An urban stream can support a healthy population of coastal cutthroat trout

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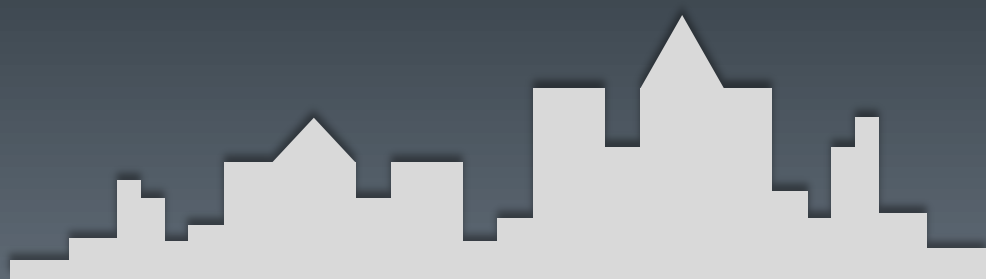
Coastal Cutthroat Trout Symposium
November 7, 2018

Introduction

- The proportion of urban landscape continues to increase
- Urbanization presents numerous challenges to aquatic species
- “Urban Stream Syndrome”

Introduction

- Imperiled fish inhabit urban landscapes
- The value of conserving fish populations in urban areas has growing recognition



Our Question

- Can an urban stream support a healthy population of fish?

Coastal Cutthroat Trout Monitoring Workshop 2007

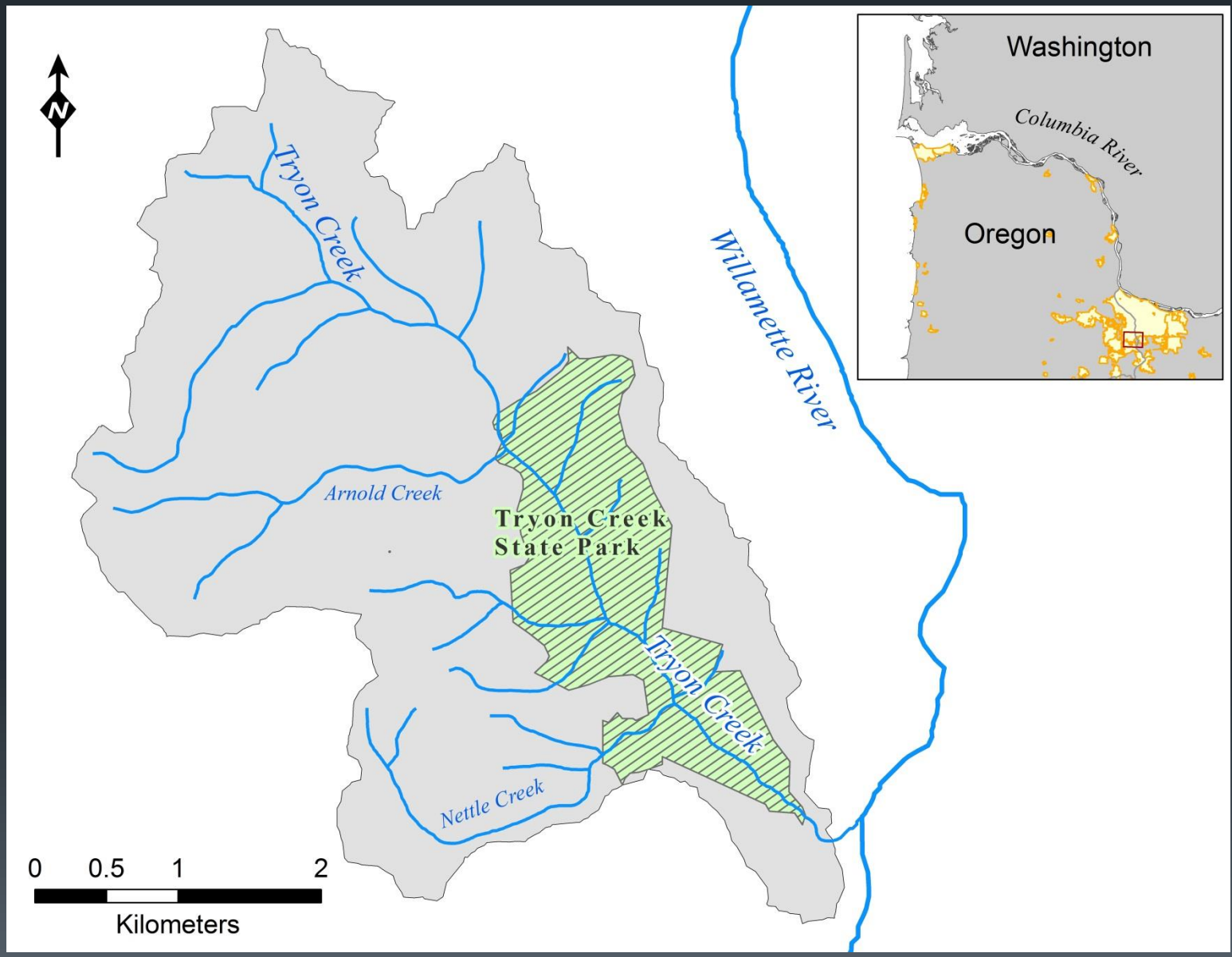
- “Healthy populations of coastal cutthroat trout express a range of life history traits and migratory behaviors and have connectivity to other local populations that allows the subspecies to successfully respond to environmental changes over long-time periods.”

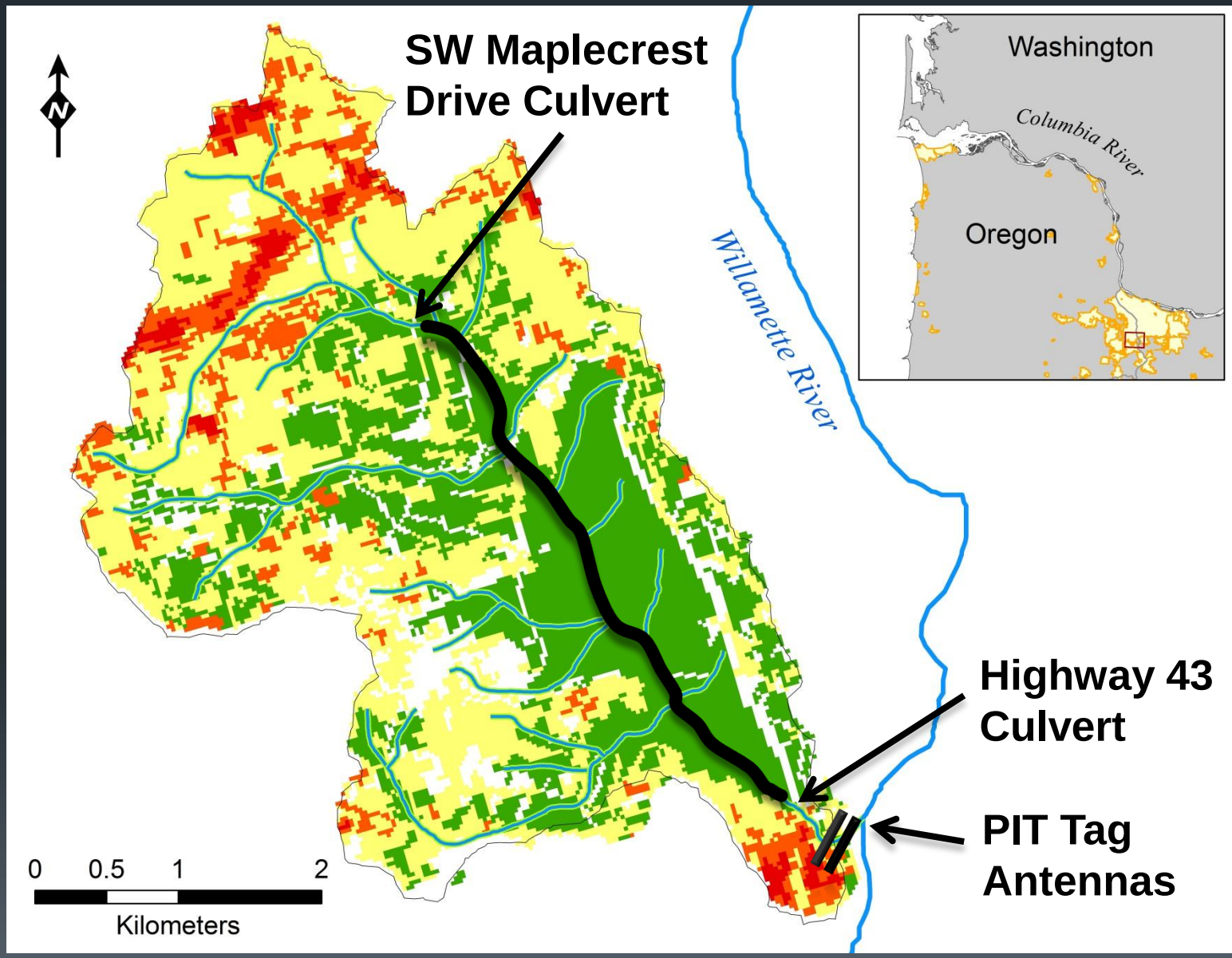
Our Model

- Urban Area: Portland
- Stream: Tryon Creek
- Population: Coastal Cutthroat Trout

Methods

- Evaluate the characteristics of:
  - Morphology
  - Fish Pathology
  - Ecology
  - Genetic Diversity
  - Migration Behavior
- Compare these characteristics to non-urbanized populations (Northern California, Mt. Hood, SW Washington, Alaska)


N
Tryon Creek
Willamette River
Arnold Creek
Tryon Creek
State Park
Tryon Creek
Nettle Creek
0 0.5 1 2
Kilometers
Washington
Columbia River
Oregon


SW Maplecrest Drive Culvert
Willamette River
Highway 43 Culvert
PIT Tag Antennas
Washington
Columbia River
Oregon
0 0.5 1 2
Kilometers

Methods
Fish Sampling

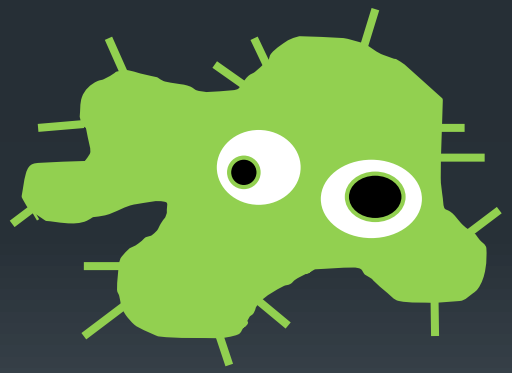
- Fish were collected with a backpack electrofisher 2008, 2009, 2011, 2013, and 2015
- Only coastal cutthroat trout > 100 mm were included in this study
  - Length and Weight
  - Tissue samples collected from pelvic fin
  - PIT tags implanted in abdominal cavity

Methods
Morphology

- Length weight relationship (Fulton's Condition Factor)
- Size classes
  - 100 - 149
  - 150 - 199
  - 200 - 249
  - 250^{+}

Methods
Fish Pathology

- 35 Fish were analyzed at US Fish & Wildlife's Fish Health Center in 2013
  - Viruses (4)
  - Parasites (2)
  - Bacterial Pathogens (6)



Methods
Ecology

Abundance Estimate

Capture and release

First Pass: Mark and release fish

Second Pass: Total marked and unmarked fish

Abundance = Proportion of marked fish to total marked population

Density

$$\frac{\text{Abundance}}{m^2 \text{ of sampled habitat}}$$

Methods
Genetics

- Samples were genotyped at US Fish & Wildlife's Abernathy Fish Technology Center
- Diversity
  - Heterozygosity
  - Allelic richness
- Genetic Drift
  - Between 2008 and 2013

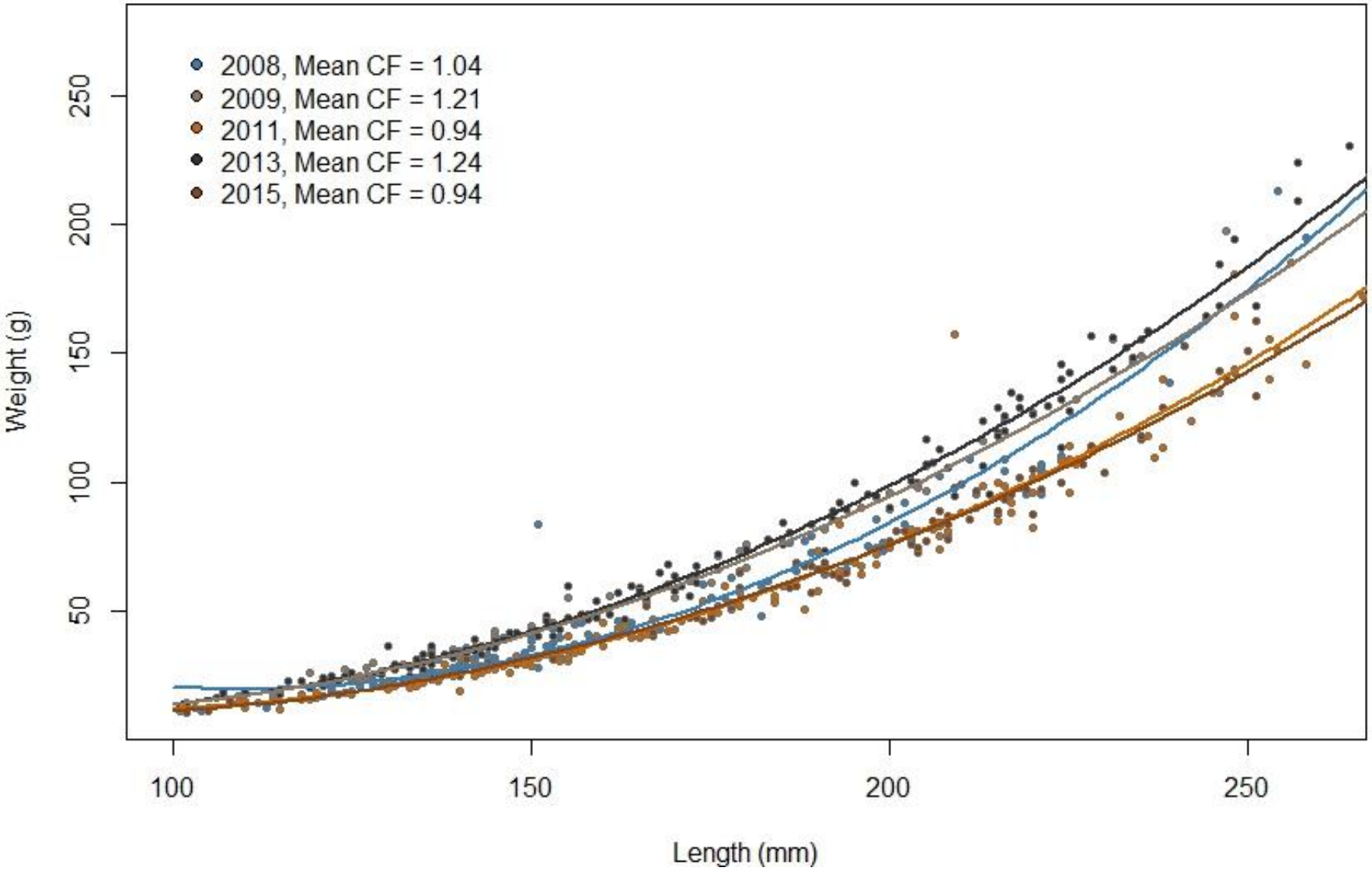
Methods
Migration Behavior

- If a fish was detected by an antenna, we assumed it was attempting to migrate downstream
- We monitored for downstream migration for two years after two tagging events
  - October 2008
  - September 2013

Methods
Migration Behavior

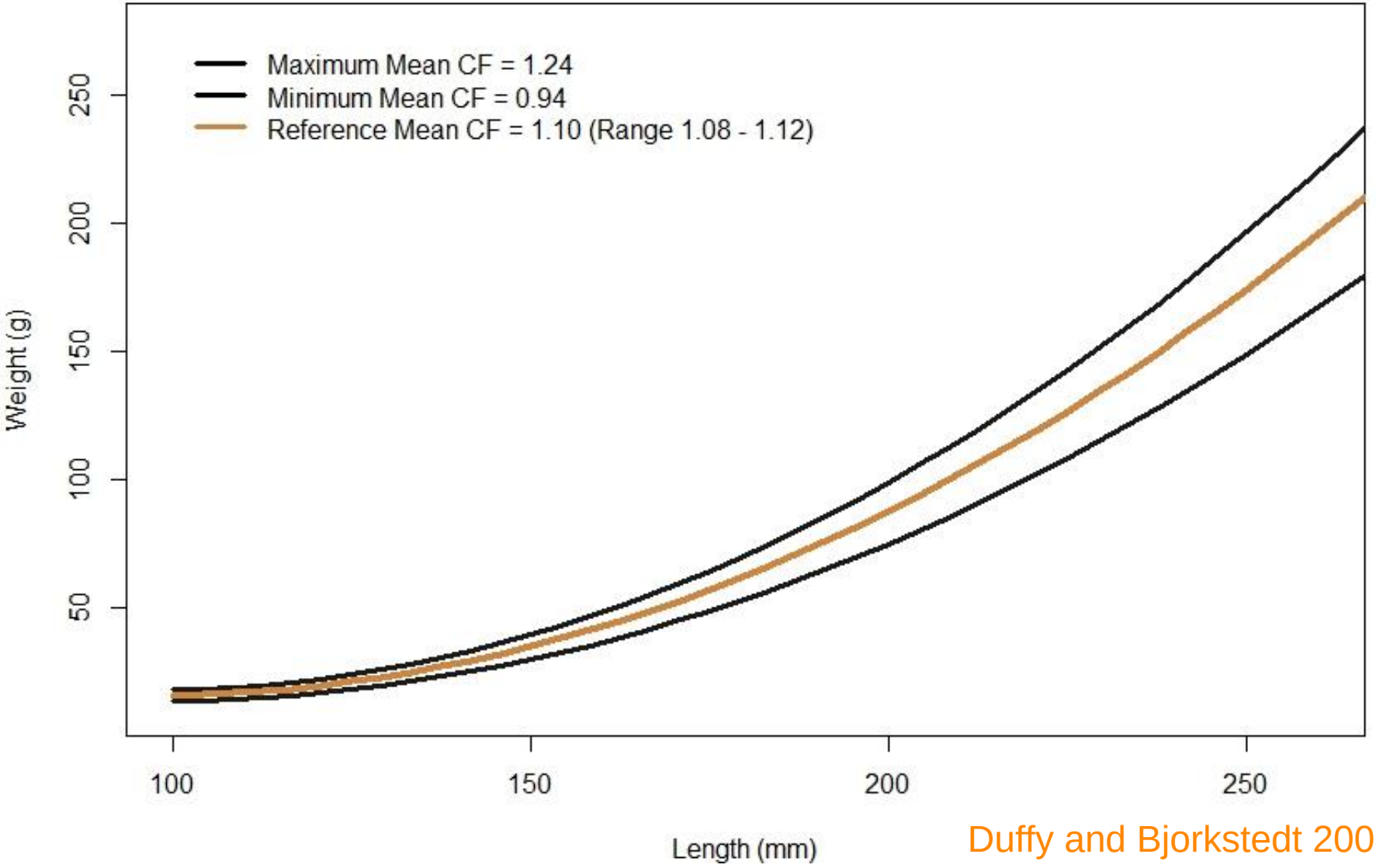
Results

Morphology – Condition Factor



Results

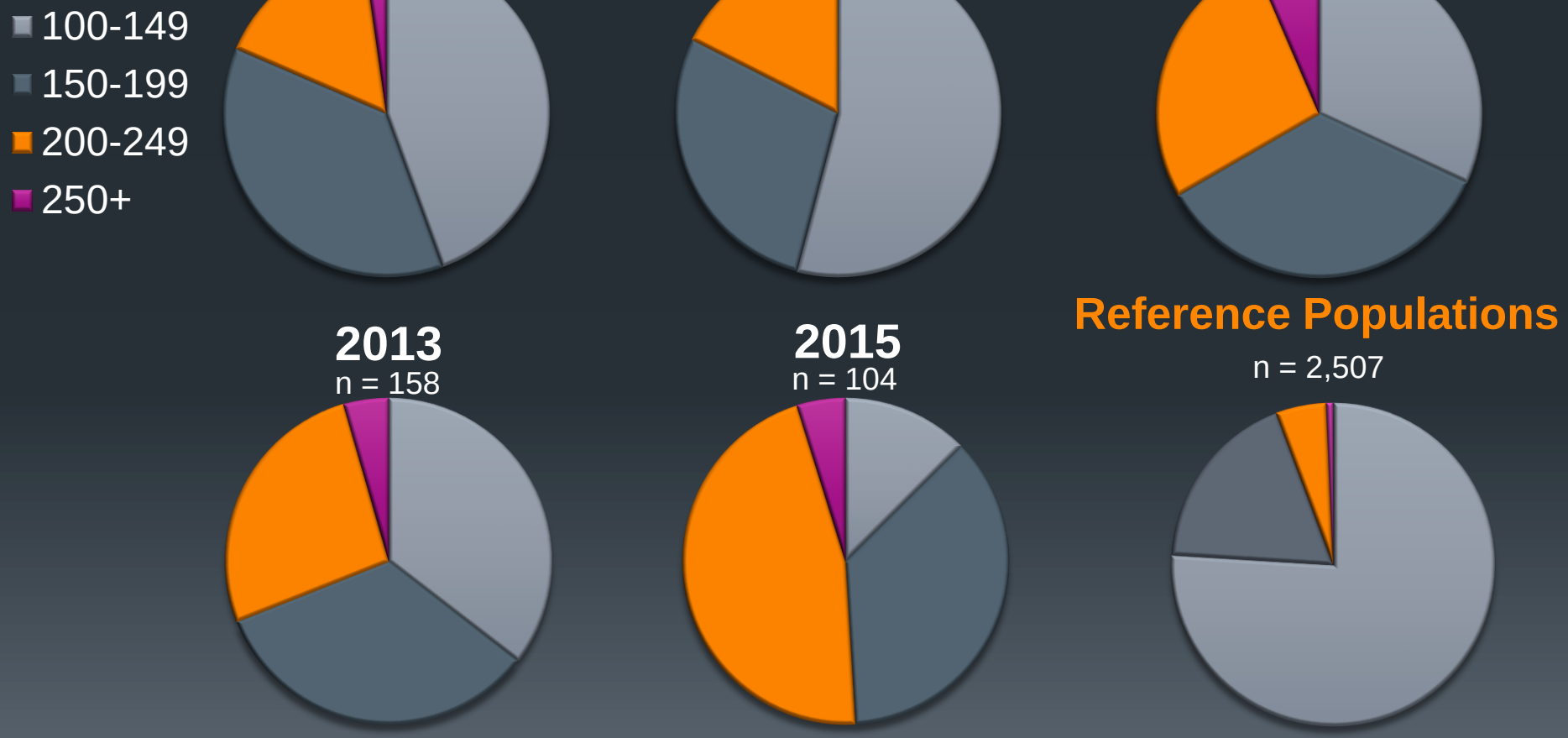
Morphology – Condition Factor



Duffy and Bjorkstedt 2008

Results

Morphology – Size Classes



Duffy and Bjorkstedt 2008, ODFW 2008

Results
Fish Pathology

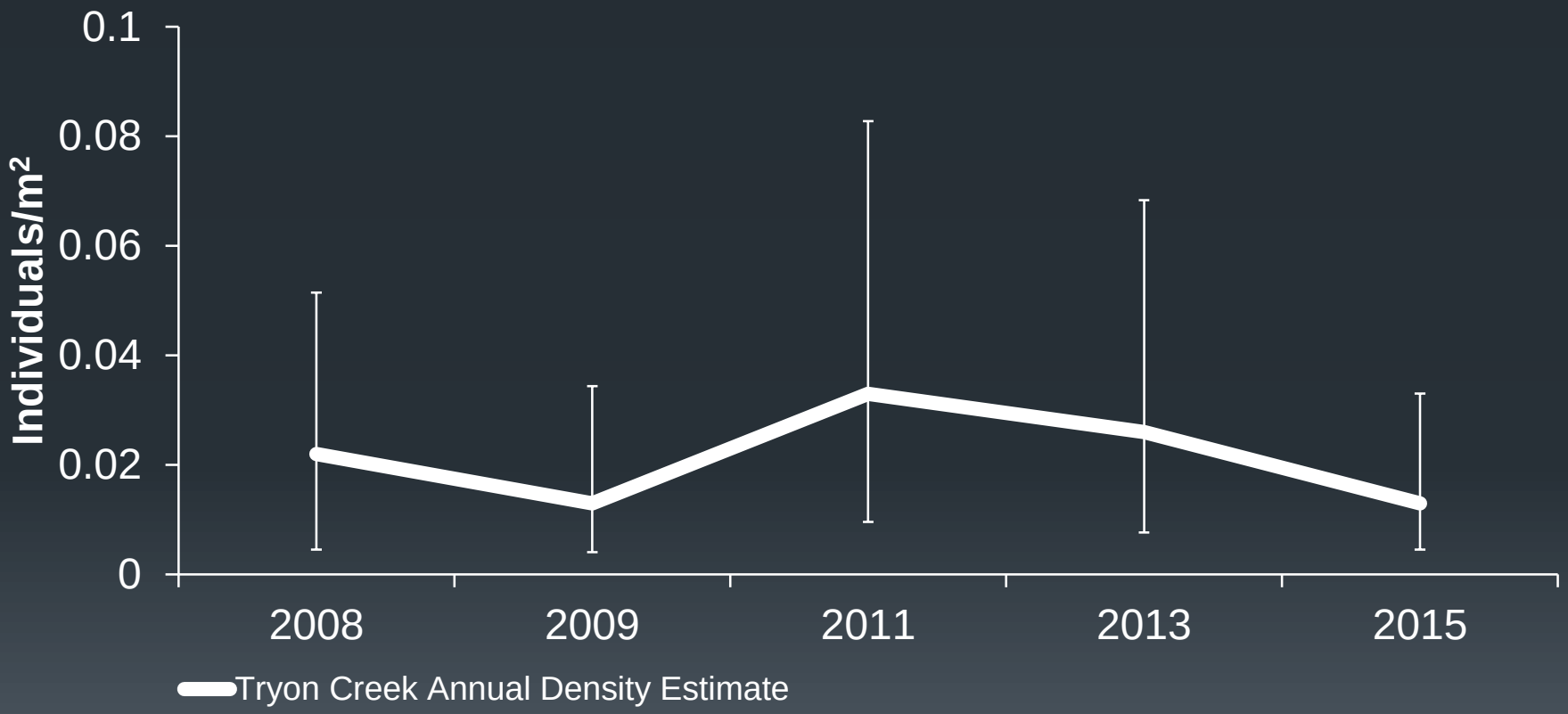
- IPNV Infectious Pancreatic Necrosis Virus — NO
- IHNV Infectious Hematopoietic Necrosis Virus — NO
- VHS Viral Hemorrhagic Septicemia Virus — NO
- SVCV Spring Viremia of Carp Virus — NO
- AS Furunculosis (*Aeromonas salmonicida*) — NO
- YR Enteric Redmouth (*Yersinia ruckeri*) — NO
- ESC Emphysematous Putrefactive Disease (*Edwardsiella ictaluri*) — NO
- BCD Coldwater Disease (*Flavobacterium psychrophilum*) — NO
- CD Columnaris (*Flavobacterium columnare*) — NO
- CS Salmonid Ceratomyxosis (*Ceratonova shasta*) — NO
- WD Whirling Disease (*Myxobolus cerebralis*) — NO

Results
Fish Pathology

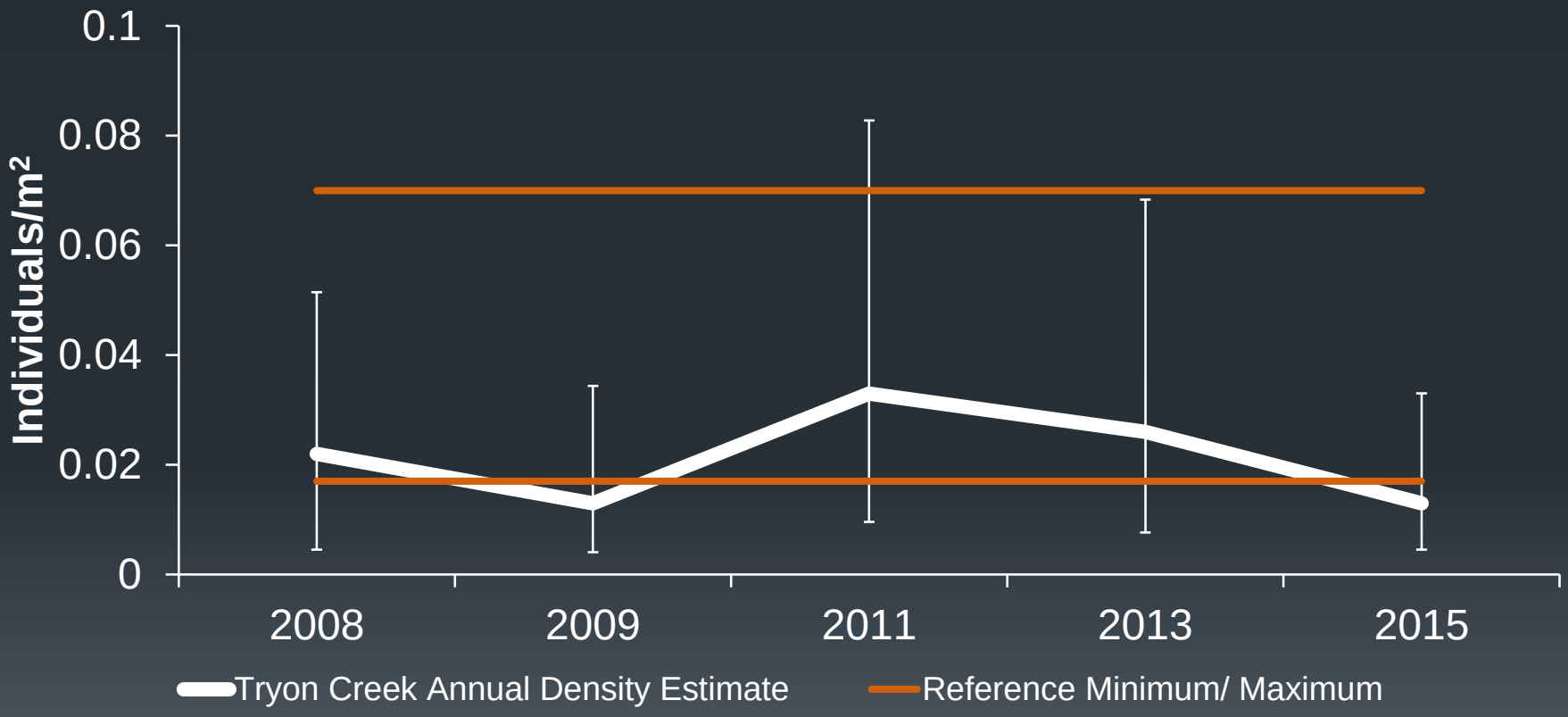
- RS BKD (*Renibacterium salmoninarum*) Possible
- The causative agent of BKD was present but the DNA was not, likely a false signal

No evidence for significant disease

Results
Population Density



Results
Population Density



Duffy and Bjorkstedt 2008, Reeves et al. 1993

Results
Population Genetics

- Genetic Diversity — Reference Population
  - Heterozygosity = 0.76 — 0.76 – 0.81
  - Allelic richness = 6.6 — 3.9 - 5.5

Similar levels of diversity to non urbanized populations

- Genetic Drift
  - Fst ~ 0 between 2008 and 2013

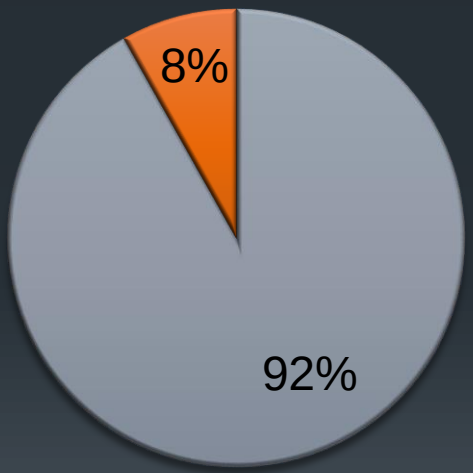
No evidence of genetic drift

Results
Population Genetics

- Tryon Creek does not seem afflicted by the genetic consequences of small population size
- Contains a large, randomly mating population
- Diverse and adaptable for long term persistence

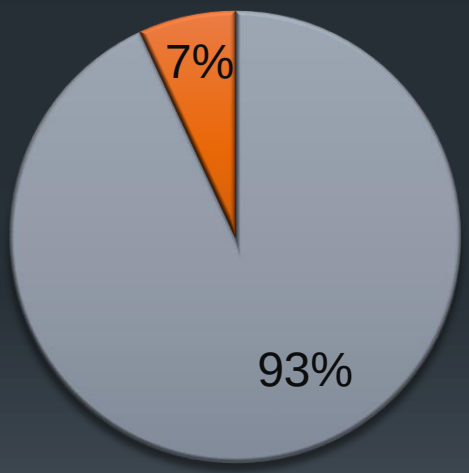
Results
Migration Behavior

Tryon Creek 2008



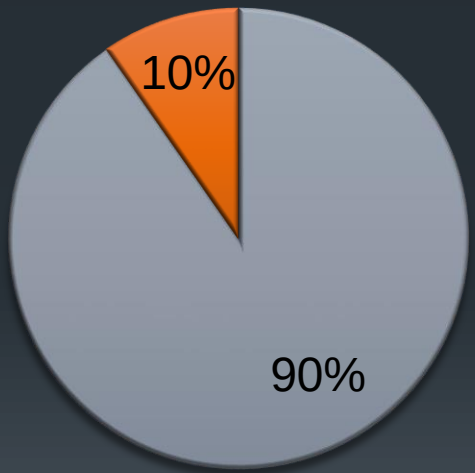
n = 135

Tryon Creek 2013



n = 148

Reference Populations Mean (Range 3.8% – 30%)



n = 3,216

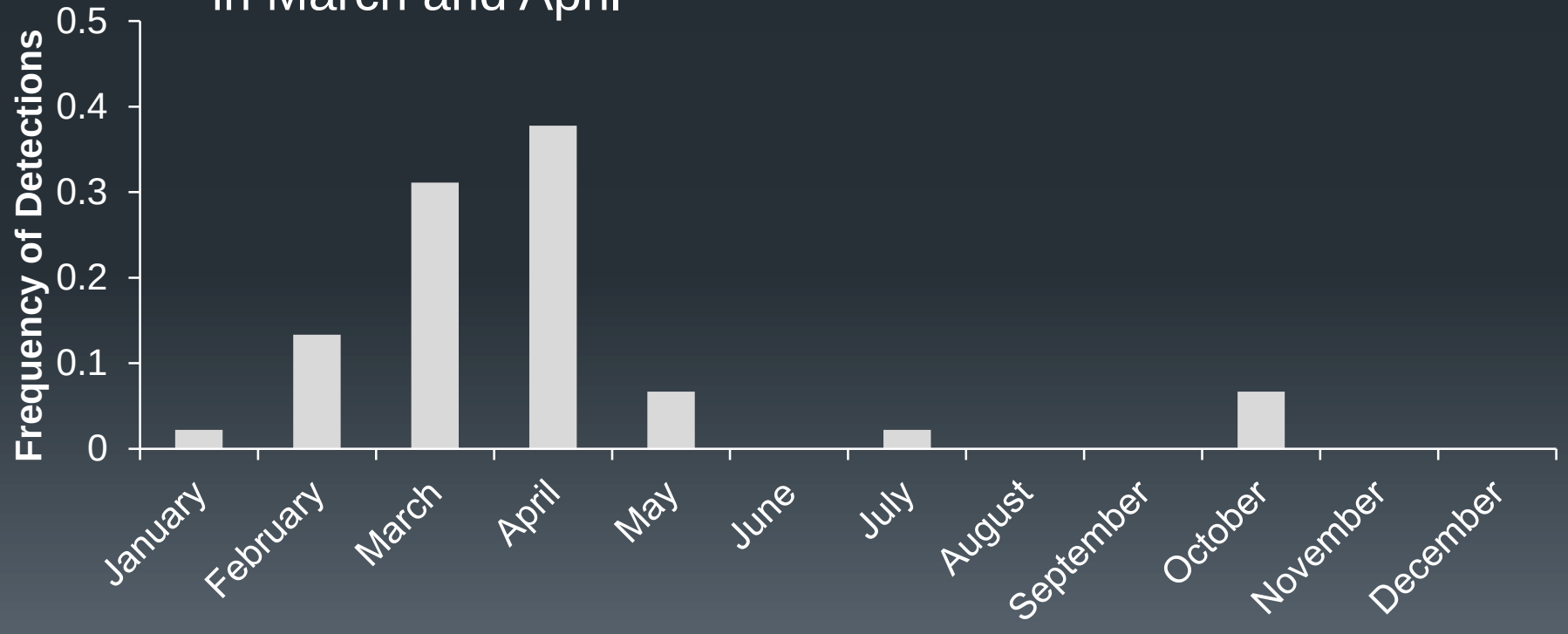
Resident Migrant*

*Detected at a downstream antenna

ODFW 2008, USFWS 2008

Results
Migration Behavior

- Migration Timing
  - Fish migrate downstream in the spring
  - 70% of detections (unique fish per month) occurred in March and April



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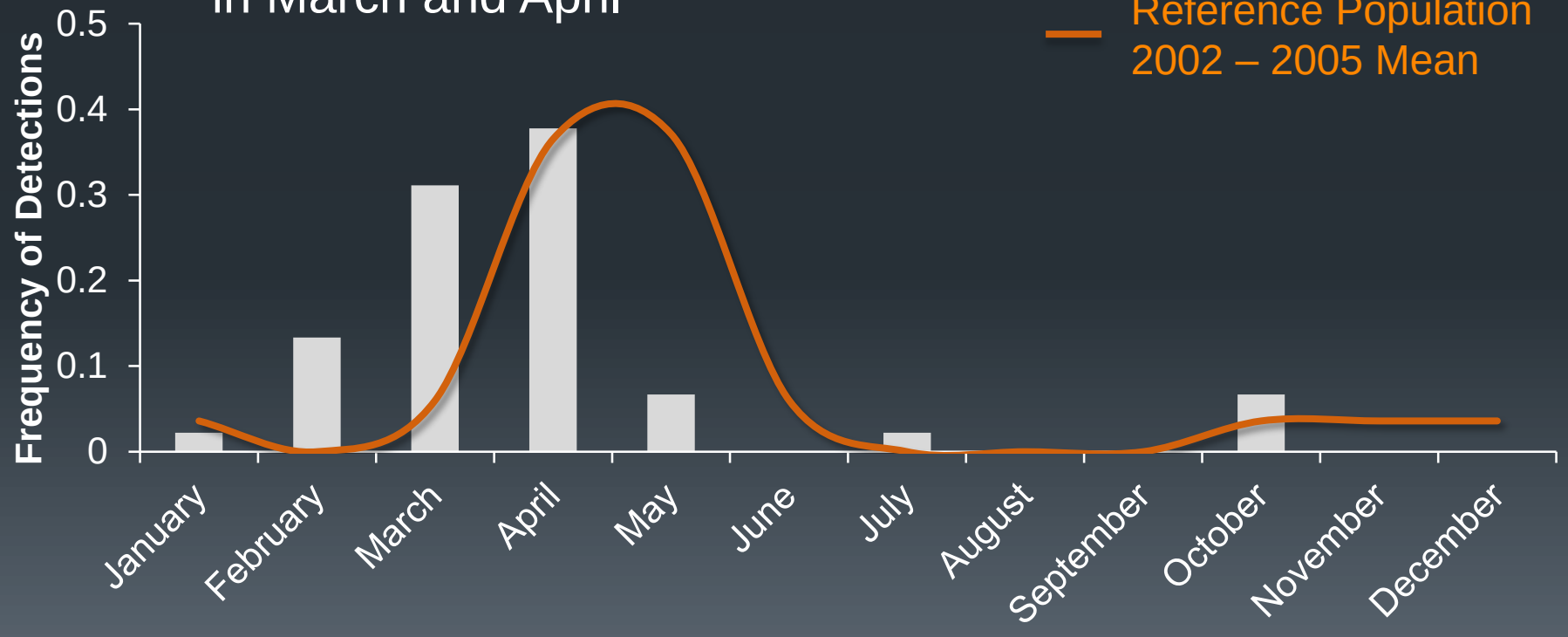

Discussion

- Overall, the characteristics of coastal cutthroat trout in Tryon Creek are similar to those found in populations not influenced by urbanization

Characteristic	Tryon Creek	Non Urbanized Populations	Similar?
Morphology Condition Factor	**1.07** (0.94, 1.24)	**1.10** (1.08, 1.12)	✓
Fish Pathology	**None**	**None**	✓
Ecology Population Density	**0.02** (0.01, 0.03)	**0.04** (0.01, 0.07)	✓
Genetics	He 0.76 AR 6.6 Fst 0	He 0.76 – 0.81 AR 3.9 – 5.5 Fst 0	✓
Migration Behavior Proportion of Migrants	**7.8%** (7.4% - 8.1%)	**10.7%** (3.8% - 30%)	✓

Discussion

- Tryon Creek did show some differences from reference populations
  - Greater proportion of larger fish
  - Low end of density range
  - Earlier emigration
- This may be due to available habitat, sample method, distance from the Pacific Ocean
- There are various life histories depending on local conditions (Trotter 2008)

Discussion

- Our results suggest an urban stream can support a healthy fish population
- However, Tryon Creek may be an unusual urban watershed, with some protection from surrounding public land and supported by multiple conservation programs
- Tryon Creek can be an example of an urban watershed that supports a healthy fish population



Acknowledgements

- City of Portland
- City of Lake Oswego
- Friends of Tryon Creek
- Tryon Creek Watershed Council
- Oregon Department of Fish & Wildlife
- Oregon Department of Transportation
- Oregon State Parks
- National Marine Fisheries Service
- National Fish and Wildlife Foundation

Questions?