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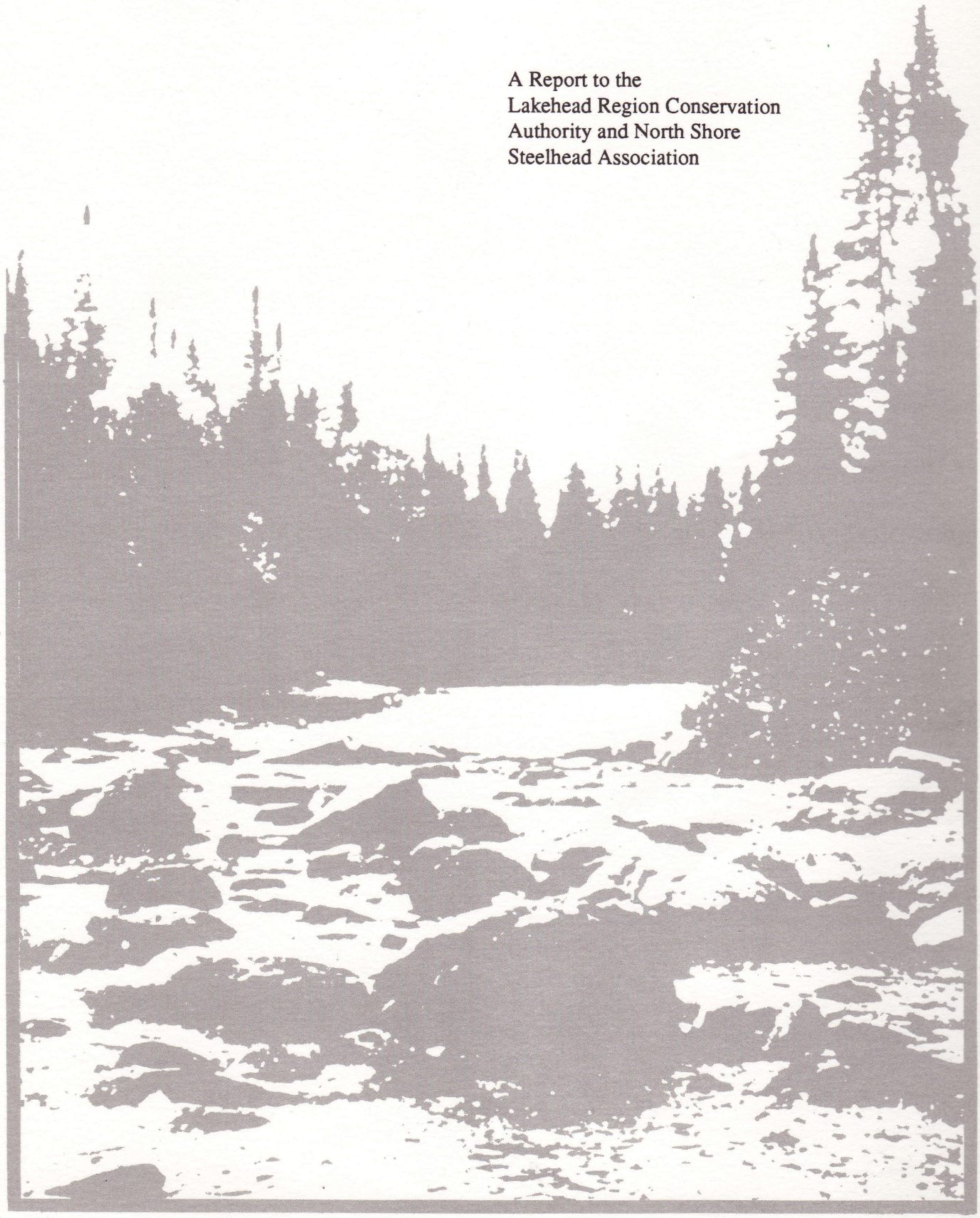
A Report to the
Lakehead Region Conservation
Authority and North Shore
Steelhead Association



POTENTIAL STEELHEAD PRODUCTION IN THE CURRENT RIVER, THUNDER BAY, ONTARIO

A Report for:

LAKEHEAD REGION CONSERVATION AUTHORITY

and

NORTH SHORE STEELHEAD ASSOCIATION

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SUMMARY

Beak Consultants Limited (BEAK) was commissioned by the Lakehead Region Conservation Authority (LRCA) to conduct an investigation of the feasibility of facilitating steelhead trout passage up the Current River past the Boulevard Lake Dam. In November 1989 and April 1990, site visits were undertaken to assess the quality and quantity of steelhead spawning and rearing habitat upstream of the dam to Onion Lake Dam and in the lower reaches of the North Current River and Ferguson Creek, respectively.

The river was divided into 7 zones or reaches based on physiographic and habitat features for spawning and rearing of steelhead. A Habitat Suitability Index model was applied to classify habitat in each zone. Production estimates were calculated for each zone by referring to values obtained from the literature for other Lake Superior tributaries. A conservative approach was taken in all estimates and it is conceivable that steelhead production could be significantly higher than the values reported in this study.

The Current River was estimated to have a total riverine low flow habitat area of 510,000 m^2 downstream of Onion Lake. Of this area, 360,000 m^2 was considered adequate to excellent spawning and nursery habitat for steelhead trout. It was estimated that this area has the potential to produce 30,000 smolts annually which would support a population of 5,000 adults. A substantial fraction of this population would be available for harvest by anglers.

River flow was determined to be sufficient for the operation of a fishway device as well as to allow for maximum use of the hydroelectric facility during the critical migration period from early April to late July, during most years. In rare circumstances when spring river flows are below requirements of the turbine, no water would flow through the fishway and a poor year class of steelhead may be expected.

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1.0 INTRODUCTION

Recreational fishing in the District of Thunder Bay is an important attraction for tourists as well as one of the major recreational activities of local residents. Approximately one million tourists visit the region annually contributing well over $100 million to the local economy, making tourism Thunder Bay's third largest industry. At present, angling pressures in the region exceed the supply of sport fish. Consequently, habitat enhancement projects that may increase the production of sport fish would be of benefit.

On 14 December 1988, the North Shore Steelhead Association (NSSA) presented a proposal to the Lakehead Region Conservation Authority (LRCA) to facilitate the migration of steelhead trout (Salmo gairdneri) to the upper reaches of the Current River, a tributary of Lake Superior flowing through the northeastern portion of the City of Thunder Bay. The main component of the proposal is the installation of a fish ladder at the Boulevard Lake Dam, located approximately 0.75 km from the mouth of the river, to allow the migration of fish up the river.

Beak Consultants Limited (BEAK) was commissioned by the LRCA to undertake an independent study of the concept and provide input into its economic and technical feasibility. The first component of this study assesses the potential of the Current River to support a self-sustaining rainbow trout fishery. If adequate potential production is identified, related resource use issues would be evaluated, including the compatibility of a fishway with the existing hydroelectric facility and movement of non-target species into the river. The technical, economic and aesthetic aspects of potential fishway devices would be further assessed before a decision is made to proceed with design and construction.

This report presents an evaluation of the potential of the Current River to support a viable steelhead fishery, provided a fishway is implemented at Boulevard Lake Dam allowing upstream access. The report focuses on the quantity and quality of available fish habitat and estimates the potential production of steelhead in the river.

1.1 Study Area

The Current River drains a watershed area of 652 km^2 and terminates in Lake Superior, in the northeast section of the City of Thunder Bay (Lat. 48°27', Long. 89°11'). The river originates approximately 47 km northeast of Thunder Bay and has a surface length of 63 km. There are over thirty tributaries to the river with the main branches being North Current River and Ferguson Creek, contributing watershed areas of 115 km^2 and 72 km^2, respectively (refer to Figure 2.1).

The average gradients of the Current River and North Current River are 5 m/km and 7 m/km, respectively (Figure 1.1). The drainage basin is composed principally of Precambrian bedrock and glacial tills. The bedrock is chiefly shales of low porosity and permeability resulting in marginal groundwater supply (Armstrong et al., 1983).

The river has undergone numerous man-made alterations over the past century. As early as 1901-1902, three wooden dams were constructed along the course of the river for flood control, one at Boulevard Lake (0.75 km upstream), one at Paquette Dam (13 km upstream) and one at Onion Lake (27 km upstream). The present Boulevard Lake Dam was constructed in 1909-1910 and has eliminated fish passage to the upper Current River (Adamson, 1976). The Onion Lake dam, although damaged by fire, maintains the level of Onion Lake and remains a complete obstruction to fish passage. Paquette Dam was washed out during flooding in 1904 and remnants still obstruct flow of the river.

Water quality of the Current River is considered good with summer dissolved oxygen levels of 8-9 mg/L and temperatures in June and July ranging 17-21°C. The average annual stream flow at Boulevard Lake Dam ranged from 1.98 to 5.86 m^3/s over the years 1976-1981. The minimum flow estimated for extreme drought conditions expected once every 50 years is 0.2 to 0.3 m^3/s (Dillon, 1989).

At present, the lower 0.75 km reach of the river up to Boulevard Lake Dam supports runs of steelhead trout, rainbow smelt and one of the last remaining large walleye spawning runs on Lake Superior. The river upstream of the dam provides lake and riverine habitat. Fish inhabiting these upstream waters include brook trout, suckers, pike, perch, cyprinids and burbot (Laws, 1982). Walleye populations have been reported from Onion and Hazelwood Lakes. Rainbow trout were introduced in the upper Current River prior

GRADIENT TABLE

RIVER	FROM POINT	TO PT	DISTANCE IN MILES	ELEVATION OF POINTS		DIFFERENCE OF ELEV	GRADIENT FT PER MILE
CURRENT	1	2	0.45	601.0	700.0	99.0	220.0
CURRENT	2	3	1.28	700.0	720.0	20.0	15.6
CURRENT	3	4	1.48	720.0	780.0	60.0	40.5
CURRENT	4	5	0.66	780.0	830.0	50.0	75.8
CURRENT	5	6	4.93	830.0	1055.0	225.0	45.6
CURRENT	6	7	1.2	1055.0	1062.0	7.0	5.8
CURRENT	7	11	6.9	1062.0	1240.0	178.0	25.8
CURRENT	11A	15	4.2	1240.0	1370.0	130.0	31.0
CURRENT	15	17	3.1	1370.0	1540.0	170.0	54.9
CURRENT	17	18	7.5	1540.0	1575.0	35.0	4.7
TRIBUTARY A	15	16	8.8	1370.0	1660.0	290.0	33.0
SAVINGY CREEK	4	19	4.4	780.0	1075.0	295.0	67.2
NORTH CURRENT	5	20	7.9	830.0	1255.0	425.0	53.9
NORTH CURRENT	20	21	3.5	1255.0	1455.0	195.0	55.7
NORTH CURRENT	21	22	3.3	1450.0	1575.0	125.0	37.9
NORTH CURRENT	20	23	11.3	1255.0	1560.0	305.0	27.0
FERGUSON CR.	7	8	3.5	1062.0	1410.0	348.0	99.5
FERGUSON CR.	8	9	8.3	1410.0	1490.0	80.0	9.6
FERGUSON CR.	9	10	2.2	1490.0	1620.0	130.0	59.1
CROCK CREEK	11A	12	2.8	1240.0	1330.0	90.0	32.2
CROCK CREEK	12	13	9.7	1330.0	1620.0	290.0	29.9
SUNDAY CREEK	12	14	10.3	1330.0	1670.0	340.0	33.0
BARNUM CR.	11	24	6.9	1240.0	1610.0	370.0	53.6

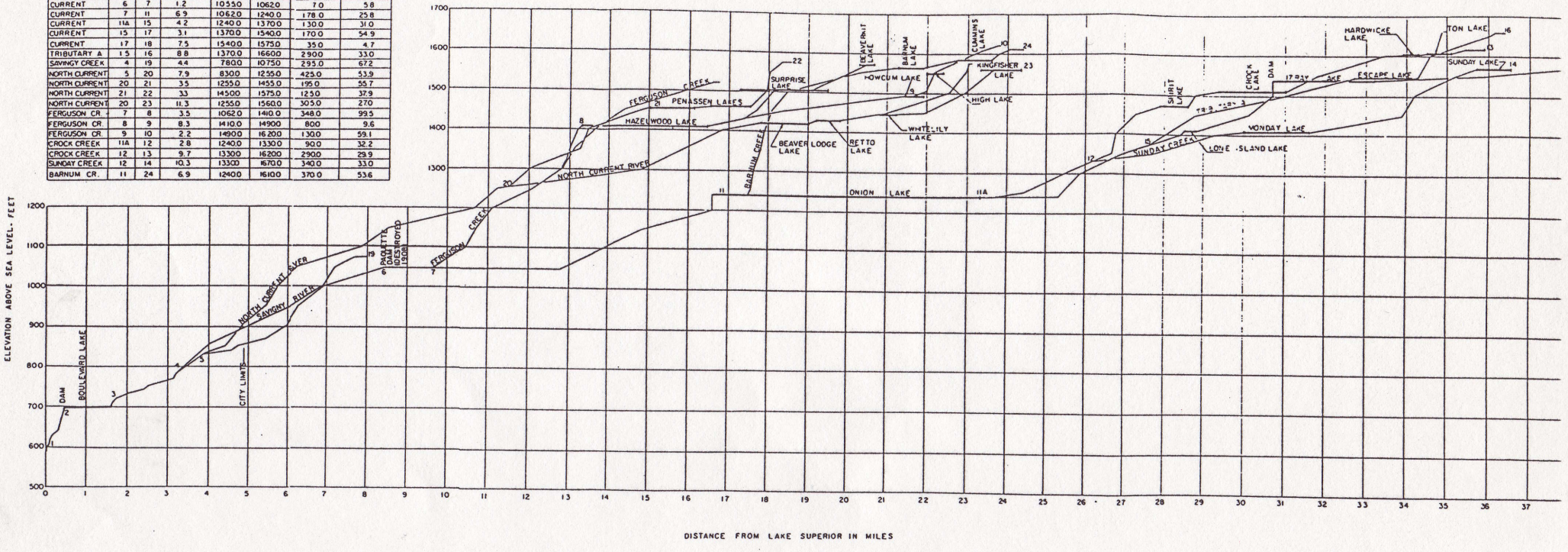


FIGURE 1.1: GRADIENT PROFILE OF THE CURRENT RIVER

to 1950 (Armstrong, 1948) and possibly again in 1952. Good catches of rainbow trout 35 cm in length were reported in the Current River in 1948 (Johnson, 1948). However, to the best of our knowledge, there are no recent records of rainbow trout still inhabiting the upper river.

1.2 Water Uses

The lower Current River is a popular angling location for walleye and rainbow trout. The upper Current provides a marginal brook trout stream with the population mainly regulated by frequent warm summer temperatures.

Hazelwood, Onion and Boulevard Lakes are popular recreational areas for swimming and boating. Hazelwood Lake is popular for canoeing, fly-fishing programs and swimming (Dillon, 1989). Boulevard Lake is probably the most popular lake for swimming because of its warm summer temperatures and location within the city. Onion Lake is principally used for fishing. In addition, there are a number of campgrounds and parks along the river between Lake Superior and Onion Lake. The flow over the Boulevard Lake Dam provides a scenic attraction for tourists and residents.

In 1986, a small, privately-owned hydroelectric generating station was installed at the Boulevard Lake Dam. The capacity of the single Kaplan turbine at the facility is 3.9 m^3/s, which is greater than the monthly mean flows in late summer and winter. The turbine is generally shut down during low flow periods since the maintenance of water levels in Boulevard Lake, especially in summer, takes priority over power generation. Water rights for power generation would similarly take precedence over any water requirements of a fishway structure.

1.3 The Species

Rainbow trout were first introduced into Thunder Bay region in 1912 when McVicar's Creek was stocked. The species is presently well-established throughout many streams and rivers entering Lake Superior.

The term steelhead refers to an anadromous race of rainbow trout that migrates between the sea and freshwater. Like all rainbow trout, steelhead spawn and spend their juvenile

stages in streams and rivers. Juveniles (parr) undergo a physiological change termed smoltification before migration to the sea where they mature before returning to their natal streams and rivers to spawn. The steelhead introduced into the Great Lakes have the same life history as their west coast ancestors, but grow and mature as adults in the Great Lakes rather than the sea. Rainbow trout of the McCloud River strain were introduced into Lake Superior near Sault Ste. Marie in 1883 (Kwain, 1981).

Steelhead usually move into tributaries of the Great Lakes during spring freshets and move upstream seeking gravel beds on which they spawn. The female will deposit an average of 2,028 eggs (Raleigh et al., 1984). Fry generally emerge from the redds 45-75 days after fertilization and disperse both upstream and downstream. The juveniles (parr) generally spend 1-3 years in their natal streams prior to migration to the Great Lakes.

Specific habitat requirements for reproduction and rearing vary depending on geographic location. Good riverine habitat has clear cold water with temperatures rarely exceeding 22°C, a gravel or rocky substrate, a 1:1 pool to riffle ratio, well vegetated, stable stream banks, instream cover (e.g., surface turbulence, pool depth, boulders, logs, undercut banks) and a stable water flow (Raleigh and Duff, 1980). Cover is normally recognized as essential in trout streams with adults and juveniles requiring greater than 25% and 15% respectively (Raleigh et al., 1984). Base flow should be greater than 50% of the average annual daily flow.

Probably the most critical limiting factor for steelhead production in northern streams is adequate overwintering habitat (Raleigh et al., 1984; Close et al., 1988). Close et al. (1988) concluded that parr production in north shore streams of Lake Superior was probably limited by winter mortality and spate flows more so than by available instream and overhead cover.

Steelhead juveniles usually migrate downstream to the lakes after their first year (age 1+) in Lake Superior tributaries. Peak downstream migration is generally from May to June. Researchers have found that the downstream migrants are composed of approximately 64-76% age I and 24-36% age II and III (Stauffer, 1972, 1979; Kwain, 1983, 1984; Close et al., 1988). Rainbows migrating at age 1+ have a higher mortality rate, probably because of their smaller size. Kwain (1981) and Close et al. (1988) found that adult returns in Lake Superior streams are dominated by fish which had spent two years in their natal streams.

2.0 HABITAT CHARACTERIZATION

2.1 Field Evaluation

During November 1989, two BEAK fisheries biologists conducted a site reconnaissance of the Current River to estimate the quantity and quality of steelhead spawning and rearing habitat, and to inspect potential obstacles to upstream migration. These areas were re-visited by the same biologists in late April 1990 to examine habitat characteristics under ice-free, higher flow conditions when upstream spawning migration would occur.

The stretch of river from Lake Superior to Onion Lake Dam was subdivided into seven zones or reaches based mainly on substrate characteristics and gradient. The description, length and area of each zone are presented in Table 2.1. The area of each zone was estimated by measuring widths of representative sections, and multiplying by the length of the reach. These measurements were made under relatively low flow conditions (November) representative of typical summer and late winter flow conditions. A visual presentation of the zones and their potential for steelhead production is illustrated in Figure 2.1.

Each zone was qualified using the Model 1 Habitat Suitability Index (HSI) presented by Raleigh et al. (1984). Simplistically, the HSI is formulated on the suitability of the habitat for steelhead trout spawning and rearing. There are seven criteria in the model and each is assigned a value of 0, 0.5 or 1, depending on degree of similarity to the criteria. The criteria applied for assessing optimal riverine rainbow trout habitat are as follows:

1. clear, cold water with an average maximum summer temperature of $\leq 22^{o}C$;
2. approximately a 1:1 pool to riffle ratio;
3. well vegetated, stable stream banks;
4. instream cover $\geq 25\%$ of the stream area;
5. relatively stable water flow regime with $< 50\%$ of the annual fluctuation from the average annual daily flow;
6. relatively stable summer temperature regime, averaging about $13^{o}C \pm 4^{o}C$; and
7. a relatively silt-free rocky substrate in riffle-run areas.

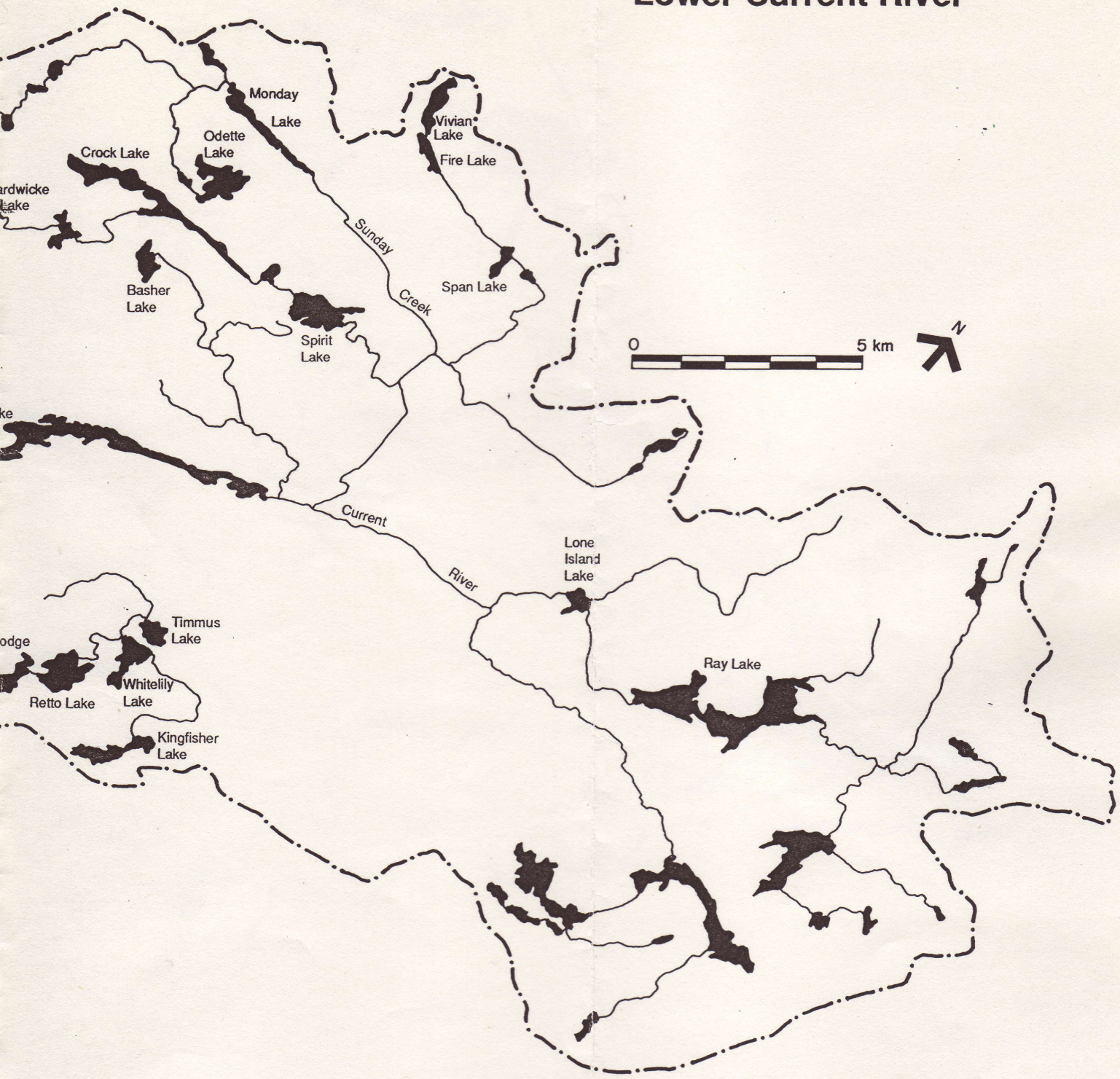
TABLE 2.1: TOTAL HABITAT AREA OF RIVER ZONES DURING MEDIUM TO LOW FLOW, NOVEMBER 1989

River Zone	Description	Length (km)	Average Width (m)	Total Area (m^2)
1	Lake Superior to Boulevard Dam	0.72	20	14,400
2	Boulevard Lake	2.05	-	-
3	Boulevard Lake to Old Paquette Dam	11.31	20	226,200
4	Paquette Dam to Kilometer 20 from Lake Superior	6.72	20	134,400
5	Kilometer 20 to Onion Lake Dam	6.24	15	93,600
6	North Current Mouth to First Obstruction	2.5*	10	25,000
7	Ferguson Creek Mouth to First Obstruction	2.5*	5	12,500

* Assumed length.


Surprise Lake
Howcum Lake
High Lake
Sunday Lake
Greenpike Lake
Lottit Lake
Cummins Lake
Hazelwood Lake
Barnum Lake
Ferguson Creek
Bald Rock Falls
Golding Lake
7
5
Dam
Onion La
Wasp Lake
Bentley Lake
Hornet Lake
4
Trowbridge Falls
3
6
2
Boulevard lake
Savigny Creek
North Current River
Beaver Lake
Thunder Bay
Thunder Bay
1

FIGURE 2.1
River Zones and Production Potential of the Lower Current River



$$HSI = \frac{\text{number of attributes present}}{7}$$

An HSI score equal to 1 would imply optimal regional conditions for steelhead trout reproduction while an HSI score equal to 0 implies that the habitat is unsuitable for rearing and spawning; however, the species may still be present but is usually scarce. Generally, HSI scores of less than 0.5 may provide some limited reproductive habitat or other useful features such as overwintering habitat. Results of HSI values for the river reaches are presented in Table 2.2. It should be noted that these calculations are not based on a rigorous analysis of data, but rather are based on value judgements made during the field reconnaissance and on habitat information available from previous Ministry of Natural Resources stream survey records.

2.2 Obstructions to Steelhead Migration

2.2.1 Lower Reach

The Current River downstream of Boulevard Lake Dam is one of the steepest reaches in the entire watershed (see Figure 1.1 and photographic appendix). Steelhead are now known to ascend to the vicinity of the power station tailwater in spring, upstream of the steep stretch near the first bridge crossing. Upstream of the tailwater area, the river flows a broad, shallow bedrock shelf with much of the flow following a channel along the east bank. It is through this area that steelhead would probably be attracted to reach the base of a fishway. It may be necessary to provide some resting pools along this stretch to facilitate fish movement through more difficult stretches. Such pools could be readily created under low flow conditions by small-scale blasting or excavation of the relatively soft shale bedrock. The need for in-stream habitat enhancement can be more readily assessed through direct inspection of this area during summer low flow conditions, or by monitoring the initial success of steelhead passage after installation of a fishway.

2.2.2 Boulevard Lake and Dam

Smolt and post-spawning adults migrating downstream from the upper watershed will pass through Boulevard Lake before reaching Lake Superior. This passage typically occurs in May in Lake Superior tributaries, although smolt continue migrating into June.

TABLE 2.2: PRELIMINARY RESULTS OF A MODEL 1 HABITAT SUITABILITY INDEX ESTIMATED DURING A SITE VISIT IN NOVEMBER 1989

River Zone	Attributes							HSI
	1	2	3	4	5	6	7	
1	0	0	1	0	0.5	0	1	0.36
2	0	0	1	0	0.5	0	0	0.21
3	1	1	1	1	0.5	1	1	0.93
4	1	0	1	0	0.5	1	0	0.5
5	1	1	1	1	0.5	1	1	0.93
6	1	1	1	1	1	1	1	1.00
7	1	1	1	1	1	1	1	1.00

1 Clear, cold water with an average maximum summer temperature of less than 22°C.

2 Approximately a 1:1 pool to riffle ratio.

3 Well vegetated, stable stream banks.

4 Cover greater than 25% of the stream area.

5 Relatively stable water flow regime with less than 50% of the annual fluctuation from the average annual daily flow.

6 Stable summer temperature regime averaging about 13°C ± 4°C.

7 Relatively silt-free rocky substrate in riffle-run areas.

Some concern has been expressed that the lake and the dam may disoreint the migrants, preventing downstream passage. However, successful downstream migration past comparable dams and reservoirs occurs in major steelhead streams in southern Ontario, such as the Ganaraska River and the Saugeen River. The Minesing Swamp in the lower reach of the Nottawasaga River in southern Ontario represents a major slow-flowing, warmwater zone through which large numbers of steelhead readily migrate in late spring. There are many other examples of productive steelhead rivers with dams and lakes that do not impede downstream migration of smolt or adults. On this basis, it is our opinion that a steelhead smolt migration would not be impeded by Boulevard Lake or the Dam.

The multiple sluiceway structures of the Dam offer the potential to concentrate the river flow through a small section such as the fishway, thereby providing maximum attraction of fish in Boulevard Lake to the fishway and reducing attraction to other areas, including the generating station intake. The installation of diversion or guiding structures in the lake near the fishway may also be contemplated to encourage fish passage through the fishway. The issue of turbine passage is discussed in Section 2.5.

The Boulevard Lake Dam appears well suited to a fishway installation. The dam features several stop log controlled sluiceways on the east side, allowing flexibility in controlling the distribution of flow. A fishway could be designed to fit on the downstream side of one of these sluiceways and the sluiceways operated to maintain optimal flow through the fishway. The easternmost sluiceway appears to be the prime candidate location, as it is located at the head of the channel that follows the eastern bank through which steelhead would likely migrate. A fishway design and site similar to the McIntyre River structure (see Photographic Appendix) appears suitable for the Boulevard Lake Dam.

2.2.3 Trowbridge Falls to Boulevard Lake

The Current River follows a relatively steep gradient from Trowbridge Falls downstream to Boulevard Lake. Potential obstacles through this reach include Trowbridge Falls, the Cascades and the steep, narrow stretch immediately upstream of Boulevard Lake. The Cascades represents a series of relatively gentle rapids and are not judged to present a barrier to migration. The vertical drop at Trowbridge Falls is in the order of 1 to 1.5 m under high flow conditions (April 1990) and is not unlike the conditions presently

surmounted by steelhead in the lower reach below Boulevard Lake Dam (see photographic appendix); thus, upstream passage will probably not be obstructed. The steep stretch immediately upstream of Boulevard Lake also appears to present conditions for passage similar to those seen in the lower reach below the Dam. Any obstacles proving to exist through the Trowbridge Falls to Boulevard Lake reach can probably be remedied through the creation of strategically located resting pools below the obstacles.

2.2.4 North Current River

A private pond located about 2.5 km upstream of the confluence with the Current River presents a complete obstacle for upstream passage, as it is impounded by a relatively high dam (see photographic appendix).

2.2.5 Ferguson Creek

The largest potential obstacle to steelhead passage on Ferguson Creek is "Bald Rock Falls", located about 2.5 km upstream of the confluence with the Current River (see photographic appendix). Under spring flow conditions, the falls appear passable, particularly on the east side (right side in photo). Upstream of the falls, the river follows a very steep gradient that provides only riffle habitat between the falls and Hazelwood Lake. Because Ferguson Creek provides relatively limited spawning and rearing habitat potential upstream of the falls, it is conservatively assumed that steelhead would be produced only in the downstream 2.5 km reach.

2.3 Water Quality and Quantity

It is not anticipated that water temperatures or dissolved oxygen levels will reach detrimental levels during low flow episodes in the Current River. At present, there is a viable brook trout population in some reaches of the Current River. Rainbow trout are a hardier species able to tolerate warmer water temperature and are consequently expected to be more productive than the resident brook trout population. Typical summer dissolved oxygen levels and temperature for the Current River are 8-9 mg/L and 21^{o}C, respectively.

During years of extreme low flow it is expected that smolt production could decrease as a direct result of reduction in availability of summer habitat, increased antagonistic behaviour and reduced food supply. Low flow episodes are thought to be responsible for the early migration of parr, resulting in higher smolt mortality, although Rimmer (1985) found that experimentally reduced discharge did not result in an increase in downstream emigration nor did it effect distribution. Close et al. (1988) similarly reported that summer densities of Y-O-Y were independent of low flow habitat. Normal low flow habitat in the Current River may not be limiting; however, extreme events such as the 50 year minimum of 0.2 - 0.3 m^3/s should be expected to reduce production of steelhead trout.

The water requirements of the Boulevard Lake Dam hydroelectric facility are compatible with a fishway for steelhead passage at the dam. Steelhead adults and smolt will migrate upstream and downstream during spring (April-June) when there is normally ample flow for full operation of the hydroelectric facility as well as a fish ladder (Figure 2.2 adopted from Dillon, 1989). During the steelhead run in late April-early May, flows in the Current River typically average 20 m^3/s to 22 m^3/s, well in excess of hydroelectric requirements, and the adult run should readily pass through the fishway. Flows in late May and June are lower (average of 8 m^3/s in June), but in most years will be sufficient to pass water and smolt downstream. Even in occasional years when flows are 4 m^3/s or lower at Boulevard Lake, most smolt may be expected to reach Lake Superior through the hydro turbine (see Section 2.5).

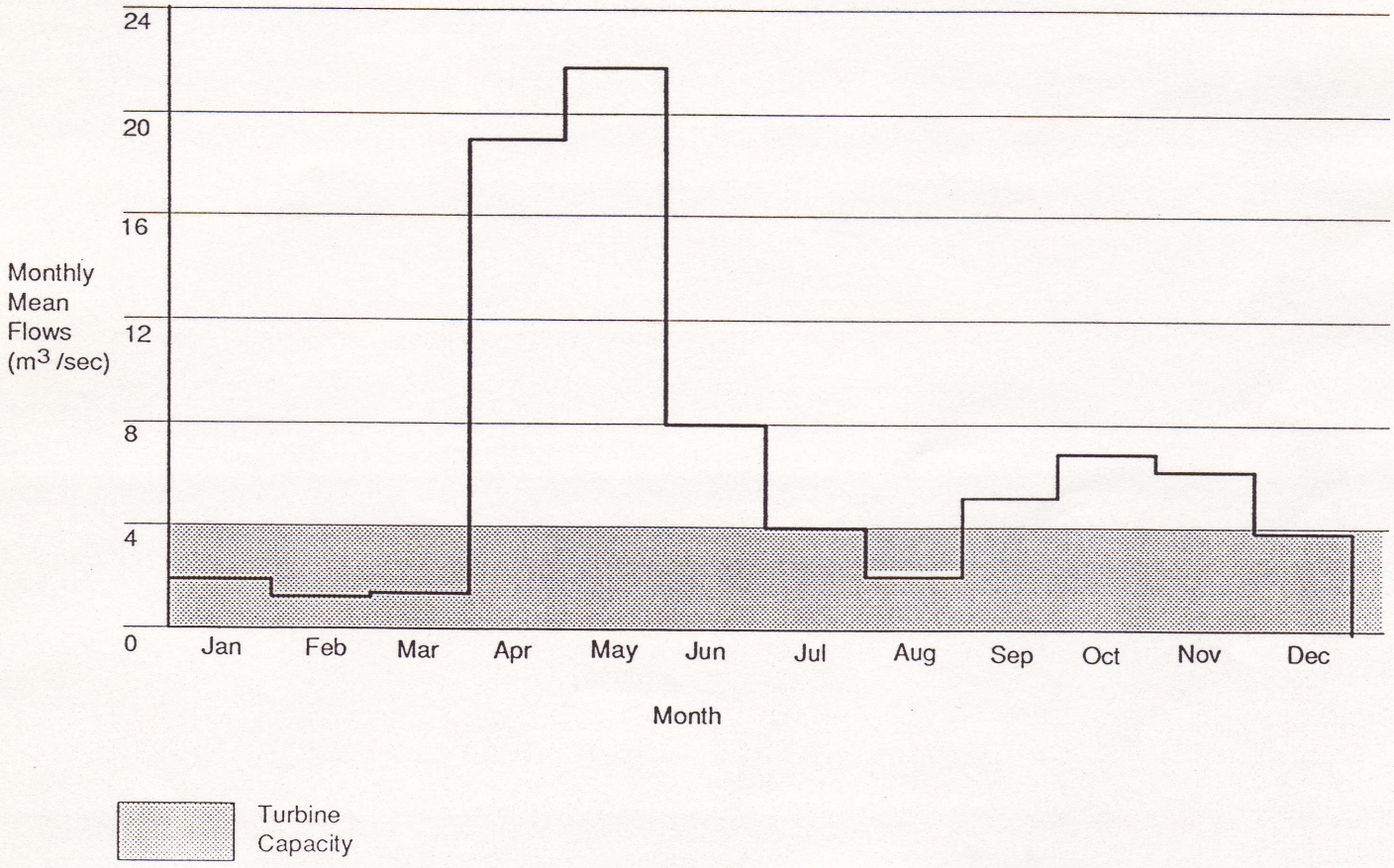
2.4 Habitat Zonation

Potential productivity of each of the seven river zones is illustrated in Figure 2.1. Table 2.2 shows the corresponding HSI values for each zone.

Zone 1 extends for less than one kilometre from Lake Superior to Boulevard Lake Dam. The gradient of this stretch is steep (41 m/km); consequently, water velocity is high and pools are few. The substrate is principally bedrock with scattered pockets of cobble and gravel providing limited spawning habitat. This zone was rated with an HSI score of 0.36 indicating low steelhead productive potential. Presently there appears to be some successful reproduction of steelhead trout in this zone although the population size is unknown.

FIGURE 2.2:

Mean Monthly Flows at Boulevard Lake and Turbine Capacity of the Hydro-electric Facility



Zone 2 is represented by Boulevard Lake and provides no reproductive habitat for steelhead. The lake may provide resting habitat after fish have navigated through the steep gradient of Zone 1 and the fishway. The lake may also provide angling opportunities at the end of the spawning season.

Following Boulevard Lake is an 11.3 kilometre stretch to the site of the old Paquette Dam. The gradient is fairly steep in some sections with other gentler runs that provide spawning and rearing habitat. The substrate is mainly bedrock at the steep sections and boulder, cobble and gravel at the more gradual gradients. Upstream of about Trowbridge Falls, the substrate contains considerable gravel and provides potential spawning habitat. This section of river has been classified with an HSI value of 0.93. It is expected that this reach of river will be moderately to highly productive.

Zone 4, with very low gradient, is a slow meandering section of river. This reach is characterized by depositional substrates, with little or no spawning or rearing habitat, and will serve as a zone of passage and resting area. It may also provide winter habitat if parr in adjacent areas are forced to seek refuge because of ice conditions.

The next section of river (Zone 5) upstream was assessed to provide very good steelhead spawning and rearing habitat, with abundant pools and riffles, and a predominantly gravel-cobble-boulder substrate. The zone extends from a point approximately 20 km from the mouth of the river 6.2 km upstream to Onion Lake, and contributes a habitat area of 93,600 m^2. The zone is assigned an HSI score of 0.93, implying moderately to highly productive habitat.

Zone 6 (lower North Current River) and Zone 7 (lower Ferguson Creek) both provide very good steelhead spawning and rearing habitat. Each section is expected to produce high yields of parr and is classified with an HSI of 1. The distance that fish could ascend these streams is estimated to be 2.5 km for each tributary before encountering barriers (see Section 2.2). In the event steelhead have greater access than estimated or can be aided in further upstream migration (i.e., obstacle removal), then greater production estimates could be expected from these zones.

2.5 Turbine Mortality

As discussed in Section 2.2, it may be possible to install structures near the hydro station intake to divert fish from the area, forcing a greater number to pass through the fishway or over the spillway. Furthermore, the sluiceways may be operated to concentrate the flow over one portion of the dam, providing a greater attraction to the smolt than the intake area.

Despite measures that may be taken to minimize the passage of smolt through the turbine, some fish may nonetheless migrate through the hydro facility. The station uses a single unit Kaplan turbine with a relatively low operating head. In a review of experiments on fish survival during passage through Kaplan turbines, an average survival rate of 86% was reported (Ruggles and Collins, 1981). A mortality rate of 10% to 20% for smolt passing through the Boulevard Lake generating station may, therefore, be expected. Because this mortality rate is relatively low, and because the dam and fishway may be operated to minimize the numbers of smolt passing through the turbine, the overall effect of turbine passage on the steelhead population will probably be small. If flows in the Current River are regulated in the future through reconstruction of the Onion Lake Dam, flows over the Dam may be enhanced in late spring-early summer, thereby decreasing the numbers of smolt passing through the turbine.

Post-spawning adults returning to Lake Superior may be less able to safely pass through the turbine due to their greater size. However, because these fish may be expected to typically migrate downstream in May when Current River flows are well in excess of turbine requirements, the effects of turbine passage on the population should be minimal.

3.0 STEELHEAD PRODUCTION MODEL

3.1 Production Factors

Estimates for potential production are based solely on recent literature values from comparable streams, mainly north Lake Superior tributaries. Three conservative values are applied to obtain the potential young-of-the-year (Y-O-Y) production in each of the river zones. A low production value of 10 Y-O-Y/100 m^2 is selected for the most unproductive habitat. This production value is substantially lower than any found in the literature for rainbow trout streams. Close et al. (1988) reported the carrying capacity of north shore Lake Superior tributaries to be 50-85 Y-O-Y/100 m^2. Again, to keep production estimates on the conservative side, a value of 50 Y-O-Y/100 m^2 was selected to estimate the highest production rates in the Current River. In fact, the Current River may support much higher densities of Y-O-Y in zones with high HSI values. Entwistle (1986) found that some stretches of the neighbouring McIntyre River had standing stocks of 119 Y-O-Y/100 m^2. The moderate production value of 25 Y-O-Y/100 m^2 assumed for habitat of intermediate quality is simply a mid-value between the low and high figures.

Smolt production is estimated using Y-O-Y mortality rates obtained from the literature. In addition, an assumption is made that all smolt produced would successfully reach the lake. Stauffer (1972) demonstrated a mortality rate of 57% from 0^+ to 1^+ and reported the age composition of parr in a Lake Michigan stream to be 68% Y-O-Y, 29% age I and 3% age II. Kwain (1981, 1983) estimated Y-O-Y mortality to be 77% in Stokely Creek, which enters Batchawana Bay, Lake Superior. Based on these data, a mortality rate of 70% is assumed to estimate smolt production in the Current River.

Kwain (1981) found that 26,000 juveniles resident in Stokely Creek supported a population of 868 adults. Of the 26,000 juveniles, 21% were age I and II. It can therefore be assumed that a production rate of 5,460 smolt per year maintained a population of 868 returning adults. This ratio of smolt to returning adults is assumed for the Current River. Kwain (1981) also reported that the total mortality rate of adults was 41%, including 18.9% of the mortality attributed to angling in Stokely Creek, and that 59% of the adult population in Stokely Creek were repeat spawners.

3.2 Potential Steelhead Production

Table 3.1 presents estimated juvenile and adult steelhead production for each river zone. The estimates presented have been made in a conservative fashion assuming high mortality rates and selecting the lower end of the ranges for steelhead carrying capacity of northern streams.

A reasonable scenario for total steelhead production of the Current River would be to suggest that Zone 1 would have low production potential, Zones 3 and 5 would exhibit medium production potential and Zones 6 and 7 would produce high yields of steelhead. Zones 2 and 4 would act simply as rest areas and possibly provide overwintering habitat. If this were the case, the Current River would be expected to produce approximately 30,000 smolt. Kwain's (1981) findings for Stokely Creek showed that a yearly smolt population of 5,460 maintained a constant adult population of 868. Assuming lake mortality of smolt and adults are the same anywhere in Lake Superior, Current River should be able to support a population of about 5,000 adults.

Stokely Creek, which had a habitat area of approximately 65,000 m^2, supported 868 adult steelhead. Because of the large habitat area of the Current River, of which 360,000 m^2 is considered to be fair to excellent for steelhead reproduction, it is conceivable that 5,000 adult steelhead could be sustained by the Current River. Hassenger (1974) found higher mortality rates of smolt in Lake Superior, reporting smolt survival at 2.8-3%. Using this value and assuming the same estimate for smolt production, the Current River would sustain a population of about 2,300 adult steelhead.

3.3 Angling Opportunities

Kwain (1981) and Bjornn (1977) determined that it requires approximately 34% of the spawning adult population to fully seed the nursery areas to maintain a constant population. Therefore, based on an estimated adult population of 5,000 fish, it is felt that Current River would support an annual harvest of about 3,000 adults.

A creel survey of Stokely Creek showed that the steelhead fishery provided 378 anglers with 1,398 hours of angling opportunity (Kwain, 1981). Because the Current River is estimated to be capable of producing three to five times as many steelhead as Stokely

TABLE 3.1: PRELIMINARY, Y-O-Y, SMOLT AND ADULT PRODUCTION POTENTIAL MODEL FOR THE CURRENT RIVER

River Zone	General Habitat Features	Total Area (m^2)	Potential Y-O-Y Production[1]			Potential Smolt Production[2]			Potential Adult Production[3]		
			Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
1	Bedrock, boulder, high velocity	14,400	**1,440**	3,600	7,200	**432**	1,080	2,160	**69**	171	342
2	Lake	-	-	-	-	-	-	-	-	-	-
3	Gravel, cobble, boulder, medium velocity	226,200	22,620	**56,550**	113,100	6,786	**16,965**	33,930	1,077	**2,693**	5,386
4	Depositional substrate, low velocity	134,400	-	-	-	-	-	-	-	-	-
5	Gravel, cobble, medium velocity	93,600	9,360	**23,400**	46,800	2,808	**7,020**	14,040	446	**1,114**	2,229
6	Gravel, cobble, boulder	25,000	2,500	6,250	**12,500**	750	1,875	**3,750**	119	298	**595**
7	Gravel, cobble	12,500	1,250	3,125	**6,250**	375	938	**1,875**	60	149	**298**
TOTAL AREA		506,100									
TOTAL RIVER PRODUCTION					**100,140**		**30,042**			**4,769**	

1 Low production - 10 parr/100 m^2, moderate production - 25 parr/100 m^2, high production - 50 parr/100 m^2.

2 Assuming 70% mortality of Y-O-Y and 100% migration of 1+ and older.

3 Based on Kwain's (1981) estimates that Stokely Creek required 5,460 smolt to maintain a constant population of 868 returning adults.

Note: Bold values are estimated production rates for each zone.

Creek, a Current River steelhead fishery may attract 1,100 to 1,900 anglers and provide 4,200 to 7,000 hours of angling annually. Greater angling activity may, in fact, occur on the Current River owing to the river's excellent accessibility.

4.0 STOCKING

If a decision is made to proceed with the detailed design of a fishway, the establishment of a population in the river may be accelerated by planting juvenile steelhead in the upper reaches of the Current River for several consecutive years. In this manner, adults may be expected to "home" to these areas after the fishway is complete. The upwelling box constructed for the North Shore Steelhead Association and presently stored at the Lakehead Region Conservation Authority headquarters may be used to assist in this effort.

5.0 RECOMMENDATIONS

This study concludes that the Current River would provide sufficient spawning and rearing habitat to support a steelhead spawning run of approximately 5,000 fish, if a fishway is installed in the Boulevard Lake Dam. Based on this conclusion, it is recommended that a concensus be reached concerning the desirability of the general fishway concept and on the funding and operation of a fishway. A preliminary engineering design and cost estimation should be initially completed to focus this review process.

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PHOTOGRAPHIC APPENDIX

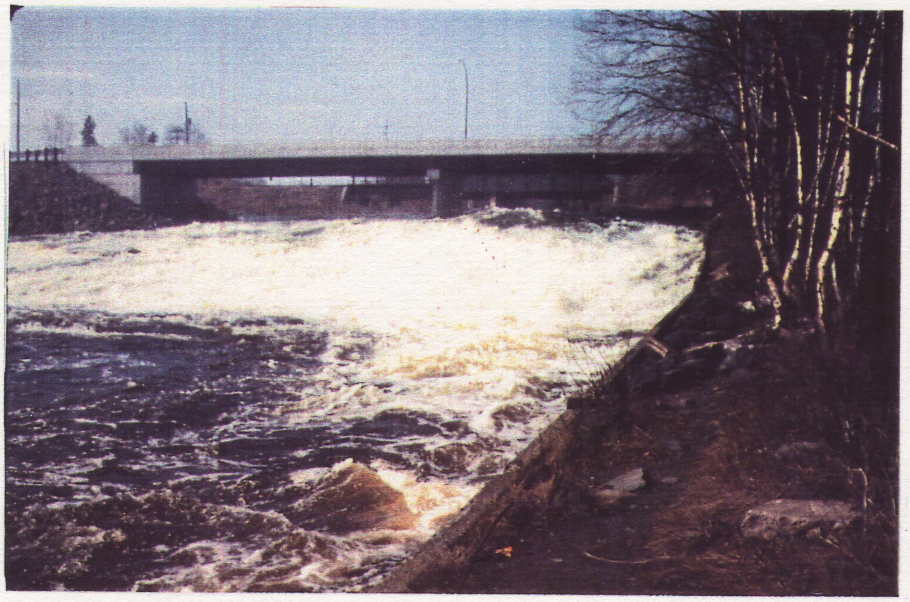

Photo 1: Lower Current River, Zone 1, 25 April 1990. Steelhead are reported to presently pass through this steep reach.

Photo 2: Lower Current River, Zone 1, looking towards the Boulevard Lake Dam, 25 April 1990. The Hydro discharge is located in the fenced area at right. Steelhead are believed to spawn in the foreground area.

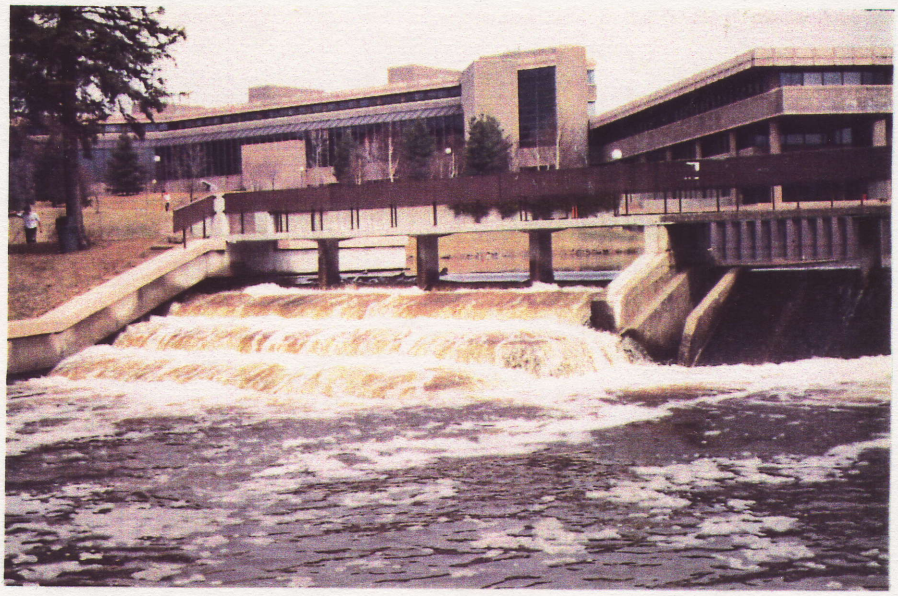

Photo 3: Fishway on the McIntyre River, 25 April 1990. A structure similar to this may be adapted to an existing sluiceway at Boulevard Lake.

Photo 4: Trowbridge Falls, Zone 3, 25 April 1990. Steep stretches such as this through Zone 3 may require simple in-stream improvements (resting pools) to facilitate upstream passage.

Photo 5: Current River, Zone 5, at road crossing downstream of Paquette Dam, 25 April 1990. Good spawning and rearing habitat.

Photo 6: Current River, Zone 5, near Onion Lake Dam, 22 November 1989. Good spawning and rearing habitat.

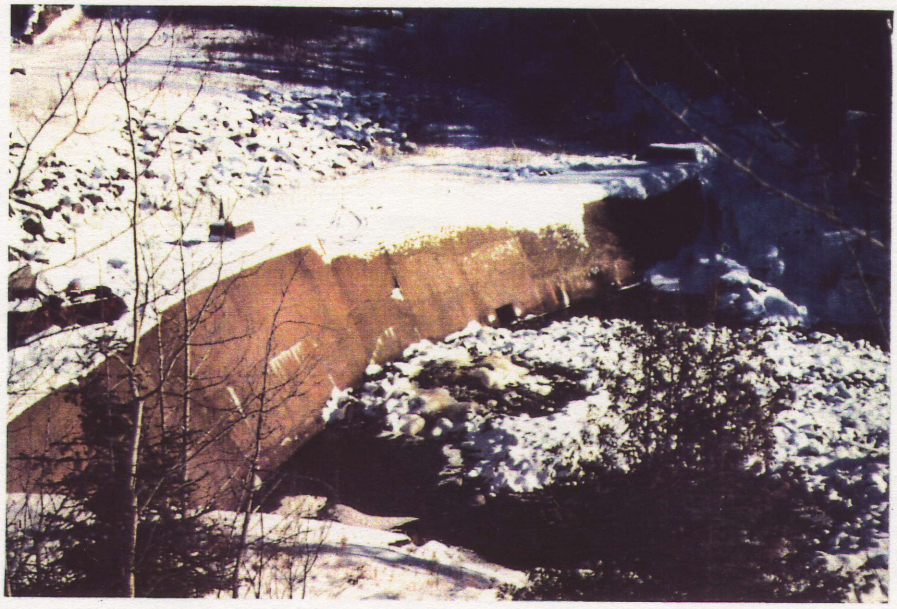

Photo 7: Onion Lake Dam, 22 November 1989. The remnants of this dam will block steelhead from upstream passage. Reconstruction of the dam for future low-flow augmentation would enhance downstream habitat.

Photo 8: North Current River at Copenhagen Road Crossing, looking downstream, 25 April 1990. Abundant pools and riffles provide excellent potential steelhead habitat.

Photo 9: North Current River at Copenhagen Road Crossing, looking upstream, 25 April 1990.

Photo 10: Complete barrier to migration on the North Current River, 25 April 1990.

Photo 11: Ferguson Creek near mouth, 25 April 1990. This section has a predominantly cobble-gravel bottom and offers excellent spawning habitat potential.

Photo 12: Ferguson Creek, Bald Rock Falls, 25 April 1990. Under these conditions, the falls appears passable to steelhead on the east (right) side. Areas upstream appear to offer more limited habitat potential.