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EXTENSIVE PRODUCTION OF ATLANTIC SALMON PARRS (SALMO SALAR L.) IN FOUR NURSERY STREAMS OF NORTHERN BRITTANY

by

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ABSTRACT

Restocking of four tributaries of the Aulne and Elorn rivers with Atlantic Salmon fry of foreign origin gave variable results from 1974 to 1977.

Survival rates at one year varied from 0.1 % to 1.7 %. It appeared that stocking stage and stream flow were the most important factors conditioning the parr production.

When flow increases normally in autumn and fry are planted at an appropriate stage (unfed fry), growth of parrs issued from foreign spawners is similar to parrs issued from the local population.

Considering the small number of fish migrating in these two rivers, Atlantic Salmon parr production of the two first streams restocked contributed to 5 % of the Aulne and Elorn rivers angling fishery during 1977 season.

RESUME

Des alevinages à partir d'alevins de Saumon Atlantique d'origine étrangère, pratiqués de 1974 à 1977 sur quatre ruisseaux affluents de l'Aulne et de l'Elorn, ont donné des rendements variables selon le ruisseau et l'année considérée.

Les taux de survie à 1 an se sont échelonnés de 0.1 % à 1.7 %. Il apparaît que le stade d'immersion de l'alevin et le débit du ruisseau ont joué un rôle prépondérant sur la production de jeunes saumons.

Lorsque l'étiage ne se prolonge pas pendant l'automne et que le stade d'immersion est approprié (alevins à vésicules non résorbées), la croissance des parrs issus d'oeufs d'origine étrangère est comparable à celle des parrs sauvages.

Compte tenu du faible nombre de saumons remontant ces deux rivières, la production en Saumon Atlantique issue des ruisseaux pépinières, bien que limitée, a contribué pour 5 % aux captures à la ligne sur l'Aulne et l'Elorn lors de la saison de pêche 1977.

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INTRODUCTION

Restocking of four tributaries of the Aulne and Elorn rivers have been performed since 1974 as a part of the management and Atlantic Salmon restocking program created by CNEXO (1) and A.P.P.S.B. (2), in relation with the "Fédération des Associations de pêche du Finistère" and local anglers associations.

This paper presents the quantitative results obtained during the three first restocking years, and the influence of various factors conditioning parr production, such as : stage of planting, flow variations and slope of the streams, are discussed.

Other factors such as competition between different species and the same species, physical characteristics of the streams and of the surrounding environment, are still being studied at the present time.

1 - CHARACTERISTICS OF THE RIVERS AND STREAMS

The AULNE is a river with a course of 143 km, channelled in its lower part, and flowing into the Rade de Brest. Restockings were performed in a tributary on the lower portion of the river : the Ster Vian, and one of its tributaries : the Runigou.

The source of the ELORN is in the "Monts d'Arrée" at an altitude of 290 m and the river flows into the Rade de Brest after a course of 58 km. The catching area (260 km2), cut by deep valleys, is made of a dense system of tributaries among which the Dour-ar-men-glas (medium course) and the Saint-Jean (lower course) have been selected for the planting experiments.

Physical and hydrological characteristics of these four streams are summarized in Table 1.

Figure 1 shows important flow variations on two nursery streams during the years 1974-1975.

Table 2 shows the fish population characteristics prior to restocking.

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(1) - Centre National pour l'Exploitation des Océans.
(2) - Association Pour la Protection du Saumon en Bretagne.

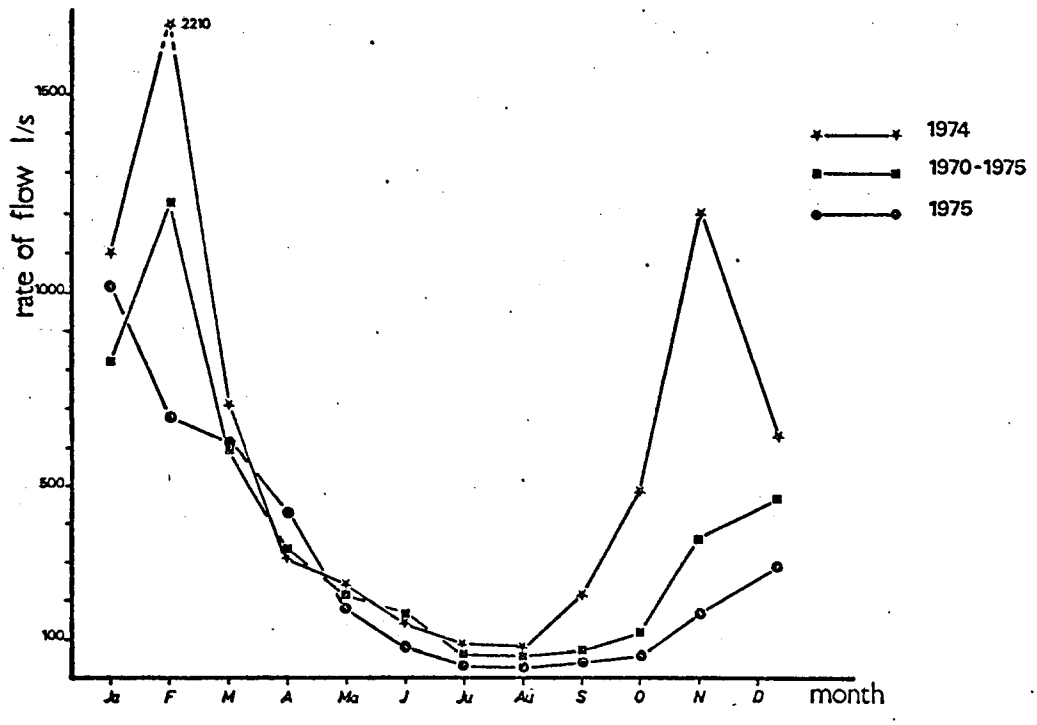
TABLE 1 - PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

	PHYSICAL CHARACTERISTICS								HYDROLOGICAL CHARACTERISTICS (1)						
STREAM	Environment	Substratum	Drainage area (km^2)	Length (km)	Width (m)	Slope (%)	Rate of flow (l/s)	Restocking area (m^2)	pH	oxygen / saturation (%)	Annual temperature range (°C)	Nitrites µatg N/l	Nitrates µatg N/l	BOD_5 (ml/l)	Calcium (2) (mg/l)
COUR-AR-MEN-GLAS	Grass land, turf-moors, brushwood, cultures and pig farms on the hillsides.	Schist and quartzit of Plougastel Graywacke of Le Faou and sanstone of Landevennec	8,3	5	2,07	1 (Max. 2,35)	50 to 300	4600 (1974) 5500 (1975 & 1976)	7,26 ± 0,11	100 ± 3,5	6 to 21	0,57 ± 0,29	110,6 ± 25	1,38 ± 0,52	3,5 to 8,5
SAINT-JEAN	Grass land, oak and chestnut tree groves alongside the medium and upper course of the stream.	Gedinnian schist and quartzit	6	4	2,03	3,5	30 to 260	3400	6,91 ± 0,18	100 ± 5,7		0,40 ± 0,6	105,0 ± 5,36	1,12 ± 0,98	3,5 to 8,5
STER-VIAN	Grass land, Oak, beech and alder groves, maize culture with manure spreading at the confluence ..	Schist of Chateaulin Graywacke of Le Faou Schist of Rostellec Nodules schist Limestone of Rozan and schist of Angers	26	14	4,03	1 (Max. 2)	50 to 1700	4500	7,10 ± 0,11	98 ± 2,6	5 to 18	0,58 ± 0,37	177,5 ± 38,7	1,28 ± 0,38	6 to 8
RUNIGOU	Grass land, maize culture with manure spreading	Limestone of Rozan and schist of Angers	3	3	1,5	3 (Max. 4)	6 to 160	1950							6 to 8

(1) - 4 to 23 analyses.

(2) - Analyses on Elorn and Aulne rivers.

STER-VIAN



DOUR-AR-MEN-GLAS

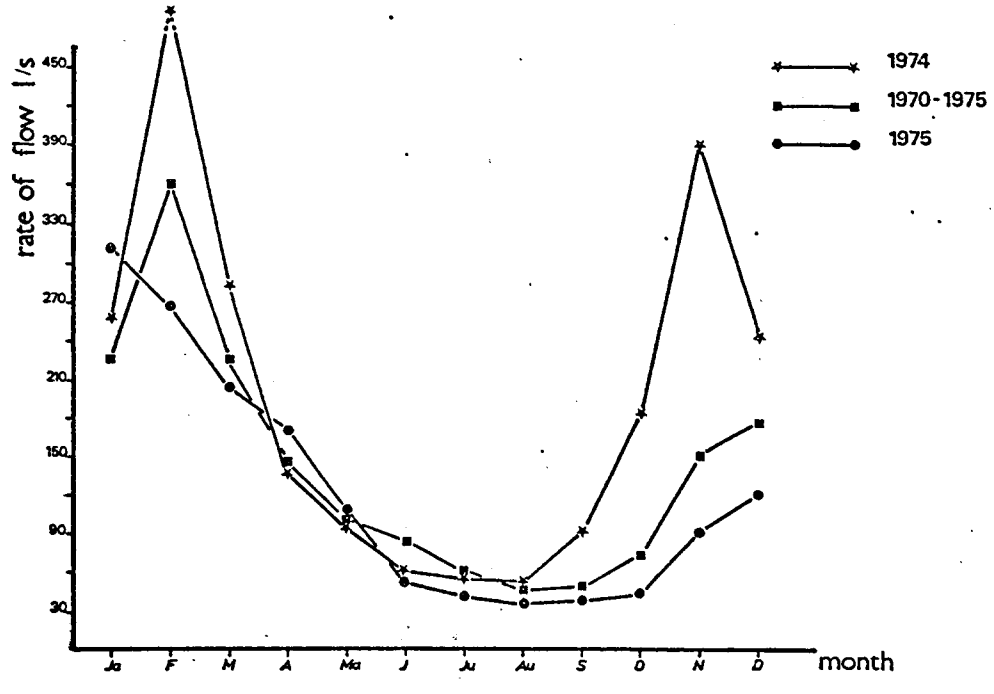


FIGURE 1 - Flow variations of two nursery streams.

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TABLE 2 - FISH POPULATION CHARACTERISTICS

STREAM	*Salmo trutta L.*		*Anguilla anguilla L.*		*Salmo salar L.*		*Cottus gobio L.*		*Noemacheilus barbatulus L.*	
	D/Ha	B/Ha (Kg)	D/Ha	B/Ha (Kg)	D/Ha	B/Ha (Kg)	D/Ha	B/Ha (Kg)	D/Ha	B/Ha (Kg)
Dour-ar-men-glas (12/09/74)	1700	50	340	30	20	0,3	4000	15	5	0,005
Saint-Jean (25/03/75)	1000	37,7	220	11,8	200	4,1	1500	4,5	0	0
Ster-Vian (11/04/74)	530	26,6	1100	90	90	1,46	900*	3,5	250	2,5
Runigou (11/03/75)	1010	42,3	470	46	0	0	2950	9	0	0

* Underestimated.

2 - METHODS

- Restocking technics

Trouts (Salmo trutta L.), eels (Anguilla anguilla L.) and bullheads (Cottus gobio L.) were removed by electrofishing one or two weeks before planting eggs or fry as it is shown that eel (ARRIGNON 1972), bullhead (PATTEN 1962) and trout (PIGGINS 1964 - EGGLISHAW 1967 and MILLS 1969) may have a negative influence on Atlantic Salmon parrs production.

Eggs obtained from Spring Salmon of the Tay River (Scotland) were imported and incubated in a french hatchery.

Restocking was performed either :

- in planting eggs in Vibert boxes : Saint-Jean, Ster Vian, Runigou (1976) ;
- in planting unfed fry in gravel nests at a density of 250 to 1 000 fry per nest : Dour-ar-men-glas (1974, 1975, 1976), Saint-Jean (1975), Ster Vian (1974) ;
- with fry at the feeding stage planted with the same technic : Ster Vian (1975), Runigou (1975).

The stocking densities varied from 2.5 to 7.7 eyed eggs or fry/m2 (cf. Table 3).

.../...

TABLE 3 - STOCKING DENSITY (Fry or eyed eggs/m2)

	DOUR-AR-MEN-GLAS			SAINT-JEAN		RUNIGOU		STER-VIAN		
	1974	1975	1976	1975	1976	1975	1976	1974	1975	1976
Eyed eggs					4,4		3,0			2,2
Alevin	7,7	7,3	2,5	4,4				5,6		
Fry						5,1			4,0	

- Investigation and calculation methods

A control electrofishing was performed twice a year during Spring and Autumn. Each stream was divided in 100 m sectors, isolated with stopnets. All the fish captured were anesthetized with MS 222, and salmonids were measured to the nearest m/m (fork length) and weighted to the nearest gram with a Mettler scale. Starting in 1975, all the parrs captured have been marked by adipose clip.

Calculation of the most probable population was performed with two different methods :

- SEBER and LE CREN (1967) method, based on two successive fishing efforts. This method produced underestimated results about the population of the young as shown by tagging experiments ;
- the PETERSEN method, based on recaptures of tagged fish which may have provided overestimated results for the same fish.

The simultaneous use of these two methods allowed us to find a medium value probably close enough of the real value of the population.

Productions were estimated for each population by the graphic method of ALLEN (1952).

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3 - RESULTS

- Survival (Table 4 - Fig. 2)

TABLE 4 - SALMO SALAR SURVIVAL RATE

t = time interval in months
Z = Instantaneous mortality rate
S = Survival rate

STER VIAN

	SEBER - LE CREN			
Date	N	t	Z	S
17/04/74	68 ± 26			
		11	0,854	0,426
12/03/75	29 ± 2			

Natural population (1 to 2 years old)

	SEBER - LE CREN				PETERSEN			
Date	N	t	Z	S	N	t	Z	S
19/04/74	25.000				25.000			
		5	4,69	0,014		5	3,93	0,023
18/09/74	350 ± 28				493			
		6	0,758	0,468		6	0,758	0,468
12/03/75	164 ± 38				231 ± 38			
		8	0,373	0,689		8	0,567	0,567
07/11/75	113 ± 3				131 ± 12			
		3	0,384	0,681		3	0,384	0,681
14/02/76	77 ± 4				90*			

1st restocking

	SEBER - LE CREN				PETERSEN			
Date	N	t	Z	S	N	t	Z	S
01/04/75	18.000				18.000			
		7	5,37	0,005		7	4,68	0,009
07/11/75	84 ± 14				167 ± 65			
		3	0,847	0,429		3	0,847	0,429
14/02/76	36 ± 18				72*			

2nd restocking

DOUR-AR-MEN-GLAS

	SEBER - LE CREN				PETERSEN			
Date	N	t	Z	S	N	t	Z	S
14/04/74	35.000				35.000			
		5	4,41	0,0136		5	3,63	0,026
20/09/74	470 ± 24				930			
		5	0,65	0,522		5	0,65	0,522
21/02/74	245 ± 8				484 ± 92			
		9	0,746	0,474		9	1,265	0,282
15/11/75	116 ± 10				137 ± 18			
		3	0,714	0,49		3	0,724	0,485
06/02/76	57 ± 1				66 ± 17			
		8	2,097	0,123		8	2,097	0,123
13/10/76	7				8*			

1st restocking

	SEBER - LE CREN				PETERSEN			
Date	N	t	Z	S	N	t	Z	S
20/03/75	40.000				40.000			
		8	4,896	0,007		8	4,446	0,012
15/11/75	299 ± 25				469 ± 104			
		3	0,541	0,582		3	1,003	0,367
06/02/76	172 ± 30				174 ± 17			
		8	0,623	0,536		8	0,623	0,536
13/10/76	92 ± 1				93*			

2nd restocking

	SEBER - LE CREN			
Date	N	t	Z	S
03/03/76	10.500			
		7	4,523	0,011
13/10/76	114 ± 26			

3rd restocking

* Estimated.

.../...

SAINT-JEAN

	SEBER - LE CREN				PETERSEN			
Date	N	t	Z	S	N	t	Z	S
27/02/75	⩾ 34	11	0,348	0,706	53 ± 27	11	0,792	0,453
08/02/75	24				24*			

Natural population (1 to 2 years old)

	SEBER - LE CREN			
Date	N	t	Z	S
25/03/75	15.000	10	4,082	0,0169
08/02/76	253 ± 8			

1st restocking

RUNIGOU

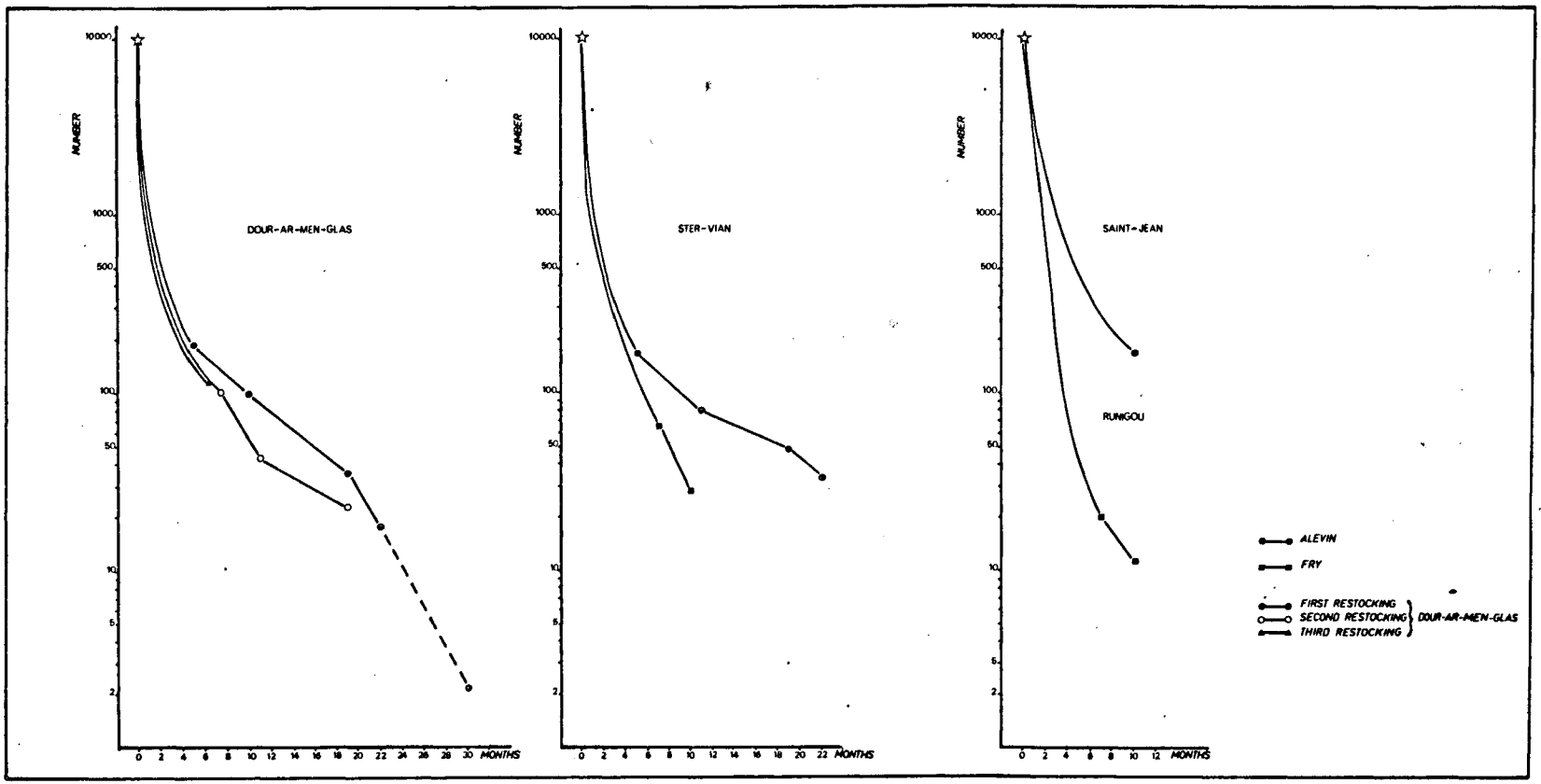
	SEBER - LE CREN				PETERSEN			
Date	N	t	Z	S	N	t	Z	S
01/04/75	10.000	7	6,32	0,0018	10.000	7	6,058	0,0023
08/11/75	18 ± 7	3	0,578	0,561	23 ± 8	3	0,578	0,561
13/02/76	10 ± 1				13*			

Restocking

* Estimated.

.../...

FIGURE 2 - Parr survival rates



Between 1974 and 1976, a variation of the survival rate is appearing, for different years and streams, between 0.1 % to 1.7 % from fry to 1 year parr.

The lower survival rate was obtained on the Runigou during the Spring of 1976, with alevin planting (stocking density : 5.1 fry/m2).

The higher rate was found in the Saint-Jean during the Spring of 1976 with unfed fry (stocking density 4.4 fry/m2).

In the other streams, survival rates between fry and one year parr were :

Dour-ar-men-glas : 1 % Spring 1975 (unfed fry - stocking density : 7.7/m2)
0.6 % Spring 1976 (unfed fry - stocking density : 7.3/m2)

Ster-Vian : 0.9 % Spring 1975 (unfed fry - stocking density : 5.6/m2)
0.28 % Spring 1976 (alevin - stocking density : 4/m2).

- Dispersion

The tendancy of Atlantic Salmon fry to migrate downstream was very sensible on Dour-ar-men-glas in 1974, where a higher density is found in Autumn in the lower part of the stream. Dispersion seems then to stabilize during winter months (Fig. 3).

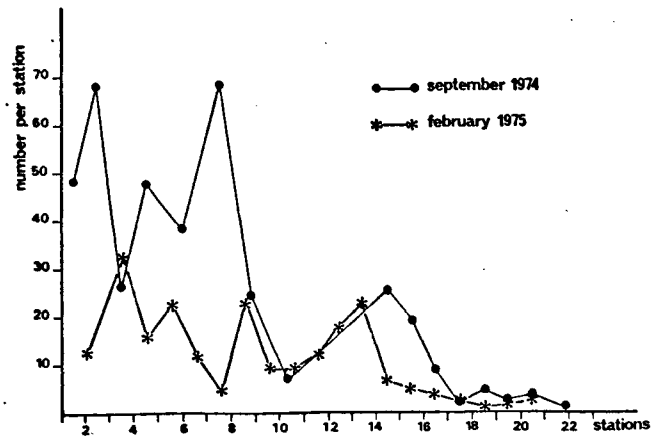


FIGURE 3 - Parrs dispersion on the Dour-ar-men-glas

This migration seems to correspond with the downstream movement of the bigger parrs which will smolt during the following spring, as shown by EGGLISHAW and SHACKLEY (1973).

However, it is highly possible that the important flow in Autumn 1974 increased this migration which is not so sensible in Autumn 1975 with lower waters.

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- Growth

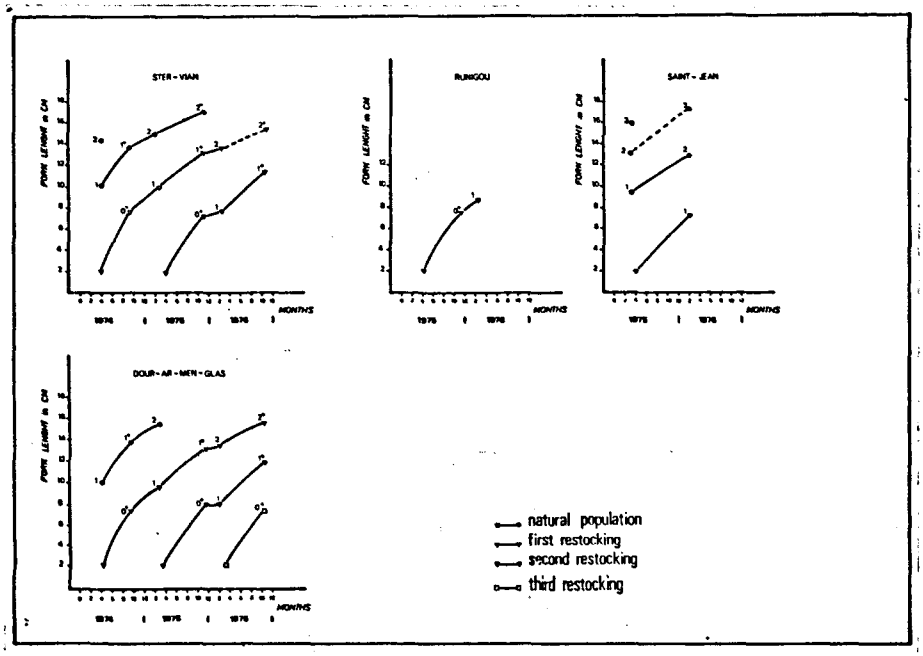
For one year fish, the lower growth rates are obtained in the Saint-Jean in 1976 (average fork length : 7.2 cm) and the better growth rate is found in Dour-ar-men-glas and Ster Vian in 1975 (9.5 and 9.9 cm) (Table 5 - Fig. 4).

TABLE 5 - GROWTH IN LENGTH OF ATLANTIC SALMON PARR (Fork length in cm)

AGE	DOUR-AR-MEN-GLAS								SAINT-JEAN				RUNIGOU		STER-VIAN					
	Natural population		1974 - 1st restocking		1975 - 2nd restocking		1976 - 3rd restocking		Natural population		1975 - 1st restocking		1975 - 1st restocking		Natural population		1974 - 1st restocking		1975 - 2nd restocking	
	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m	$\bar{L}$	Li/m
0+			7,40 ± 0,09	3,14	8,02 ± 0,19	2,08	7,44 ± 0,22	2,25				1,54	7,42 ± 0,54	2,25			7,65 ± 0,12	3,22	7,15 ± 0,21	2,18
				0,611		-0,034								0,659				0,514		0,228
1	9,93 ± 0,6		9,54 ± 0,22		7,96 ± 0,23				9,49 ± 0,6		7,25 ± 0,12		8,75 ± 0,9		10,13 ± 0,35		9,90 ± 0,25		7,57 ± 0,44	
		0,77		0,471		0,586				0,354						0,711		0,424		0,605
1+	13,76 ± 0,41		13,05 ± 0,18		11,76 ± 0,20										13,63 ± 0,24		13,13 ± 0,21		11,33 ± 0,34	
		0,27		0,103												0,189		0,093		
2	15,40 ± 0,86		13,40 ± 0,27						13,37 ± 0,36 13,05 ± 0,21 12,67 ± 0,51						14,33 ± 0,59 14,97 ± 0,35		13,43 ± 0,25			
				0,224						0,209						0,196				
2+	xx 16,2		15,55 ± 0,30												17,06 ± 0,67		xx 15,3			
3									15,88 ± 0,71											

Li/m = monthly length growth rate (cm) $\bar{L}$ = average length (cm) xx one fish

FIGURE 4 - Growth in length of immersed Atlantic Salmon parrs



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In the three streams presenting a small natural population, one year parrs do not present significant size difference.

In 1975, the average length of planted parrs is not significantly different from the size of the wild parr's, when planted parrs of the same origin were significantly smaller in 1976.

In 1975, one year parrs present the same size in both streams planted, but in 1976 a significant difference appeared in the Saint-Jean which produced smaller fish.

In 1976, the average length at one year is generally smaller than restocked and wild parrs obtained the previous year.

The population inventory realized in the Spring of 1975 shows a bimodal distribution frequency of one year fish (averages : 7.65 and 10.58 cm) (Dour-ar-men-glas).

This fact, discussed by SIMPSON & THORPE (1976) for hatchery reared fish seems to characterize the part of the population due to smolt at one year and slow growing fish which will stay two years in the river.

This bimodal repartition does not appear the following year, as growth rates are inferior (1.51 in 1976 and 1.88 in 1975) (Table 6 - Fig. 5).

TABLE 6 - GROWTH IN WEIGHT OF ATLANTIC SALMON PARR (Weight in grams)

AGE	DOUR-AR-MEN-GLAS								SAINT-JEAN				RUNIGOU		STER-VIAN					
	Natural population		1974 - 1st restocking		1975 - 2nd restocking		1975 - 3rd restocking		Natural population		1975 - 1st restocking		1975 - 1st restocking		Natural population		1974 - 1st restocking		1975 - 2nd restocking	
	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m	$\bar{G}$	Gi/m
0+			5,55 ± 0,18	9,01	7,11 ± 0,48	6,00	5,61 ± 0,51	6,45				4,33	4,93 ± 1,15	6,23			6,37 ± 0,28	9,34	4,43 ± 0,59	6,05
				1,49		- 0,78								1,79				1,22		0,57
1	14,22 ± 2,27	2,09	10,31 ± 0,64	1,44	5,85 ± 0,57	1,86			10,76 ± 2,50	0,92	4,78 ± 0,27		7,71 ± 1,90		13,40 ± 1,22	2,02	11,61 ± 0,97	1,28	5,11 ± 1,08	1,52
1+	34,01 ± 6,92	0,527	26,87 ± 1,14	-0,016	20,26 ± 1,22										31,06 ± 1,67	0,299	27,29 ± 1,56	0,047	14,06 ± 1,85	
2	42,35 ± 8,26		26,76 ± 1,74	0,597					26,11 ± 1,98	0,69					35,5 ± 2,27 38,3 ± 2,93	0,590	27,61 ± 1,66			
2+	x 46,1		39,83 ± 5,95												53,36 ± 6,64		x 34,7			
3									47,00 ± 3,52											

Gi/m = monthly weight growth rate (g) $\bar{G}$ = average weight (g) x one fish

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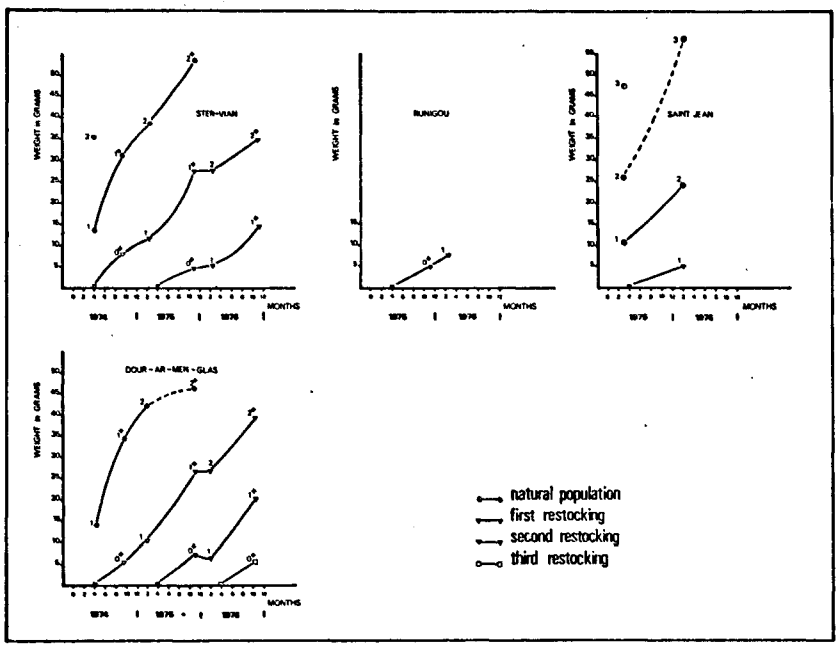
FIGURE 5 - Growth in weight of immersed Atlantic Salmon parrs



- Biomass and density

Natural population of parrs in the streams studied are constituted in a majority of one and two years fish.

Scale reading observations of adults captured during the fishing season in both the Aulne and Elorn rivers between 1971 and 1977 confirm this result. Population issued from the 1974 restocking is formed of two age classes and population analysis on Dour-ar-men-glas during the Spring of 1976 suggests that about 50 % of the parrs will smolt as yearlings, 50 % as two years old fish and very few as three years old.

The variation limits of biomass and density are as follow :

• Biomass

- age class 0^+ = 10 g / 100 m2 (Runigou 1975)
  to 90 g / 100 m2 (Dour-ar-men-glas 1974)
- age class 1 = 4 g / 100 m2 (Runigou 1976)
  to 70 g / 100 m2 (Dour-ar-men-glas 1975)
- age class 1^+ = 34 g / 100 m2 (Dour-ar-men-glas 1976)
  to 74 g / 100 m2 (Ster-Vian 1976)
- age class 2 = 30 g / 100 m2 (Dour-ar-men-glas 1976)
- age class 2^+ = 5.5 g / 100 m2 (Dour-ar-men-glas 1976).

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• Density

- age class 0^+ = 1 / 100 m2 (Runigou 1975)
  to 15.2 / 100 m2 (Dour-ar-men-glas 1974)
- age class 1 = 0.6 / 100 m2 (Runigou 1976)
  to 7.6 / 100 m2 (Saint-Jean 1976)
- age class 1^+ = 1.7 / 100 m2 (Dour-ar-men-glas 1976)
  to 2.7 / 100 m2 (Ster-Vian 1976)
- age class 2 = 1.13 / 100 m2 (Dour-ar-men-glas 1976)
- age class 2^+ = 0.14 / 100 m2 (Dour-ar-men-glas 1976).

TABLE 7 - BIOMASS AND DENSITY OF SALMO SALAR

		DOUR-AR-MEN-GLAS						SAINT-JEAN		RUNIGOU				STER-VIAN					
		1974		1975		1976		1975	1976	1975		1976		1974		1975		1976	
		Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Spring	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
BIOMASS (g / 100 m²)	Alevin	98,9		94,5		24,8		57,3						72,2					
	Fry									66,9						52,0			
	0^+		56,7 à 112,2		38,6 à 60,5		11,6 à 14,3				4,6 à 5,8		0 xx		49,6 à 69,8		8,3 à 16,4		0 xx
	1	2,47		46 à 90,7		18,3 à 18,5		5,7 à 16,8	35,6 à 36,7			3,9 à 5,1		6,3 à 7,9		42,3 à 59,6		4,1 à 8,2	
	1^+		3,1		56,9 à 66,9		33,9 à 34,3						0 xx		27,6 à 29,0		68,5 à 79,4		0 xx
	2			1,54		27,7 à 32,3		36,9 à 56,8	17,2					21,8 à 35,9		24,5 à 25,5		47,2 à 55,2	
	2^+						5,1 à 5,8										5,9		
	3^+								3,5										
	TOTAL	101,3	60,4 à 115,9	142 à 187	95,5 à 127,4	70,8 à 75,6	50,6 à 54,3	99,9 à 131	56,3 à 57,4	66,9	4,6 à 5,8	3,9 à 5,1	0	94 à 108	77,2 à 98,8	118,3 à 137,1	82,7 à 101,8	51,3 à 63,4	
NUMBER / 100 m²	Alevin	760		727		191		441				304 x		556				222 x	
	Fry									513						400			
	0^+		10,2 à 20,2		5,43 à 8,52		2,07 à 2,55				0,92 à 1,18		0 xx		7,78 à 10,96		1,87 à 3,71		0 xx
	1	0,17		4,46 à 4,80		3,13 à 3,16		0,53 à 1,56	7,44 à 7,68			0,51 à 0,67		1,16 à 2,09		3,64 à 5,13		0,80 à 1,60	
	1^+		0,11		2,12 à 2,49		1,67 à 1,69						0 xx		0,89 à 0,93		2,51 à 2,91		0 xx
	2			0,04		1,04 à 1,21		1,41 à 2,18	0,71					0,18 à 0,22		0,64 à 0,67		1,71 à 2,00	
	2^+						0,13 à 0,15										0,11		
	3								0,06										
	TOTAL	760,2	10,3 à 20,3	732 à 736	7,55 à 11,01	195 à 195,3	3,87 à 4,39	442,9 à 444,7	8,21 à 8,45	513	0,92 à 1,18	0,51 à 0,67	0	557,3 à 558,3	8,67 à 11,89	404,3 à 405,8	4,49 à 6,73	2,51 à 3,60 + 222 oeufs	

x eyed eggs

xx no water during the summer months

During successive control fishing (Ster-Vian, Dour-ar-men-glas) prior to planting fry, a decrease of biomass and density of trouts is observed, possibly due to two main causes :

- removal of trouts at each control fishing ;
- territorial occupation by Atlantic Salmon fry before downstream migration of the trout fry issued from upstream spawning areas.

This decrease is not, however, associated with a relative increase of the biomass and density of parrs (Fig. 6, P. 18).

- Production

The most important production levels are obtained with the 0 age group. An increase of production occurs during the Spring-Summer period and a decrease during the Autumn-Winter months (Dour-ar-men-glas, Ster-Vian). The low production level of the Autumn 1975-Winter 1976 period, associated to an important diminishment of the growth rate and density, can be attributed mainly to very low waters during this period (Table 8, P. 19).

- Adults recapture

Between November, 1976, and June, 1977, six adipose clipped salmon were recaptured and declared by anglers in the Aulne and Elorn rivers, 5 of which were caught during the 1977 fishing season (Table 9, P. 20).

Considering the existence of a small natural population of Atlantic Salmon parrs in 1974 when the first planting occured (Dour-ar-men-glas, Ster-Vian), it is impossible to evaluate the exact contribution of the restocking to the fishery.

Scale reading of one fish (captured on April 5, 1977) shows that this fish cannot originate from the restocking.

- ELORN

The 3 salmon recaptured on this river came from a group of 237 parrs clipped on February 21, 1975. This group was formed by two populations characterized by different growth rates. One was formed of slowgrowing fish (number : 120 - average length : 7.65 cm), the other part was constituted by faster growers (number : 117 - average length : 10.58 cm).

By November 15, 1975, only 56 tagged salmon were found in the stream, suggesting that a maximum of 180 smolts migrated downstream during the Spring of 1975. However, it is reasonable to think that most of the smolts belonged to the fast growing part of the population (117 parrs).

In these conditions, the recapture rate would be ranging between 1.66 % and 2.56 %, considering that all the tagged fish were reported by the anglers.

.../...

• AULNE

The 3 adults recaptured came from a group of 156 parrs adipose clipped on March 12, 1975, 134 of them being yearlings.

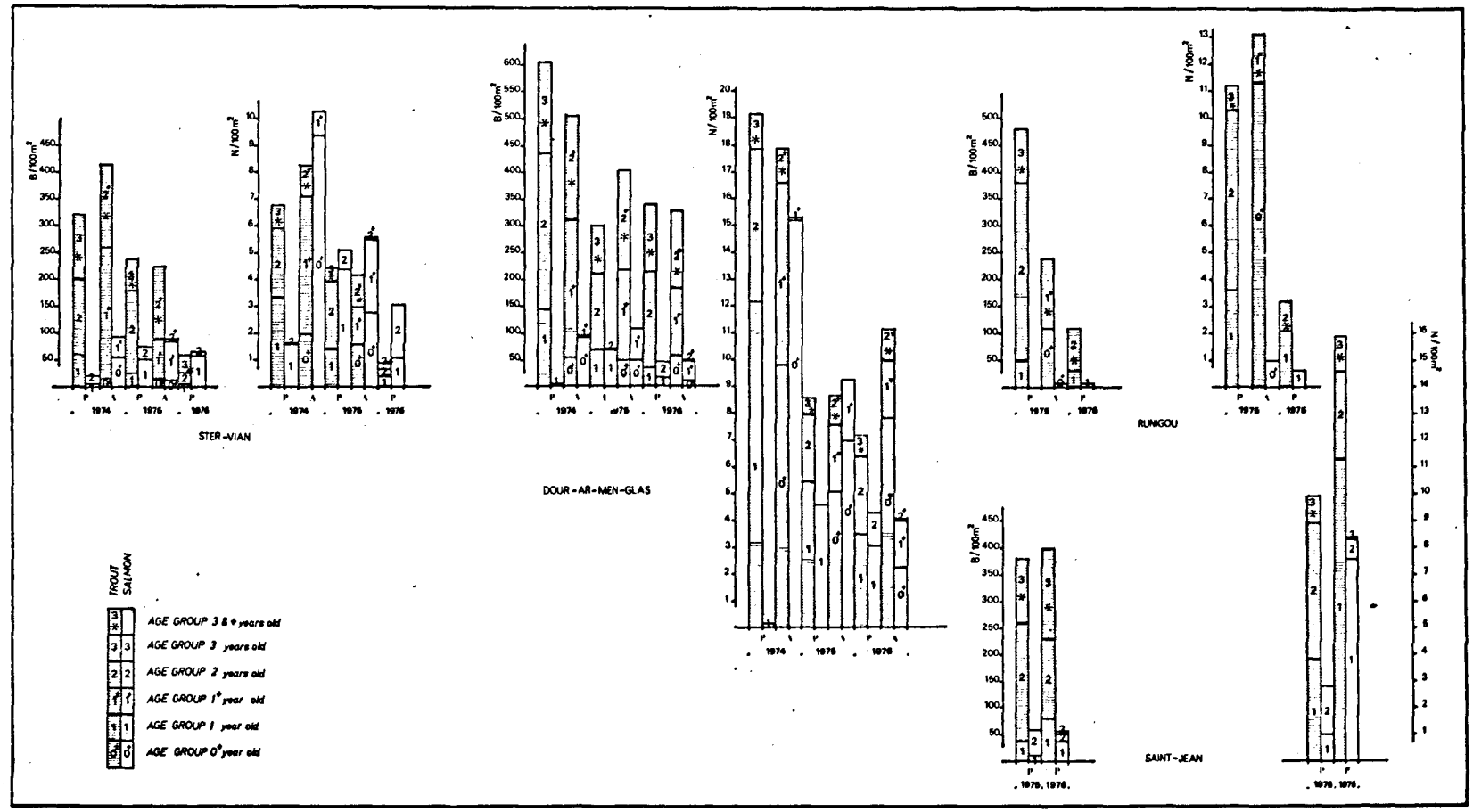
On November 10, 1975, 61 parrs were found in the stream.

We can consider that the adults caught came from 95 parrs (78 yearlings and 17 two years).

The rate of recapture is 3.16 %.

.../...

FIGURE 6 - Trout (Salmo trutta L.) and Salmon (Salmo salar L.) biomass and density



According to MUNDIE (1974), the first decision to optimize a nursery stream would be to set discharge within defined limits.

During our restocking experiments, important flow variations were recorded. Heavy floods occuring during the 1974-1975 Winter have probably favorized precocious downstream migration, especially in steep slope streams as Dour-ar-men-glas, as shown by the dispersion curve. Such phenomena are demonstrated by MILLS (1969) and BULLEID (1972).

The unusual flow reduction of the following year seems to induce a similar behaviour. The decrease of the average length of the same age class between two inventories, indicating the migration of a proportion of the bigger fish, due to smolt the next Spring. This negative effect can be attributed to the diminishment of territorial surface inducing agressive behaviour.

Consequently, a neat decrease of the growth rate is visible at the same period, compared to the results of the previous year.

The slope of the streams also affects the productivity of a nursery stream. The best results are obtained in Saint-Jean in 1975. This stream is characterized by numerous successions of pools and riffles considered by MUNDIE (1974) as the optimum environment for smolt production.

In a given stream, it was impossible to prove a clear correlation between the decrease of biomass and density of trouts and a relative increase of productivity for the Atlantic Salmon fry plantings.

BACKIEL and LE CREN (1967) showed a correlation between the mortality rate of young salmon and total density of salmon and trout in a stream, and HUNT (1974) found a negative correlation between brook trout (Salvellinus fontinalis) underyearling production and yearling production.

Thus, a competition between 0 age and 1 year parrs may have existed after the second restocking, masking the positive effect of the decrease in density and biomass of trouts.

However, we found :

- that two plantings realized in similar conditions (stocking stage and density) show a significantly higher salmon survival rate in the stream presenting the lowest trout density (4.2/100 m2 - Ster-Vian ; and 13.2/100 m2 - Runigou ; Autumn 1975) ;
- during the Autumn-Winter 1974-1975 period, growth rates were much lower than the previous year, except on the Runigou where total density of trout and yearling parrs was low.

.../...

CONCLUSION

The first results of this study allow us to evaluate the possibilities of extensive production of Atlantic Salmon parrs in small tributaries and show the major influence of immersion stage on a restocking efficiency.

However, the impossibility to control the downstream migrations does not allow us to define precisely the real yield of the stream.

When stocked in appropriate conditions, fry issued from a foreign stock of eggs present growth characteristics similar to wild parrs, in spite of a later hatching date.

It is thus possible with northern strains of salmon to obtain an important rate of one year smolts, showing the importance of the environmental conditions on the dynamic characteristics of the population.

The first fish recaptured (6) issued from the two first streams planted contribute to about 5 % of the captures of the 1977 angling season, on the Aulne and Elorn rivers (330 fish caught) showing the importance of parr production in small tributaries in the total Atlantic Salmon production of a small river.

This type of restocking, although insufficient, can be recommended as a complementary technic for rivers like the Aulne and the Elorn where Atlantic Salmon stocks present a dangerous depletion, especially if the spawning grounds surface is under exploited.

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