, Smith and Norcross (1968) found that scup scales were unreliable for age determination beyond age-2 due to difficulties in identifying the second annulus. In some cases, scup aged 4 and older were difficult to determine due to crowding of annuli, and the erosion of the focus and anterior margin of the scale. Pierce (1981) also noted that annuli in scup scales beyond five years were difficult to locate and could not be confidently identified.

When constructing scup age-length keys for each season (Appendix K), at least three samples per cm group were collected. This in turn produced accurate calculations of proportions of length at age. For all three age-length keys, scales were most commonly collected between 17 – 32 cm CL. Scale samples were encountered less frequently for scup between 0 – 16 cm CL and sizes greater than 33 cm CL. Lack of sample sizes within these size ranges can produce biased estimates of proportions of length at age and can inhibit the determination of an accurate length-age relationship within these size intervals.

Age-3 and age-4 scup were the dominant age classes reported in landings in all sampled fisheries. Age-2 scup (and to a lesser extent, age-3 and age-4 fish) dominated the discarded components in these fisheries. This is also consistent with age distributions of three market categories studied. Catches in these fisheries appear to be influenced by strength of recruitment of this species. Recent NEFSC trawl surveys predicted potentially strong 1997, 1998 and 1999 year classes were recruiting to the stock (NEFSC 2000). These year classes were the most common components of landings and discards in these fisheries, thus confirming these predictions.

Assessment of Fishing Effort in 2001

The spring fishery was dominated by federal permit holders. All the weir fishermen were federal permit holders, and almost all the trawlers own fed-

eral permits (only one trip by a state permit holder was reported). In contrast, the summer season is dominated by state permit holders. The majority of trips conducted in the hook and line fishery during the summer were made by state permit holders (1,448). Almost all trips conducted by pot fishermen during the summer were also state permit holders. A similar trend was also evident in the autumn fishery. The majority of trips were conducted by hook and line fishermen and pot fishermen who are state permit holders. However, all trips made by otter trawl fishermen in November were federal permit holders.

During the spring, weirs increased in effort by 25%, however, the otter trawl fishery targeting *Loligo* experienced a substantial (70%) decrease in effort. This was in part due to a shorter season in 2001. In 2000, the fishing season ran from April 23 – June 8, whereas in 2001 the season ran from April 23 – May 31. Furthermore, the analysis of the fleet composition contrasts that of McKiernan and Pierce (1995) who found that Class 3 vessels comprised the majority of the fishing fleet from 1978 – 1993. The scup directed trawl fishery in the autumn also experienced a decline in effort, but to a smaller degree (23%).

Due to changes in effort, the minimum target sampling intensities based on the estimated number of trips in 2000 were not appropriate for the summer fisheries in 2001. Because it is difficult to accurately predict changes in future effort, it is equally difficult to determine standard minimum sampling intensities for different fisheries using estimates of effort from the previous year. Considering this, it was DMF policy to sample each fishery as much as possible to attain or exceed the 5% standard mandated by the ACCSP.

Setting Future Sampling Intensities

Minimum sample sizes were not estimated in commercial weir and scup directed trawl fisheries due to the small number of sampling trips made in each. When using bootstrapping, it is ideal to over-sample so that the calculated minimum sample size lies within the sample range on the plotted curve. If the sample size is small, the curve is not well defined, thus producing a high degree of uncertainty especially if the calculated minimum sample size is well outside the sample range, and it is likely the variance will be underestimated. Given the available data, it is inconclusive as to whether or not discard ratios are an accurate measure to estimate fu-

ture sampling intensities in these two fisheries.

Minimum sample size was not estimated in the spring *Loligo* trawl fishery due to uncertainty in the calculated discard ratios. The sample size was adequate (5% of the total effort), however, only one trip produced a ratio of discards to landings. The majority of the sampling trips were conducted in the first two weeks of the season, in which there were low levels of scup landed (Table 24), further suggesting that scup were just beginning to arrive in Nantucket Sound. As indicated by the landings data, scup became available in larger quantities by the second week of May, in which only one sampling trip was conducted. Because sampling was not stratified, discard ratios may not be representative of the fishery, and therefore, could not be used with confidence to determine an accurate minimum sampling intensity.

In the commercial pot fishery, the minimum sample size determined using bootstrapping (27) and the Variance Method (18) accounts for 6% and 4%, respectively of the total effort estimated in this fishery in 2001 (see Table 25). This indicates that the minimum number of samples required for this fishery is consistent with the desired target sampling intensity (5%) mandated by the ACCSP. The number of sampling trips conducted by DMF (10 trips) is below the estimated sample size, thus suggesting that this fishery was under-sampled.

The minimum sample size estimated in the commercial hook and line fishery (23 via bootstrapping; and 6 using the Variance Method) constitutes only 2% and 0.4%, respectively of the total number of trips estimated in 2001. This also suggests that the minimum number of samples required for this fishery is below the standard ACCSP target sampling intensity. DMF conducted 26 trips in this fishery, which implies that the sample size was sufficient to obtain an accurate representation of the discard rates in this fishery.

In the recreational fishery, the differences in catch rates among seasons justified the separation of discard rates in the autumn trips from those of the spring and summer. Hence, separate bootstrapping tests were conducted for both data sets. The number of sampling trips estimated in 1999 (Table 5) and 2001 survey estimates (Table 25) do not report the number of trips conducted in each season (only total number of trips for the year). Therefore, it was not possible to accurately determine 5% ACCSP sampling targets to this fishery by season. This also un-

derlies the importance of maintaining logbooks to derive accurate estimates of effort and observer coverage in this fishery.

Based on field observations and interviews with vessel captains and owners, it is believed that about 85% of trips (1,253) occurred during the spring and summer and 15% (221 trips) were conducted in the autumn. Based on these assumptions, the 5% ACCSP standard sampling intensities for these two periods are 63 and 11 trips, respectively.

In spring and summer seasons, DMF conducted 29 sampling trips, which is greater than the minimum sample size estimated by bootstrapping (27; 2.2% of estimated trips); and equal to the sample size calculated from the Variance Method (29; 2.3%). This indicates that the calculated discard rates are representative of this fishery during these two seasons. In the autumn, the minimum number of sampling trips estimated by bootstrapping (21; 10.0% of estimated trips); and the Variance Method (23; 10.4%) is greater than the number of sampling trips conducted by DMF (seven trips), which suggests that the autumn recreational fishery was undersampled. This was largely due to a reduction in fishing effort by the recreational fleet. Some companies focused their efforts on other species, while others stopped fishing altogether.

Reporting Requirements: Discrepancies and Challenges

The historical data on commercial landings generated from the NMFS Commercial Fisheries Database (Table 1 and Table 2, respectively) must be regarded with caution due to certain caveats involved. Sometimes, the fishing gear used was not reported, and therefore, the landings were recorded as "Unspecified Gear." Other landings were commonly reported as "Combined Gears," meaning that multiple types of gear were fished. Total landings by state includes confidential data and is accurate, but landings reported by individual species may, in some instances, be misleading due to data confidentiality.

Until 1993, all landings in the pots and traps category were reported under fish pots. It may have been in recent years that NMFS increased the resolution on reporting landings in this category by adding other fisheries into the database. The NMFS port agents are charged with preparing dealer weigh-out data for entry into the commercial fisheries database, and they will decide on the fisheries categories in which the landings data shall be en-

tered. Changes in port agents occurred around this time, and they may have chosen to increase precision on reporting by gear types and species name (Personal communication from the National Marine Fisheries Service Fisheries Statistics and Economics Division).

Since 1994, landings of unknown gear types have been reported, but this issue has become particularly acute within the last two years (146,279 lbs. in 1999, and 72,819 lbs. in 2000). These landings accounted for 22% and 21% of the total landings for 1999 and 2000, respectively. Therefore, within the last two years, a large number (over 20%) of reported landings did not have gear types assigned to them, making it impossible to accurately assess total landings in each participating fishery. In 2001, over 10,500 lbs. of scup was landed by fishermen using unspecified gear types. This underlies the growing need for more accurate reporting from seafood dealers, as well as the need for management agencies to enact and enforce stricter reporting requirements.

A summary of scup landings in Massachusetts for the year 2001 reported to the National Marine Fisheries Service Commercial Fisheries Database, the NMFS Northeast Regional Office and landings reported to DMF are shown in Table 27. Landings are separated by seasons in which the major fisheries targeting scup occur. These landings are compared to the total landings generated from researching all state and federal transaction forms that were obtained from NMFS port agents as well as all state licensed dealers. Note that these estimates are based on reports as of February 12, 2002, and are subject to change. Of particular interest is the discrepancies in the amount landed in pounds and their respective percentages (calculated in relation to the total landings for that period). Total annual landings reported from the NMFS Commercial Fisheries Database (over 327,000 lbs.) are far less than the total annual landings reported to NMFS Northeast Regional Office (over 459,000 lbs.), DMF (over 469,000 lbs.) or the total landings from all weigh-out data (over 474,000 lbs.).

Weekly quota numbers provided by DMF are generated using data from the IVR call-in system. All dealers (state and federal) purchasing fish directly from fishermen are required to report to an automated data collection system with their purchases of quota monitored species for the week. These data were the best that was available to DMF and should be considered preliminary. IVR data is

Table 27: Comparisons of scup landings (by season) reported by NMFS Commercial Fisheries Database (CFDBS), NMFS Northeast Regional Office Statistics Division (NERO), DMF (by state and federal dealers), and analysis of state and federal weigh-out forms obtained from NMFS port agents and DMF Statistics Division. Figures based on reports as of 2/12/02.

Season	DMF	Weigh-out Data	Difference (lbs)	Difference (%)
JAN-MAR	0	1,028	-1,028	-
APR-JUN	85,687	85,320	-367	0.4
JUL-AUG	319,323	319,036	-287	0.1
SEP-OCT	0	5,037	-5,037	-
NOV	64,593	64,078	-515	0.8
ANNUAL	469,603	474,499	-4,896	1.0

Season	NMFS CFDBS	DMF	Difference (lbs)	Difference (%)
JAN-MAR	1,028	0	1,028	-
APR-JUN	85,320	85,687	-367	0.4
JUL-AUG	192,693	319,323	-126,630	40
SEP-OCT	4,895	0	4,895	-
NOV	43,301	64,593	-21,292	33
ANNUAL	327,237	469,603	-142,370	30

Season	NMFS CFDBS	Weigh-out Data	Difference (lbs)	Difference (%)
JAN-MAR	1,028	1,028	0	0
APR-JUN	85,320	85,320	0	0
JUL-AUG	192,693	319,036	-126,343	40
SEP-OCT	4,895	5,037	-142	3
NOV	43,301	64,078	-20,777	32
ANNUAL	327,237	474,499	-147,262	31

Season	NMFS CFDBS	NMFS NERO	Difference (lbs)	Difference (%)
JAN-MAR	1,028	2	-1,026	99
APR-JUN	85,320	85,320	0	0
JUL-AUG	192,693	316,023	-123,330	39
SEP-OCT	4,895	454	-4,441	91
NOV	43,301	57,697	-14,396	25
ANNUAL	327,237	459,496	-132,259	29

Season	NMFS NERO	DMF	Difference (lbs)	Difference (%)
JAN-MAR	2	0	-2	-
APR-JUN	85,320	85,687	-367	0.4
JUL-AUG	316,023	319,323	-3,300	1
SEP-OCT	454	0	-454	-
NOV	57,697	64,593	-6896	11
ANNUAL	459,496	469,603	-10,107	2

Season	NMFS NERO	Weigh-out Data	Difference (lbs)	Difference (%)
JAN-MAR	2	1,028	-1,026	99
APR-JUN	85,320	85,320	0	0
JUL-AUG	316,023	319,036	-3,013	1
SEP-OCT	454	5,037	-4,583	91
NOV	57,697	64,078	-6,351	10
ANNUAL	459,496	474,499	-15,003	3

"real time" and can be used to make quick management decisions (such as determining closure dates). Any changes in previous weeks data are the result of corrections or late reporting. For species such as scup that are monitored coastwide, the NMFS Northeast Regional Office Fisheries Statistics Division also provides weekly reports of landings using a similar IVR system to that used by DMF. All federal dealers outside of Massachusetts are required to call in their quota-monitored species to them. Weekly landings are supplied to NMFS by federal dealers and state agencies and are considered preliminary. These data are the best available to NMFS and are also used for management purposes, such as quota monitoring on a regional (inter-state) scale, by providing information on other state landings. Massachusetts is exempted from this requirement in that DMF has a cooperative agreement with NMFS such that DMF collects the IVR data from all quota-monitored species (including scup) and reports to NMFS weekly.

In theory, the weekly landings reported to NMFS for the state of Massachusetts should be the same as those reported to DMF via the IVR system. All dealers that purchase quota monitored species directly from fishermen in Massachusetts must be authorized by the state whether they hold a federal permit, a state permit or both. Being authorized obligates them to call the MADMF IVR system. However, discrepancies can occur when dealers report their landings to NMFS instead of reporting it to DMF. If dealers call both DMF and NMFS, NMFS finds the duplicates and the issue is resolved. If there were dealers that were calling in to the NMFS IVR for Massachusetts landings, those dealers were identified and then notified that they should be calling DMF.

To generate total landings, weigh-out data is more accurate than IVR because the landings reported in the weigh-out data should be supported by VTR data (Holly McBride, NMFS, *pers. comm.*). In addition, the weigh-out data (dealer transaction form) documents the transactions that occurred with each individual fisherman (the amount landed, the unit price, and the total value of the catch). Thus, when the state dealer weigh-out data is incorporated with the landings entered into the NMFS commercial fisheries database, it provides the most accurate estimates of landings and effort for each fishery possible.

The largest discrepancies occur in NMFS commercial fisheries database landings reported during

the summer months (July-August), and during the autumn fishery (November). This is largely due to the nature of the commercial scup pot and hook and line fisheries, which are the predominant fisheries operating during these periods. These fisheries are comprised almost entirely of state permit holders (many of which sell their catches to state licensed seafood dealers). Seafood dealers that only possess state licenses are required to report only to DMF. A large volume of the landings during the summer are reported to DMF by state permitted dealers, which are not immediately being reported to NMFS. State dealers are required to send catch reports to DMF at the end of the year.

History has shown inconsistent sharing of landings information between DMF and NMFS, and this explains the large disparity between estimates of annual landings of scup between these two agencies. According to NEFSC (2000), scup landings reported for Massachusetts have been revised in this assessment for 1986-1996, increasing an average of 92% or 218 mt per year (range, 182 to 268 mt and 40 to 216%). These revisions were made due to the collection of records by DMF personnel from several major scup dealers detailing previously unreported landings in the hook and line gear category. These records have been inspected by NEFSC fishery statistics staff and have now been included in the NMFS NER dealer landings database.

Recommendations

These discrepancies not only underlie the complexities of reporting total landings, but also in reporting landings and effort by gear type. Federal dealers are allowed to purchase scup caught by fishermen possessing state permits. However, when these reports are sent to the NMFS port agents to be processed and entered into the commercial fisheries database, the landings from state permitted fishermen are grouped together under an "unidentified" code. This prevents the system from being able to identify the number of permit holders, the number of trips, the gear type that was used, or the amount that was landed for each gear type. All this information is essential for creating accurate assessments of fishing effort, and setting proper quota levels for each fishery.

To improve the quality of data for assessment purposes, the following recommendations are proposed. The commercial fisheries database at this time is not designed to accommodate state permit numbers, and it is highly recommended that the sys-

tem be expanded with data entry fields to account for landings by state permit holders. This will serve three main purposes: (1) This will make the facilitation of information sharing easier for both agencies because this will allow the landings data from state permit holders to be entered into the commercial fisheries database more easily; and (2) This will create more accurate assessments of fishing effort by fishery (i.e. the number of trips, the number of permit of state and federal permit holders); and (3) This will enable the commercial fisheries database to generate actual total landings and effort data more quickly. To fulfill this last purpose, it is recommended that state permitted dealers be required to send their catch reports monthly rather than annually (which is the current requirement) to DMF.

Fishing vessels with federal permits are required to send VTRs to NMFS on a trip basis. Currently, no such regulation exists for state permit holders. It is recommended that state permitted fishermen be required to fill out and send in VTRs per trip. Included in the VTR should be information (such as the gear type used, number of hours, days, and areas fished, the number of tows, and landings by species, etc.), that is provided in the NMFS federal dealer transaction form. The information from the VTR can be linked to the landings from the state dealers to provide full details of each individual trip.

Dealer reports and VTR data form a system of checks and balances such that the information in both should be consistent with each other. However, these reporting requirements must be strictly enforced. If it is discovered that dealers did not report their purchases or that unauthorized dealers were buying fish then that is an issue for enforcement. Law enforcement officials can play an important role in fisheries management not just by monitoring catches, but also by insuring that dealers are following the proper reporting procedures and reporting accurate landings.

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Appendix A: A listing of all species landed and discarded from observed commercial squid sampling trips (4/23/01 - 5/15/01).
All weights recorded in pounds.

Sampling Date	4/23/01	4/25/01	4/27/01	4/30/01
Hours Towing	3.25	3	7.17	3.42
N Tows	4	2	5	5
Species	<u>Landed</u>	<u>Discarded</u>	<u>Landed</u>	<u>Discarded</u>
<i>Loligo</i>	24	0	1,450	0
Northern sea robin	0	1	0	2
Winter flounder	0	0	0	0
Summer flounder	0	0	0	0
Spider crab	0	35	0	10
Striped sea robin	0	0	0	0
Striped bass	0	0	0	0
Alewife	0	1	0	1
Tautog	11	0	0	0
Butterfish	0	14	0	5
Little skate	0	0	0	0
Scup	0	0	0	0
Horseshoe crab	4	0	0	3
Windowpane	0	2	0	1
Black sea bass	0	0	0	0
Atlantic herring	0	8	0	0
Bluefish	0	0	0	0
Winter skate	0	0	0	0
Conch	4	2	0	0
American lobster	0	0	0	0
Lady crab	0	0	0	1
Whelk	0	0	0	1
Rock crab	0	1	0	0
Sand eel	0	0	0	0
Totals	43	64	1,450	23
		192		98
			3,364	

Appendix A (cont.): A listing of all species landed and discarded from observed commercial squid sampling trips (4/23/01 - 5/15/01).
All weights recorded in pounds.

Sampling Date	5/1/01		5/2/01		5/4/01		5/7/01	
	Hours Towing	N Tows	Landed	Discarded	Landed	Discarded	Landed	Discarded
	1.78	2	436	0	2,150	0	107	0
Species								
<i>Loligo</i>			78	0				0
Northern sea robin			0	0	0	1	0	2
Winter flounder			0	26	0	7	0	1
Summer flounder			7	0	7	2	10	1
Spider crab			0	12	0	1	0	0
Striped sea robin			0	104	0	0	0	0
Striped bass			0	8	0	30	0	14
Alewife			0	0	0	90	0	0
Tautog			3	0	12	3	12	0
Butterfish			0	10	0	0	0	0
Little skate			0	10	0	3	0	0
Scup			19	0	1	0	0	0
Horseshoe crab			0	2	0	3	0	0
Windowpane			0	0	0	0	0	0
Black sea bass			0	0	0	0	0	0
Atlantic herring			0	0	0	0	0	0
Bluefish			0	0	4	0	0	0
Winter skate			0	8	0	0	0	0
Conch			0	0	0	0	0	0
American lobster			0	1	0	1	0	0
Lady crab			0	0	0	0	0	0
Whelk			0	0	0	0	0	0
Rock crab			0	0	0	0	0	0
Sand eel			0	0	0	0	0	0
Totals			107	181	476	231	129	18
					2,174	141		

Appendix A (cont.): A listing of all species landed and discarded from observed commercial squid sampling trips (4/23/01 - 5/15/01).
All weights recorded in pounds.

Sampling Date	5/8/01	5/15/01	Number of Trips		
Hours Towing	2.25	6.83	Total Hours Towing		
N Tows	2	4	Total Number of Tows		
Species	Landed	Discarded	Landed	Discarded	Combined
Loligo	2,500	0	11,475	0	Totals
Northern sea robin	0	2	0	310	11,475
Winter flounder	0	13	0	288	Percentage
Summer flounder	0	0	113	17	88
Spider crab	0	1	0	122	2.4
Striped sea robin	0	0	0	105	2.2
Striped bass	0	0	0	104	1
Alewife	0	1	0	99	1
Tautog	18	0	73	5	1
Butterfish	0	1	12	43	1
Little skate	0	2	0	51	1
Scup	2	0	24	11	1
Horseshoe crab	0	3	4	23	1
Windowpane	0	0	0	24	0.8
Black sea bass	4	0	21	1	0.6
Atlantic herring	0	0	6	9	0.4
Bluefish	0	4	4	8	0.4
Winter skate	0	0	0	8	0.3
Conch	0	0	4	2	0.2
American lobster	0	1	0	6	0.2
Lady crab	0	0	0	2	0.2
Whelk	0	0	1	0	0.1
Rock crab	0	0	0	1	0.1
Sand eel	0	1	0	1	0.1
Totals	2,524	29	11,737	1,240	100

Appendix B: Summary of all species landed and discarded in the commercial scup pot fishery (7/18/01 - 8/6/01). All weights were recorded in pounds.

Trip ID	T01262	T01284	T01273	T01263	T01252
Sampling Date	7/18/01	7/18/01	7/18/01	7/19/01	7/19/01
<u>Species</u>	<u>Landed</u>	<u>Discarded</u>	<u>Landed</u>	<u>Discarded</u>	<u>Landed</u>
Scup	230	99	240	615	220
Black sea bass	29	9	26	23	0
Spider crab	0	10	0	300	0
Striped bass	0	0	0	0	0
American lobster	0	1	0	0	0
Toadfish	0	3	0	5	0
Tautog	0	0	0	0	0
Channeled whelk	0	0	0	0	4
Bluefish	0	0	0	0	0
Puffer fish	0	0	0	1	0
Mummichug sp.	0	0	0	0	0
Total catch	259	122	266	944	224
				58	143
Trip ID	T01267	T01268	T01269	T01287	T01271
Sampling Date	8/1/01	8/1/01	8/2/01	8/2/01	8/6/01
<u>Species</u>	<u>Landed</u>	<u>Discarded</u>	<u>Landed</u>	<u>Discarded</u>	<u>Landed</u>
Scup	83	39	234	83	127
Black sea bass	0	17	0	28	0
Spider crab	0	20	0	0	0
Striped bass	0	16	0	2	0
American lobster	1	0	0	0	0
Toadfish	0	0	0	1	0
Tautog	0	0	0	0	0
Channeled whelk	0	0	0	0	0
Bluefish	0	0	0	2	0
Puffer fish	0	0	0	0	0
Mummichug sp.	0	1	0	0	0
Total catch	84	93	234	116	127
				8	202

Appendix C: Summary of all species landed and discarded in the commercial hook and line fishery (7/1801 - 8/20/01). All weights recorded in pounds.

Sampling Date	7/20/01A		7/20/01B		7/25/01A		7/25/01B		7/26/01		7/30/01A	
	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers
	5	3	3	3	6	2	4.5	3	3	4	5	4
Species	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded
Scup	209	13	185	36	98	4	204	2	130	4	117	0
Black sea bass	0	23	0	1	0	4	0	6	6	0	0	5
Striped bass	0	8	0	0	0	0	28	6	0	0	322	0
Smooth dogfish	0	2	0	0	0	4	0	15	0	0	0	0
Summer flounder	0	0	0	0	0	0	0	0	0	0	2	0
Tautog	0	0	0	1	0	0	0	0	0	0	0	0
Total Catch	209	46	185	38	98	12	232	29	136	4	441	5

Sampling Date	7/30/01B		8/1/01		8/3/01A		8/3/01B		8/3/01C		8/6/01A	
	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers	Hours Fished	No. Anglers
	3.25	4	7.25	1	3.5	3	2	4	10.17	4	3	2
Species	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded
Scup	200	0	48	2	200	1	210	2	156	11	70	25
Black sea bass	0	0	0	0	3	2	0	1	0	17	0	1
Striped bass	0	0	0	0	0	0	0	2	0	0	0	0
Smooth dogfish	0	0	0	0	0	0	0	0	0	0	0	0
Summer flounder	0	0	0	0	0	0	0	0	0	0	0	0
Tautog	0	0	0	0	0	0	0	0	0	2	0	0
Total Catch	200	0	48	2	203	3	210	5	156	30	70	26

Appendix C (cont.): Summary of all species landed and discarded in the commercial hook and line fishery (7/1801 - 8/20/01). All weights recorded in pounds.

Species	8/17/01B		8/20/01		Number of Trips		Total		Percent		Total		Percent		Combined	
	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Totals	Percentage
Scup	210	9	213	1	4,285	179	90.7	44.5	4,464	87.1						
Black sea bass	20	0	0	4	350	44	7.3	11	394	7.7						
Striped bass	0	0	0	15	48	113	1	28.1	161	3.1						
Smooth dogfish	0	0	0	0	0	53	0	13.2	53	1						
Summer flounder	0	0	0	0	41	1	1	0.2	42	0.8						
Tautog	0	0	0	0	0	5	0	1.2	5	0.1						
Bluefish	0	0	0	0	0	5	0	1.2	5	0.1						
Triggerfish				0	0	2	0	0.5	2	0.04						
Total Catch	230	9	213	19	4,724	402	100	100	5,126	100						

Appendix D: Number and percentage of scup landed and discarded by commercial hook and line fishermen during the summer fishery (7/20/01 - 8/20/01). Included are estimated totals for landed and discarded categories and calculations of D/L ratios for each trip.

Gear Type: Hook and Line	Trip Date													
	7/20/01A	7/20/01B	7/25/01A	7/25/01B	7/26/01	7/30/01A	7/30/01B	8/1/01	8/3/01A	8/3/01B	8/3/01C	8/6/01A	8/6/01B	
Total Catch (lbs)	222	221	102	206	134	117	200	50	201	212	167	95	201	
Total Landed (lbs)	209	185	98	204	130	117	200	48	200	210	156	70	200	
Percentage	94	84	96	99	97	100	100	96	99.5	99	93	74	99.5	
Subsampled Weight (lbs)	104	92.5	98	101	130	60	100	48	90	105	156	70	100	
Percentage	50	50	100	49	100	52	50	100	45	50	100	100	50	
No. fish in subsample	114	125	120	92	158	128	119	68	105	125	207	75	105	
Estimated No. fish landed	229	250	120	186	158	249	238	68	233	250	207	75	210	
Total Discarded (lbs)	13	36	4	2	4	0	0	2	1	2	11	25	1	
Percentage	6	16	4	1	3	0	0	4	0.5	1	7	26	0.5	
Subsampled Weight (lbs)	13	36	4	2	4	0	0	2	1	2	11	25	1	
Percentage	100	100	100	100	100	0	0	100	100	100	100	100	100	
No. fish in subsample	34	108	14	5	8	0	0	17	2	3	19	42	1	
Estimated No. fish discarded	34	108	14	5	8	0	0	17	2	3	19	42	1	
Discard Ratio (discards/landings)														
by weight	0.06	0.19	0.04	0.01	0.03	0	0	0.04	0.005	0.01	0.07	0.36	0.005	
by number	0.15	0.43	0.12	0.03	0.05	0	0	0.25	0.01	0.01	0.09	0.56	0.005	

Appendix D (cont.): Number and percentage of scup landed and discarded by commercial hook and line fishermen during the summer fishery (7/20/01 - 8/20/01). Included are estimated totals for landed and discarded categories and calculations of D/L ratios for each trip.

Gear Type: Hook and Line	Trip Date													
	8/7/01	8/8/01	8/9/01A	8/9/01B	8/10/01A	8/10/01B	8/14/01	8/16/01A	8/16/01B	8/16/01C	8/17/01A	8/17/01B	8/20/01	
Total Catch (lbs)	150	201	200	201	204	201	162	99	171	108	206	219	214	
Total Landed (lbs)	146	200	199	200	203	200	155	87	168	74	203	210	213	
Percentage	97	99.5	99.5	99.5	99.5	99.5	96	88	98	69	99	96	99.5	
Subsampled Weight (lbs)	146	95	103	100	103	100	77	87	168	74	102	210	106	
Percentage	100	48	52	50	51	50	50	100	100	100	50	100	50	
No. fish in subsample	160	115	118	119	114	105	120	125	170	91	103	215	132	
Estimated No. fish landed	160	242	228	238	225	210	242	125	170	91	205	215	265	
Total Discarded (lbs)	4	1	1	1	1	1	7	12	3	34	3	9	1	
Percentage	3	0.5	0.5	0.5	0.5	0.5	4	12	2	31	1	4	0.5	
Subsampled Weight (lbs)	4	1	1	1	1	1	7	12	3	34	3	9	1	
Percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	
No. fish in subsample	8	9	4	5	2	1	10	34	5	68	8	18	3	
Estimated No. fish discarded	8	9	4	5	2	1	10	34	5	68	8	18	3	
Discard Ratio (discards/landings)														
by weight	0.03	0.005	0.005	0.005	0.005	0.005	0.05	0.14	0.02	0.46	0.02	0.04	0.005	
by number	0.05	0.04	0.02	0.02	0.01	0.005	0.05	0.27	0.03	0.75	0.04	0.08	0.01	
Arithmetic mean D/L Ratio														
by weight	0.06													
by number	0.12													

Appendix E: Summary of all species caught (landed and discarded) in the commercial otter trawl fishery (11/1/01 - 11/14/01). All weights recorded in pounds.

Sampling Date	10/31/01 - 11/1/01		11/8/01		11/12/01		11/13/01 - 11/14/01	
N Hauls	13		3		4		8	
Hours Fished	13.08		3.08		4		7.33	
Species	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded
Spiny dogfish	0	2,615	0	3,540	0	950	0	2,615
Little skate	0	4,385	0	640	0	1,215	0	3,181
Scup	2,357	115	757	28	1,460	80	1,300	139
Winter skate	0	220	0	60	0	135	0	509
Summer flounder	0	266	0	66	0	76	0	360
Winter flounder	75	68	0	61	0	56	0	352
Monkfish	0	123	0	55	0	39	0	195
Torpedo Ray	0	200	0	0	0	30	0	0
Black sea bass	90	8	0	68	0	12	0	30
Smooth dogfish	0	35	0	172	0	0	0	0
Windowpane	0	40	0	6	0	4	0	96
Striped bass	0	19	0	0	0	12	0	70
Striped sea robin	0	23	0	8	0	11	0	41
Yellowtail flounder	0	2	0	2	0	8	0	67
Fourspot flounder	0	10	0	1	0	2	0	26
Bluefish	0	17	0	8	0	0	0	0
Rock crab	0	0	0	0	0	0	0	21
Tautog	12	0	0	0	0	3	0	0
Conger eel	0	0	0	0	0	10	0	0
Atlantic cod	8	0	0	0	0	0	0	0
<i>Loligo</i>	0	1	0	1	0	2	0	3
Sea Raven	0	0	0	0	0	3	0	2
Silver hake	0	0	0	1	0	0	0	4
Triggerfish	0	0	0	0	0	0	0	3
Northern sea robin	0	0	0	0	0	3	0	0
Conch	0	0	0	0	0	0	0	2
Horseshoe crab	0	0	0	0	0	2	0	0
Sea scallop	0	1	0	1	0	0	0	1
White hake	0	1	0	1	0	0	0	0
Spotted hake	0	0	0	0	0	0	0	1
Longhorn sculpin	0	0	0	1	0	1	0	0
American plaice	0	0	0	0	0	0	0	1
Butterfish	0	0	0	1	0	1	0	0
American lobster	0	0	0	0	0	0	0	1
Lizardfish	0	1	0	0	0	0	0	0
Total catch	2,542	8,150	757	4,721	1,460	2,655	1,300	7,720

Appendix F: Summary of the total number of species landed and discarded by recreational anglers sampled by DMF personnel on board charter and party boats targeting scup during the 2001 scup recreational season.

Date	Total Fishing		Sampling Interval (hrs)	N Anglers	Scup				Black				Tautog				Sea Robin				Summer Flounder				Total Species Caught per Trip
	Time (hrs)				Landed	Discarded	Sea Bass Landed	Sea Bass Discarded	Landed	Discarded	Sea Bass Landed	Sea Bass Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	
5/9/01	3.08		3.08	9	78	1	0	26	20	28	2	1	0	0	0	0	2	1	0	0	0	0	0	0	156
5/17/01	5.7		0.5	10	63	1	3	0	0	1	4	1	0	0	0	0	0	1	0	0	0	0	0	0	73
5/18/01	5.5		0.5	7	55	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63
5/22/01	2.5		0.5	5	28	0	1	0	0	0	6	7	0	0	0	0	0	7	0	0	0	0	0	0	42
5/24/01	5.9		0.333	12	29	1	2	0	1	0	1	4	0	0	0	0	1	4	0	0	0	0	0	0	38
5/31/01	2		0.333	6	19	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	21
6/4/01	3.9		0.333	10	7	16	2	4	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0	0	33
6/6/01	4.46		0.333	11	96	9	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112
6/7/01	4.72		0.5	8	78	9	2	0	4	0	4	0	0	0	0	0	4	0	0	0	4	4	4	0	105
6/7/01	2.333		0.333	7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6/11/01	4.76		0.333	12	35	7	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	45
6/13/01	5		0.5	8	63	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70
6/19/01	2.28		0.333	5	12	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	23
6/19/01	3.55		0.333	12	26	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
6/26/01	3.33		0.333	9	62	23	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
6/28/01	2		0.25	8	31	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39
6/29/01	3.33		0.333	10	40	23	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70
7/3/01	2.16		0.333	5	9	24	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
7/10/01	2.47		0.25	8	18	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
7/12/01	3.73		0.25	9	41	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47
7/18/01	4		0.25	12	64	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82
7/20/01	5.78		0.25	10	51	17	3	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	74
7/27/01	5.05		0.25	10	22	52	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81
7/31/01	2.1		0.333	6	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
8/2/01	4.4		0.333	22	23	21	5	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	50
8/7/01	2.22		0.333	4	1	8	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
8/8/01	2.47		0.333	6	26	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
8/24/01	6.5		0.333	12	53	41	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97

Appendix F (cont.): Summary of the total number of species landed and discarded by recreational anglers sampled by DMF personnel on board charter and party boats targeting scup during the 2001 scup recreational season.

Date	Total Fishing		Sampling Interval (hrs)	N Anglers	Scup		Black Sea Bass		Tautog		Sea Robin		Summer Flounder		Total Species Caught per Trip	
	Time (hrs)				Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Landed	Discarded	Caught per Trip	
8/29/01	2.5		0.17	12	4	0	4	4	0	0	0	0	0	0	12	
8/31/01	5.3		0.333	9	70	13	1	0	0	0	0	0	0	0	84	
9/7/01	4.6		0.333	12	59	9	2	0	0	0	0	0	0	0	70	
9/11/01	3.75		0.33	6	11	1	0	0	0	0	0	0	0	0	12	
9/11/01	3.75		0.333	6	9	6	1	0	0	0	0	0	0	0	16	
9/14/01	2.2		0.333	7	7	29	2	0	0	0	0	0	0	0	38	
9/21/01	4.4		0.333	8	28	2	0	0	0	0	0	0	0	0	30	
9/27/01	2.7		0.333	7	0	6	3	3	0	0	0	0	0	0	12	
9/27/01	3.8		0.333	8	43	22	3	0	0	0	0	0	0	0	68	
10/3/01	3.1		0.25	11	22	1	0	0	0	0	0	0	0	0	23	
Totals	141.3		-	339	1,289	413	75	44	25	29	20	17	6	4	1,922	
Percent of the total number of species caught					67%	21%	4%	3%	1%	1%	1%	1%	0.5%	0.5%	1	

Appendix G: Summary of scup landings and the number of trips made by state and federal permit holders during the 2001 fishing season (all areas combined). Landings from state permit holders were derived from state and federal sea-food dealer weigh-out transaction forms. Landings from federal permit holders were obtained from the National Marine Fisheries Service Commercial Fisheries Database. All landings in pounds.

Month	Gear Type	No. State Permits	No. Federal Permits	No. Trips (St. Permits)	No. Trips (Fed. Permits)	Landings (St. Permits)	Landings (Fed. Permits)	Combined Landings
January	Otter Trawl		1		4		887	887
Total			1		4		887	887
February	Otter Trawl		1		1		2	2
	Gill Net		3		5		139	139
Total			4		6		141	141
April	Gill Net		1		1		41	41
	Otter Trawl		4		4		125	125
	Scallop Dredge		2		2		1,250	1,250
Total			6		6		1,375	1,416
May	Hook & Line	2	1	4	1	248	4	252
	Otter Trawl	1	31	1	98	175	4,841	5,016
	Pound Net		8		51		70,910	70,910
	Pots (Other)	1		2		100		100
	Scottish Seine		1		4		217	217
Total		4	41	8	154	523	75,972	76,495
June	Line Trawl		2		4		4,739	4,739
	Hook & Line	1	1	3	2	315	1,810	2,125
	Otter Trawl		2		4		450	450
	Scottish Seine		1		1		95	95
Total		1	6	3	11	315	7,094	7,409
July	Hook & Line	198	3	585	20	79,795	434	80,229
	Otter Trawl	*	16	170	54	12,083	6,750	18,833
	Pots (Other)		2		8		268	268
	Pots (Fish)	55		204		30,803		30,803
	Pots (Off. Lobster)		1		3		192	192
	Pots (Coast. Lobster)	8		17		1,820		1,820
	Other Gear	3		15		2,586		2,586
	Unknown							1,779
Total		*264	22	991	85	127,087	7,644	136,510
August	Hook & Line	208	2	916	7	135,684	267	135,951
	Otter Trawl		18		84		3,916	3,916
	Pots (Other)	1	1	1	35	200	2,614	2,814
	Pots (Fish)	35		218		31,548		31,548
	Pots (Coast. Lobster)	5		26		3,840		3,840
	Scottish Seine		1		1		3	3
	Other Gear	4		19		2,515		2,515
	Unknown							1,939
Total		253	22	1,180	127	173,787	6,800	182,526

Appendix G (cont.): Summary of scup landings and the number of trips made by state and federal permit holders during the 2001 fishing season (all areas combined). Landings from state permit holders were derived from state and federal seafood dealer weigh-out transaction forms. Landings from federal permit holders were obtained from the National Marine Fisheries Service Commercial Fisheries Database. All landings in pounds.

Month	Gear Code	No. State Permits	No. Federal Permits	No. Trips (St. Permits)	No. Trips (Fed. Permits)	Landings (St. Permits)	Landings (Fed. Permits)	Combined Landings
September	Hook & Line	*		6		4,895		4,895
Total		*		6		4,895		4,895
October	Otter Trawl		1		1		142	142
Total			1		1		142	142
November	Hook & Line	33	1	70	3	40,802	32	40,834
	Otter Trawl		8		23		15,027	15,027
	Pots (Other)	1	4	6	7	141	217	358
	Pots (Fish)	3	3	5	13	5,771	326	6,097
	Pots (Off. Lobster)		1		1		7	7
	Other Gear	2		2		990		990
	Unknown							765
Total		39	17	83	47	47,704	15,609	64,078

Totals by Gear Type	No. State Permits	No. Federal Permits	No. Trips (St. Permits)	No. Trips (Fed. Permits)	Landings (St. Permits)	Landings (Fed. Permits)	Combined Landings
Line Trawl		2		4		4,739	4,739
Hook & Line	*257	7	1,584	33	261,739	2,547	264,286
Otter Trawl	*	52	171	273	12,258	32,140	44,398
Gill Net		3		6		180	180
Scallop Dredge		2		2		1,250	1,250
Pound Net		8		51		70,910	70,910
Pots (Other)	3	7	9	50	441	3,099	3,540
Pots (Fish)	51	3	427	13	68,122	326	68,448
Pots (Off. Lobster)		2		4		199	199
Pots (Coast. Lobster)	8		43		5,660		5,660
Scottish Seine		1		6		315	315
Other Gear	4		36		6,091		6,091
Unknown							4,483
Grand Totals (2001)	*322	87	2,270	442	354,311	115,705	474,499

* Unidentified permit holders which were recorded in NMFS CFDBS as (000000,190998, or 390998).

The commercial fisheries database does not identify the number of distinct state permit holders, only the number of trips and the amount landed.

Appendix H: Listing of D/L ratios and calculated coefficients of variation (*cv*) in each fishery and calculated parameters needed to estimate minimum sampling intensities *x* (exponential equation) and *n* (Zar 1996).

Fishery: **Scup Pot**

					Minimum sample size (exponential equation)						Minimum sample size (Zar 1996)			
Date	D/L Ratio	<i>cv</i>	GMDL	Var	<i>y</i>	<i>N</i>	Sum of Squares	α	<i>x</i>	Target <i>cv</i>	<i>n</i>	α	<i>d</i>	<i>t</i>
7/18/01A	0.43	-	0.34	1.19	-0.55	119.5	38.5	0.1	27	19.23	18	0.05	-0.54	2.11
7/18/01B	2.56	80.84												
7/18/01C	0.14	67.34												
7/19/01A	0.19	52.16												
7/19/01B	0.31	52.34												
8/1/01A	0.47	41.38												
8/1/01B	0.71	40.00												
8/2/01A	0.35	38.15												
8/2/01B	0.04	35.01												
8/6/01	0.53	34.67												

Fishery: **Hook & Line**

					Minimum sample size (exponential equation)						Minimum sample size (Zar 1996)			
Date	D/L Ratio	<i>cv</i>	GMDL	Var	<i>y</i>	<i>N</i>	Sum of Squares	α	<i>x</i>	Target <i>cv</i>	<i>n</i>	α	<i>d</i>	<i>t</i>
7/20/01A	0.06	-	0.03	2.96	-0.67	297.9	902	0.1	23	35.85	6	0.05	-1.73	2.57
7/20/02B	0.19	180.12												
7/25/01A	0.04	141.51												
7/25/01B	0.01	134.19												
7/26/01	0.03	119.21												
7/30/01A	0	79.32												
7/30/01B	0	73.57												
8/1/01	0.04	70.85												
8/3/01A	0.005	63.01												
8/3/01B	0.01	59.8												
8/3/01C	0.07	60.55												
8/6/01A	0.36	54.58												
8/6/01B	0.005	52.31												
8/7/01	0.03	47.48												
8/8/01	0.005	47.76												
8/9/01A	0.005	43.74												
8/9/01B	0.005	43.27												
8/10/01A	0.005	43.77												
8/10/01B	0.005	42.26												
8/14/01	0.05	38.96												
8/16/01A	0.14	39.39												
8/16/01B	0.02	36.48												
8/16/01C	0.46	39.13												
8/17/01A	0.02	37.08												
8/17/01B	0.04	35.12												
8/20/01	0.005	35.6												

Appendix H (cont.): Listing of D/L ratios and calculated coefficients of variation (*cv*) in each fishery and calculated parameters needed to estimate minimum sampling intensities *x* (exponential equation) and *n* (Zar 1996).

Fishery: **Recreational (Spring & Summer)**

					Minimum sample size (exponential equation)						Minimum sample size (Zar 1996)			
Date	*D/L Ratio	<i>cv</i>	GMDL	Var	<i>y</i>	<i>N</i>	Sum of Squares	α	<i>x</i>	Target <i>cv</i>	<i>n</i>	α	<i>d</i>	<i>t</i>
5/9/01	0.01	-	0.32	2.2	-0.55	173.7	114.2	0.1	27	28.04	29	0.05	-0.57	2.05
5/17/01	0.02	124.05												
5/18/01	0.11	90.38												
5/22/01	0.00	79.15												
5/24/01	0.03	67.33												
5/31/01	0.00	60.58												
6/4/01	2.29	59.31												
6/6/01	0.09	56.13												
6/7/01	0.12	49.88												
6/11/01	0.20	49.65												
6/13/01	0.10	46.39												
6/19/01	0.75	44.79												
6/19/01	0.35	40.4												
6/26/01	0.37	40.72												
6/28/01	0.26	39.09												
6/29/01	0.58	37.3												
7/3/01	2.67	39.07												
7/10/01	0.17	37.7												
7/12/01	0.10	34.58												
7/18/01	0.27	32.47												
7/20/01	0.33	32.99												
7/27/01	2.36	33.45												
7/31/01	0.50	30.99												
8/2/01	0.91	29.71												
8/7/01	8.00	30.02												
8/8/01	0.23	29.46												
8/24/01	0.77	27.37												
8/29/01	0.00	27.46												
8/31/01	0.19	26.46												

Fishery: **Recreational (Autumn)**

					Minimum sample size (exponential equation)						Minimum sample size (Zar 1996)			
Date	*D/L Ratio	<i>cv</i>	GMDL	Var	<i>y</i>	<i>N</i>	Sum of Squares	α	<i>x</i>	Target <i>cv</i>	<i>n</i>	α	<i>d</i>	<i>t</i>
9/7/01	0.15	-	0.25	2.52	-0.76	264.9	51.8	0.1	21	26.5	23	0.05	-0.69	2.07
9/11/01A	0.09	159.31												
9/11/01B	0.67	112.58												
9/14/01	4.14	88.05												
9/21/01	0.07	79.49												
9/27/01	0.51	69.82												
10/3/01	0.05	64.17												

* Mean D/L ratios (derived from sampled anglers) per trip.

Appendix I: Summary of species landings and discarded scup sampled from weirs after the commercial season by DMF observers. All landings in pounds.

Trip Date	Species Landings (in pounds)					
	Black Sea Bass	Bluefish	Bonito	Summer Flounder	Loligo Squid	*Scup
5/18/01	0	0	0	0	1,785	300
5/30/01	300	200	0	181	400	60,000
7/12/01	0	160	50	80	10	250
Totals	300	360	50	261	2,195	60,550

* Scup were released due to harvest quota being reached (except on 5/18: scup were released because the weir operator sells to a fresh market). This market does not exist on weekends.

Appendix I (cont.): Length frequency data of scup sampled from weirs outside of the commercial season.

CL (cm)	Trip Date			
	5/18/01	5/30/01	7/12/01	Totals
10				
11				
12				
13				
14				
15			1	1
16				
17			7	7
18	1		54	55
19	2		53	55
20	3		23	26
21	3	1	3	7
22		2	2	4
23	1	5	2	8
24	8	22	2	32
25	10	21	1	32
26	11	16		27
27	8	41		49
28	11	27		38
29	7	20		27
30	2	15		17
31	1	9		10
32		5		5
33	1	5		6
34		4		4
35		4		4
36		4		4
37		3		3
38		2		2
39				
40				
41				
42		1		1
43				
44				
45				
Totals	69	207	148	424

Appendix J: Summary of the number of fishing trips targeting scup by the major fishing charter companies in Massachusetts (May 1, 2001 - October 6, 2001). Included is information describing the demographics of the fishing clientele who participated in the fishery this year.

Total number of fishing trips targeting scup: 1,474

Company	Home Port	No. of Vessels	Season of Operation	Peak Period	No. Trips	Demographics of the Fishing Clientele			
						% In-State	% Out-of-State	% Repeat Clients	Participating States (Out-of-State Anglers)
A	Hyannis	1	May - Oct.	May - June	117	10	90	100	NY, NJ, CT, PA, MIL
B	New Bedford	1	May - Oct.	May - June	81	5	95	100	NY, NJ, PA, VA
C	Harwich	1	May - Oct.	July - Aug.	225	60	40	60	VT, NH, RI, CT, NY, NJ OH, CO, MD, FL, MIL
D	Hyannis	1	May - June	May - June	29	20	80	20	NY, NJ, CT, PA, MIL
E	Hyannis	2	May - Oct.	May - Sept.	330	25 (1) 25 (10) 75 (3)	75 (1) 75 (2) 25 (3)	>5	NY, NJ, CT
F	Onset	1	May - Oct.	May - June	170	20	80	99	NY, NJ, PA, MD, NC, FL SC, NH, VT, RI, MIL
G	Falmouth	1	May - Sept.	June - Sept.	172	60	40	50	NY, NJ, PA
H	Hyannis	1	May - June	May - June	30	10	90	75	NY, NJ, CN, DC, PA
I	Oak Bluffs	1	May - Sept.	July - Aug.	180	50	50	20	NY, CT
J	Harwich	1	May - Oct.	July - Aug.	140	40	60	55	NY, NJ, CN, PA, OH

* Percentages were divided into three segments based on seasons: (1) Spring; (2) Summer; and (3) Fall seasons.

**States were listed according to their abbreviations (Note: DC is abbreviated for District of Columbia, and MIL is abbreviated for Montreal, Canada).

Appendix K: Length at age key (proportions of size at age) of scup sampled from all combined fisheries during the Spring (May and June) 2001 (N = 684).

CL (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15			1								
16		0.25	0.75								
17		0.2	0.8								
18		0.15	0.8	0.05							
19		0.1	0.6	0.2	0.1						
20		0.05	0.7	0.2	0.05						
21			0.55	0.38	0.07						
22			0.32	0.59	0.09						
23			0.15	0.63	0.22						
24			0.13	0.48	0.38						
25			0.12	0.53	0.33	0.02					
26				0.52	0.45	0.04					
27				0.42	0.47	0.11					
28				0.3	0.44	0.23	0.03				
29				0.15	0.61	0.24					
30					0.53	0.43	0.03	0.03			
31				0.12	0.28	0.56	0.04				
32					0.22	0.61	0.17				
33						0.31	0.69				
34							0.6	0.4			
35							0.43	0.57			
36					0.17		0.5		0.17	0.17	
37							0.67		0.33		
38							0.5		0.5		
39											1
40								1			
41											
42											1

Appendix K (cont.): Length at age key (proportions of size at age) of scup sampled from all combined fisheries during the Summer (July and August) 2001 (N = 1,363).

CL (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X
5											
6											
7											
8											
9											
10											
11											
12		1									
13		0.8	0.2								
14		1									
15		0.55	0.36	0.09							
16		0.05	0.86	0.09							
17		0.03	0.85	0.12							
18		0.03	0.83	0.14							
19		0.01	0.8	0.19							
20		0.02	0.59	0.37	0.02						
21			0.53	0.44	0.03						
22			0.26	0.64	0.09	0.01					
23			0.12	0.56	0.32						
24			0.07	0.59	0.34						
25			0.02	0.43	0.54	0.01					
26			0.02	0.37	0.55	0.05	0.01				
27				0.3	0.66	0.04					
28				0.15	0.78	0.07					
29				0.15	0.55	0.25	0.05				
30				0.02	0.56	0.41	0.01				
31					0.22	0.56	0.22				
32					0.14	0.52	0.31	0.03			
33					0.09	0.35	0.43	0.13			
34						0.11	0.67	0.22			
35						0.17	0.5	0.33			
36						0.2	0.6	0.2			
37								1			
38						1					
39											
40											
41											
42											

Appendix K (cont.): Length at age key (proportions of size at age) of scup sampled from all combined fisheries during the Autumn (September - November) 2001 (N = 394).

CL (cm)	0	I	II	III	IV	V	VI	VII	VIII	IX	X
5											
6											
7											
8	1										
9	1										
10	1										
11	0.89	0.11									
12	0.83	0.17									
13	0.6	0.4									
14											
15		0.75	0.25								
16		0.89	0.11								
17		0.33	0.67								
18		0.21	0.79								
19			0.73	0.27							
20			0.7	0.26	0.04						
21			0.44	0.52	0.04						
22			0.15	0.73	0.12						
23			0.111	0.79	0.1						
24				0.76	0.24						
25				0.38	0.45	0.17					
26				0.29	0.71						
27				0.18	0.82						
28					0.76	0.24					
29				0.05	0.53	0.42					
30					0.44	0.48	0.04	0.04			
31					0.21	0.79					
32						1					
33					0.25	0.25	0.25	0.13	0.12		
34							1				
35								1			
36								0.5	0.5		
37							1				
38											
39											
40											
41										1	
42											