

Unique spawning movements and behavior of adfluvial bull trout in a protected watershed

Seattle Public Utilities
 Heidi K. Barnett and Dwayne K. Paige
 Seattle Public Utilities – Watershed Services Division
 19901 Cedar Falls Rd. SE, North Bend, WA 98045

INTRODUCTION

- A population of adfluvial bull trout (*Salvelinus confluentus*) resides in the upper Cedar River Municipal Watershed (CRMW) in one of the City of Seattle's main water supply reservoirs, Chester Morse Lake (CML) (Figure 1 and 2)

- CML, located approximately 55 km east of Seattle, serves as a major reservoir in the water supply system for the City of Seattle, provides managed instream flows, a small amount of hydroelectric power and limited flood control

- The entire watershed landscape contributing water to CML is owned by the City of Seattle, closed to unsupervised public access, and managed under a Habitat Conservation Plan (HCP) (City of Seattle 2000) to protect fish and wildlife habitat while providing high quality drinking water to Seattle

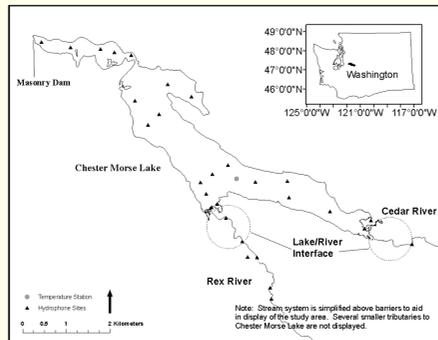


Figure 1.—Chester Morse Lake (CML) located in the upper Cedar River Municipal Watershed where a population of adfluvial bull trout resides.



Figure 2.—Confluence of the Cedar River immediately upstream of CML (left), and extensive stump fields along Cedar River delta perimeter (right).

OBJECTIVES

As part of a concurrent movement/behavior study, objectives were as follows:

- 1) Determine characteristics of the spawning migration (initiation date, number of trips between lake and river, timing of movements)
- 2) Determine percent of tagged population exhibiting annual spawning behavior

DEFINITIONS

Movement = directed change of habitat from lake to river or river to lake

Trip = discrete time interval in which a fish moved from lake to river (and back) during a given year's spawning migration; may be single for the year or multiple

Migration = one or more trips into river during a spawning season (mid-Sept to November)

METHODS

- An array of acoustic receivers (Vemco, Inc.) was established in CML, and individual receivers were placed in the Cedar and Rex rivers at locations where bull trout would likely hold or rest during a spawning migration (Figure 1 and 3).

- PIT tag antenna array was installed in the Cedar River (0.6 km upstream of CML) as part of a concurrent study examining juvenile bull trout and rainbow trout movements (Mesa et al. 2008) (Figure 1 and 3). Juvenile and adult bull trout were PIT tagged.

- Acoustic transmitters were surgically implanted in adult bull trout (Vemco, Inc.) (Figure 9).

- All acoustic and PIT tag detections collected between September 15th and November 30th, were compiled for 69 individual bull trout.

- The duration of a movement into riverine habitat was determined by calculating the amount of time between a detection in riverine habitat and a subsequent detection in the lake (receiver array in the river was not dense enough to continuously monitor movement in riverine habitat.)

- In some cases, a bull trout disappeared during the spawning run and was presumed a mortality or a tag failure. These fish were excluded from analysis determining number of trips by individual.

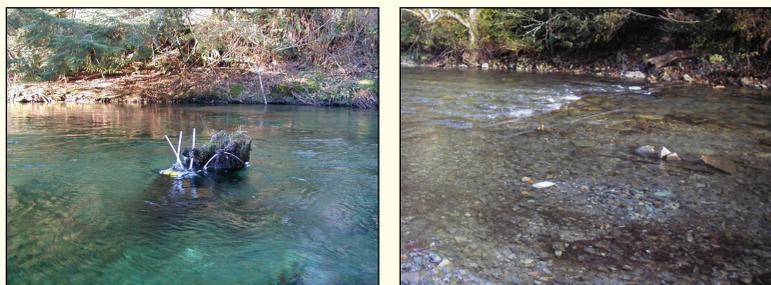


Figure 3.—Receiver attached to a submerged log in the Cedar River (at left). Bull trout redd immediately upstream of a PIT (passive integrated transponder) tag antenna array on the Cedar River.

RESULTS

- Spawning surveys (2000 – 2010) show that most bull trout spawn in habitat in close proximity to CML (Figure 5). 82 percent of all documented bull trout redds were less than 3.0 km from CML (N = 4,515) (Barnett et al., in prep, Figure 4)

- The initial movement of tagged bull trout into the river from the reservoir after Sept 15th declined gradually over the spawning year (Figure 5) with most activity initiating before the middle of October

- 40% of tagged fish made an initial movement during the last two weeks of September
- 39% made an initial movement during October

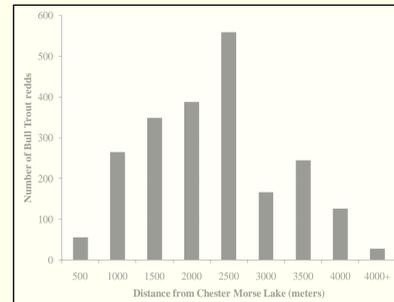


Figure 4.—Distribution of bull trout redds in the Cedar River Municipal Watershed relative to distance from Chester Morse Lake, spawning years 2000 - 2010 combined.

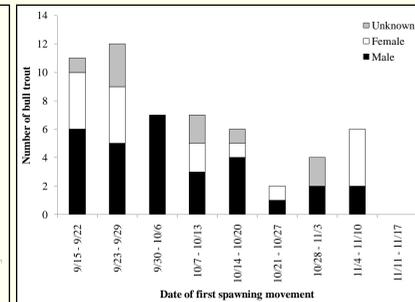


Figure 5.—Initial spawning movement by acoustically tagged bull trout in tributaries of Chester Morse Lake, spawning years 2006 – 2010 combined.

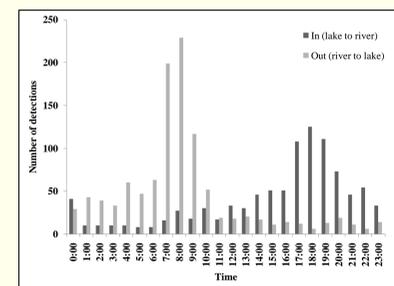


Figure 6.—Time of day for all bull trout movements into and out of the Cedar and Rex rivers during the spawning season (9/15 – 11/30) for years 2006 - 2010 combined.

NUMBER OF TRIPS BETWEEN CML AND RIVER HABITAT

- **97 percent** of annual spawning migrations were comprised of **more than one trip** (N = 60 of 62) (Figure 7)

- 73 percent of all tagged bull trout made between 4 to 21 distinct trips between CML and river during a spawning season
- 24 percent made more than 22 distinct trips
- 3 percent made only a single trip

- Maximum number of trips between CML and riverine habitat in a single season by an individual bull trout was 49 distinct trips



Figure 8.—Acoustically tagged male bull trout observed spawning in Cabin Creek, tributary to the Rex River during fall 2010. This fish made 13 distinct trips between CML and the Cabin Creek site is ~1.8 km.

DIURNAL MOVEMENTS

Bull trout move between the river and lake throughout the day, but exhibit two major peaks in directional activity (Figure 6)

- **07:00 to 10:00** (moving from river to lake)
- **17:00 to 20:00** (moving from lake to river)

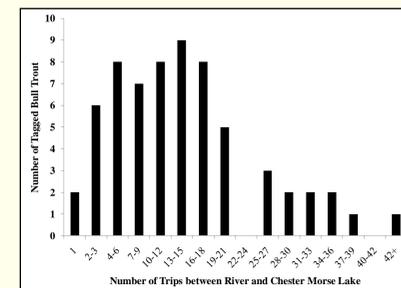


Figure 7.—Number of spawning trips made by individual bull trout between the river system and Chester Morse Lake for years 2006-2010 combined.

NUMBER OF TRIPS - AVERAGE
 Number of trips by individual bull trout varied significantly among year ($F_{crit} = 2.5, P > 0.01$)

- 2006 = 12.5
- 2007 = 14.2
- 2008 = 9.0
- 2009 = 26.6
- 2010 = 15.1

CONCLUSIONS

1) **Most bull trout make several trips** between Chester Morse Lake and riverine spawning habitat during a single spawning season **and move primarily at dawn and dusk hours**

POSSIBLE ADVANTAGES OF THIS BEHAVIOR

- May minimize predation risk in river during daylight hours by retreating to deep water cover in the lake
- Deep pools providing cover in river habitat are limited in spawning reaches
- Likely increases probability of females pairing with more than one partner = increased genetic diversity
- Reduces likelihood that one environmental event (e.g., peak flow, flood) could destroy all eggs from a single female (we observed partially spent females at river mouths during the spawning run, suggesting that more than one redd may be created by at least some individuals)

IMPLICATIONS FOR MANAGEMENT/RECOVERY OF BULL TROUT

- Highly likely that some females dig multiple redd pockets, therefore annual redd count surveys should consider this possibility in adfluvial systems as in CML
- Consider connectivity between lacustrine and riverine habitat throughout the spawning season to facilitate natural movement behavior
- Genetic diversity of a population may be increased through this movement behavior

2) **58 percent of female bull trout** in this study were **annual spawners**, 42 percent appeared to be biennial (or greater) spawners

3) **70 percent of male bull trout** in this study were **annual spawners**, while 30 percent appeared to be biennial (or greater) spawners

4) Initial individual spawning migration is distributed over a wide interval (mid-Sept to Nov)



Figure 9.—Implanting acoustic transmitter in adult bull trout (left) and adult bull trout with floy tag (right).

Literature cited

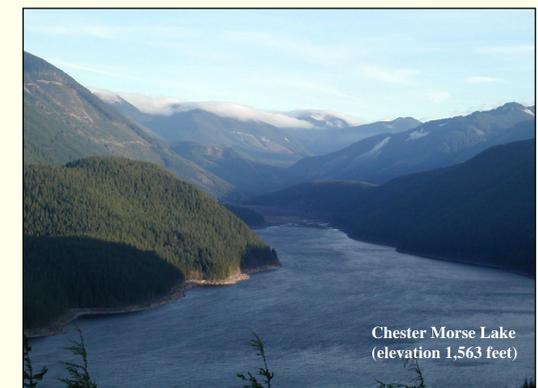
Barnett, H.K. and D.K. Paige. in prep. Unique spawning movements and behavior of adfluvial bull trout in a protected watershed.

Barnett, H.K., D. K. Paige, and W. B. Belknap. in prep. Spatial and temporal spawning characteristics of bull trout in the Cedar River Municipal Watershed, Washington, USA.

City of Seattle. 2000. Final Cedar River Watershed Habitat Conservation Plan. City of Seattle. Seattle, Washington. http://www.seattle.gov/util/About_SPU/Water_System/Habitat_Conservation_Plan/index.asp

Fraley, J. J. and B. B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and river system, Montana. Northwest Science 63(4):133-143.

Mesa, M. G., P. J. Connolly, N. A. Zorich, L. K. Weiland, H. K. Barnett, and D. K. Paige. 2008. Juvenile bull trout and rainbow trout movements and growth in selected tributaries of the Chester Morse Lake basin, Cedar River Municipal Watershed, Washington. Final report of research. http://www.cityofseattle.net/util/groups/public/@spu/@ssw/documents/webcontent/spu02_015175.pdf



For further information:

Contact Heidi.Barnett@seattle.gov or Dwayne.Paige@seattle.gov

More information on the Cedar River Municipal Watershed at

http://cityofseattle.net/util/About_SPU/Water_System/Habitat_Conservation_Plan/index.asp
http://www.seattle.gov/util/About_SPU/Water_System/Water_Sources_& Treatment/CedarRiverBio diversity/Fish/BullTrout/index.htm