

A report of the genetic structure of steelhead populations along  
the North Shore of Lake Superior

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This document summarizes some of my research that was supported by the NSSA which addressed the following genetic questions about steelhead from the North Shore of Lake Superior:

- 1) Are individual tributary steelhead populations on the North Shore genetically different from steelhead populations from Lake Ontario and stocked Kamloops strain rainbow trout?
  - 2) Are individual tributary steelhead populations on the North Shore genetically distinct populations, and if so to what extent?
  - 3) What was the ancestral stock(s) of North Shore steelhead populations?
  - 4) What was the source of juvenile rainbow trout caught in Ferguson Creek (2002) and the Current River (2004)?
  - 5) Are Kamloops strain rainbow trout that are stocked by Minnesota of concern to the genetic integrity of wild North Shore steelhead?
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**1) Are individual tributary steelhead populations on the North Shore genetically different from steelhead populations from Lake Ontario and stocked Kamloops strain rainbow trout?**

*Absolutely!* Lake Superior steelhead are genetically distinct from Lake Ontario populations as well as Kamloops strain rainbow trout stocked by Minnesota. Figure 1 shows a genetic tree (similar to the idea of a family tree), where populations that are similar genetically are grouped together. The tree shows that Kamloops strain rainbow trout and wild Lake Ontario steelhead populations from Cobourg Creek and Shelter Valley are genetically distinct from Lake Superior populations.

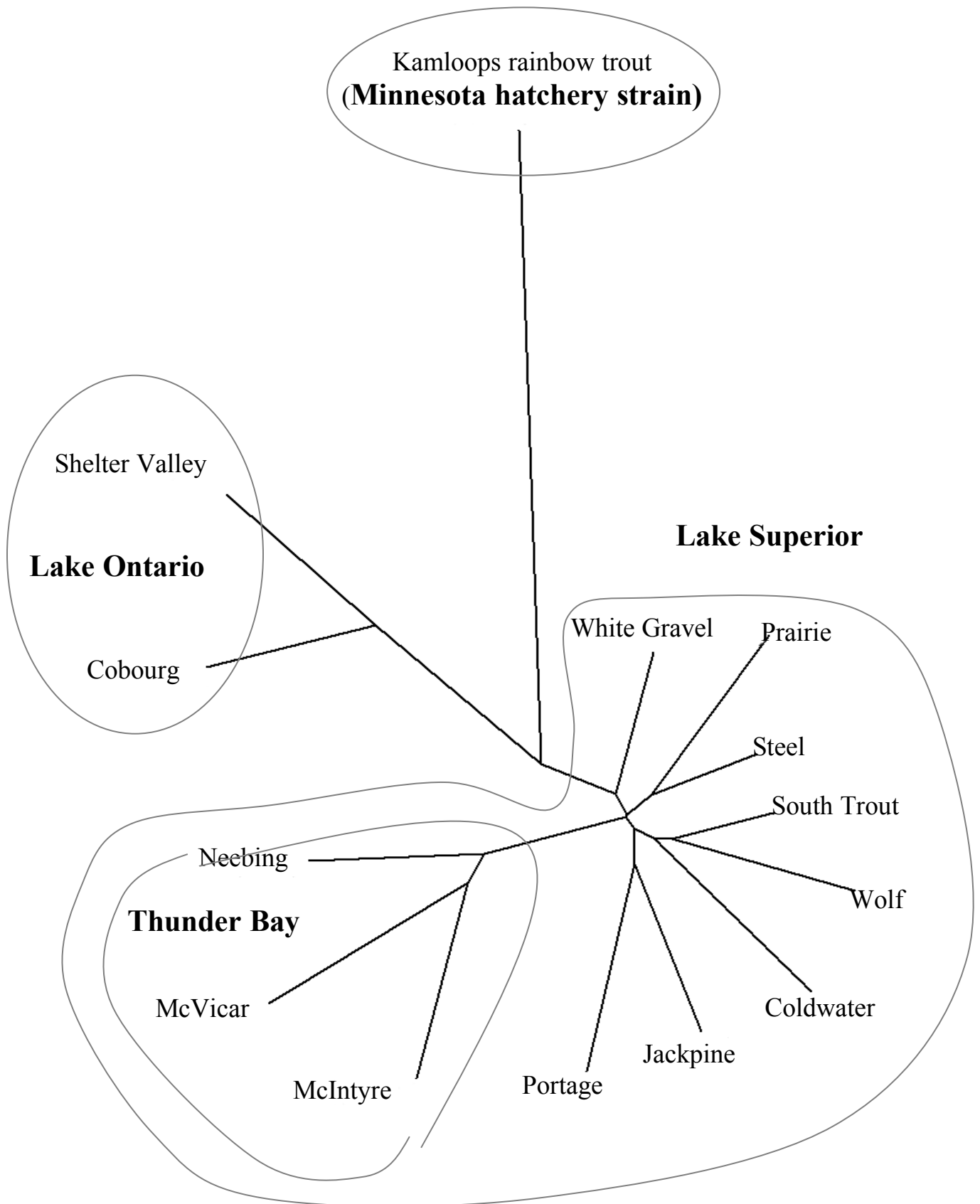


Figure 1. A tree diagram that shows the genetic relationships among Lake Superior and Lake Ontario steelhead as well as Kamloops strain rainbow trout.

## 2) Are steelhead populations on the North Shore genetically divergent from one another and if so to what extent?

Yes, all Lake Superior tributary steelhead populations *are genetically different from one another*. The tributary populations included in this genetic analysis included: Neebing River, McIntyre River, McVicar Creek, Portage Creek, Coldwater Creek, Wolf River, South Trout Creek, Jackpine River, Steel River, Prairie River, White Gravel River.

*What does this suggest?*

- Fish have very strong homing instincts, and transfer of genes among populations through straying is uncommon.
- Tributary populations are the most appropriate biological management unit.
- Genetic isolation of populations comes before adaptation of tributary populations to their specific environment. Current genetic differences among populations (and the isolation that infers) suggest that North Shore steelhead populations are likely becoming locally adapted. Locally adapted populations are better suited to their environment and, simply put, are generally *superior* (more fit) when compared to stocked fish.

The studied tributary populations fit into two large genetic groups; 1) Thunder Bay tributary populations; and 2) Black Bay, Nipigon Bay, Terrace Bay, Pukaskwa and tributary populations. These groups can be seen in the genetic tree (Figure 1), where the three Thunder Bay populations are all grouped together in the bottom left corner.

*What does this suggest?*

- Movement of genes between the two groups due to straying fish is very rare.
- The two groups are different enough that the genetic method used can often tell from which of the two groups an individual originated.

Populations within Lake Superior are more genetically different from each other than are populations of steelhead within Lake Ontario and Lake Michigan (Figure 2).

*What does this suggest?*

- Stocking has had a homogenizing effect in Lakes Ontario and Michigan, which means that populations aren't given the change to become genetically different or locally adapted.

Lake Superior steelhead populations are less divergent when compared to native steelhead populations in British Columbia. This is to be expected as divergence takes time; populations in British Columbia have had thousands of years in their native habitats, where steelhead have only been in Lake Superior for just over a century.

*What does this suggest?*

- Given more time without stocking, genetic differences among Lake Superior populations will probably increase as they continue to adapt to different local conditions.

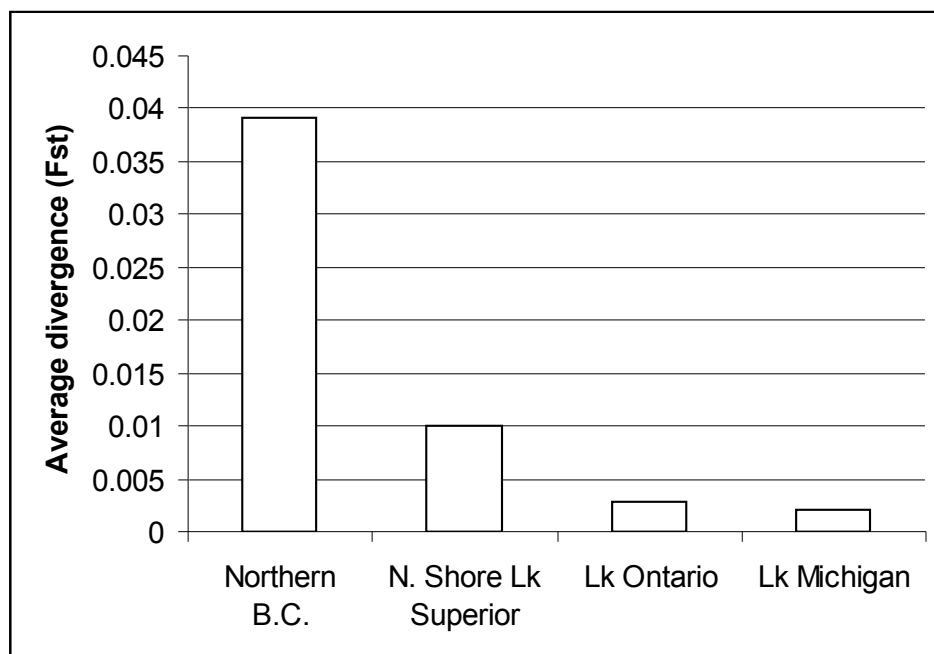


Figure 2. Shows a measure of average genetic difference among steelhead populations from 1) Northern British Columbia; 2) North Shore of Lake Superior; 3) Lake Ontario and; 4) Lake Michigan. (Results shown from British Columbia are from Heath et al. 2001. *Heredity* 86: 618-627. Results from Lake Michigan are from Bartron and Scribner. 2004. *Environmental Biology of Fishes* 69: 95-109.)

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### 3) What was the ancestral stock of North Shore steelhead populations?

There may never be a direct answer to this question. However, genetic analysis showed that current populations are high in genetic diversity.

*What does this suggest?*

- This suggests that more than one strain contributed to the genetic pool now found along the North Shore.
- North shore steelhead are not McCloud River, Donaldson's or Richardson's strain, they have mixed to become *Lake Superior strain steelhead* that are well suited to the Lake Superior environment.

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### 4) What was the source of juvenile rainbow trout caught in Ferguson Creek (2002) and the Current River (2004)?

The NSSA has been working towards building a self-sustaining population of steelhead in the Current River. Part of this project was the introduction of adult steelhead from the McIntyre and Neebing Rivers and McVicar Creek, as well as eggs/fry from Portage Creek

into the Ferguson Creek (For more information see <http://www.northshoresteelhead.com/project2.html>).

Genetic analysis shows that juveniles caught in Ferguson Creek (2002) and the Current River (2004) are lower in diversity than the other wild populations sampled, including the populations from which the adult and eggs that were transferred originated (Figure 3).

*What does this suggest?*

- The sampled juveniles are the offspring of a limited number of adults.

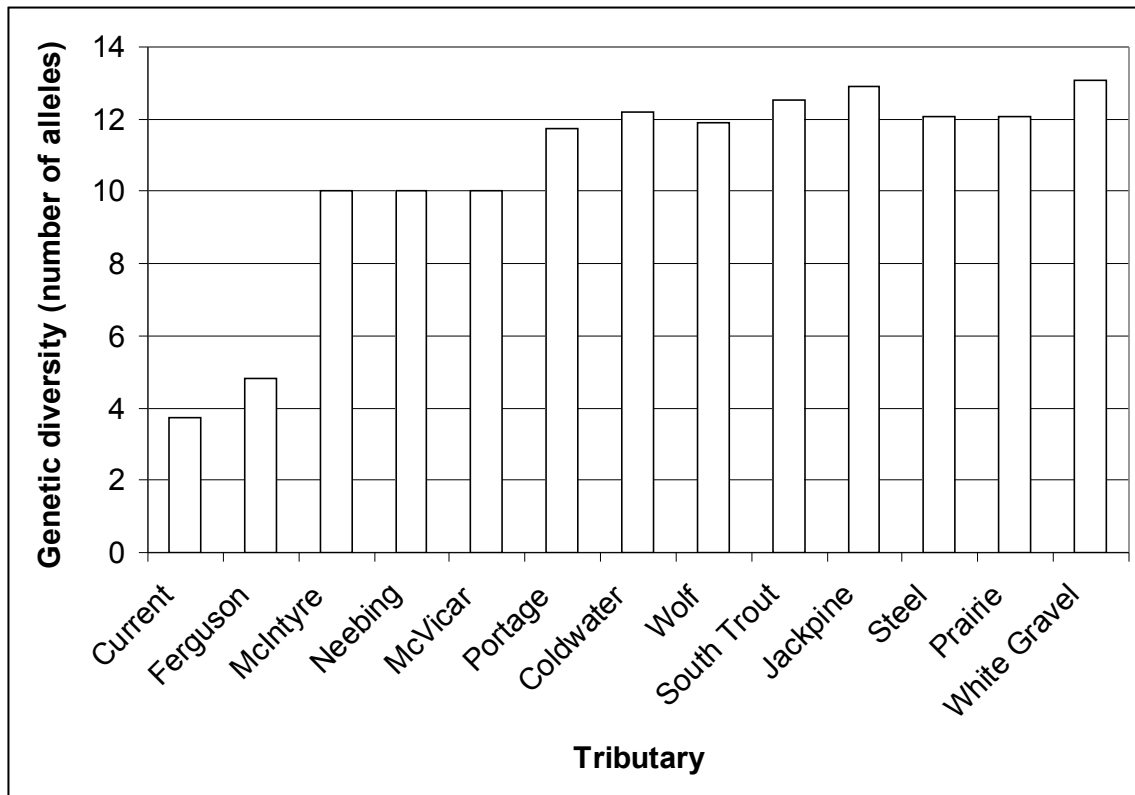


Figure 3. Genetic diversity of steelhead populations along the north shore of Lake Superior.

Of juveniles captured in Ferguson Creek (49 fish; 2002) and the Current (4 fish; 2004), genetic analysis suggests that 74% of fish are most likely the offspring of adult fish transfers from Thunder Bay tributaries (McIntyre, Neebing and McVicar), while 36% are most likely the offspring of egg / fry transfers from Portage Creek.

*What does this suggest?*

- Both methods were successful in seeding Ferguson Creek, but adult transfers appear to have provided the greatest benefits in this case.
- The capture of juveniles in Ferguson Creek (2002) and young-of-year at the Cascades on the mainstream of the Current River (2004) indicates that rainbow trout/steelhead have reproduced subsequent to the time of the transfers. Genetic results suggest that the fish captured were related to the populations that were

the source of adults and eggs for the transfer, and therefore it is highly likely that these individuals were second generation descendants of the transferred individuals (offspring of the offspring that resulted from the transfers).

- It is unknown if the juveniles were the offspring of resident fish or of migratory fish. However, the fact that original transfers were all migratory individuals would suggest that the juveniles caught were most likely the offspring of first generation (after transfer) migratory fish returning to the Current River.
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5) Are Kamloops strain rainbow trout that are stocked by Minnesota of concern to the genetic integrity of wild North Shore steelhead?

*No*, there is no genetic evidence of successful Kamloops breeding or reproduction between Kamloops fish and wild populations, even in tributaries where they appear to be very common (Steel River). This result is consistent with other work from Minnesota.

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That concludes the major genetic findings. Any questions pertaining to the material included here can be sent via email to [peter.addison@ontario.ca](mailto:peter.addison@ontario.ca) or [paddison@zoo.utoronto.ca](mailto:paddison@zoo.utoronto.ca). Full details of the research discussed are described in my upcoming M.Sc. thesis, “Adaptive naturalization of steelhead populations from the Ontario shoreline of Lake Superior”, that will be available on request from the University of Toronto and Ministry of Natural Resources libraries as of June 2007.

I would like to express my sincere gratitude to the NSSA for the financial and logistical assistance. I’m sure that the club’s great interest in fish and fish habitat along the North Shore of Lake Superior will continue to help maintain your wonderful resources!

Regards,  
Peter Addison