Hit the road: assisted migration as population enhancement?

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1. WHAT IS ASSISTED MIGRATION (A.M)?

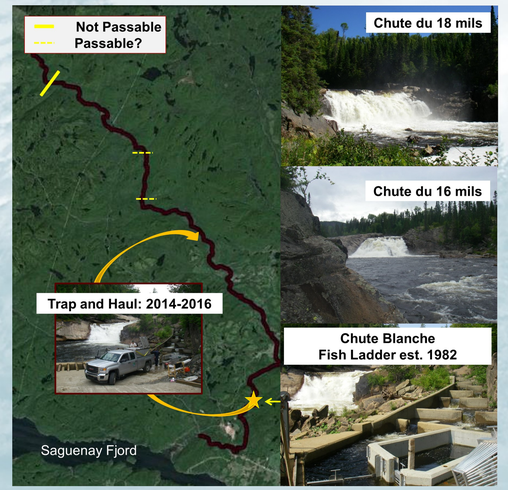
- Human intervention allowing migratory fish to bypass unfavourable habitat or manmade structures though **volitional passage** (i.e. via fishways) or **"Trap and Haul"** by truck or barge

2. A.M. FOR POPULATION ENHANCEMENT

- Favored by the Province of Quebec
- Especially in rivers that enter the St. Lawrence River along its North Shore to re-establish connections between habitats lost to migrating salmon through isostatic rebound since the last Glacial Maxima (usually by installation of fish ladders)
- Based on the hypothesis that increasing available spawning habitat will decrease spawner density and:
  - Reduce juvenile rearing density, thus reducing density dependent effects on growth and survival
  - Increase size-at-age and overall abundance of outmigrating smolts
- **Benefits:** Avoids some of the negative evolutionary impacts of hatcheries
  - E.g. reduced genetic diversity, reduced reproductive success
- Sexual selection operates during spawning
- Natural selection occurs during juvenile rearing

3. A.M. ON THE NORTHEAST ST. MARGUERITE RIVER

- Prior to 1982: Atlantic salmon could access 6.7 km of river habitat
- 1982: Volitional passage implemented at Chute Blanche
  - Fishway installation opened an additional 10.5 km of habitat
- Further upstream passage is blocked by a pair of natural waterfalls



- 2014: 3-year "Trap and Haul" program implemented
- Goal: capture a maximum of 30 salmon per year at the Chute Blanche fish ladder for transport and release upstream of the two impassable waterfalls (Chute du 16 and Chute du 18)
- **The objective of our study is to evaluate the impact of this "trap and haul" program on the population productivity of the Sainte-Marguerite River**
- Specifically, we aim to:

1) **assess habitat use and migratory behavior of adult Atlantic salmon following transport**
2) **determine the implications of spawning habitat choice on juvenile growth and development**

4. TRANSPORT, TAGGING, and TELEMETRY

- **We transported 12 adults (2F, 10M) in 2014 (total run size: 148)**
- **We transported 25 adults (11F, 13M, 1Unk) in 2015 (total run size: 92)**

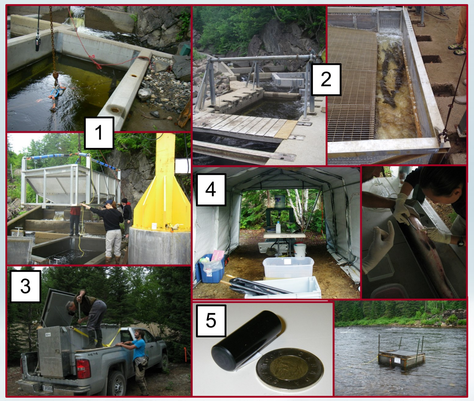


Figure 2. Salmon entering the fish ladder at Chute Blanche are: (1) diverted into a retention cage for holding until transport or (2) captured by net from the entrance cage and immediately transferred to the transport truck (3). Upon arrival at the release site (4) an acoustic tag (Vemco V13; 5) is surgically implanted (6) and fish are allowed to recover in river (7).

5. ACOUSTIC TELEMETRY IN A GRAVEL-BED RIVER

- We used a combination of active and passive acoustic telemetry to track movements of tagged fish following release.
- A range test conducted June 2014 indicated that when acoustic receivers are placed in shallow pools (≥ 0.5 m), detection efficiency is
  - 95% of expected detections at 40-115 m
  - 78% of expected detections at 200 m
- Based on the range test we installed a network of 9 acoustic receivers in 2014 and 17 acoustic receivers in 2015 (Vemco VR2W)

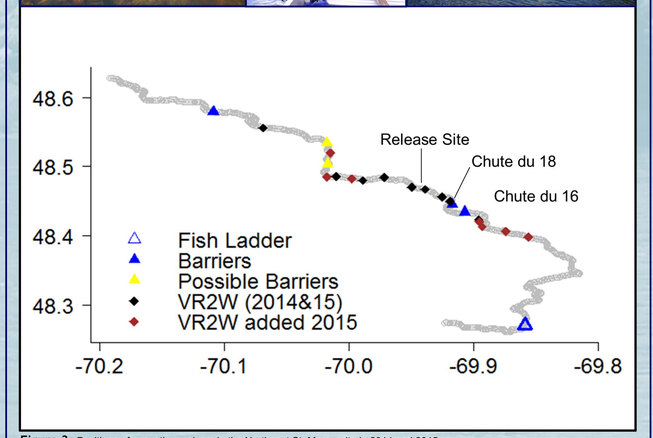


Figure 3. Positions of acoustic receivers in the Northeast St. Marguerite in 2014 and 2015

6. FISH MOVEMENT PATTERNS

- **Fish movement patterns varied considerably** among individuals (Fig. 4)
- In general, **males moved** substantially **more than females** (Fig. 5)

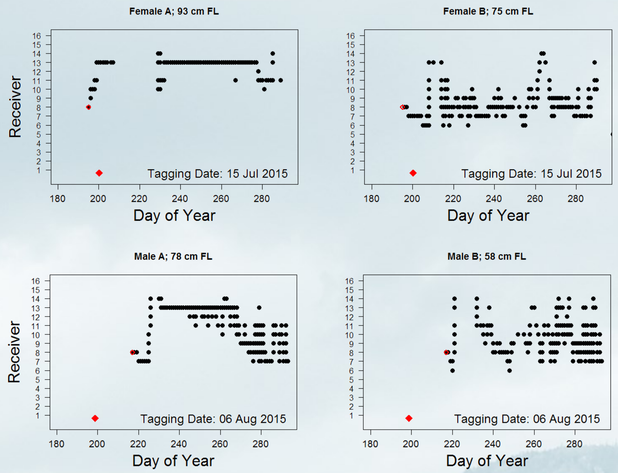


Figure 4. Movement patterns of representative females (top panels) tagged on 15 July and males (bottom panels) tagged on 6 Aug.

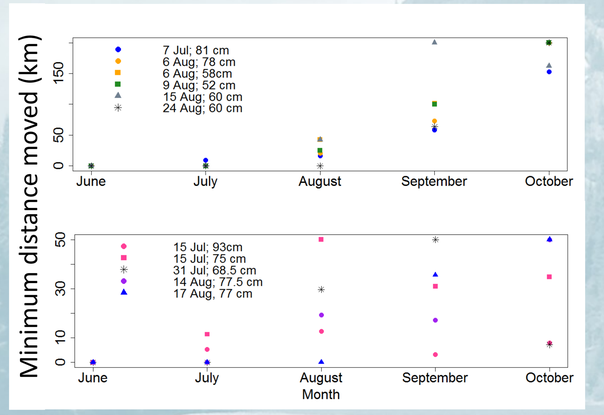


Figure 5. Minimum distance moved per month (km) by females (top panel) and males (bottom panel) that remained in the study area until spawning (2015). Note the different y-axes.

7. STRAYING RATE

- Defined as **percentage of fish that left the study area by swimming downstream over the impassable falls**
  - High in both years: **42% in 2014 (5 of 12) and 28% in 2016 (7 of 25)**
- Most fish that strayed did so within 1 week of tagging, however 2 adults tagged in 2015 spent 28 and 34 days above the falls before staying.
- Of the fish that strayed, 1 fish in 2014 and 4 fish in 2015 were detected passing both waterfalls.
- **Descent rate** (time elapsed between last detection upstream and first detection downstream of the falls) **was between 5.2 and 158.9 hours**
- Fish that strayed but were not detected downstream of Chute du 16 (4 fish in 2014 and 3 fish in 2015) are assumed to have remained between Chute du 18 and Chute du 16 and may have died descending the falls.

8. CONFIRMATION OF SPAWNING

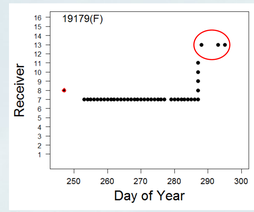


Figure 6. Movement patterns of the one tagged female that remained in the study area until spawning in Oct 2014. Note: only receivers 5-14 and 16 were installed in 2014.

- 2014: High water prevented river access between 26 Sept and 23 Oct 2014
- A potential spawning area was identified using fish movement patterns from acoustic receivers
- The one tagged female and 6 males converged on the stretch of river between Receiver 12 and 13 on Oct 15, 2014 (Fig. 6)

- **Electro-fishing in Sept 2015 confirmed that spawning occurred between Receivers 12 and 13 in 2014.**
- **Methods:** Transects were spaced 15 m apart and perpendicular to the river flow, from the bank to (a) the river centreline or (b) the point where the water became to deep to wade. Fishing continued until at least 3 transects were completed without any salmon present to determine longitudinal distribution.
  - 6 age-0+ parr (62-75 mm FL) were captured in swift moving, cobble-boulder habitat.
- **Spawning in 2015 was confirmed via a combined canoe and snorkel visual survey.**
  - 2 redds and 3 test redds between Receiver 12 and 13, and in Ulrich Brook, a tributary that enters the Northeast SMR at Receiver 14
  - Early onset of ice cover prevented a complete survey

11. CONCLUSIONS

- Acoustic telemetry is ideal for tracking fish movements in this remote, turbulent, gravel-bed river.
- Placement of receivers in pools (≥ 0.5 m deep) allowed us to:
  - obtain multiple positions per fish per day, at all but flood-stage discharge
  - collect data when river access was not possible
- Adults selected the same river section for spawning in both years.
- Initial (though very limited) observations indicate that assisted migration to reduce spawning densities may have positive benefits on juvenile growth.

12. FUTURE DIRECTIONS

- Conduct one final year of transport and telemetry in 2016 and if possible, incorporate a control group (transported & released in natal, not novel habitat)
- Examine the effects of environmental conditions (temperature, river discharge) on pre-spawning movements
- Assess how spawning density affects juvenile density and subsequent growth, size-at-age, and age at outmigration (via electro-fishing and smolt trapping)
- Model ideal number of adults needed to achieve positive benefits of transport on juvenile production
- Findings will be used to inform this and other A.M. programs in Quebec.

References

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