Inter-basin Introductions of Crayfish

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Crayfish in Food Webs

- Crayfish are prey for fish, birds, mammals, reptiles, amphibians
- Crayfish process large amounts of organic matter
 - CPOM→FPOM
- Crayfish feed on:
 - Detritus
 - Plants algae & macrophytes
 - Animals invertebrates
 & fish
- "Crayfish eat everything and everything eats crayfish."

Fig. 3. Conceptual model of major energy flow pathways in the Jacks Fork River involving crayfishes and comparison of organic matter consumption and egestion by crayfishes in relation to the rest of the benthic community. All values are in $g \cdot m^{-2} \cdot y ear^{-1}$. Values with a single asterisk are from Rabeni et al. (1994) and those with a two asterisks are from Rabeni (1992). The rest are from this study.





Southeastern U.S. is center of global crayfish diversity Crayfish likely act as keystone species in most freshwaters

Proportion of U.S. and Canadian Species at Risk by Plant & Animal Group (2010)





Crayfish Conservation

 Crayfish 2nd most threatened aquatic taxon (~50% of species at risk in US)

(Ricciardi and Rasmussen 1999)

- Small ranges (Taylor et al. 2007)



Robison and Wagner (unpublished)

- Invasive species (Lodge et al. 2000)



Minnesota Sea Grant

Spatial Scale of Invasion

- Extraregional species that have invaded another continent or crossed major drainage boundaries within North America (Larson and Olden 2010)
 - Large range size
 - High fecundity
 - Regional processes
 - Human-assisted transport
 - Environmental compatibility
- Extralimital species that have invaded a drainage or state adjacent to their native range
 - Large chelae size
 - Local processes
 - Biotic interactions

Spatial Scale of Invasion

- Extraregional
 - Red Swamp Crayfish *Procambarus clarkii* (Hobbs et al. 1989)
 - Rusty Crayfish Orconectes rusticus (Lodge et al. 2000)
- Extralimital
 - Woodland Crayfish Orconectes hylas (Riggert et al. 1999)
 - Ringed Crayfish Orconectes neglectus (Magoulick and DiStefano 2007)

Extraregional Invasion

Rusty crayfish



Extralimital Invasion





Orconectes neglectus introduced

Orconectes neglectus native

Case Study: Orconectes neglectus invasion

- Orconectes neglectus White River Drainage
- Orconectes eupunctus
 Spring River Drainage
- Introduced into Spring River between 1984 and 1998









Magoulick and DiStefano 2007



Research Questions

- Did environment or *O. neglectus* displace *O. eupunctus* from portion of range?
- What are the mechanisms behind this displacement?
 - Competition
 - Habitat/shelter
 - Food
 - Life history
 - Reproductive interference
 - Hybridization
 - Disease/pathogens
 - Differential predation
 - Drying/Disturbance



Streams Dry in the Ozarks



Do O. neglectus,
 O. eupunctus differ in response or tolerance?



Intermittent

O. neglectus



Permanent

South Fork Spring River



Rabalais and Magoulick 2006a, 2006b Larson and Magoulick in press





O. eupunctus

Research Questions

Do O. eupunctus, O. neglectus differ in:

- Desiccation tolerance?
- Survival under simulated drying?
- Distribution with drying severity?
- Response to predation and drying?



Methods

Simulated Stream Drying:

- Climate controlled greenhouse
- Twenty 0.67 m² riffle mesocosms
- Filled to 15 cm depth with gravel, pebble, cobble, boulder substrate
- Water circulated with canister filters
- ¹/₂ mesocosms drying treatment
- 4 *O. eupunctus* and 4 *O. neglectus* per mesocosm





Methods

Simulated Stream Drying:

- Two week acclimation period
- Two week removal of 500 ml water daily
- Water dropped to 13 cm below substrate, 1-2 cm depth on bottom
- Crayfish recovered: size, species, burrow depth and survival recorded





Survival During Simulated Drying





Methods

Field Sampling (2007):

- May, July, August, September, October
- 11 sites from 11.3 river km down to 94.7 km
- Measured discharge, crayfish density





Crayfish Distribution and Drying

Crayfish Density and Riffle Area by River Kilometer





Crayfish Distribution and Drying





Crayfish Density and Minimum Discharge

Methods

- Deep and shallow habitats in each tank
- Treatments bass presence/absence and wet/dry
- Dry treatments dried to 10cm depth from bottom



Predation and Drying on Crayfish Survival







Discussion

- O. eupunctus, O. neglectus differ in:
 - Desiccation tolerance
 - Survival under simulated drying
 - Distribution with severity of seasonal stream drying
 - Survival under predation*drying interaction



- Disturbance (stream drying) and predation may serve as mechanisms in the displacement

Discussion

- Refuge hypothesis
 - O. eupunctus displaced from periphery of range
 - Prefers large, permanent, spring fed rivers
 - Flinders and Magoulick 2005





Discussion

- Implications:

-Disturbance and interactions between disturbance and other mechanisms should be considered in crayfish species displacements

-Water stress may increase in future

- Water extraction, river impoundment, global climate change
- -Xenopoulos et al. 2005, Palmer et al. 2008
- -Extralimital crayfish introductions may be very important



Land Owners Don and Laurie Benedict Eunice Foster Bob Pilkinson South Fork Resort

Funding Agencies: Arkansas Game and Fish Commission Missouri Department of Conservation U.S. Fish and Wildlife Service

Acknowledgements:

Advice and Support: Eric R. Larson Michael R. Rabalais Clint Turner Kelly H. Laycock Dr. Art Brown Dr. Gary Huxel Dr. Steve Beaupre Bob DiStefano Brian Wagner

Field Assistance: Carolyn Wisniewski Miller Jarrell Matt Dekar Amy Gaudet Glenn Piercey

