



# Brook Trout in a Fragmented Landscape



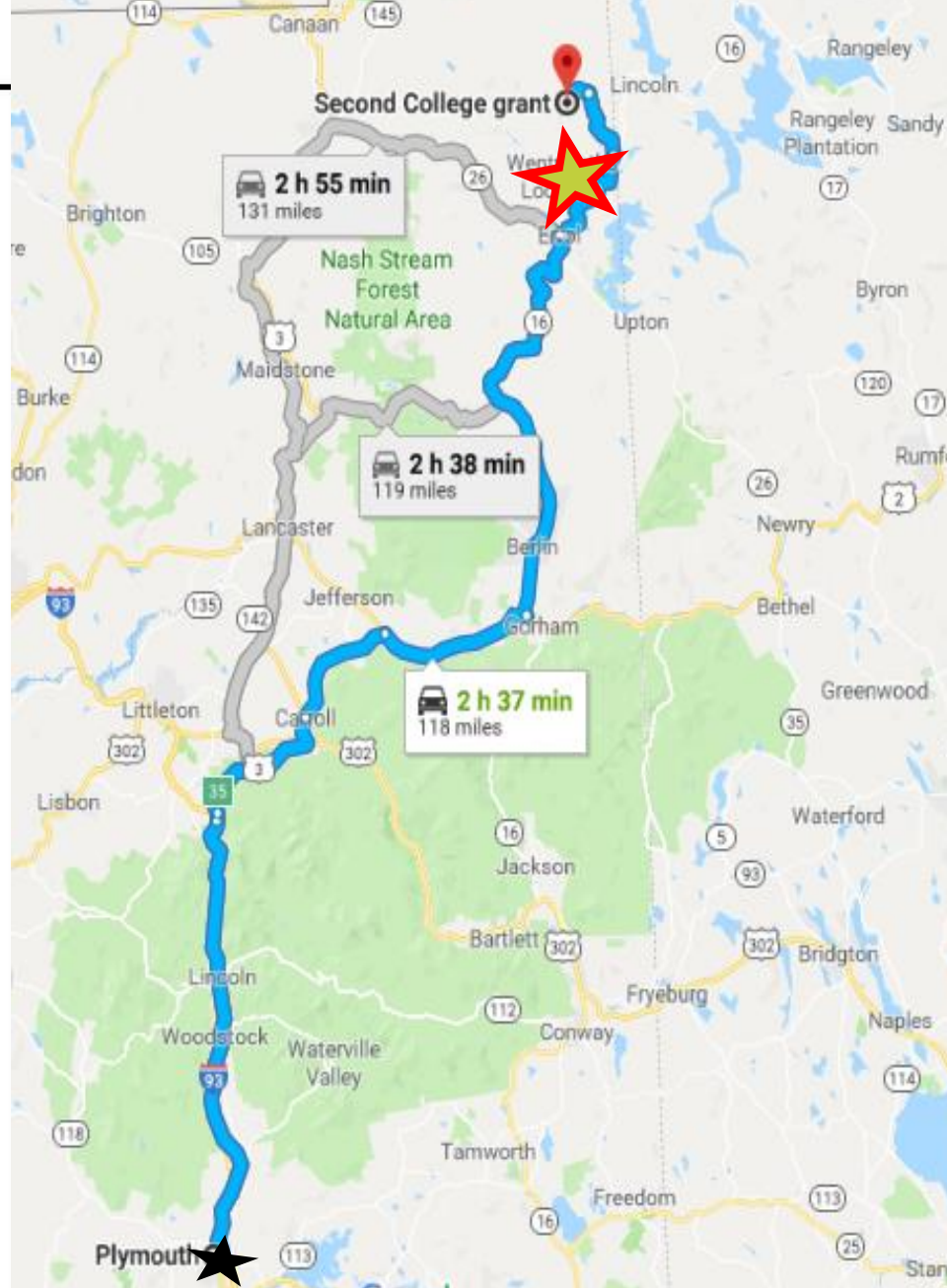
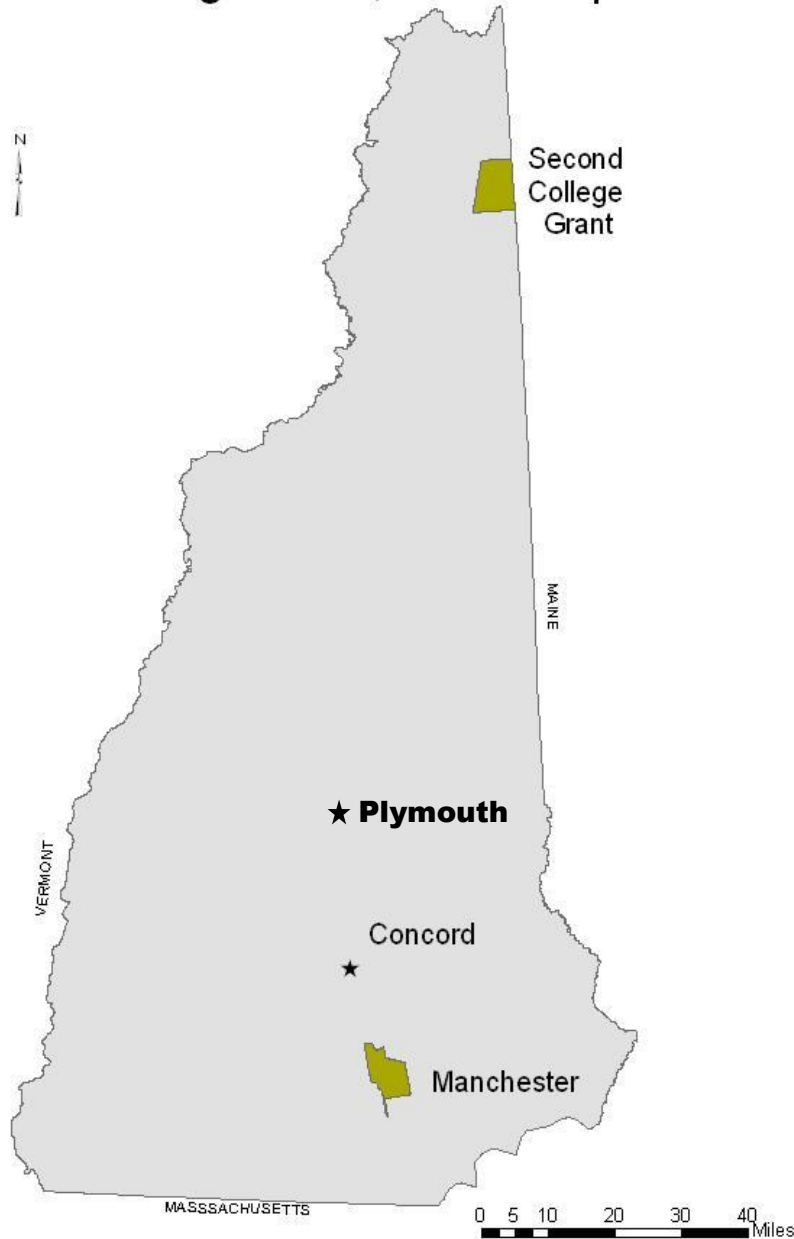


# Where Are We?

---

- Brook trout behavior and migration
- Habitat and wood
- Fragmentation
- Management-how this all fits

# Second College Grant, New Hampshire



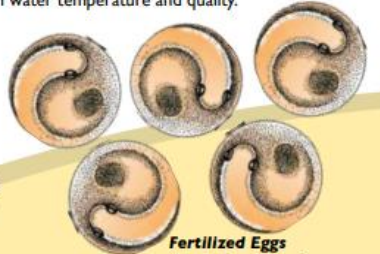
# Brook Trout Life Cycle

**FALL:** Adult females (2 to 5 years of age) select a spot for a nest, called a redd. A gravel stream bottom with a steady flow from underneath is an ideal location. Using her tail, the female clears a pit to lay the eggs. Female trout ranging between 5 to 10 inches in length will lay between 20 and 400 eggs. The male brook trout fertilizes the eggs as they sink to the stream bottom. After being fertilized, the eggs are then covered with gravel by the female. About 1 to 2 percent of the eggs will survive to adulthood.



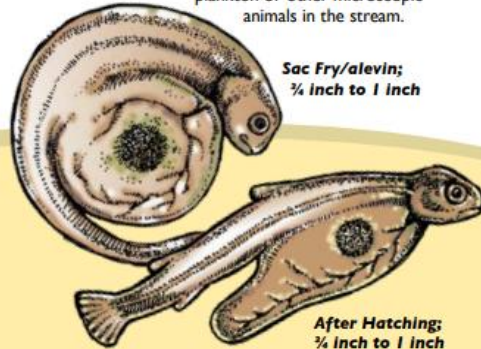
Female Trout  
Excavating a Redd

**WINTER:** Fertilized eggs develop. Within about two weeks, the egg develops eyes (eyed egg-stage). The egg gets oxygen from the water flow around it. Nutrition for the trout comes from the egg yolk. Water temperatures must stay within the 35 to 55 degree range for brook trout. At this stage, the trout are very sensitive to changes in water temperature and quality.



Fertilized Eggs  
(Eyed Egg-Stage);  
1/4 inch or less in diameter

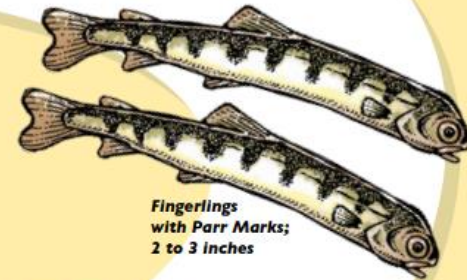
**SPRING:** Developing eggs, still in the redd, hatch from February to March. Hatch date depends on stream temperature and quality. Fry, still living in the gravel, live off the yolk sac (sac fry or alevin). When the sac is used up, the fry emerge from the gravel to begin eating. This usually happens between March and April. Fry will eat plankton or other microscopic animals in the stream.



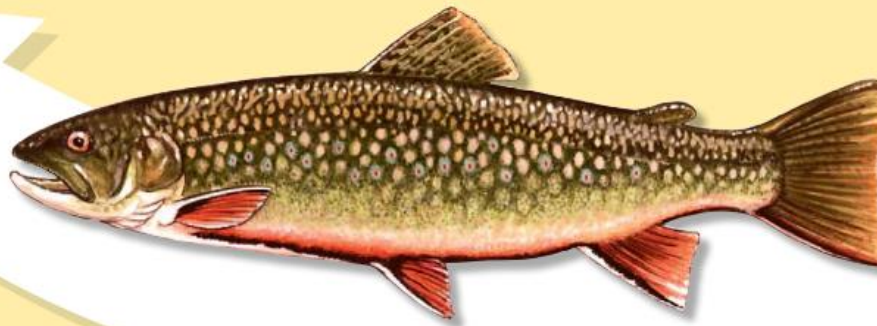
Sac Fry/Alevin;  
1/4 inch to 1 inch

After Hatching;  
1/4 inch to 1 inch

**SUMMER:** To hide from predators, young trout spend time in shallow water hiding under and around rocks. They eat small insects and plankton. Young trout grow quickly and reach 2 to 3 inches long by the end of the summer. As the fry continue to develop, vertical lines called parr marks begin appearing along their body. These bars help camouflage the young trout and protect them from predators. When the trout have parr marks, they are called fingerlings or parr.



Fingerlings  
with Parr Marks;  
2 to 3 inches



## BROOK TROUT ADULT:

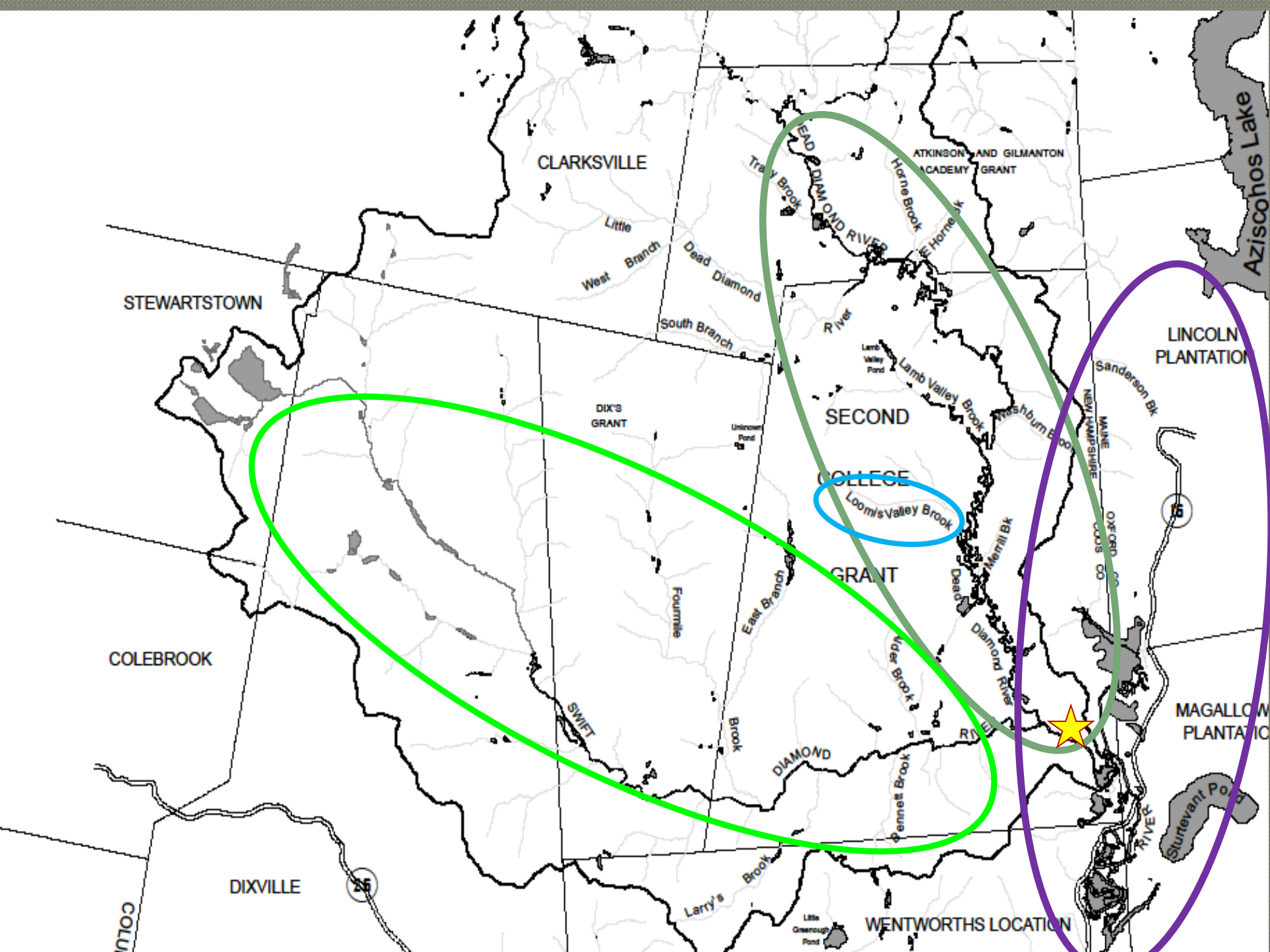
They are Pennsylvania's state fish and only native trout. A brook trout's body is dark green with light "wormy" lines across the top. Their fins are orange with white edges. Red spots with bluish halos dot the body, and their belly appears orange in color. The tail is nearly square.

**Adult;**  
5 to 10 inches

[www.patROUTintheClassroom.org](http://www.patROUTintheClassroom.org)







CLARKSVILLE

STEWARTSTOWN

COLEBROOK

DIXVILLE

CLARKSVILLE

Little West Branch

South Branch

DIX'S GRANT

Fourmile Brook

SWIFT

Larry's Brook

DEAD DIAMOND RIVER

River

SECOND COLLEGE GRANT

GRANT

DIAMOND RIVER

WENTWORTHS LOCATION

Tray Brook

Lamb Valley Brook

Loomis Valley Brook

Pepper Brook

Pennell Brook

East Branch

Little Oneough Pond

Unknown Pond

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook

Merrell Bk

Merrell Bk

Horn Brook

Washburn Brook

Merrell Bk

Ossipee Brook

Diamond Brook

Merrell Bk

Washburn Brook

Merrell Bk

Diamond Brook







# We Learned...

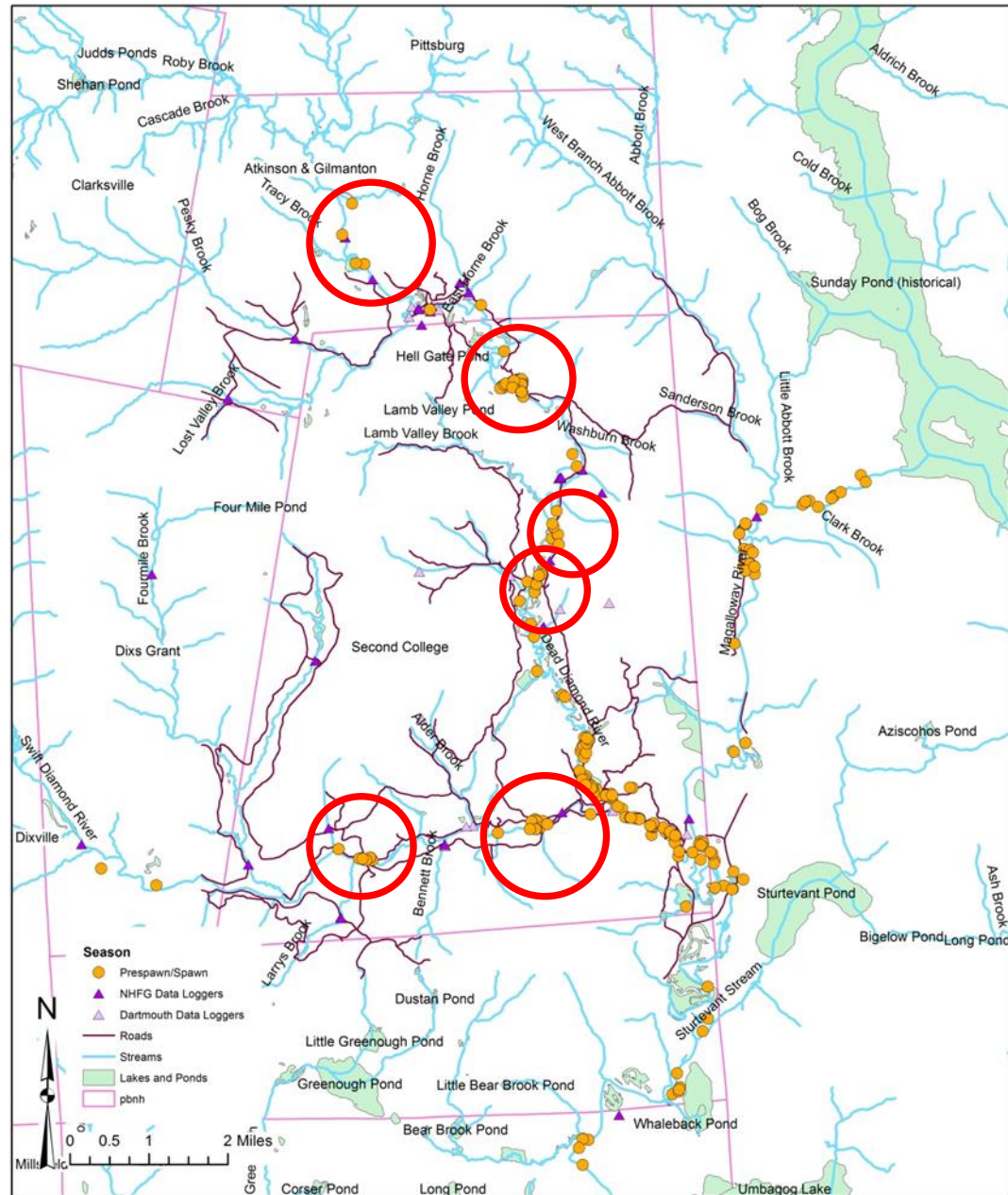
---



- Fish move A LOT when they can
- Big, wild brook trout in NH
- Spawning and GW



# Dead Diamond Telemetry and Dataloggers by Season 2005-2012



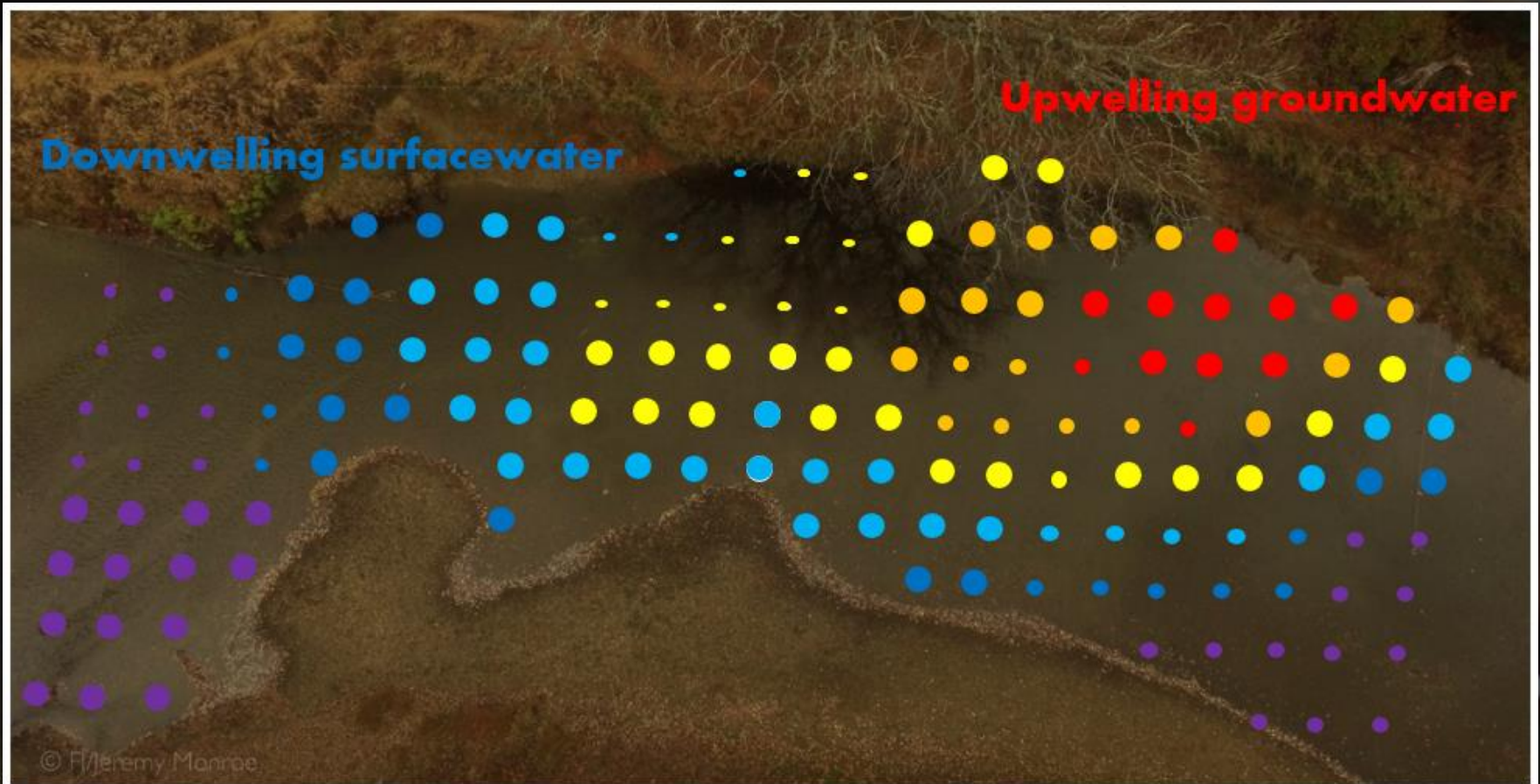


# Why This Spot?





# GW habitat important for spawning?



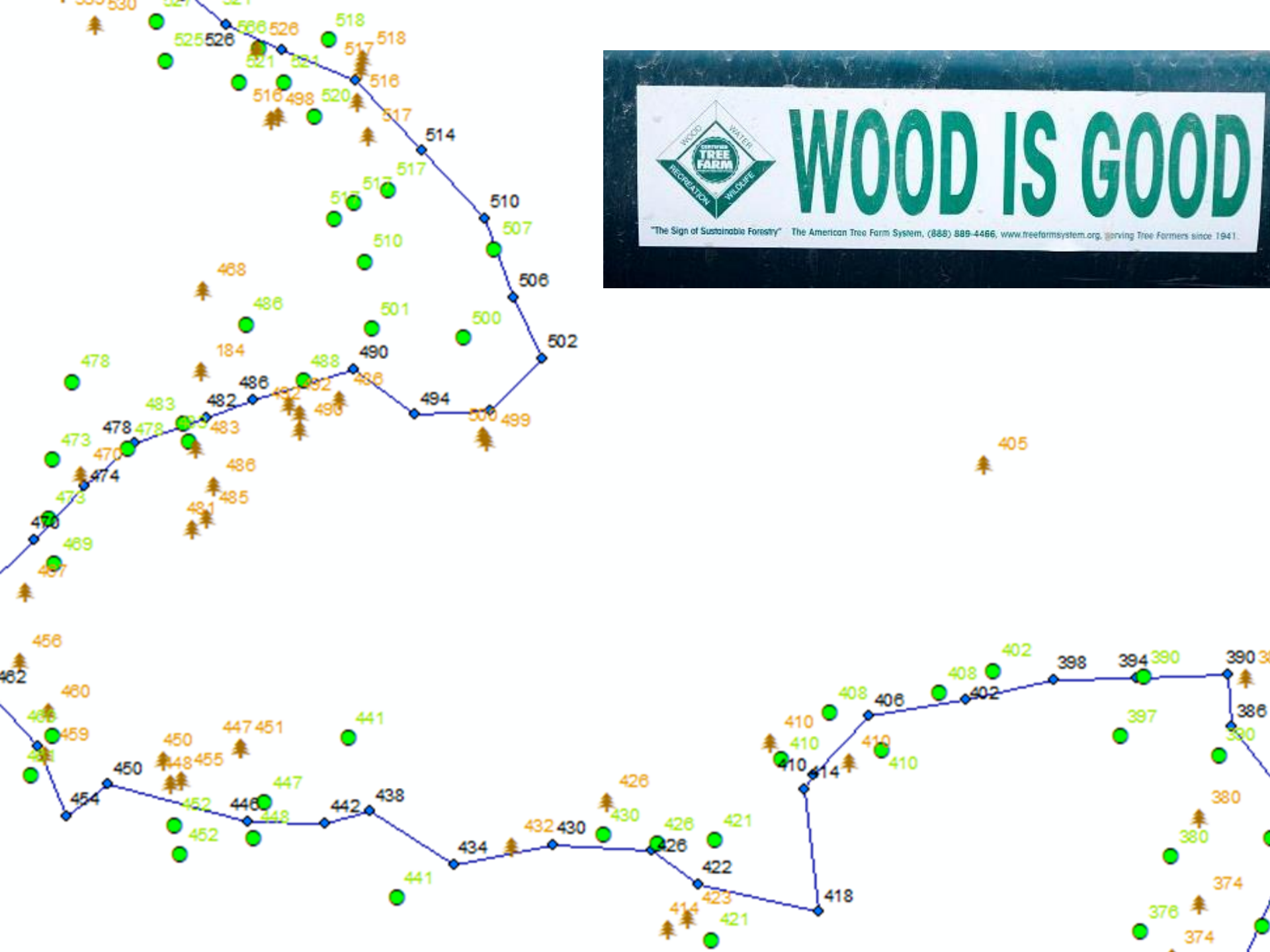
**Cold Substrate (0.5C)** ←  **Warm Substrate (5C)**

**Low Dissolved O<sub>2</sub> (<4mg/L)** ◦  ◦ **High Dissolved O<sub>2</sub> (>8mg/L)**

# Wild Reproduction







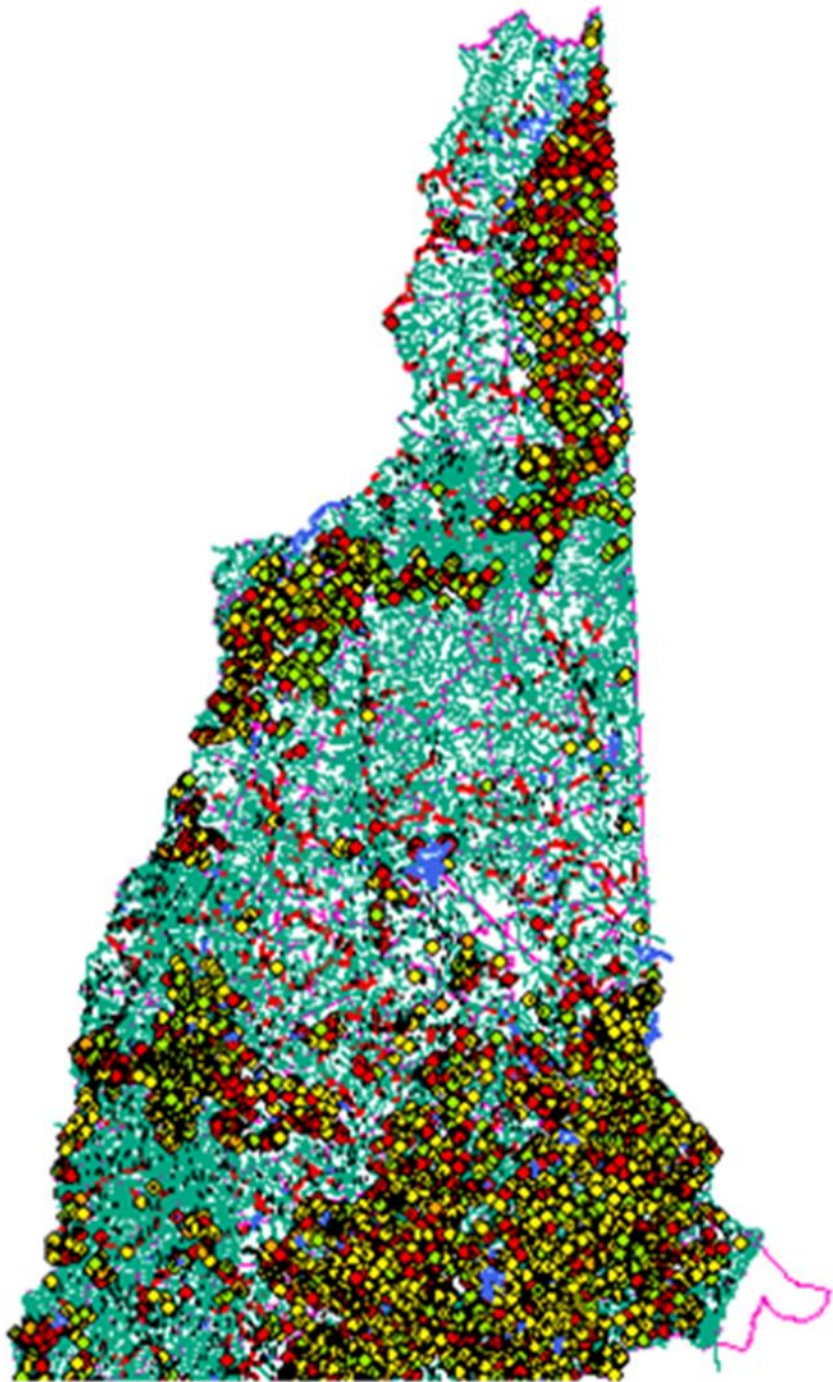
# WOOD IS GOOD

"The Sign of Sustainable Forestry" The American Tree Farm System, (888) 889-4466, [www.treefarmssystem.org](http://www.treefarmssystem.org), serving Tree Farmers since 1941.

# Seasonal Movement (Avg m/day)

Season	2005	2006	2007	2008	2010	2011	2012
Summer	0.27(10)	0.25(9)	0.48(18)	0.19(13)	0.32(14)	0.19(18)	
Spawn/ Prespawn	0.61(5)	0.14(4)	0.62(14)	0.11(8)	0.18(7)	0.08(14)	
Post spawn Dispersal and Overwinter	0.41(4)	0.48(8)	0.07(6)	0.40(6)	0	0.03(11)	
Post Winter	0.62(2)	0	0	0	0	0.10(3)	



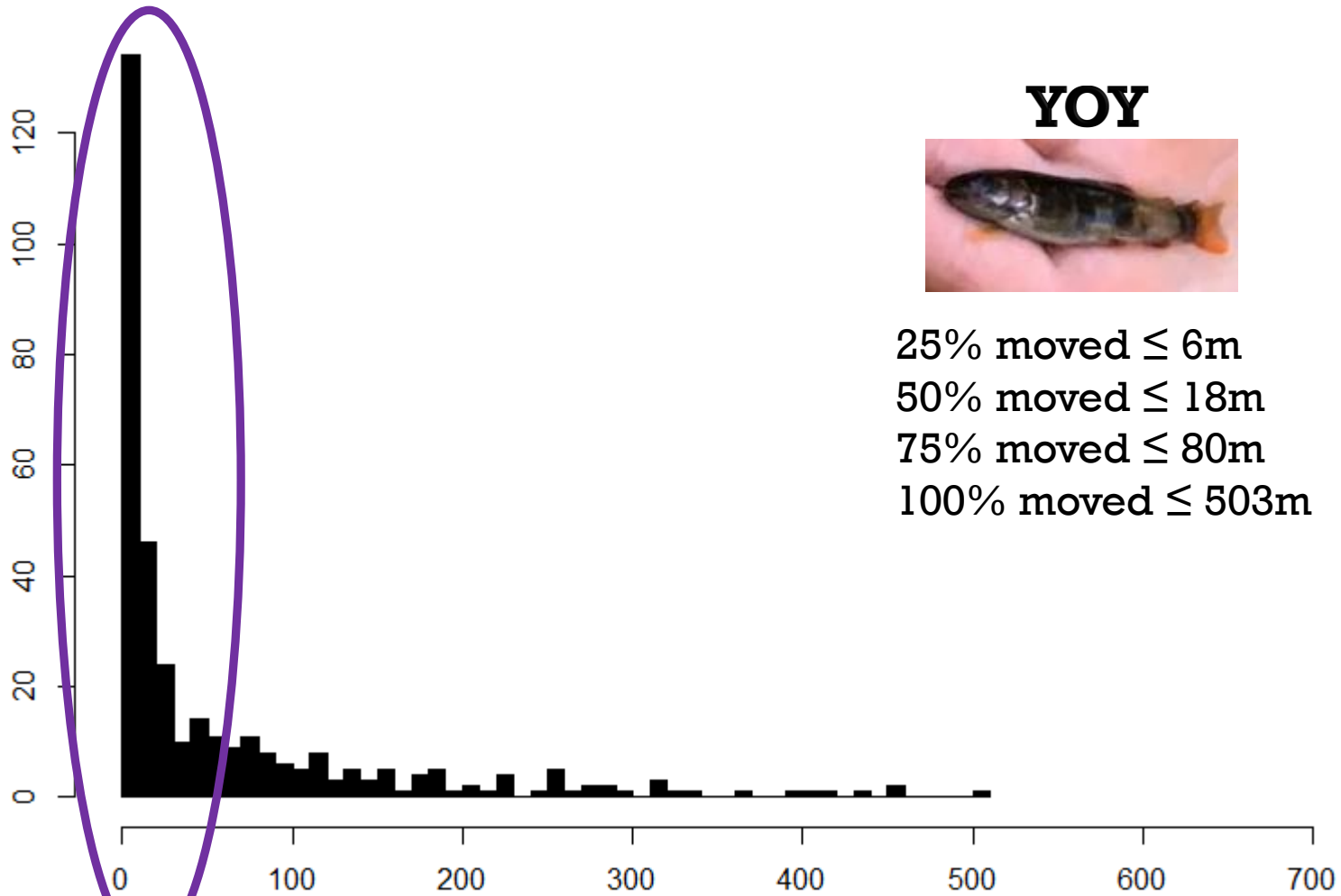


# The Somewhat Silent Partner....

- Poor stream crossings
- 8000+ stream crossings assessed
- 6600+ on the Aquatic Mapper
- More to go (ie Saco, upper Connecticut)

# 2018 PIT Home Range\*

Fish Count



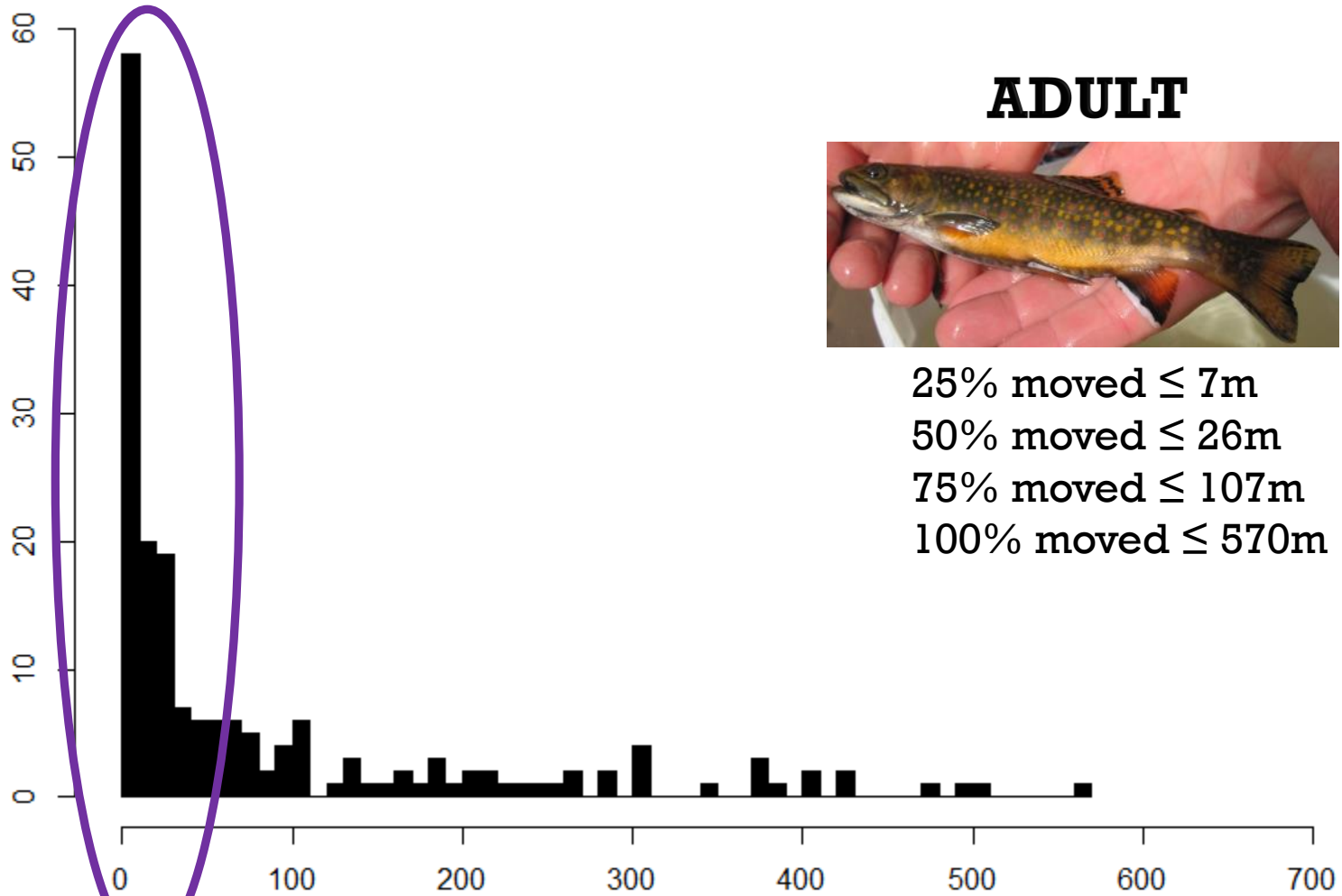
Home Range Size (meters)

\*(max minus min of in-stream locations for fish with at least 1 re-detection)



# 2018 PIT Home Range\*

Fish Count



**ADULT**



25% moved  $\leq 7\text{m}$   
50% moved  $\leq 26\text{m}$   
75% moved  $\leq 107\text{m}$   
100% moved  $\leq 570\text{m}$

Home Range Size (meters)

\*(max minus min of in-stream locations for fish with at least 1 re-detection)

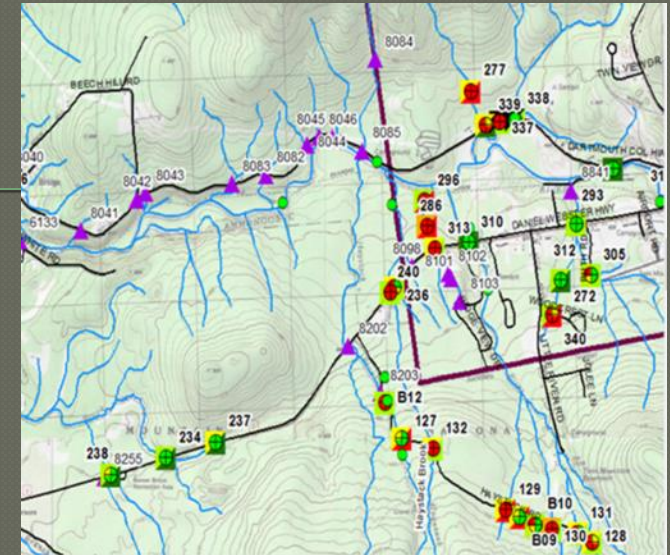




# Fragmented Segments (m, mi)

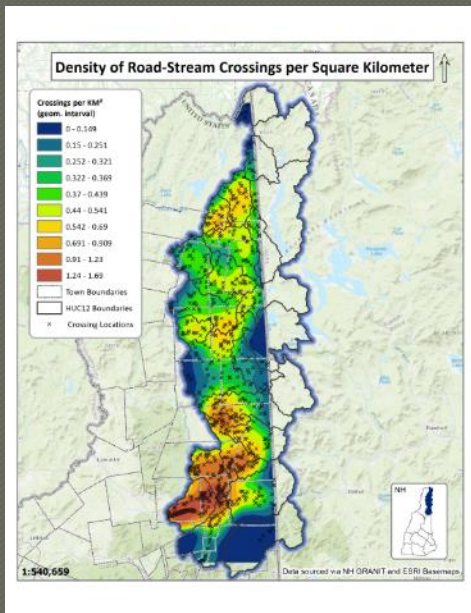
## METERS

Direction	Avg (m) Distance	Min	Max
US nearest	832.5	1.0	5246.7
Downstream	9012.1	1.0	46569.1



## MILES

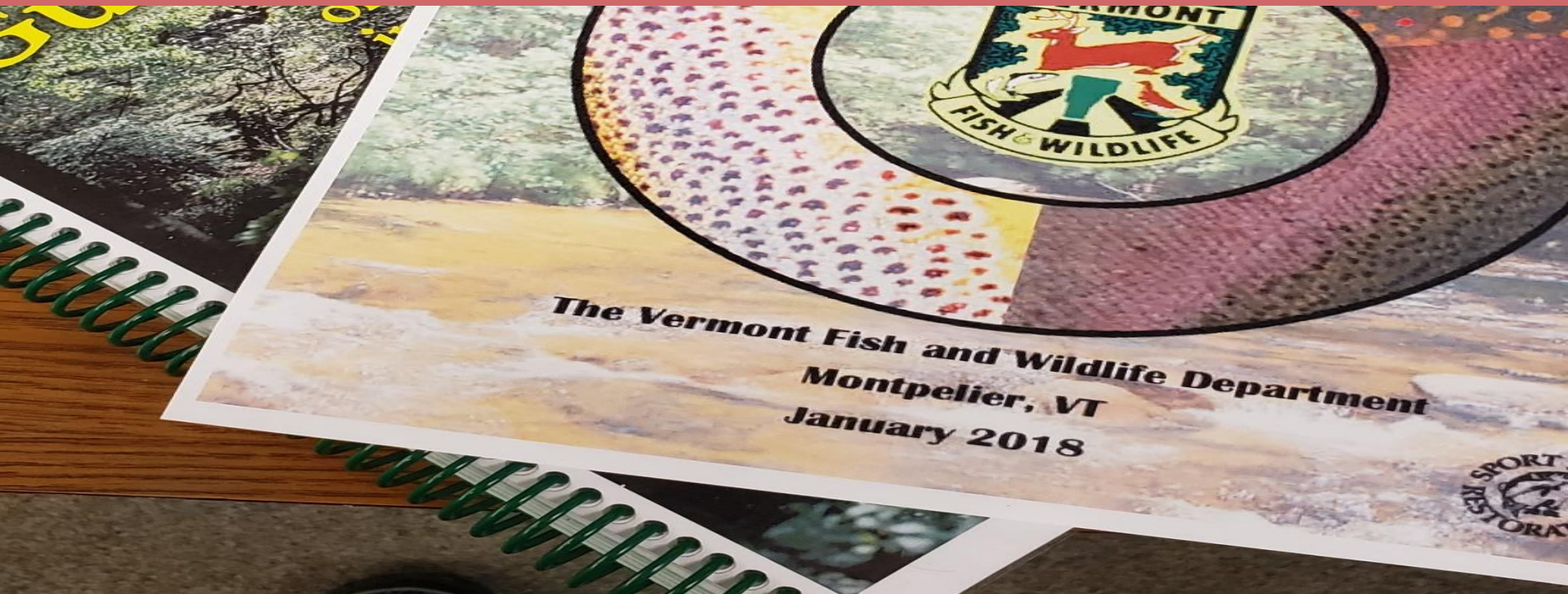
Direction	Avg (mi) Distance	Min	Max
US nearest	0.5	0.0006	3.3
Downstream	5.6	0.0006	28.9



Maine Brook Trout  
Fisheries Division  
Technical Report

Coldwater  
Management

# Management Plan- ARGHHHHHH!!!





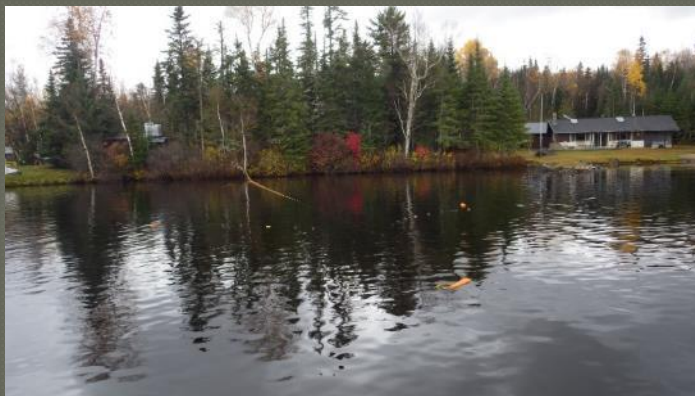
# Stocking Rates (Trout/Mi)\*

Modeled Stream Type	Stream Order	AVG BT/Mi	AVG EBT/Mi	AVG RT/Mi
Coldwater	1	0	22	0
Coldwater	2	0	<b>298</b>	0
Coldwater	3	14	86	23
Coldwater	4	0	64	0
Transitional	1	0	99	0
Transitional	2	4	49	0
Transitional	3	21	104	15
Transitional	4	52	87	<b>115</b>
Warmwater	1	62	<b>188</b>	87
Warmwater	2	<b>574</b>	<b>125</b>	19
Warmwater	3	14	<b>124</b>	20
Warmwater	4	32	<b>156</b>	70
Warmwater	5	<b>116</b>	65	68
Warmwater	6	<b>172</b>	<b>186</b>	<b>297</b>

# Stocking Rates (Trout/Ac)

## LAKES AND PONDS\*

Spp	Avg/Ac	Min	Max
BT	2	0	45
EBT	<b>118</b>	0	<b>2716</b>
RT	15	0	<b>412</b>





# The Next Steps

Habitat  
Research

*Habitat  
Restoration*

*Trout  
Management*

Success



Policy  
Reviews

Fish  
Research

**I haven't seen you  
around these  
parts before...**

