

**Final Evaluation of Chinook Salmon Net Pen Studies  
at Oak Orchard and Lower Niagara River**

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Several cooperative pen rearing projects for Chinook salmon have been conducted annually in New York since 1998. Initial evaluations of pen-reared Chinook salmon were done at Oak Orchard Creek and the Lower Niagara River and are now essentially complete with returns through age-3 from both sites. This report summarizes the relative performance of pen-reared and direct stocked fish. Indicators include the relative contribution of pen-reared and traditionally stocked fish to the sport fishery and/or hatchery run, as well as relative rates of adult fish homing to their respective stocking sites.

**Methods**

A four year (1999-2002) marking study was conducted to evaluate the relative performance of Chinook salmon stocked at Oak Orchard Creek and Lower Niagara River. Three lots of 40,000 fin clipped fish were stocked at Oak Orchard in 1999 and 2001 and Lower Niagara River in 2000 and 2002 (Table 1). Each year, one lot consisted of fish raised at Salmon River Hatchery and stocked directly into the tributary. A second lot was raised at Caledonia Hatchery and also stocked directly into the tributary, and the third lot was Salmon River fish stocked into net pens. The fish stocked into the pens were reared for an additional period of approximately 2-3 weeks and then released. Returns have been monitored from 2001-2004 at Oak Orchard Creek and 2001-2005 at Lower

Niagara River, and at the Salmon River Hatchery since 2000.

For Chinook data collected in 2001, ages were assigned to fish from the pen experiments on the basis of length frequency. Since all returns were from age-1 and age-2 fish, all fish <28.5 in (725mm) were assigned age-1 (2000 year class (yc)) and larger fish were assigned age-2 (1999 yc). Ages were determined from scale samples for the 2002 through 2005 samples.

Chi square tests were performed to evaluate departures from expected return ratios (1:1:1) to the return sites. To evaluate homing, chi square tests of association were performed to compare distributions of returns from each year class to the different monitoring sites for all three stocking methods. We used SAS release 8.0 (SAS Institute 1999) for all statistical analyses reported here.

**Results and Discussion**

The 2001 yc returning at age-3 in 2004 completed the Oak Orchard evaluation. Returns from the 1999 and 2001 stockings at Oak Orchard Creek showed that more pen reared fish returned to the stocking site than either of the hatchery stockings (Table 2). For the 1999 stocking, more direct stocked Caledonia fish returned than direct stocked Salmon River fish; however, the opposite was true, to a lesser degree, for the 2001 stocking.

Table 1. NYSDEC fin clips for Chinook salmon by year class, stocking site, hatchery (CD-Caledonia, SR-Salmon River), and stocking method (DIR-direct, PEN-pen reared).

Year class	Stocking Site	Hatchery-Method	Fin Clip			
			LV	RV	LP	RP
2002	L Niagara R	CD-DIR				X
2002	L Niagara R	SR-DIR	X			
2002	L Niagara R	SR-PEN		X		
2001	Oak Orchard Ck	CD-DIR				X
2001	Oak Orchard Ck	SR-DIR	X			
2001	Oak Orchard Ck	SR-PEN		X		
2000	L Niagara R	CD-DIR				X
2000	L Niagara R	SR-DIR	X			
2000	L Niagara R	SR-PEN		X		
1999	Oak Orchard Ck	CD-DIR		X		
1999	Oak Orchard Ck	SR-DIR			X	
1999	Oak Orchard Ck	SR-PEN				X

Returns of the 2000 and 2002 year classes to the Niagara River showed a very different pattern. There, direct stocked Salmon River fish returned best, followed by pen reared fish, and direct stocked Caledonia fish returned poorest.

Chinook straying from either stocking site to the Salmon River Hatchery was negligible, regardless of stocking method. Only three of the study fish were collected at the hatchery. One marked fish originated from the 2000 Niagara River pen stocking. The other two originated from Salmon River direct stocked fish, one from the 1999 Oak Orchard stocking and the other from the 2002 Lower Niagara River stocking.

Chi-square tests of association revealed that no differences ( $p > 0.45$ ) in relative returns for either of the Niagara River stockings (i.e., stocking method had no effect on the relative amount of straying). At Oak Orchard, however, there were significant differences ( $p < 0.04$ ) in the distribution of strays from the different stocking methods. For the 1999 yc, relatively

higher numbers of direct stocked Salmon River fish strayed to the Niagara River. For the 2001 yc, relatively higher numbers of direct stocked Caledonia fish strayed to the Niagara River. For both year classes, and especially the 2001 yc, the tendency for relatively fewer pen reared fish to stray suggests a relatively strong homing affinity to Oak Orchard.

One particularly noteworthy result of this study is the relatively high numbers of unmarked Chinook observed each year at both sites. For example, 77.4% of all Chinook stocked at Oak Orchard in 2001 were fin clipped. In 2004, 1,782 Chinook salmon were examined at Oak Orchard, only 68 (3.8%) of which were marked fish from the 2001 stocking. Similarly, 65% of all Chinook stocked in the Lower Niagara River in 2002 were marked, but only 66 marked fish (8% of the sample) from that stocking were observed in the Lower Niagara River in 2004.

Table 2. Chi square tests for 1:1:1 return ratios of Chinook salmon stocked from the Caledonia Hatchery (direct/CD), the Salmon River Hatchery (direct/SR), and Salmon River Hatchery fish reared in net pens (pen/SR) at Oak Orchard and the Lower Niagara River 1999-2002.

Year class	Stocking Location	Return Location	Year Returned	Method / Hatchery			chi square	p
				direct /CD	direct /SR	pen /SR		
2002	Niagara R	Niagara R	2003	10	18	18	2.8	0.24
			2004	14	32	20	7.7	0.02
			2005	30	46	29	5.3	0.07
			All	54	96	67	12.9	< 0.01
		Oak Orchard	2003	1	0	0	-	-
			2004	2	8	4	4.0	0.13
All	3		8	4	2.3	0.24		
2001	Oak Orchard	Niagara R	2002	1	2	0	-	-
			2003	12	8	8	1.2	0.56
			2004	3	4	8	2.8	0.24
			2005	0	1	2	-	-
			All	16	15	18	0.3	0.86
		Oak Orchard	2002	1	0	1	-	-
			2003	8	3	32	33.9	< 0.01
			2004	5	18	45	37.1	< 0.01
			All	14	21	78	66.1	< 0.01
			2000	Niagara R	Niagara R	2001	6	35
2002	46	52				52	0.5	0.78
2003	90	115				113	3.7	0.15
2004	0	1				0	-	-
All	142	203				181	11.0	< 0.01
Oak Orchard	2001	1			1	1	-	-
	2002	3			3	2	0.3	0.88
	2003	4			6	12	4.8	0.09
	2004	1			0	0	-	-
	All	9			10	15	1.8	0.40
1999	Oak Orchard	Niagara R	2001	4	9	4	3.0	0.23
			2002	5	2	7	2.7	0.25
			2003	2	0	1	-	-
			All	11	11	12	0.6	0.96
		Oak Orchard	2001	20	4	27	16.5	< 0.01
			2002	18	9	31	12.8	< 0.01
			2003	0	2	0	-	-
			All	38	15	58	25.3	< 0.01

The relatively poor representation of marked fish in these evaluations is surprising. Spawning runs are composed of primarily age-2 and 3 fish, therefore approximately half of the sample in a given year at a given site was from a year class with a high percentage of stocked, marked fish.

Consequently, we would have expected to see a higher percentage of marked fish in the samples.

Reasons for the relatively low numbers of marked fish in the samples are not known. Perhaps these sites attract a relatively large number of strays

which would be unmarked. Straying of marked fish between sites in this study suggests that this may have been true. Another potential source of unmarked fish could be wild fish. Finally, it is possible that fin clipped fish simply do not survive as well as unmarked fish.

Regardless of the cause for the relative scarcity of marked fish in our samples, we feel that the returns of marked fish in this study provided a fair assessment of the relative performance of the stocked lots. If the pen reared fish were returning

the most fish at both sites, one could argue that the extended period of post-clipping recovery afforded by pen rearing was a factor. This argument fails, however, when one considers that the direct stocked fish from Salmon River have returned the most fish to Lower Niagara River.

#### **References**

SAS Institute Inc. 1999. Release 8.0 TS level 00M0. Cary, NC, USA.