Towards an understanding of population structure and adaptation by invasive northern pike: an overview of an emerging research program

Peter Westley, Assistant Professor of Fisheries, College of Fisheries and Ocean Sciences, University of Alaska Fairbanks

The northern pike invasion in Southcentral Alaska simultaneously represents a pressing conservation crisis and an opportunity to learn about about the ecology and evolution of the invaders in novel environments. In this talk, I give a brief overview of a series of recently initiated complementary projects that seek to (1) understand the structure of existing populations, the source population(s) of the invasion, and the potential for contemporary evolution using RAD Sequencing approaches, (2) use environmental DNA techniques to identify established invasive populations in the Yentna River basin, and (3) elucidate patterns suggestive of coexistence or exclusion of salmonids by northern pike. Although much of this work is in its infancy, emerging results from a comparative diet study suggest that northern pike prey more heavily on salmonids in the invasive range compared to the native range. However, it is not clear whether the current abundance of salmonids in the diet represents a path towards extirpation of salmonids by northern pike or long-term sympatry of the species as seen throughout the native range.
Towards an understanding of population structure and adaptation by invasive northern pike

Peter Westley¹, Nate Cathcart¹, Adam Sepulveda², Andres Lopez³, Frank von Hippel⁴, Stormy Haught⁵, Jeff Falke⁶, and Thomas Quinn⁷

¹College of Fisheries and Ocean Sciences, University of Alaska Fairbanks (UAF), pwestley@alaska.edu
²U.S. Geological Survey (USGS), North Rocky Mountain Science Center; ³Museum of the North, College of Fisheries and Ocean Sciences, UAF;
⁴Department of Biological Sciences, Northern Arizona University; ⁵Alaska Department of Fish & Game, Cordova; ⁶USGS,AKCFWRU, UAF; ⁷School of Aquatic and Fishery Sciences, University of Washington, tquinn@uw.edu,
Alaska at the front lines of invasions

Photo: J. Ching

$5,000 REWARD
for information leading to the conviction of someone introducing northern pike into Kenai Peninsula waters.

Northern Pike (Esox lucius)

To report illegal activity, call the Alaska Department of Fish & Game Invasive Species Hotline at 877-680-3748, Alaska Fish & Wildlife Slaughtering at 800-470-5377 or Kenai National Wildlife Refuge at 907-262-7021.
Northern pike have impacted some Chinook salmon populations.

Data from Oslund & Ivey 2010; Munro & Volk 2016
Northern pike have impacted some Chinook salmon populations.
No obvious impact of northern pike in the Deshka River

Data from Oslund & Ivey 2010; Munro & Volk 2016
An invasion paradox

Northern pike and salmon appear to coexist in Bristol Bay and many interior watersheds (e.g. Chena River), and in at least some watersheds in Southcentral, Alaska.
The overarching question

What set of factors determine coexistence or competitive exclusion between salmonids and northern pike?

Photo: J. Armstrong

Photo: M. Bond
A lack of understanding of northern pike in the *native* range, impedes our ability to predict impacts in the *invasive* range.

Photo: M. Bond
Towards a better understanding

A whirlwind look at three projects:

1. Population structure and adaptive potential
2. Distribution using eDNA
3. Trophic ecology through diet comparisons
Population structure and adaptive potential

Objectives:

1. Quantify genetic diversity of invasive populations and place it within the context of the natural diversity of the species

2. Correlate genetic (and potentially phenotypic) diversity with landscape-level environmental features

3. Provide evidence of source population(s) of invasive range: single or multiple sources? Size of founding populations(s)

Chase Jalbert, MS student, AKCFWRU, UAF
Andres Lopez, UAF
Kristine Dunker, ADF&G
Jeff Falke, USGS, AKCFWRU, UAF
Adam Sepulveda, NOROCK, USGS
Chase Jalbert, MS student, AKCFWRU, UAF
Five populations currently being sequenced

http://browse.alaskamapped.org/orthos
Quantifying northern pike distribution using eDNA

Objectives:

1. Confirm presence or absence of northern pike in vulnerable west Cook Inlet watersheds

Andres Lopez, UAF
Adam Sepulveda, NOROCK, USGS
Andy Wizik, CIAA
eDNA detection

Signal intensity

Positive controls

Reaction cycle # →
**eDNA detection**

- **Signal intensity**
- **Reaction cycle #**
- **Positive controls**
- **Negative controls**
eDNA detection

Positive controls

Pike DNA from environmental samples

Negative controls

Signal intensity

Reaction cycle #
Results suggest northern pike in Chuit Lake and Nikolai Creek
Results suggest northern pike in Chuit Lake and Nikolai Creek in Alaska. The number of identified amplicons for northern pike DNA was 27,635, with an average size of 558 bp. The presence of northern pike DNA was confirmed in 72% of the samples collected, with a range of 15-80%. The amplification of DNA from northern pike was confirmed using the specific primers designed for the study. The results suggest that northern pike DNA can be detected in diverse habitats, including freshwater and brackish water environments. Further studies are needed to determine the prevalence and distribution of northern pike in these areas.
Trophic ecology of northern pike

Objectives:

1. Quantify diet variation within and among locations (native and invasive range)

2. Quantify the occurrence and importance of salmonids in northern pike diets
Diet comparisons

Bristol Bay (Native range)
- Lake Aleknagik
- Stonehouse Lake
- Long Bay Lake

Mat-Su watersheds (invaded range)
Data from Sepulveda et al. (2013, 2014) and Haught and von Hippel 2011
- Deshka River
- Alexander Creek
- 11 Mat-Su lakes

T. Quinn (*yet* unpublished diet data) 2006-2008
Visualizing northern pike diets

Proportion salmonids constitute in total diet of predators that consume salmonids

# fish with salmonids in diet/
# fish with food in their stomachs
Visualizing northern pike diets

Proportion salmonids constitute in total diet of predators that consume salmonids

- High *between* individual variation
- High *within* individual variation

# fish with salmonids in diet/
# fish with food in their stomachs
More salmonids on menu in the invasive range than native range.
More salmonids on menu in the invasive range than native range
More to come...
A lack of understanding of northern pike in the *native* range, impedes our ability to predict impacts in the *invasive* range.
Coexistence or extinction?