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GROWTH AND SURVIVAL OF TWO STRAINS OF RAINBOW TROUT, TAGWERKER, AND NISQUALLY, IN A WINTERKILL LAKE AND FOUR EXPERIMENTAL PONDS

by

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ABSTRACT

Gibson, J. 1995. Growth and survival of two strains of rainbow trout, Tagwerker and Nisqually, in a winterkill lake and four experimental ponds. Can. Tech. Rep. Fish. Aquat. Sci. 2022: iv + 9 p.

A test stock of certified Tagwerker strain of rainbow trout (Oncorhynchus mykiss) spawned at Spring Valley Trout Farm, New Dundee, Ontario was matched-planted with a Nisqually strain spawned at the Rockwood Aquaculture Research Centre (RARC), Manitoba. After rearing both strains to fingerlings at RARC, they were stocked in Lake 114 (30 ha) at Erickson, MB and in four ponds (0.05 ha) at RARC for comparison of growth and survival between the strains. Harvest occurred at 151 growing days in Lake 114 compared to 130 days in the ponds. Recoveries were 30% and 49% for Nisqually and Tagwerker in the ponds and 10% and 35% in Lake 114 but significant differences were not evident. In the ponds, mean weight at harvest was significantly higher for Tagwerker compared to Nisqually. In Lake 114, harvest weight had to be adjusted because stocking weights were not equal. Adjusted weight at harvest was significantly higher for Tagwerker compared to Nisqually. There was no significant difference in dressing loss between Tagwerker and Nisqually.

A strain of trout commonly used by the Manitoba Rainbow Trout Farmers Association (MRTFA) was stocked into Lake 114. Survival was 22.5% which fell in between the survival of Tagwerker and Nisqually. MRTFA fish had an adjusted weight similar to Tagwerker and significantly higher than Nisqually. Dressing loss was significantly higher than it was for Nisqually.

Key words: aquaculture; rainbow trout; Oncorhynchus mykiss; growth; survival; strains.

RÉSUMÉ

Gibson, J. 1995. Growth and survival of two strains of rainbow trout, Tagwerker and Nisqually, in a winterkill lake and four experimental ponds. Can. Tech. Rep. Fish. Aquat. Sci. 2022: iv + 9 p.

Un stock de truites arc-en-ciel (Oncorhynchus mykiss de la souche certifiée Tagwerker, provenant de la trutticulture de Spring Valley, à New Dundee (Ontario), a été soumise à un essai comparatif avec des poissons de la souche Nisqually, provenant du Centre de Recherche Aquicole de Rockwood (CRAR), au Manitoba. Après élevage des deux souches jusqu'au stade de l'alevin de moins d'un an au CRAR, on a déversé les poissons dans le lac 114 (30 ha), à Erickson (Man.), et dans quatre étangs (0,05 ha), au CRAR pour comparer la croissance et al survie des deux souches. Le prélèvement a eu lieu au bout de 151 jours de croissance au lac 114 contre 130 jours en étang. Les taux de récupération étaient de 30 et 49% pour les souches Nisqually et Tagwerker dans les étangs et de 10 et 35% au lac 114, mais les différences étaient peu significatives. Dans les étangs, le poids moyen à la récolte était nettement plus haut chez les Tagwerker que chez les Nisqually. Dans le lac 114, il a fallu rajuster le poids à la récolte parce que les poids au déversement n'étaient pas égaux. Le poids rajusté à la récolte était nettement plus haut chez les Tagwerker que chez les Nisqually. Il n'y avait pas de différence significative dans les pertes à l'habillage entre les deux souches.

Une souche de truites communément employées par l'association des trutticulteurs du Manitoba (MRTFA) s été ensemencéé dans le lac 114. Le taux de survie était de 22,5%, ce qui se situe entre les taux des souches Tagwerker et Nisqually. Les poissons de la MRTFA présentaient un poids rajusté semblable à celui des Tagwerker et nettement plus élevé que celui des Nisqually. Les pertes à l'habillage étaient nettement plus élevées que celles des Nisqually.

Mots clés: aquaculture; truite arc-en-ciel, Oncorhynchus mykiss; croissance, survie; souches.

INTRODUCTION

In December, 1983, Tagwerker, a strain of rainbow trout (Oncorhynchus mykiss) was introduced to the Rockwood Aquaculture Research Centre (RARC). This certified stock originating from Spring Valley Trout Farm, New Dundee, Ontario, is no longer available from this location but still is available from RARC and a small number of commercial producers in Manitoba and Alberta. Many strains used in the aquaculture industry have been introduced to RARC over the years. Domestic strains obtained from commercial hatcheries were used growth and survival studies in prairie pothole lakes and/or dugouts (Bernard and Holmstrom 1978, Ayles and Baker 1982, Uraiwan 1982, and Glenn et al. 1989). The Tagwerker strain had been shown to have good growth characteristics in intensive culture (B. Billeck, personal communication). The purpose of this study was to compare the performance of Tagwerker trout to that of other traditional strains in extensive culture in prairie pothole environments.

METHODS

Nisqually rainbow trout were received as eyed eggs at RARC in January 1976, from Nisqually Trout Farms in Olympia, WA. Adults were spawned in December 1982 and provided the Nisqually trout used in this study. The Tagwerker rainbow trout were received as eyed eggs in December, 1983 (spawned in November 1983) from Spring Valley Trout Farm, New Dundee, Ontario.

The fry from both stocks were reared at RARC until they were stocked. Growth of the Nisqually strain was retarded by rearing at 8°C, in order to achieve a stocking size comparable to Tagwerker while Tagwerker were reared at 10°C. Two weeks prior to stocking, fingerlings were hot-branded (Bernard and Van der Veen 1974). Nisqually were branded left mid dorsal and Tagwerker were branded right mid dorsal. Stocking size of the fingerlings was 17.6 g $\pm$ 1.47 for Nisqually and 25.4 g $\pm$ 2.53 for Tagwerker. This was the closest weight range available at the time of stocking Lake 114. As each strain was stocked at a different size, the final weight of Nisqually was adjusted as follows (Ayles and Baker 1983) to matchTagwerker:

Log_{10} adjusted harvest weight (g) = $\log_{10}$ original harvest weight (g) - 0.292 $\log_{10}$ original stocking weight (g) + 0.292 $\log_{10}$ adjusted stocking weight(g), using an adjusted stocking weight of 25.4 g. Lake 114 (Perch Lake), located on the Rolling River Reserve 10 km from Erickson, Manitoba with a surface area of 30.0 ha and a mean depth of 5 m, is a typical prairie pothole lake of the Erickson-Elphinstone area (Sunde and Barica 1975). Lake 114 was stocked with 1,000 fingerlings of each strain on May 29, 1984.

The third assessed strain was obtained as fingerlings by the Manitoba Rainbow Trout Farmers Association (MRTFA) from Trout Haven Ranch, Buffalo Gap, SD. This particular strain (MRTFA) was being used by the majority of private trout producers in Manitoba. MRTFA fish were stocked in Lake 114 on May 17 at 133/ha or 2000 trout. The size at the time of stocking was 11 cm (4.25 in) which represented a 13.8 - 14.6 g fish (31 -33 fish/lb) (personal communication, G. Curry). All fish were held in cages for three days prior to release into the lake, and were not branded prior to release. Log_{10} adjusted harvest weight was calculated for MRTFA fish, using the same formula as used for Nisqually above. Lake 114 final harvest occurred in October using gangs of gill nets set overnight. Nets were set until catches decreased to three fish per net. Mean weight, length and condition factor were calculated from a sample of 50 fish of each strain measured immediately after collection.

Four 0.05 ha ponds (18 m x 60 m x 2 m depth) located at RARC were each stocked with 100 branded fish from each of the Nisqually and Tagwerker strains on May 25, 1984. Mean weights were 31.8 g $\pm$ 2.48 and 32.7 g $\pm$ 0.42 for the Nisqually and Tagwerker strains respectively. The fish were acclimated to the ponds in cages for one week and released on June 2. The final total stocking rate was 4000/ha which was within the limits of productive stocking rates (Johnson et al. 1970). Pond fish were hand fed at least once a day at a calculated ration based on body weight and water temperature (Piper et al. 1976). Commercial trout food (Martin Feed Mill, Elmira, ON) was used and ration was adjusted monthly for changes in fish weight and water temperature. Water samples for dissolved oxygen, transparency, pH, NH_4-N, and NO_2-N (Stainton et al. 1977) were taken at 1-2 week intervals from 0.5 m and 1.0 m below the water surface (Table 1). Daily mean pond temperatures were recorded in pond 4 from June 13 to September 26 (Fig. 1). Temperature was maintained below 25°C by adding 6°C well water when necessary. Samples of fish were taken once a month in the ponds from June to August to assess growth. A minimum number of 5 fish per strain were caught by angling or gill net to calculate ration for each pond. Final harvest of the ponds in mid October using gill nets set overnight for four nights recovered a total of 334 fish that were weighed and measured from all the ponds.

A subsample of the fish recovered from the ponds and lake were dressed (removal of gills, gut and kidney). At least 25 fish per strain were sampled for Lake 114 but most of the 34 fish sampled in the ponds were from ponds 2 and 4 (16-18 fish per strain).

One-way analysis of variance and Duncan's Multiple Range test was used (Statistical Analysis System 1982) to measure statistical significances between strains for the lake data. Two-way analysis of variance and Duncan's Multiple Range test was used to measure statistical significances between strains and ponds for the pond data. Arcsin transformation (Steel and Torrie 1980) was used on recovery data for the ponds prior to analysis of variance. Square root transformation was used on percent dressing loss data for the ponds and lake.

RESULTS AND DISCUSSION

In the ponds, harvest occurred between October 9 to 12th, giving an average growing time of 130 days. Tagwerker outperformed Nisqually in growth in the ponds. Analysis of variance showed that the strains were significantly different in weight, length, and condition factor but were not significantly different in recovery. Overall recoveries (including fish with no distinguishable brands) were 12.5% for pond 1, compared to 58.0% for pond 2, 47.0% for pond 3 and 49.5% for pond 4 (Table 2). Cormorants were observed on the ponds and bird predation may have contributed to the poor recovery in pond 1 as 24% of the fish recovered from pond 1 had cormorant scars, compared to 0.9-3.2% in ponds 2-4. At harvest, Tagwerker trout were 36 to 43% heavier than the Nisqually strain in ponds 2-4. Fish with no identifiable brand at harvest time represented a small number of fish (4-7 fish/pond) and were not included in the statistical analysis. Water temperature was 9.5°C at stocking and ranged from 4.0°C to 25.3°C as shown in Fig.1. Temperature decreased from 22°C in late August to 4°C in late September. The predicted growth (Fig. 2) based on initial size and temperature throughout the summer was calculated according to the model of Papst and Hopky (1982). Tagwerker grew at a faster rate than the model, while Nisqually grew at a slower rate.

In Lake 114, harvest occurred from October 27th to November 5th, giving an average growing time of 151 days for Nisqually and Tagwerker and 163 days for MRTFA fish. Statistics from 50 randomly selected trout from each strain harvested from Lake 114 are shown in Table 3. Water temperature was not recorded at stocking but comparable sized lakes in the area were 14°C at stocking time. Both open water fishing and ice fishing were used to complete the harvest and showed similar results to the ponds at harvest time. Tagwerker strain showed a 35% recovery compared to 10.4% recovery for Nisqually in this lake while the MRTFA strain had a recovery of 22.5%. To allow a final comparison between strains, $\log_{10}$ adjusted harvest weights are given for Nisqually and MRTFA fish. Tagwerker and MRTFA fish had a significantly higher adjusted weight than Nisqually. Tagwerker (258.3 kg) outproduced Nisqually (60.5 kg) and MRTFA (174.6 kg) in production based on adjusted weight of 1000 fish stocked (recovered number x adjusted weight). It should be kept in mind that MRTFA fish had a 12 day longer growing season than the other strains.

Samples were taken from both the ponds and the lake for dressed weights. MRTFA showed a significantly higher percent loss in dressed weight than Nisqually in Lake 114 (Table 4). The mean dressing loss in Tagwerker and Nisqually was not significantly different when raised in the ponds or Lake 114. Since Nisqually had a higher condition factor than Tagwerker, less loss in dressing would have been expected and trends in fact support this.

Weight gain per day in both the lake and the ponds was interesting. In similar lakes in the Erickson-Elphinstone area, gains of 1.15 to 1.97 g/d (Bernard and Holmstrom 1978),2.09 and 3.48 g/d (Glenn et al. 1989) were reported for rainbow trout 1.83 and 2.44 g/d for brown trout (Salmo trutta). Growth of fish in Lake 114 was much higher than this with gains of 4.72 g/d for Tagwerker and 3.45 g/d (3.68 g/d as adjusted weight) for Nisqually and 3.95 g/d (4.63 g/d as adjusted weight) for MRTFA. The observed higher growth may have been due to a lower stocking density and/or the larger than average fingerling size. Bernard and Holmstrom (1978) found harvest weights were similar to this study except when larger fingerlings (8.7g) were stocked. Their mean stocking weights ranged from 4.5 g to 8.7 g which produced a 212 g to 372 g trout. Glenn et al. (1989) used mean stocking size (May) of 15 g to 27 g which produced rainbow trout that weighed 255 g to 574 g at harvest (October). By comparison in the ponds, in a growing period of 130 days Tagwerker showed gains of 1.95 g/d compared to 1.40 g/d for Nisqually. In farm dugouts in the Erickson-Elphinstone area, Glenn et al. (1989) reported gains of 1.91 g/d for 18 g rainbow trout and 2.03 g/d for 33 g brown trout.

Specific growth rate was calculated for each of the strains as [Specific growth rate ln final weight (g) - ln initial weight (g) / time (days)] x 100. In Lake 114, specific growth rates were 2.24, 2.23, and 2.35% body weight per day for Nisqually, Tagwerker, and MRTFA

respectively. In the ponds specific growth was significant with rates of 1.47 and 1.67% body weight per day for Nisqually and Tagwerker. By comparison, Uraiwan (1982) stocked RARC ponds with Nisqually and Manx strains. Specific growth rates for Nisqually were 2.81, and 2.29% body weight per day when fish were stocked with 3.5g, and 10.5g fish during two growing seasons.

In terms of both a higher percent return and larger harvest weights, Tagwerker as a strain of rainbow trout would allow a more viable fishery for private trout producers. Tagwerker brood stocks have become quite valuable not only to RARC but also to provincial hatcheries who have used this strain for stocking in many Manitoba lakes (R. Olson, personal communication).

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Table 1. Physical and chemical characteristics of ponds used for match planting.

Pond No.		1	2	3	4
NH_4-N (μg/L)	Range	0-50	0-30	0-40	0-40
	Mean	16	8	15	13
NO_2-N (μg/L)	Range	1-6	1	1-5	2
	Mean	4	1	2	2
Dissolved O_2	Range	5.7-11.1	6.5-11.7	5.8-13.0	7.3-12.2
(mg/L)	Mean	9.2	9.3	8.9	9.7
pH	Range	8.6- 9.3	8.7- 9.7	8.5- 9.1	8.6- 9.3
	Mean	9.09	9.3	8.8	9.0
Transparency	Range	0.9- 1.3	0.8- 1.2	0.8- 1.2	0.8- 1.2
(m)	Mean	1.2	1.2	1.1	1.1

Table 2. Summary of harvest data[1] in the 0.05 ha ponds.

Strain	Pond	No. Recovered	Weight (g)		Length (mm)		SGR[2] (% wt/day)	K[3]	Recovery (%)	Production (kg/100 fish stocked)
			Mean	SD	Mean	SD	Mean	Mean		
Nisqually	1	7	197.7	55.2	231.4	16.5	1.41	1.56	7.0	1.4
	2	52	211.8	46.1	240.2	19.9	1.46	1.51	52.0	11.0
	3	31	228.1	58.2	243.2	30.6	1.52	1.66	31.0	7.1
	4	28	219.4	64.4	243.6	27.2	1.49	1.48	28.0	6.1
	Mean		214.2[a]		239.6[a]		1.47[a]	1.56[a]	29.5[a]	6.4
Tagwerker	1	14	227.8	49.7	254.3	18.4	1.49	1.37	14.0	3.2
	2	60	295.8	47.4	277.5	18.5	1.69	1.39	60.0	17.7
	3	56	308.9	48.3	278.8	13.9	1.73	1.42	56.0	17.3
	4	64	313.1	56.7	278.0	15.5	1.74	1.45	64.0	20.0
	Mean		286.5[b]		272.1[b]		1.66[b]	1.40[b]	48.5[a]	14.6
No Brand	1	4	181.0	86.6	232.5	35.2		1.36	2.0	
	2	4	263.8	70.0	262.5	26.0		1.44	2.0	
	3	7	272.7	92.7	261.0	36.5		1.46	3.5	
	4	7	281.3	52.8	275.0	16.4		1.34	3.5	
	Mean		249.7		257.8			1.40	2.8	

[1] For each variable, column values which share a common superscript are not significantly different.
[2] Specific growth rate ln final weight (g) - ln initial wt (g)/time (days)] x 100.
[3] K = Condition factor = (Weight (g) x 100)/Length^3 (cm)

Table 3. Summary of harvest data[1,2] in Lake 114.

Variable	Strain	Mean	Standard Deviation	Range
Length (cm)	Nisqually	297.4[a]	26.2	217- 343
	Tagwerker	336.9[b]	14.7	305- 368
	MRTFA	324.9[c]	14.6	295- 366
Weight (g)	Nisqually	522.3[a]	127.7	227- 754
	Tagwerker	737.9[b]	131.8	502-1141
	MRTFA	658.8[c]	92.1	494- 843
Adjusted weight[3] (g)	Nisqually	581.4[a]	142.2	252- 839
	Tagwerker	737.9[b]	131.8	502-1141
	MRTFA	780.8[b]	109.2	585- 999
K[4]	Nisqually	1.96[a]	0.24	1.35-2.48
	Tagwerker	1.91[a]	0.18	1.57-2.31
	MRTFA	1.91[a]	0.15	1.61-2.29
Recovery (%)	Nisqually	10.4		
	Tagwerker	35.0		
	MRTFA	22.5		
Production (kg/1000 fish stocked)	Nisqually	54.3		
	Tagwerker	258.3		
	MRTFA	148.2		
Adjusted[2] production (kg/1000 fish stocked)	Nisqually	60.5		
	Tagwerker	258.3		
	MRTFA	174.6		

[1] For each variable, column values which share a common superscript are not significantly different.
[2] Nisqually and Tagwerker harvested at 151 days; MRTFA harvested at 163 days [3] Adjusted weight based on the measured stocking weight of 17.6 g for Nisqually, 25.4 g for Tagwerker and an estimated weight of 14.2 g for MRTFA.
[4] K = Condition factor = (Weight (g) x 100)/Length^3 (cm)

Table 4. Comparison of dressing losses[1] of three strains of rainbow trout.

Location	Strain	Mean Weight (g)	Mean Length (mm)	Mean Dressed Wt (g)	Dressing Loss (%)
Lake 114	Nisqually	537	297	436	8.4[b]
	Tagwerker	736	339	592	19.6[ab]
	MRTFA	649	322	518	20.3[a]
Ponds	Nisqually	208	241	176	18.5[x]
	Tagwerker	282	276	224	20.5[x]

[1] Column values which share the same superscript are not significantly different.

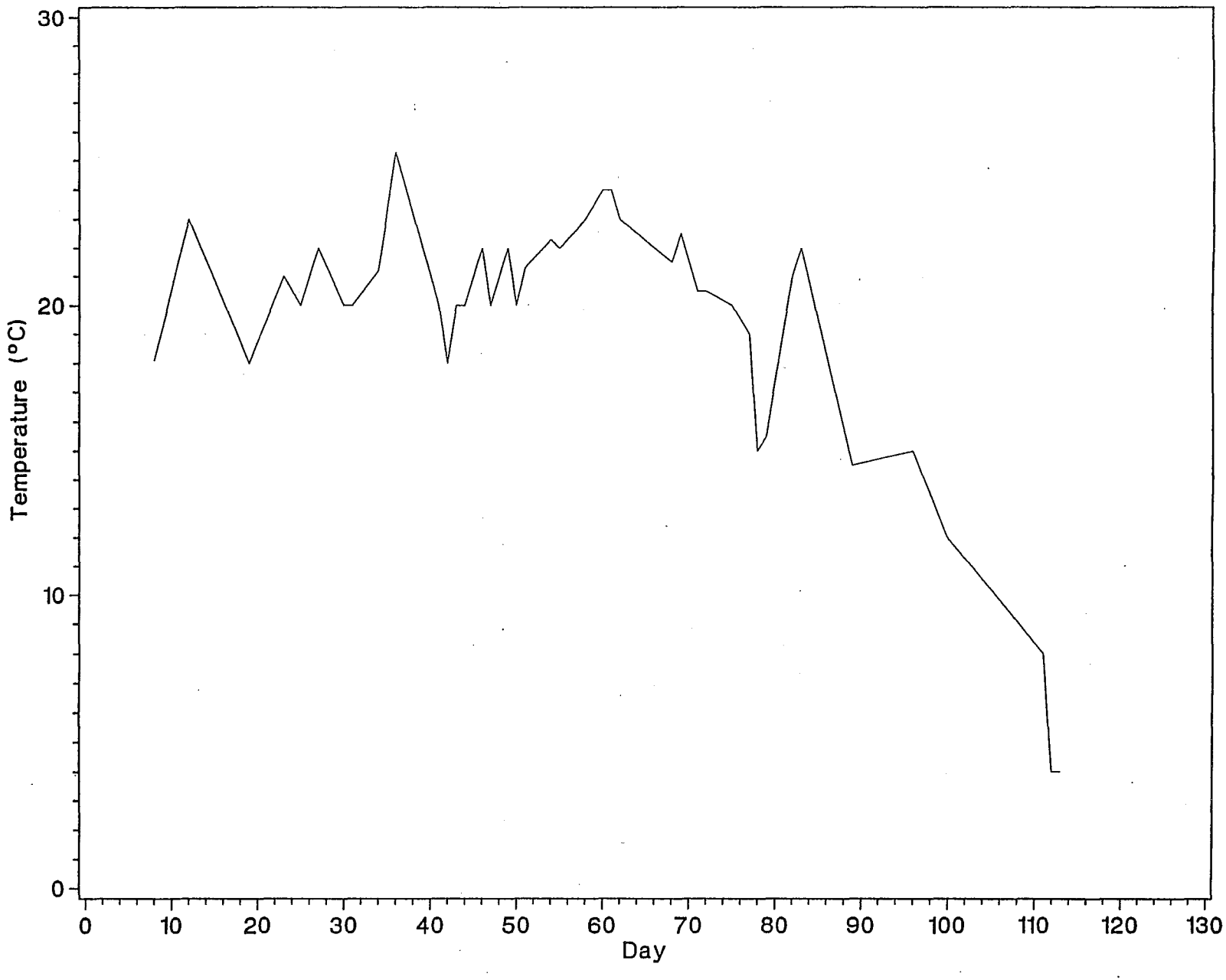

Figure 1. Daily temperature in pond 4.

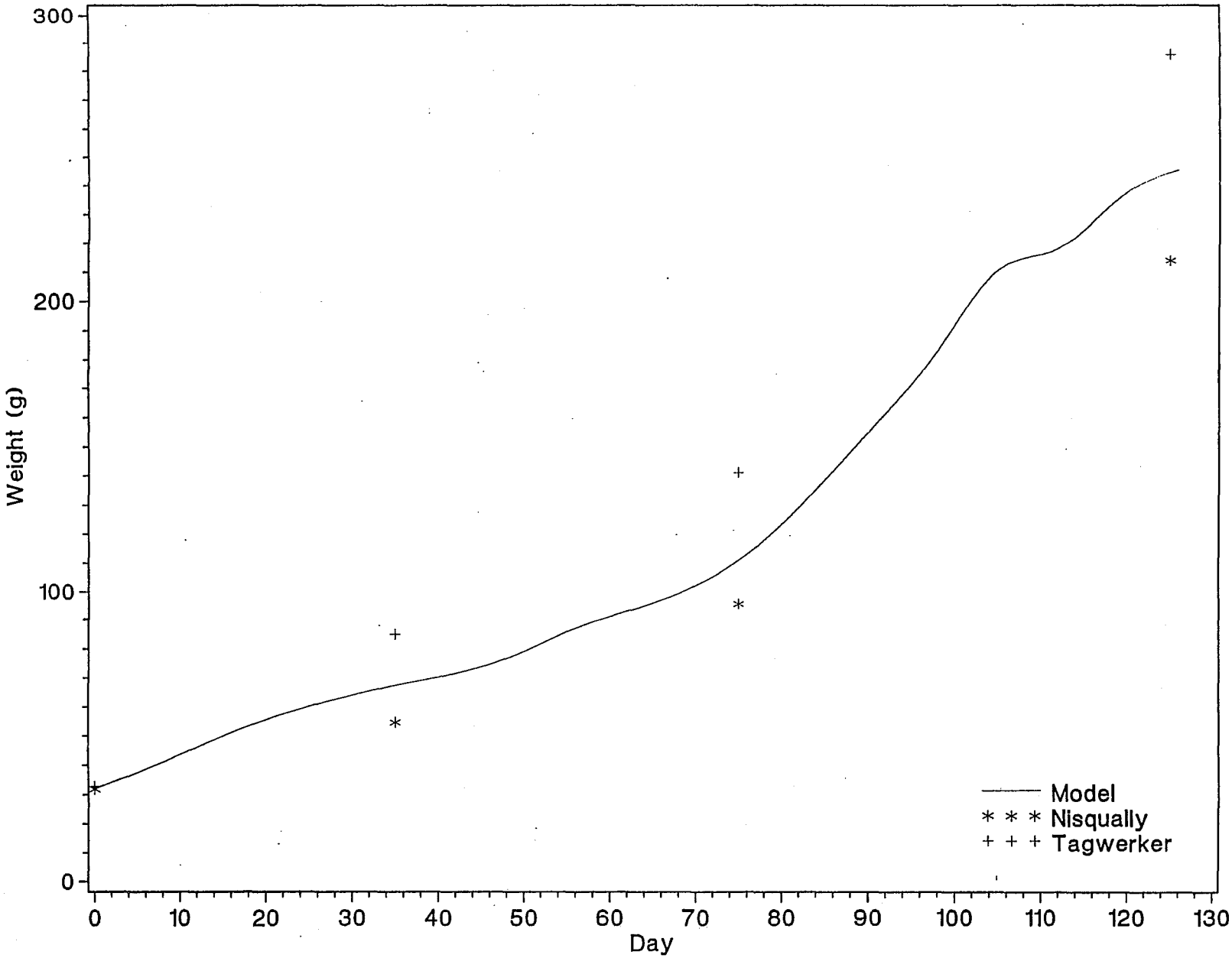

Figure 2. Comparison of growth of Tagwerker and Nisqually rainbow trout in the ponds with predicted growth model.