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Evaluation of Lake Trout Egg Plants in Michigan Waters of Lakes Michigan and Huron

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Abstract.—Lake trout *Salvelinus namaycush* eggs were planted on two Lake Michigan and nine Lake Huron reefs during 1973-81 to evaluate this method to propagate lake trout. Most eggs were taken from hatchery broodstock and incubated in a hatchery to the eyed stage. Eggs were planted either by releasing them at the surface or by scuba divers who released them just above the substrate. The number of eggs planted at each site ranged from 27,000 to 6,600,000. Survival of eggs to hatching was assessed by placing samples of eggs in containers on the sites Many containers on offshore reefs were moved by severe turbulence during the winter and were lost. Mean survival of eggs to the fry stage in containers on protected nearshore sites averaged 77% prior to early June, then decreased. Prolonged confinement in the containers probably was the cause of the low survival after mid-June. Emergent fry traps were used to collect swim-up fry during 1977-82. Fry production was estimated by extrapolation of the number of fry caught. Survival from planted egg to swim-up fry was 1.8% or less. Gill nets fished over the planting sites 6 to 8 years later caught 60 fin-clipped, hatchery-reared lake trout, but only one unclipped lake trout. That fish could have been either a survivor from the planted eggs, from successful natural reproduction, or a hatchery fish that was improperly clipped. Planting eyed eggs by seeding them on reefs is not a practical method to propagate lake trout.

Lake trout *Salvelinus namaycush* have been planted in Lake Michigan since 1965 and in Lake Huron since 1973 in an attempt to reestablish self-sustaining populations of lake trout. In 1973, when this study was initiated, there was no evidence of successful reproduction. No wild lake trout fry had been collected, and the few older unclipped lake trout that were seen were believed to be hatchery-reared fish that had been improperly fin clipped. Most fish were planted at shore sites that were easily accessible to the fish planting trucks. Lake trout from these plants apparently did not reproduced successfully because they tended to return to the planting sites to spawn, and generally the substrate at the planting sites was unsuitable for reproduction (Peck 1979a; Rybicki and Keller 1978). Some plants of yearling lake trout have been made on traditional spawning reefs, so that when these fish matured they would home to the suitable spawning substrate on those reefs and thus establish a naturally reproducing population. However, the same goal might be accomplished by planting eggs on the reef instead of planting yearlings. Lake trout which are hatched from eggs planted on the spawning grounds likely would receive a much better imprint than yearlings. This would be cheaper and result in a better return of mature lake trout, if survival were sufficiently high.

My objective was to determine if planting eyed eggs was a feasible method of establishing spawning populations of lake trout. In this report I describe the methods used to plant the eggs (1973-81), evaluate the survival of the eggs to the fry stage (1977-82), and evaluate the adults returning to the planting sites (1979-88).

Methods

Select Planting Sites

Eleven planting sites were selected in northern waters of Lake Michigan (2) and Lake Huron (9). In most cases, they were in areas where lake trout were known to have spawned in pre-sea lamprey times but where they were not spawning when this study was begun. Large-mesh (114-mm, stretched-measure) gill nets were fished for about 24 hours on or near the proposed planting sites during the spawning season to determine if lake trout were presently spawning at these locations. Other fish collected were stomach sampled to determine if they had eaten lake trout eggs. If no or little evidence of spawning lake trout was found, the areas were examined by scuba divers to assure that the planting sites had suitable substrate. Lake trout eggs have been found on broken rock and rubble (Martin 1955; Prevost 1957; DeRoche 1969), honeycombed limestone (Smith 1968) and on rounded pebble, cobble, and boulder substrates (Wagner 1982). Probably the most important substrate factor of all, that might affect egg survival, is the presence of deep and clean interstices.

After the divers had found an area of suitable substrate, markers were placed on the bottom (with floats attached) so the area could be located when planting eggs in fall and evaluating the survival of eggs and fry in the following spring. During 1973-77 (no plants were made in 1975) a single marker was placed on the reef and the perimeter of the planting site was an estimated distance from the marker. During 1978-81, the planting sites were measured by scuba divers and markers were placed at the four corners.

Names of the planting sites, their location in latitude and longitude, depth, and substrate type are shown in Table 1. Area, planting dates, and number of eggs are given in Table 2. The names assigned to the sites were those of the reefs on which they were located or of nearby terrestrial areas. During the first 2 years of this study professional scuba divers were hired to make the observations, but during the remainder of this study the divers were Fisheries Division personnel with extensive experience on the Great Lakes.

Plant Eggs

Eggs planted in 1973 and 1976-81 were taken from broodstock held at the Marquette State Fish Hatchery, but in 1974 the eggs were taken from Lake Michigan fish that were collected near Charlevoix. After the eggs were water hardened, they were transferred to state hatcheries at Thompson, Oden, or Harrietta for quicker incubation to the eyed stage because water temperatures at these hatcheries were warmer. Consequently, eggs reached the eyed stage by mid-December and could be planted before ice formed in harbors near the planting sites. Green eggs were planted at Jamsen and R-4 reefs in 1976 because there was an unexpected surplus of eggs, and at Pomeroy Reef in 1977 because hatchery facilities were unavailable to rear the eggs to the eyed stage.

Eggs were seeded either by releasing them at the surface while the boat moved slowly over the area or by divers that took them to the bottom. Eggs seeded from the surface at Dahlia Shoal in 1973, at Irishmans Grounds in 1974, and at Pomeroy Reef on November 2, 1977 were placed in a hopper and were flushed through a 38-mm hose that discharged about 1 to 3 m above the substrate. Divers observed the eggs planted at Dahlia Shoal and Pomeroy Reef. Those planted from the surface at Bear Island, Williams, R-4, and Jamsen reefs in 1976, at Pomeroy Reef on October 26, 1977, and at Arnold Island in 1980 were poured directly into the lake. All other eggs were taken to the bottom in 7.6-L containers and were released by divers while they swam a pattern that had been marked with lead lines laid on the substrate.

Assess Survival

Egg and fry survival was assessed at various stages of incubation on the reef. Samples of the eggs to be planted were placed in containers and positioned on the planting site so egg survival could be monitored. The type of container was changed several times during the study to eliminate problems.

In 1973, 150 eggs were placed in each of 20 containers. The containers were open metal cylinders, 56 cm in diameter and 30 cm high (the end of a 55-gallon drum). They were filled with 5 cm of sand (to prevent eggs from resting on the steel bottom) then 10 cm of small stone (1 to 5 cm in diameter), and topped off with 15 cm of rubble (5 to 13 cm in diameter). Survival to hatch was to be assessed with 16 cylinders, 8 of which were uncovered and 8 were covered with 10 mm mesh to assess the effects of predation. The remaining four cylinders were covered with fine mesh to prevent fry from escaping, thus providing information on survival to the swim-up stage and beyond.

In 1974, 12 cylindrical, screened cages were each seeded with 100 eyed eggs and placed on the planting site. The cages were 41 cm high and 46 cm in diameter with sides of 3-mm galvanized wire mesh and wooden tops and bottoms. Fifteen cm of rock and rubble were placed in the cages. Eggs were not planted in 1975. In 1976, containers were not used so survival was not monitored. Cages similar to those used in 1974 were constructed to monitor survival in 1977. These cages were larger in diameter (60 cm vs. 41) and not as high (38 cm vs. 41) so they would be more stable and less likely to be moved by currents. Rock and rubble were placed in the cages to a depth of 15 cm. Approximately 250 eggs were placed in each cage, then the cages were placed on the planting site.

During the remainder of this study, 1978-81, the cages were 24 cm in diameter and 31 cm high. They were nearly filled with gravel and small rocks and 50 eggs were placed into each cage. The cages were set into holes that had been excavated in the substrate. Setting the cages into the reef prevented currents from moving them, and made conditions for the caged eggs were more like the conditions that the planted eggs on the reef were experiencing. Cages were retrieved the following spring and the contents were examined in the laboratory to determine the number of fry produced.

Survival to the swim-up stage was assessed in spring 1977-82 with emergent fry traps (Stauffer 1981) that covered an area of 0.36 m^2. The traps were placed so that all areas of the reef were sampled. The traps were checked by scuba divers at intervals that ranged from 6 to 28 days. To check the traps, the divers changed the trapping bottles and brought those that had been fishing to the surface where the contents were preserved for later examination.

The estimated number of fry produced (FRY) on the reefs and the 95% confidence intervals (CI) of the estimates were calculated by the formulas:

$$FRY = \frac{A}{T} F$$

$$CI = \frac{A}{T} F_{CI}$$

where: A = area of site,
T = area of one trap,
F = mean number of fry per trap,
F_{CI} = CI of the mean number of fry.

Sample Mature Survivors

Final proof of the success of reestablishing lake trout by planting eyed eggs would be their return as mature fish. Some survivors of the egg plants were expected to return to the planting sites to spawn at age 5 and most were expected to be mature by age 6. Large-mesh (114-mm, stretched-measure) gill nets were fished over the planting sites during the spawning season in late October-early November, 6 to 8 years after the eggs were planted, to sample the returning adults. At each site, the length of nets set each year ranged from 549 to 1,463 m.

Results

Select Planting Sites

Fourteen mature lake trout were collected in 732 m of gill net at Dahlia Shoal during late October-early November 1973. No eggs were found in the stomachs of 103 potential egg predators that were collected concurrently with the lake trout. Thus, I judged that little spawning had occurred on the shoal.

In 1974, 12 lake trout were caught in 732 m of gill net set on Irishmans Grounds but no eggs were found in 74 potential egg predators. Again, I judged that little spawning had occurred.

In 1976, four sites were selected that were quite well protected from storms. The four areas were not known to be traditional spawning areas but the substrate appeared to be suitable for lake trout egg incubation.

Pomeroy Reef was selected as the planting site in 1977 because it was a traditional spawning area and the cobble and boulder substrate had deep interstices. Only one immature lake trout was caught there in 488 m of gill net on October 13, 1977.

Four areas near the southwest side of Drummond Island were the planting sites for the remainder of this study. The areas were not known as traditional spawning reefs, but some of the older local residents claim that many lake trout used to be in the area during the spawning season. The honeycombed limestone substrate was similar to the excellent spawning areas near Cockburn and Manitoulin islands (Smith 1968), and the areas were protected by islands except from winds from the south and southwest. Some protection from those winds was provided by offshore reefs. Gill nets were set each year at two or more areas in the vicinity of the planting sites. Lake trout catches were as follows: two immatures on October 18 and 25, 1978; four mature males in 480 m of net on October 22 and 29, 1979; four mature females, four mature males, and two immatures in 1,920 m of net on October 28 and 29, and November 5 and 6, 1980; and none in 1,464 m of net on October 27 and 28 and November 3 and 4, 1981.

Plant Eggs

During the 1973 egg planting at Dahlia Shoal scuba divers attempted to observe eggs falling to the bottom and into the crevices. They saw a faint cloud in the vicinity of the discharge end of the hose but could not see individual eggs. Eggs planted in 1976 were observed from the surface; the eggs settled into the interstices and, in general, seemed to be well protected. Scuba divers reported that eggs planted on Pomeroy Reef on November 2, 1977 seemed well distributed over the planting area and that they had settled into the interstices. However, they also observed that large numbers of eggs from the October 26 plant had windrowed over unsuitable substrate.

Eggs were planted by scuba divers during 1978-81, except the 1980 plant on Arnold Island was made from the surface. Nearly all of the eggs planted by the divers were observed to settle into the interstices. The fate of the eggs seeded on the Arnold Island site on December 6, 1980 is unknown because severe weather disrupted planting and evaluation. The eggs were transferred from the hatchery to the site in 38-L cans on December 3, but because of weather conditions they were held until December 6. On that day the winds were still too strong for diving and the forecast was for worsening conditions. The eggs already had been held in the cans for 4 days, and I judged that they would not survive until weather conditions improved. Therefore, the eggs were released over the planting site from the stern of the *R/V Steelhead*. Strong water currents at the time may have carried the eggs to areas of unsuitable substrate.

Assess Survival

Survival of eggs placed in containers on the sites is shown in Table 3. The egg containers that had been placed on Dahlia Shoal on December 17, 1973 were lifted on March 15 and April 25, 1974 to assess survival. One of the eight containers lifted on March 15 was useless because it had been upset during the winter; 45 live sac fry and two live eggs were recovered from the other seven containers. Twenty fry were in three uncovered containers, 25 fry were in three containers that had 10-mm mesh covers, and no fry were in a coverless container (the cover had been torn off during the winter). The presence of two live eggs indicated that hatching was nearly completed on this date. The small difference in the number of fry between the uncovered and covered containers indicates that predation was not an important factor in survival. The number of fry recovered from the containers was the minimum survival because fry may have been washed out as the containers were lifted.

The four containers lifted on April 25 provided little data. One container had been upset during the winter, three were filled with sand to within 5 to 8 cm of the top, and one had lost its cover during a storm. One live fry was recovered even though the sand had filled nearly all the crevices among the rocks. Eight other containers were not found in spite of extensive searching for them.

Containers were lifted to determine survival to the fry stage at Irishmans Grounds on May 7, 1975. The two buoys marking the location of the cages were found but no cages were between them. Scuba divers found one cage lying on its side about 15 m from where it had been placed in December. They also found some evidence that ice had scoured the substrate.

The four cages on Pomeroy Reef were more stable than cages on Irishmans Grounds, but they too could not be found in the spring.

For these three reefs, a total of 23 containers disappeared, and three others were upset or moved. This indicates that extreme turbulence or ice scouring occurred on the sites overwinter. The containers placed on Dahlia Shoal weighed about 100 kg each, and the cages placed on Irishmans Grounds and Pomeroy Reef weighed about 54 kg apiece.

The cages set during 1978-81 to assess survival were set in holes excavated in the substrate and were easily found in the spring. The wooden tops on five cages lifted in 1980 had warped enough that fry may have escaped. No fry were found in these cages but it is unknown if they swam out or if they died and disintegrated. Eight of the 12 cages lifted in 1982 were damaged over winter and were no longer fry tight. Survival in the undamaged cages lifted during 1979-82 at all sites was good until mid-June in all years. The mean survival in 28 cages lifted between April 16 and June 6 was 77%, with a range of 40 to 100%. The percent survival to fry in 6 of 9 cages lifted during June 18 to 24 ranged from 34 to 82% with a mean of 45%, but was very poor (≤ 4%) in 3 other cages. Forty-eight of the 136 fry found were dead, which indicates that mortality was not gradual because fry rapidly decompose after death. I suspect that mortality was due to conditions in the cages and the fish would have lived if they could have escaped.

The number of fry caught in emergent fry traps during 1977-82 are shown in Table 4. The 2 to 4 traps fished at each of the sites in 1977 may not have covered enough area and could have easily missed any swim-up fry produced, but the 42 traps fished at Pomeroy Reef should have caught some fry even if only small numbers were produced. During 1979-82 some fry were collected from each site and some during each year, but fry were not collected from every site every year. The catch of fry was quite variable among traps on some reefs. Nine of the 10 fry collected by 13 traps on the Arnold Island site in 1980 were caught in the same trap. In 1981, 37 fry were collected in the 80 traps fished at West Bellevue Island, but 10 of the fry were collected in 2 traps. The estimated number of fry produced on the reefs are shown in Table 4. The large confidence intervals of the estimates were due to the large variation in catch among traps. Survival from seeded egg to swim-up fry was very low (≤1.8%) in all cases (Table 4).

Sample Mature Survivors

Gill nets that were fished over the planting sites 6 to 8 years after the eggs were planted caught 61 lake trout in 17,378 m of net. Sixty of the lake trout were fin clipped, indicating they were hatchery reared and stocked as yearlings. One unclipped fish was caught at Irishmans Grounds in 1979.

Discussion

The capability of the emergent fry traps to accurately sample the number of fry produced on a reef is suspect because of variability and possible bias. I found the catch of fry was extremely variable. Emergent fry traps were fished at 15 site-year combinations. The coefficient of variation (CV) of the catch from the eight plants where fry were caught ranged from 89% at South Bellevue Island in 1979 to 455% at Arnold Island in 1982. At Elmwood Marina, near Traverse City, 32 traps caught 572 fry (Wagner 1981); the CV of the catch was 114%. Stauffer (1981) also said that catches in adjacent traps were quite variable but he presented no data to support his observations. He further stated that "trap catches cannot be used for accurate quantitative studies because they very likely attract fry from surrounding areas". If the traps attract fry, extrapolation of catches would overestimate production.

On the other hand, there is conflicting evidence that emergent fry traps may underestimate production or may be biased. Peck (1984) estimated fry production in 1979 and 1980 on UPPCO Reef, Marquette, with fry trap pails (Stauffer 1981). He also set 24 emergent fry traps on the offshore 60 m of the reef in 1979 and 57 traps on the entire reef in 1980 (Peck 1979b and 1980). From his data I calculated that 8.8 fry were caught per emergent fry trap in 1979 and, by extrapolation, there were about 36,800 fry produced. From the fry trap pails Peck estimated that 27,090 ± 21,070 fry were produced on that portion of the reef. Although the estimate from the emergent fry traps was somewhat greater than from the pail traps, they were not statistically different. From Peck's 1980 emergent fry trap data I calculated that about 15,400 swim-up fry were produced on the reef. This is only 21% of Peck's estimate from fry pails of 76,504 ± 36,836 and is probably significantly less.

In summary, based on the above opinions and evidence, the emergent fry traps may: (1) overestimate fry produced because they attract fry from outside of the area covered by the trap, or (2) provide an estimate that is comparable to fry pails, or (3) underestimate the number of fry produced on the reefs compared to the fry pails. I accept the estimates made on my egg planting sites with emergent fry traps as being indicative of the number of fry produced.

I found survival from seeded eyed egg to swim-up fry was much less than reported by Peck (1984) or in the cages that I examined during 1979-82. Survival at the 15 planting sites that I sampled with emergent fry traps was never greater than 1.8% and no fry were caught at 7 sites. Peck (1984) reported survival to the swim-up stage was 16% for eggs deposited by lake trout on UPPCO Reef in 1979 and 12% in 1980. His survival data are not strictly comparable with mine because his data also include the mortality from deposited egg to eye-up. He found survival from deposition to late November-early December was 68% in 1978 and 74% in 1979 (Peck 1979b and 1980). Some of the eggs were eyed at that time. From those data I calculated that survival from eyed egg to swim-up fry on UPPCO Reef was 24% in 1978-79 and 16% in 1979-80. The low survival on the egg plant sites cannot be due to water quality conditions on the reef because eggs that were in cages buried on the sites had an average survival to early June of 77%.

I suspect that the low survival of the planted eyed eggs was because most of the eggs were washed away. The planting sites were chosen because they had a clean rocky substrate with deep interstices. The reason the substrate was clean was because strong currents prevented silt, sand, and detritus from settling there. Those same currents no doubt washed away many of the planted eggs to unsuitable substrate where they perished.

This may be less of a problem with naturally deposited eggs. When eggs are deposited by spawning lake trout they settle into the crevices and may become wedged in place as they water hardened. I measured the increase in volume of three samples of lake trout eggs during water hardening. From unfertilized egg to 1 hour of water hardening the volumes increased 18, 18, and 19%. After 24 hours of water hardening the volumes had increased by 56, 57, and 59%. That increase in volume after 24 hours calculates to an increase in diameter of 16 to 17%. Eggs that are wedged in crevices during water hardening probably could withstand considerable turbulence.

The one unclipped lake trout caught at Irishmans Grounds in 1979 may have been a survivor from the eggs planted there or from natural reproduction. It also could have been an unclipped hatchery fish, although Rybicki (1991) calculated that no more than about 2% of the mature hatchery-reared fish either had regenerated the clipped fins or the fins were not clipped.

The egg plants made near Drummond Island were the only plants from which swim-up fry were collected, yet no mature unmarked lake trout were caught in the gill nets set there to assess survival. When the plants were made during 1978-81, few lake trout were being harvested by either sport or commercial fishers. Then in 1982, by court order, Statistical District MH-1 (which includes Drummond Island egg planting sites and the surrounding area) was opened to treaty Indian commercial fishing for whitefish. The incidental catch of lake trout could also be sold. The incidental catch of lake trout from MH-1 was 99,091 kg, or about 73,000 fish in 1982 (Eger and Gorenflo 1983). The lake trout catch varied from year to year but was similar until the end of this study in 1988. In 1986, 16 unclipped lake trout were in a sample of 472 collected from MH-1 and examined by tribal biologists (Fleischer 1987) Thirteen of the 14 fish whose ages were determined were of an age that could have been from the egg plants. If any lake trout were produced from the egg plants, the chance of them returning to their natal area was greatly reduced by the gill-net fishery.

Results of this study indicate that planting eyed lake trout eggs by seeding them over reefs is not a practical way to establish spawning populations of lake trout. Violent overwinter turbulence displaced eggs from the offshore reefs. Consequently, only small numbers of fry were produced on the sheltered nearshore sites. Only one adult lake trout was collected which could have been a survivor from these plants.

Recommendations

1. Plant green eggs at historical spawning areas on suitable substrate. Unfertilized eggs and sperm should be taken to the planting site within 24 hours after egg take. The eggs should be fertilized aboard the boat and planted immediately so they can settle into the interstices and become lodged in place as they water harden. Since fall storms may restrict boat operation and cause excessive turbulence at the substrate, the egg-take schedule would have to be based on favorable weather forecasts. This method would be necessary if much of the homing imprinting occurs during water hardening.

2. Plant green eggs in artificial turf at historical spawning sites as recommended by Swanson (1982). Water-hardened eggs should be placed in artificial turf at historical planting areas, but ideal substrate would not be as critical as when eggs are seeded directly on the substrate. Fall storms could hamper boat operations so egg take would depend on favorable weather forecasts. The cost of the artificial turf would at least be partially offset by the need for fewer eggs due to the higher survival in artificial turf than on natural substrate.

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Table 1.—Location, depth, and substrate of sites planted with lake trout eggs, 1973-74 and 1976-81.

Site name	Location	Depth	Predominant substrate
Dahlia Shoal	45° 38'N, 85° 12'W	6-7 m	Cobble, boulder
Irishmans Grounds	45° 26'N, 85° 22'W	11 m	Pebble, cobble, boulder
Bear Island	45° 58'N, 84° 14'W	1-4 m	Cobble, boulder
Williams Reef	45° 58'N, 84° 12'W	1-4 m	Cobble, boulder
R-4 Reef	46° 00'N, 84° 26'W	1-4 m	Cobble, boulder
Jamsen Reef	46° 00'N, 84° 28'W	1-4 m	Cobble, boulder
Pomeroy Reef	45° 51'N, 84° 15'W	4-7 m	Cobble, boulder
Anderson Point	45° 57'N, 83° 56'W	2-5 m	Honeycombed cobble, boulder
Arnold Island	45° 58'N, 83° 57'W	3-5 m	Honeycombed cobble, boulder
West Bellevue Island	45° 58'N, 83° 57'W	6-8 m	Honeycombed cobble, boulder
South Bellevue Island	45° 57'N, 83° 57'W	4-8 m	Honeycombed cobble, boulder

Table 2.—Date, area planted, and number of lake trout eggs planted, 1973-81.

Site name[1]	Date	Area (ha)	Number of eggs (millions)
Dahlia Shoal	Dec 12, 1973	0.4	1.0
Irishmans Grounds	Dec 12, 1974	0.8	1.6
Jamsen Reef	Nov 4, 1976	0.4	0.46[2]
R-4 Reef	Nov 4, 1976	1.2	1.08[2]
Williams Reef	Nov 22, 1976	0.6	0.48
Bear Island	Nov 24, 1976	0.4	0.38
Pomeroy Reef	Oct 26, 1977	0.7	3.9[2]
Pomeroy Reef	Nov 2, 1977	0.7	2.7[2]
Anderson Point	Dec 9, 1978	0.022	0.068
Arnold Island	Dec 9, 1978	0.022	0.068
South Bellevue Island	Dec 9, 1978	0.022	0.068
West Bellevue Island	Dec 9, 1978	0.022	0.068
Anderson Point	Nov 29, 1979	0.022	0.072
Arnold Island	Nov 29, 1979	0.022	0.027
West Bellevue Island	Nov 29, 1979	0.022	0.027
West Bellevue Island	Dec 4, 1980	0.40	0.74
Arnold Island	Dec 6, 1980	0.41	0.74
Arnold Island	Dec 8, 1981	0.31	0.66
West Bellevue Island	Dec 8, 1981	0.34	0.79

[1]Complete name shown in Table 1.

[2]Green eggs; otherwise green eggs.

Table 3.—Survival to hatching of lake trout eggs in containers on planting sites.

Site[1]	Eggs seeded per container	Date examined	Containers examined	Number of fry	Percent hatched
Dahlia Shoal	150	Mar 15, 1974	8[2]	45	4
Dahlia Shoal[3]	150	Apr 25, 1974	4[2,4]	1	<1
Irishmans Grounds[5]	100	May 7, 1975	1[2]	0	0
Pomeroy Reef[6]	250				
Anderson Point	50	Apr 18, 1979	2	93	93
		May 8, 1979	1	48	96
		May 30, 1979	1	47	94
		Jun 18, 1979	1	0	0
		Jul 17, 1979	2	0	0
South Bellevue Island	50	Apr 18, 1979	2	84	84
		May 8, 1979	1	47	94
		May 30, 1979	1	45	90
		Jun 18, 1979	1	0	0
		Jul 17, 1979	2	0	0
West Bellevue Island	50	Apr 17, 1979	2	89	89
		May 8, 1979	1	50	100
		May 30, 1979	1	50	100
		Jun 18, 1979	1	41	82
		Jul 17, 1979	2	0	0
Anderson Point[7]	50	Apr 16, 1980	1	45	90
		May 20, 1980	1	22	44
		Jun 3, 1980	1	39	78
		Jun 24, 1980	1	17[8]	34
Arnold Island[7]	50	Apr 16, 1980	1	31	62
		May 20, 1980	1	20	40
		Jun 3, 1980	1	24	48
		Jun 24, 1980	1	2[9]	4
West Bellevue Island[10]	50	Apr 16, 1980	1	31	62
		May 20, 1980	1	39	78
		Jun 3, 1980	1	35	70
		Jun 24, 1980	2	38[11]	38
West Bellevue Island	50	Apr 28, 1981	2	65	65
		May 27, 1981	1	25	50
		Jun 22, 1981	2	38	38

Table 3.—Continued:

Site[1]	Eggs seeded per container	Date examined	Containers examined	Number of fry	Percent hatched
Arnold Island[12]	50	Jun 4-6, 1982	2	64	64
West Bellevue Island[12]	50	Jun 4-6, 1982	2	81	81

[1]Complete names given in Table 1.

[2]Eight containers not found.

[3]One container upset, contents spilled.

[4]Three containers filled with sand to within 5 to 8 cm of top.

[5]Eleven containers not found.

[6]Four containers not found.

[7]Two cages damaged over winter.

[8]Sixteen fry were dead.

[9]Both fry were dead.

[10]One cage damaged over winter.

[11]Thirty fry were dead.

[12]Four containers damaged over winter.

Table 4.—Catch of swim-up lake trout fry in emergent fry traps, estimated fry production, and percent survival from planted egg to swim-up fry, 1977-82.

Site[1]	Year	Number of traps	Number of fry	Estimated fry production	Percent survival to swim-up
Jamsen Reef	1977	2	0		
R-4 Reef	1977	4	0		
Williams Reef	1977	4	0		
Bear Island	1977	2	0		
Pomeroy Reef	1978	42	0		
Anderson Point	1979	9	3	209 ± 241	0.3
Arnold Island	1979	9	11	768 ± 930	1.2
South Bellevue Island	1979	9	11	768 ± 529	1.2
West Bellevue Island	1979	9	5	349 ± 351	0.5
Anderson Point	1980	14	0		
Arnold Island	1980	13	10	483 ± 945	1.8
West Bellevue Island	1980	13	0		
West Bellevue Island	1981	80	37	5,280 ± 2,617	0.7
Arnold Island	1982	42	2	416 ± 593	<0.1
West Bellevue Island	1982	40	5	1,214 ± 1,030	0.2

[1]Complete names shown in Table 1.

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