IUCN

Global Re-introduction Perspectives: 2013

Further case-studies from around the globe

Edited by Pritpal S. Soorae

IUCN/SSC Re-introduction Specialist Group (RSG)

RSG

Environment Agency - ABU DHABI

DENVER ZOO

Published by: IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI

Citation: Soorae, P. S. (ed.) (2013). *Global Re-introduction Perspectives: 2013. Further case studies from around the globe*. Gland, Switzerland: IUCN/SSC Re-introduction Specialist Group and Abu Dhabi, UAE: Environment Agency-Abu Dhabi. xiv + 282 pp.

ISBN: **978-2-8317-1633-6**

Cover photo: Clockwise starting from top-left:
i. Fen Raft Spider, UK © Helen Smith
ii. *Manglietia longipedunculata* © Late Prof. Qingwen Zeng
iii. European Tree Frog, Latvia © Andris Eglitis
iv. Red Wolf © USA John Froschauer/PDZA
v. Hungarian Meadow Viper © Tamás Péchy
vi. Westslope Cutthroat Trout, USA © Carter Kruse, Turner Enterprises, Inc./Turner Endangered Species Fund
vii. Oriental White Stork, Japan © Yoko Mitsuhashi

Cover design & layout by: Pritpal S. Soorae, IUCN/SSC Re-introduction Specialist Group

Produced by: IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI

Download at: www.iucnsscrsg.org / www.iucn.org

Examining genetic diversity, outbreeding depression, and local adaptation with slimy sculpin re-introductions in the southeast Minnesota Driftless Region, USA

David D. Huff

Research Scholar, Institute of Marine Sciences, University of California, 110 Shaffer Road, Santa Cruz, CA 95060, USA ddhuff@ucsc.edu

Introduction

The slimy sculpin (*Cottus cognatus*) is a small fish that occupies benthic, cold-water habitats in small streams of the Driftless Region in Minnesota, USA. They are often locally abundant where they are present and are considered an important component of the ecosystems in which they are native. Populations of slimy sculpin were present in this region historically, but many were extirpated as a result of poor land use practices. This re-introduction project aimed to re-establish the slimy sculpin to a portion of its former range in the Driftless Region, but the re-introduction environments, although they were improved, have been substantially modified by humans. A challenge was to decide whether the existing genetically distinct source populations should be matched to a set of local conditions at the re-introduction sites or be mixed to provide greater genetically-based adaptive potential in anthropogenically affected (disturbed) environments (Huff *et al.,* 2010).

Close-up of a slimy sculpin
© David Huff / Lorissa Fujishin

Mixed-source re-introductions are thought to be advantageous in disturbed environments, but they have drawbacks because unique evolutionary lineages should be preserved as much as possible to preserve genetic diversity. Our research investigated the persistence and fitness-related traits of multi-source re-introduced populations of slimy sculpin in the Driftless Region (Huff *et al.,* 2011).

Goals

- Goal 1: Re-establish the slimy sculpin to nine isolated locations within its former range in the Driftless Region of southeast Minnesota and ensure population viability, long-term persistence in the face of environmental change and preserve the evolutionary processes that sustain genetic diversity.

- Goal 2: Characterize patterns of success or failure in re-introduced populations to identify conditions that lead to successful population establishment.
- Goal 3: Evaluate allelic richness and heterozygosity in the re-introduced populations relative to computer simulated expectations.
- Goal 4: Examine how fitness surrogates such as body size, growth rate and body condition differ by ancestral origin in the re-introduced populations and investigate the consequences of outbreeding in first- and second-generation inter-source hybrids.

Success Indicators

- Indicator 1: Establishment of slimy sculpins at all sites for at least three generations and substantial expansion of each population's range away from the re-introduction location.
- Indicator 2: Characterize habitat at each re-introduction site and compare population size estimates with different habitat features such as stream temperature, substrate type, etc.
- Indicator 3: Evaluate the allelic richness and heterozygosity in the re-introduced populations relative to computer simulated expectations.
- Indicator 4: Document how fitness surrogates such as body size, growth rate and body condition differ by ancestral origin in the re-introduced populations and investigate the consequences of outbreeding in first- and second-generation inter-source hybrids.

Project Summary

Feasibility: Brynildson and Brynildson (1978) demonstrated the feasibility of sculpin re-introductions by documenting the establishment and dispersal of sculpins in a Southwest Wisconsin stream. Following a one-time stocking of 500 individuals, stocked sculpins gradually expanded throughout the suitable areas of the stream over the course of eight years. In recent years, the Minnesota Department of Natural Resources (MNDNR) and other organizations completed many stream habitat improvement projects that stabilized eroding banks, improved substrate, increased fish cover, and increased riparian tree abundance to provide shade in the summer. The recipient streams were chosen from among these restored sites because they comprised suitable habitat (coarse-substrate, plentiful riffles and groundwater input) and were repeatedly sampled and verified not to have any sculpin species present. Most of the recipient sites were located on private land; therefore, we contacted landowners and coordinated access for repeated research and monitoring site visits. All of the landowners were amicable and some were interested in the research and also wished to accompany researchers during site visits. Several cold-water streams with abundant sculpin populations were identified as potential donor sources. These locations were surveyed for at least three consecutive years to verify that source populations would not be detrimentally affected by removal of sculpins for stocking. Disease testing was necessary to verify that sculpins to be translocated would not transmit any pathogens to organisms in recipient streams. The MNDNR required three


Slimy sculpin showing coded tag © David Huff

years of negative tests from the donor streams before sculpins could be translocated.

Implementation: To avoid disrupting spawning or stressful handling and transport during hot weather, we collected sculpins for translocation in late October. Sculpins were collected from an established set of locations at each of the three donor streams by backpack electrofishing. The entire designated donor stream reach was sampled at each collection event to provide data for population assessments. Each sculpin was weighed, measured, and marked by clipping a pelvic fin so that stocked fish could be distinguished from naturally reproduced fish. We also tagged several hundred of the sculpins in each of the recipient sites with unique identifiers to collect information about growth, survival, and movement of individual fish. Approximately 150 fish with roughly equal proportions from source streams were translocated in each year from 2003 - 2005 to nine different recipient sites. Specific quantities and timing of translocation activities may be found in Huff *et al.* (2010).

Post-release monitoring: We monitored the establishment of sculpins at each of the recipient sites by sampling sculpins at least once per year in the autumn through 2009. We collected data for population estimates and we tracked the expansion of sculpin presence away from the original re-introduction location. Sculpins spawn once per year in the spring, so we monitored these re-introduced populations for at least four generations. We documented established sculpin populations at all re-introduction sites (Huff, 2010). In 2009 population estimates ranged from 200 to 3,100 sculpins across all nine sites. In some cases the range of the re-introduced sculpins expanded to the extent of the local drainage basin and in other cases sculpin presence remained highly localized near the original stocking site.

We completed habitat surveys at the source and recipient sites in which we characterized substrate type, aquatic macroinvertebrate (an important sculpin prey) abundance and composition, water velocity, water temperature (using data-recording temperature probes), and other habitat features. Based on our results we hypothesized that thermal regime differences between the source habitats provided potential mechanisms for local adaptation development among source populations. Dissimilar optimal growth temperature ranges or maximum growth rate differences may have arisen between source populations as a compensatory


Re-introduction site showing restored riparian corridor © David Huff

response to different temperatures and growing season lengths (Huff, 2010 & Huff *et al.,* 2011). We evaluated allelic richness and heterozygosity in the re-introduced populations relative to computer simulated expectations. Sculpins in re-introduced populations exhibited higher levels of heterozygosity and allelic richness than any single source, but only slightly higher than the single most genetically diverse source population (Huff *et al.,* 2010).

We inferred the relative fitness of different pure strain and hybrid-cross descendants in the re-introduced populations by comparing their growth rate, length, weight, body condition and persistence in re-introduced populations. Pure strain descendants from a single source population persisted in a greater proportion than expected in the re-introduced populations. Length, weight and growth rate were lower for second-generation intra-population hybrid descendants than for pure strain and first-generation hybrids (Huff *et al.,* 2011).

Major difficulties faced

- This project was difficult to fund because the purpose of the re-introduction was to restore ecological integrity to streams and to potentially provide forage for game fish (trout), rather than to establish a threatened species.
- It was often problematic to recruit and organize volunteers to complete the majority of the field work.
- Because the slimy sculpin was a poorly understood species, we found it initially challenging obtain consistent and reliable information regarding its life-history and species identification.
- For genetic analyses, new microsatellite markers for slimy sculpins had to be developed for the first time by our research team (Fujishin *et al.,* 2009).
- It was difficult to identify enough re-introduction sites to meet our research needs.

Major lessons learned

- If feasible, the genetic and ecological distinctiveness of candidate source populations should be evaluated prior to re-introduction.
- Computer simulations may allow the genetic diversity benefits of mixing populations to be weighed against the risks of outbreeding depression in re-introduced and nearby populations.
- Given the absence of information regarding deep phylogenetic separation among populations, the high degree of genetic differentiation, the potential for

disrupting beneficial adaptations, and the lack of evidence that genetic rescue is necessary, the most conservative option available for future re-introductions of slimy sculpin in the Driftless Region would be to use a single source population.
- Single-source re-introductions may be carried out on a trial basis using local strains that maximize the likelihood of genetic and ecological similarity to inhabitants of the surrounding area.
- Monitoring the populations may identify the need to supplement the re-introduced populations with individuals from different strains if it is warranted.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reason(s) for success/failure:
- We devised thorough plans for re-introducing the sculpins and kept detailed records regarding how many fish were re-introduced, where they came from originally, when and where they were translocated, and we designed a comprehensive population monitoring plan.
- We were careful to translocate fish when the weather was cool and we took other measures to minimize stress on the sculpins.
- We carefully selected re-introduction sites that utilized data from detailed habitat surveys.
- We solicited information and suggestions from local fisheries professionals and academics that significantly improved our project.

References

Huff, D. D., Miller, L. M. & Vondracek, B. (2010) Patterns of ancestry and genetic diversity in re-introduced populations of the slimy sculpin: implications for conservation. Conservation Genetics 11: 2379 - 2391.

Huff, D. D., Miller, L. M., Chizinski, C.J. & Vondracek, B. (2011) Mixed-source re-introductions lead to outbreeding depression in second-generation descendants of a native North American fish. Molecular Ecology 20: 4246 - 4258.

Brynildson, O. & Brynildson, C. (1978) Distribution and density of sculpins in a Wisconsin coulee stream. Page 5pp. Wisconsin Department of Natural Resources Bureau of Integrated Science Services, Madison, Wisconsin, USA.

Huff, D. D. (2010) Examining genetic diversity, hybrid fitness, and local adaptation in a native fish re-introduction program. Dissertation. University of Minnesota, Saint Paul.

Fujishin, L. M., Barker, F. K., Huff, D. D. & Miller, L. M. (2009) Isolation of 13 polymorphic microsatellite loci for slimy sculpin (*Cottus cognatus*). Conservation Genetics Resources 1:429-432.