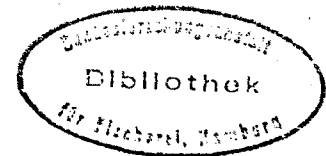


ICES C M 1996/T:2
Theme Session on Anadromous and Catadromous Fish Restoration Programmes:
A Time for Evaluation

Utilization of Wild Atlantic Salmon Parr as Captive Broodstock in USA Restoration Programs

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Abstract

Since 1992 more than 4,100 wild-origin Atlantic salmon parr have been collected from six Maine rivers and reared to maturity in freshwater. Survival, growth and maturity of parr was variable, possibly reflecting local adaptations in individual stocks. Overall, about 65% of the parr matured after two years in captivity at age 3+. Sex ratios for captive broodstock maturing as 3+ maiden spawners were 55% male and 45% female. Age 3+ females produced 2,140 eggs per spawner, while females maturing at age 4+ and repeat spawners, combined, produced 3,680 eggs per spawner. A total of 1.2 million feeding fry have been stocked into their rivers of origin during the initial two years of this program. Each parr which survived to maturity (both sexes combined) has resulted in the production of about 1,000 feeding fry for restocking purposes. Assuming 5-10 % survival between fry stocking and the parr stage, a minimum of 50-100 parr will replace each of the original parr collected for the captive broodstock rearing program. Growth and survival of stocked fry originating from captive broodstock was comparable to that observed for fry originating from traditional USA stocking programs, which utilize adult, sea run broodstock as the primary egg source for restocking programs.

Introduction

In 1992, the Maine Atlantic Salmon Authority (formerly the Maine Atlantic Sea Run Salmon Commission) and the United States Fish and Wildlife Service implemented a Prelisting Recovery Plan (PLRP) for seven Maine rivers with wild Atlantic salmon populations. The plan, which was initiated in direct response to rapidly declining salmon runs and fisheries in the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot rivers (Figure 1), was based upon the concept that conservation efforts could alleviate the need for listing under the state or federal Endangered Species Acts by sufficiently improving the status of the species. In the event that listing proved to be necessary, however, the Prelisting Recovery Plan was designed to help the remaining Atlantic salmon populations to progress without delay toward full recovery. The highest priority identified in the PLRP was the development of river-specific broodstocks which could be utilized for restocking efforts in the rivers of concern.

The management goal established for these rivers was to maximize the production of wild Atlantic salmon smolts by augmenting low wild juvenile populations with hatchery-produced, feeding fry. Target stocking densities of 50-75 fry per unit of Atlantic salmon habitat (100 m²) were established, based upon known (or assumed) wild spawning activity as evidenced by redd counts and/or juvenile population surveys which are conducted annually on each river. The purpose of this paper is to summarize results to date from the river-specific stocking program which has utilized a small number of sea run broodstock and a large number of Atlantic salmon parr which were captured in the wild and reared to maturity in freshwater.

Methods

Attempts to capture sea run, adult salmon broodstock utilizing portable weirs and with electrofishing equipment were relatively unsuccessful for a variety of reasons (e.g., low salmon numbers, inability to maintain trapping operations during high flows and/or high water temperatures,

equipment malfunctions, etc.). In late October 1991, a small number of wild-origin¹ adult salmon were captured in the vicinity of active redds in the Machias River utilizing electrofishing equipment. All but one of these fish were partially spent, and all eventually perished following artificial spawning in a hatchery environment due to the stress associated with their capture. Portable weirs were then utilized in an attempt to capture additional wild-origin, adult broodstock from three rivers. However, since the overall abundance of potential adult spawners was low, and weirs frequently were inoperable, a captive broodstock rearing program utilizing wild-origin parr was initiated in 1992. In order to continue to maximize natural spawning activity in the wild and to minimize the risk of inbreeding, wild Atlantic salmon parr (age 1+ and 2+) were captured from representative habitat reaches throughout six of the river systems shown in Figure 1. Parr were captured with standard DC backpack electrofishing equipment and transferred to Craig Brook National Fish Hatchery in an insulated, transportation tank equipped with aerators and a supplemental O₂ system.

Results

The number of wild adult broodstock (58) and parr (4,158) collected by river is shown in Table 1 and Figure 2. To date, the captive broodstock originating from the wild parr have produced 1.8 million eggs during the first two years of production for that program, while sea run broodstock (and kelts which survived to be rejuvenated to spawn again) have produced 0.3 million eggs for restocking programs (Table 2).

1992 Parr Broodstock Summary

Survival at Craig Brook Hatchery from parr collected in 1992 to initial spawning in 1994 (as age 3+ broodstock) for three Maine rivers averaged 84%, ranging from 80% for the Narraguagus

¹ The origin of all adult salmon was determined through scale analysis.

River parr to 92% for the Dennys River parr (Figure 3). Parr maturation in 1994 at age 3+ was 56%, 62% and 71% for the Machias, Dennys, and Narraguagus River salmon, respectively, averaging 62% for all three rivers combined (Figure 4). Sex ratios for the age 3+ mature salmon were 54% males (range: 49-60%) and 46% females (range: 40-51%)(Figure 5). Egg number per female for maiden spawners averaged 2,213 (range: 1,969 to 2,429) for age 3+ spawners and averaged 3,680 (range: 3,421 to 4,275) for age 4+ and repeat spawners combined in 1995 (Figure 6). For the Narraguagus River stock, the egg production per female for age 4+ maiden spawners was 3,777 while repeat spawners produced 4,372 eggs per female. Unfortunately, due to an equipment malfunction, it was not possible to obtain these data for the Dennys and Machias River stocks.

1993 Parr Broodstock Summary

Survival from capture for 1993 parr to initial spawning in 1995 for five Maine stocks was 91%, ranging from 83% for the Narraguagus River stock to 97% for the East Machias River stock (Figure 3). Parr maturation in 1995 ranged from 64% to 90%, averaging 71% for all rivers (Figure 4). Overall sex ratios for maturing salmon collected in 1993 were virtually identical to those collected the previous year: 56% males (range: 43-64%) and 44% females (range: 57-36%)(Figure 5). Egg production for maiden spawners from the 1993 parr, at 2,075 eggs per female, was not significantly different from the 1992 parr (2,213)(Figure 6). The small difference observed was probably a reflection of annual differences in growth at Craig Brook National Fish Hatchery.

Broodstock Growth Data

Average lengths and weights, taken for three individual stocks in October of 1995, are shown in Table 3. There were no consistent differences in fish lengths; however, there were small differences in fish weights with the Dennys River stock generally lighter than the Machias and Narraguagus stocks. Additional length and weight data will be collected in future years.

Numbers of Feeding Fry Stocked

The numbers of Atlantic salmon fry released back into their rivers of origin are shown in Table 4 and Figure 7. In addition to the 1.2 million fry released, 2,845 2-year smolts (910 Dennys and 1,935 Machias) were stocked into their respective rivers of origin in 1996. These fish, which originated from a small number of adult broodstock collected in 1993, had been held for a possible saltwater pen rearing experiment which did not occur. Juvenile population surveys in 1995 and 1996 indicate that growth and survival of the stocked fry to the parr size is no different from that observed from traditional Maine stocking programs where sea run broodstock were used as the source of eggs for fry production. Initial 2SW adult returns from this program will begin returning to Maine rivers in 1999.

Discussion

Increasing juvenile salmon populations in Maine rivers utilizing wild parr as captive broodstock for restocking programs has been successful to date. Combined with adult, sea run broodstock and rejuvenated kelts collected over several years, effective population sizes have been maintained at desirable levels in order to minimize the risk of inbreeding. Each parr which survived to maturity (both sexes included) has resulted in the production of about 1,000 feeding fry for restocking back into their rivers of origin. Assuming that 5-10 % of the fry survive to the parr stage, a minimum of 50-100 parr will replace each of the original parr which were collected for the captive broodstock rearing program. Eventually, as the original objective of adequately seeding vacant and/or severely underutilized habitat is met for individual rivers, it will no longer be feasible (or desirable) to collect parr for future broodstock rearing programs. Should additional stocking be required in future years, it will be necessary to utilize adult, sea run broodstock which originate from natural spawning as well as those from various ongoing and/or planned restocking programs.

Table 1. Sources of wild Atlantic salmon broodstock used in Maine (USA) river-specific stocking programs.

Year	Number of Broodstock by Source												Total	
	Dennys		E. Machias		Machias		Pleasant		Narraguagus		Sheepscot			
	Adult	Parr	Adult	Parr	Adult	Parr	Adult	Parr	Adult	Parr	Adult	Parr	Adult	Parr
1991					11								11	0
1992	6	249				414				232			6	895
1993	6	182		239	11	280				174		87	17	962
1994	4	151		166		313				165		84	4	879
1995		234		145		375		200		361	20	107	20	1,422
Total	16	816	0	550	22	1,382	0	200	0	932	20	278	58	4,158

Table 2. Atlantic salmon egg production by source of broodstock.

Year	Number of Eggs			
	Sea Run	Recond. Kelt	Captive Parr	Total
1991	15,900			15,900
1992	38,000			38,000
1993	69,400	8,600		78,000
1994	14,800	42,200	451,400	508,400
1995	78,500	61,800	1,370,600	1,510,900
Total	216,600	112,600	1,822,000	2,151,200
%	10.1	5.2	84.7	

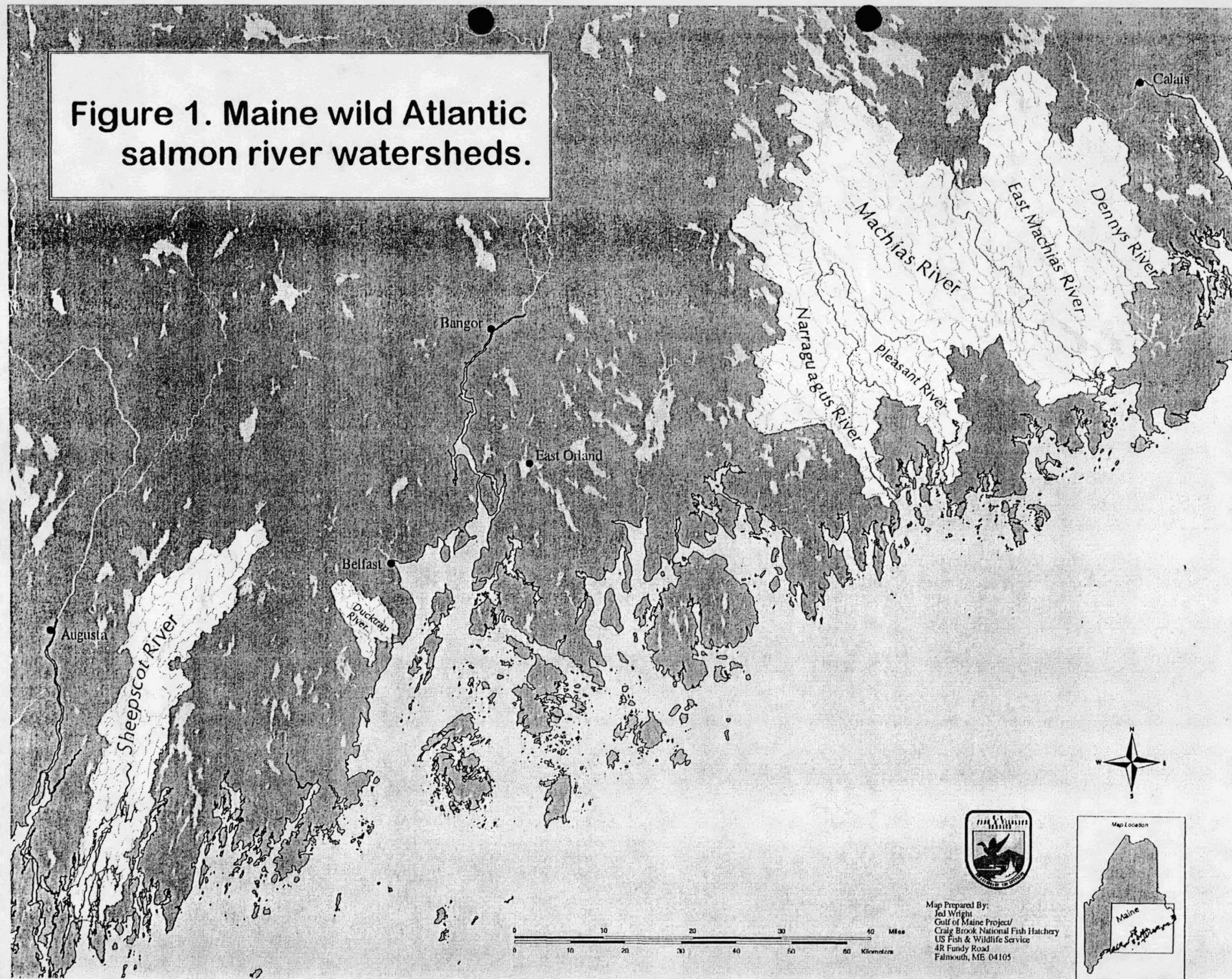
Table 3. Numbers of river-specific Atlantic salmon fry stocked into five Maine rivers.

Year	Number of Fry					Total
	Dennys	E. Machias	Machias	Narraguagus	Sheepscot	
1992			13,790			13,790
1993	32,700					32,700
1994	19,960		49,970			69,930
1995	84,000		150,000	105,000		339,000
1996	141,600	114,880	232,870	196,230	102,390	787,970
Total	278,260	114,880	446,630	301,230	102,390	1,243,390

Table 4. Average length and weight of captive Atlantic salmon broodstock. (Data collected in October, 1995; total length in cm. and weight in gm.).

Stock	1992 Year Class			1993 Year Class			1994 Year Class		
	N	Length	Weight	N	Length	Weight	N	Length	Weight
Dennys	233	51.7	1,499	177	43.2	955	135	28.1	266
Machias	293	58.0	2,097	240	42.3	983	282	28.6	283
Narraguagus	172	50.7	2,388	142	42.4	927	148	29.0	294

Figure 1. Maine wild Atlantic salmon river watersheds.



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Figure 2. Number of wild Atlantic salmon parr collected for the Maine captive broodstock rearing program.

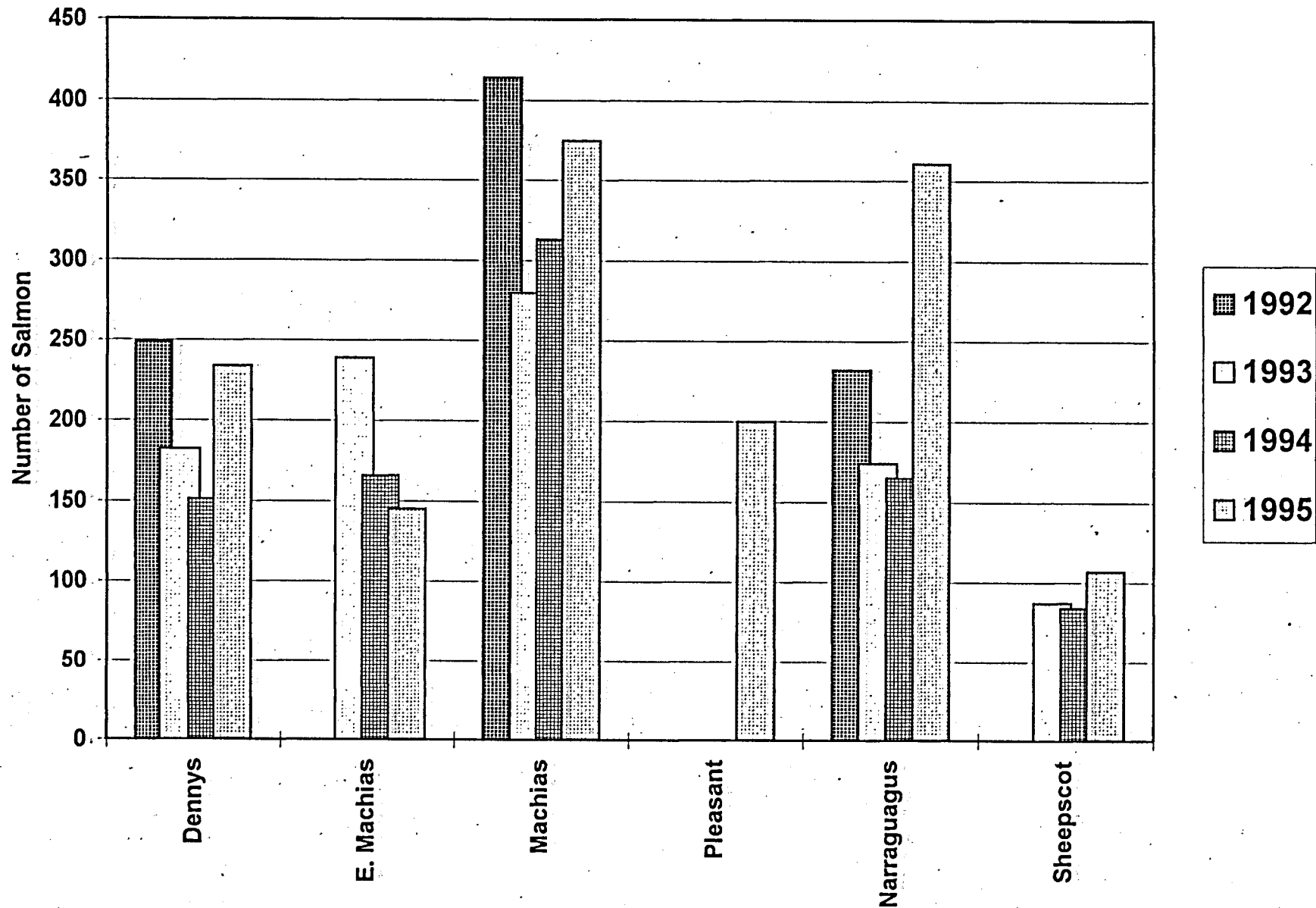


Figure 3. Survival of Maine wild Atlantic salmon parr to age 3+ maiden spawners.

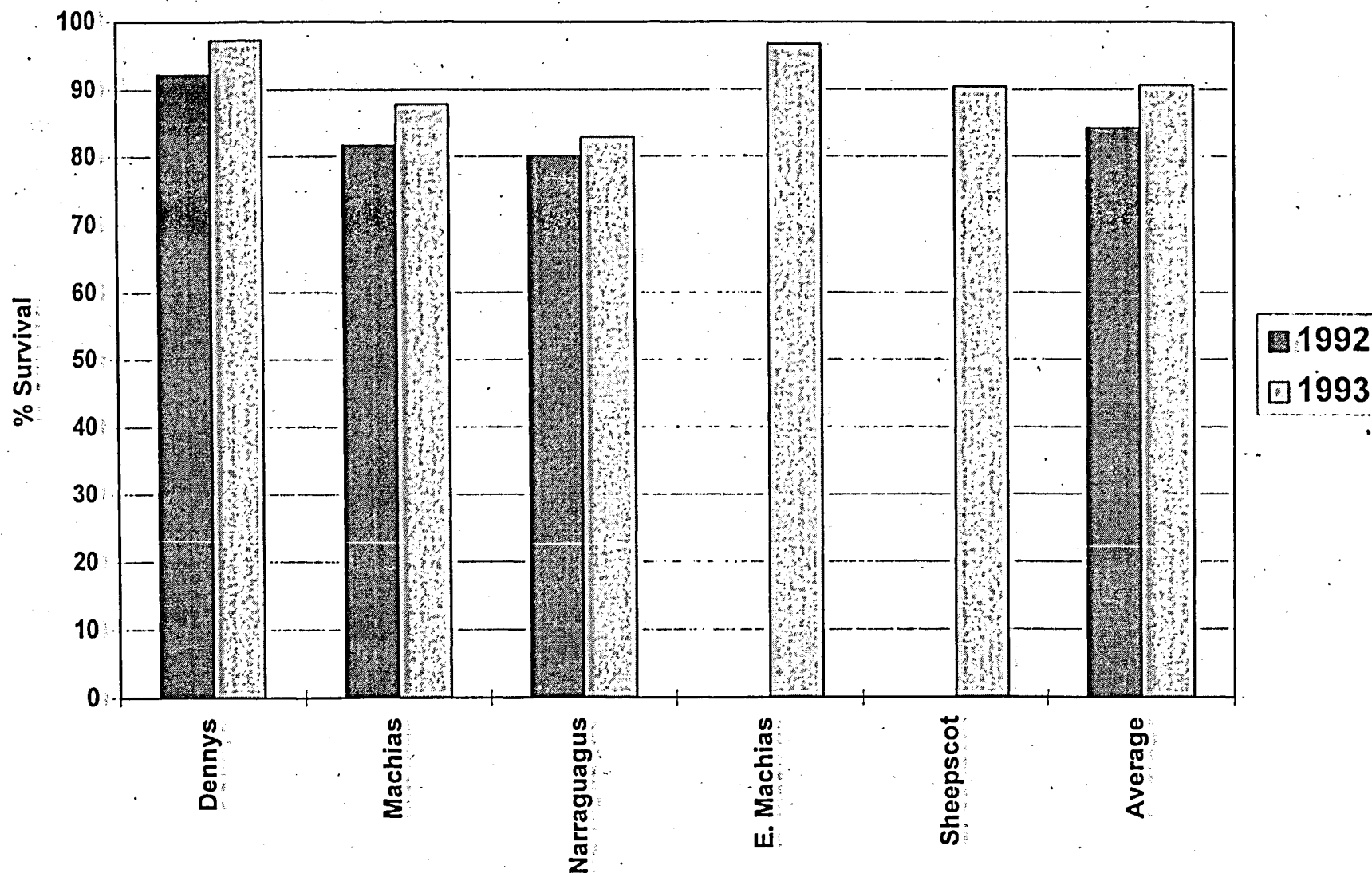


Figure 4. Maturation as 3+ maiden spawners of Maine wild Atlantic salmon parr collected in 1992 and 1993.

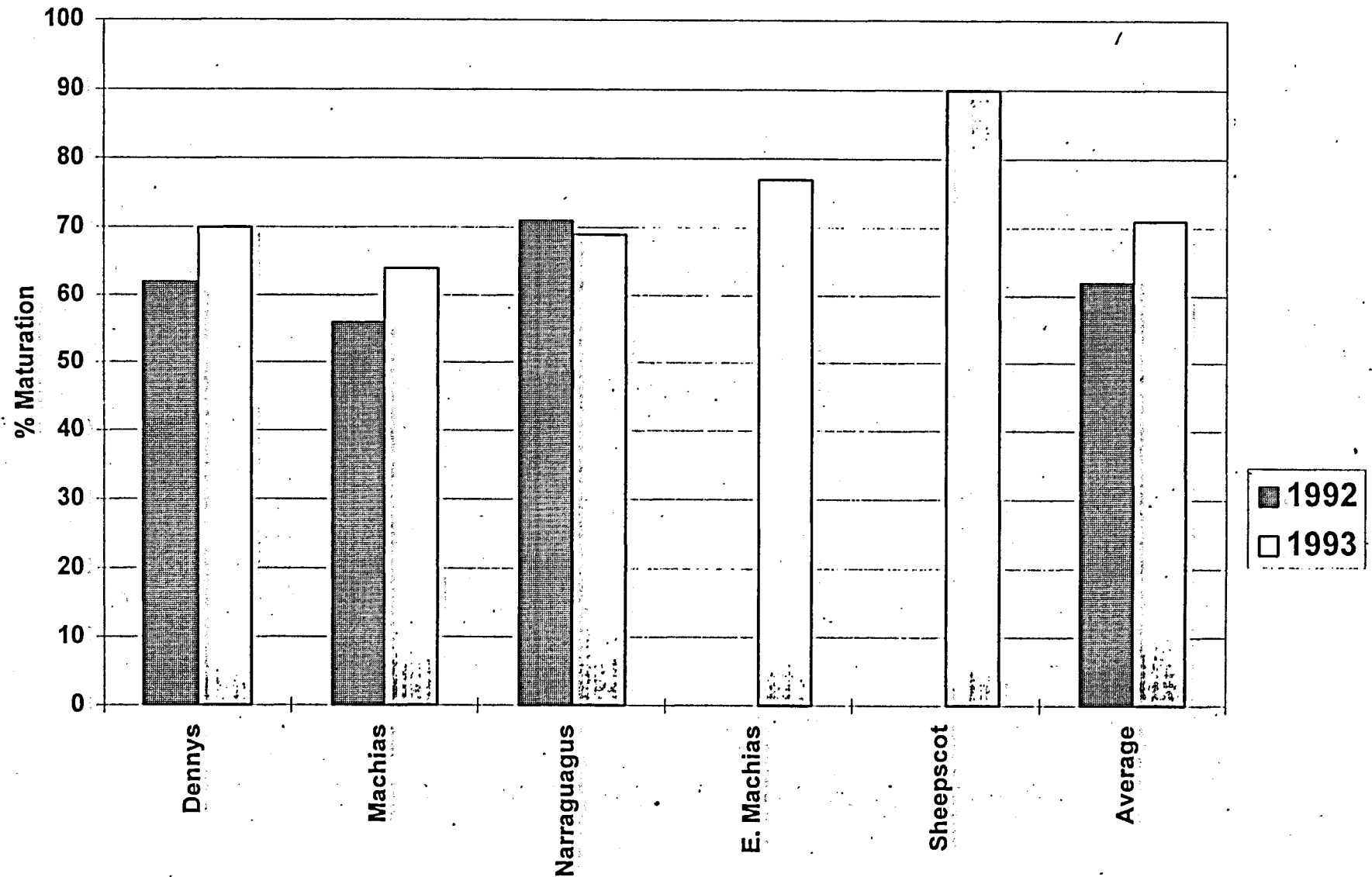


Figure 5. Sex ratios of 3+ maiden spawners.

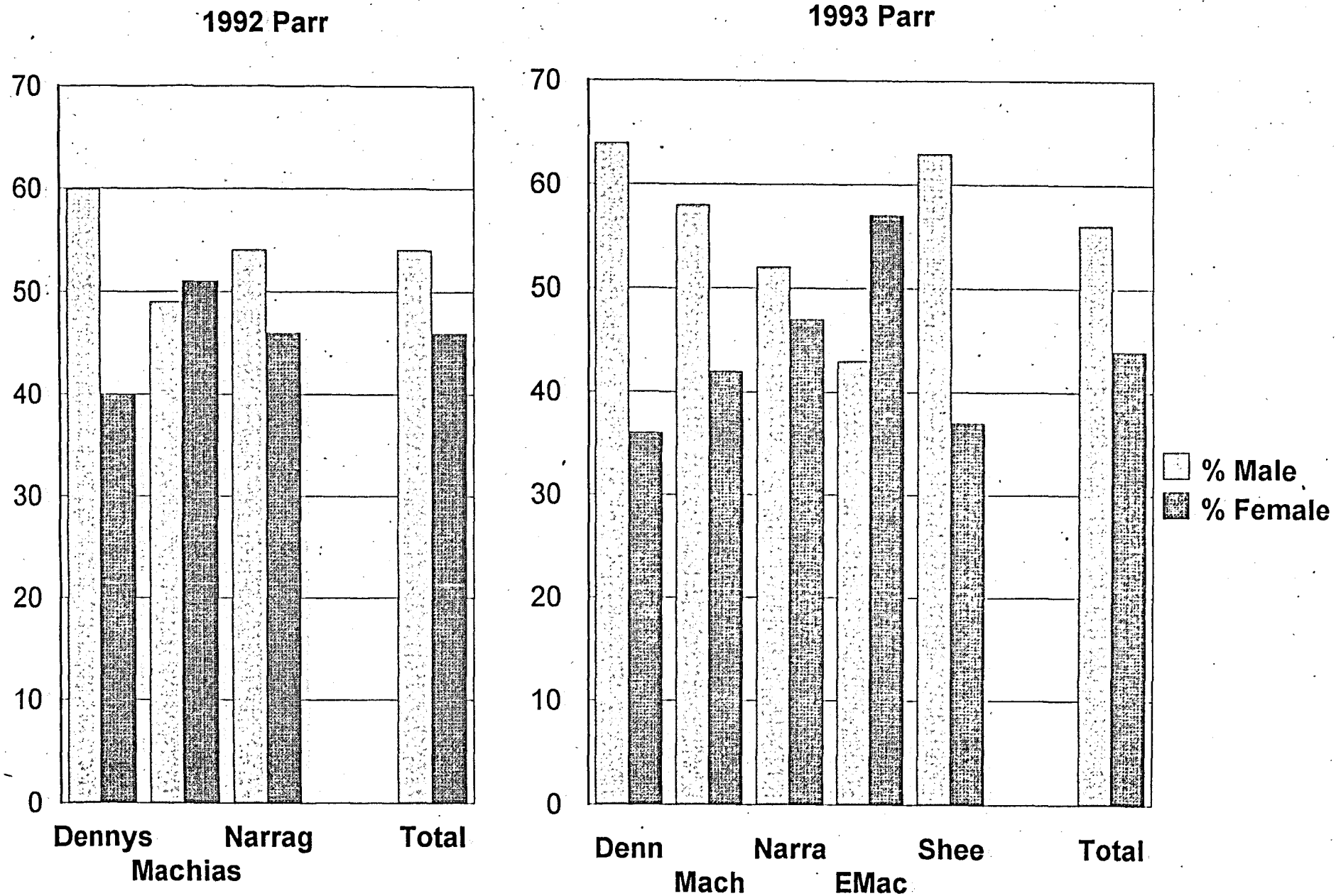
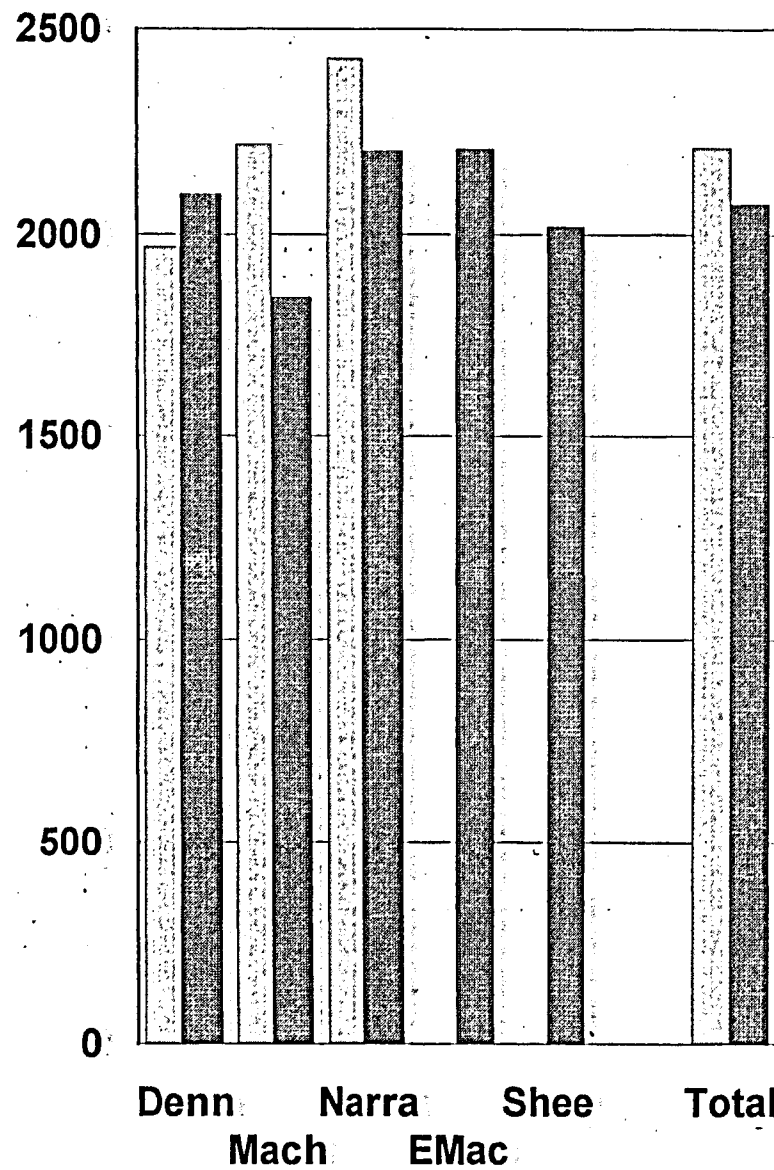


Figure 6. Fecundity of captive broodstock.

Eggs/female for age 3+ salmon



Eggs/ female for age 4+ & PS salmon

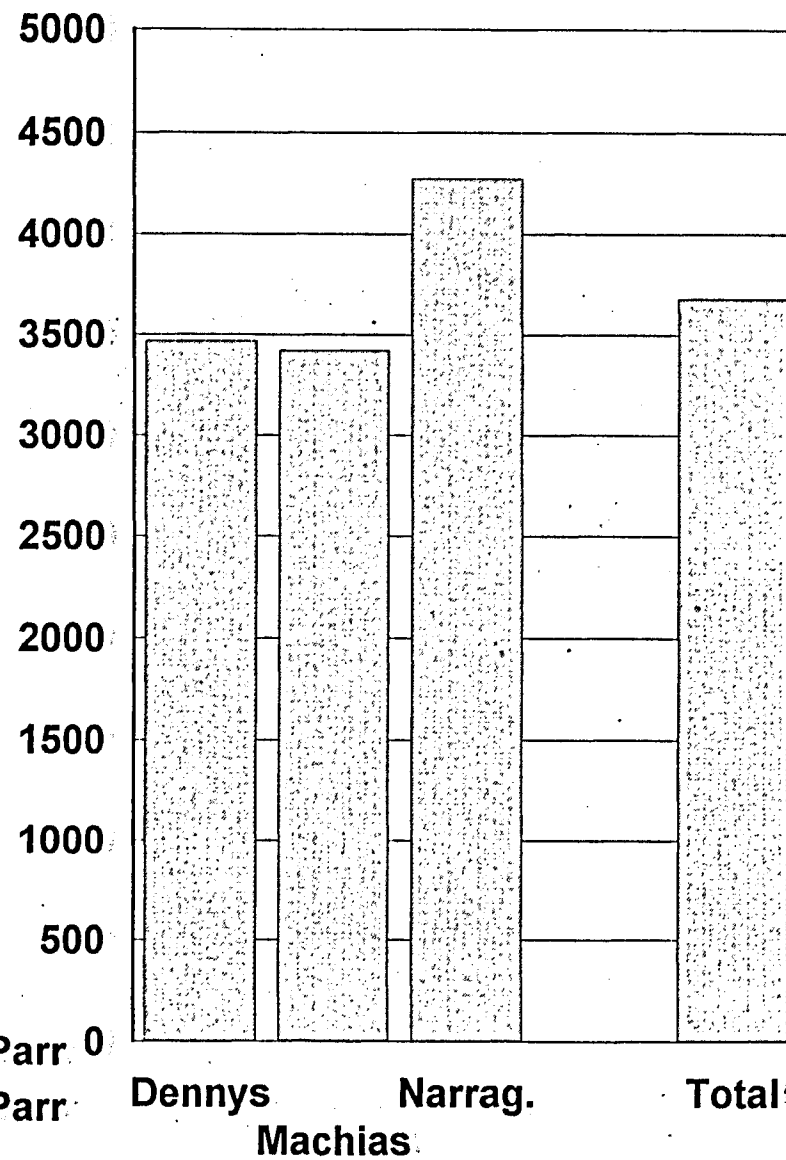


Figure 7. Number of Atlantic salmon fry stocked.
(85 % from captive parr broodstock program)

