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25th International Symposium on Freshwater Crayfish



New Orleans, USA

June 1 - 5, 2026



Nicholls State University



INTERNATIONAL ASSOCIATION
OF
ASTACOLOGY

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PREFACE



After a 36-year hiatus, the International Association of Astacology returns to Louisiana for its biennial symposia. Since it was last held here, the research interests of IAA delegates have greatly expanded and the breadth of talks and posters at IAA25 reflect that expansion. This year's Symposium features 67 talks, four plenary presentations, including the Sture Abrahamson Lecture, and 22 posters summarizing the results of years of work by scientists ranging from undergraduate students to senior-level researchers. Topics cover both traditional taxonomy and biogeography to recent advances in genetics and physiology. It is my hope that attendees are able to increase their understanding in all of these research fields and how they relate to world's crayfish fauna. If you are not able to attend, my hope is that the information contained in these abstracts will allow you to contact presenters for additional information and foster future collaborations. Thank you for supporting IAA and IAA symposia and I look forward to the continued expansion of crayfish research fostered by your hard work and dedication.

Sincerely,
Christopher A. Taylor
President, International Association of Astacology

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CONTENT

Symposium Program	7
Sture Abrahamsson Lecture	14
Plenary Lectures	15
Oral Presentations	18
Poster Presentations	88

SYMPOSIUM PROGRAM

Sunday, May 31st

- 10:00 Workshop Crayfish IUCN red list training and assessment
- 16:00-18:00 Registration

Monday, June 1st

- 08:00 Registration
- 08:45 IAA25 Opening Ceremonies
- 09:15 **Sture Abrahamson** **Crayfishes in the USA: What Good Are They? And**
lecture Robert DiStefano **What Are We Doing for Them?**

Session: Conservation and Biogeography

Moderator: Zackary Graham

- 10:00 Bronwyn Williams An integrative conservation assessment of crayfishes in the Coastal Plain of North Carolina, South Carolina, and Georgia
- 10:15 Ivana Maguire Insights into the Current Distribution of Native Crayfish and Their Future Prospects in Croatia
- 10:30 Parker Hildreth Resolution of the *Cambarus pristinus* species complex identifies new species amid growing conservation concerns across the Cumberland Plateau in Tennessee
- 10:45 David Livadariu Bridging the Gap Between Occurrence Data and Conservation Action: Automated Workflows, Temporal Awareness, and AI-Ready Evidence
- 11:00 **Break**

Session: Conservation and Biogeography II

Moderator: Ivana Maguire

- 11:30 Jaden Rusnak Updated Distributions of *Cambarus monongalensis* and *Lacunicambarus thomai* in Western Pennsylvania
- 11:45 Reginald Turner Environmentally Informed Clustering Reveals Cryptic Crayfish Community Structure in the Ogeechee River Basin
- 12:00 Kaleb Norris Updated Occurrence and Species Accounts of Crayfish in Southeastern Kentucky's Upper Cumberland River Subbasin
- 12:15 Emmy Delekta The Most Important Thing You Collect Isn't the Crayfish: Data Stewardship in Modern Astacology
- 12:30 **Lunch**

Session: Ecology

Moderator: Bram Koese

- 14:00 Zanethia Barnett Does Forest Type Matter? Assessing Food Resource and Trophic Niche Difference of Stream Crayfishes
- 14:15 Björn Rogell Plasticity and local adaptation in growth rates across northern populations of crayfish
- 14:30 Golaria Kor Impact of VIE Tags on *P. clarkii* Juvenile Growth and Survival
- 14:45 James Hartley Range-wide assessment of life history traits in burrowing crayfish *Cambarus monongalensis* (Blue Crawfish).
- 15:00 Hannah Holbert Juvenile Life History, Growth, and Maternal Behavior of the Little Brown Mudbug (*Lacunicambarus thomai*)
- 15:15 Lindsey Reisinger The influence of forest type on leaf litter resources and breakdown by freshwater crayfish
- 15:30 **Break**

Session: Ecology II

Moderator: Brian Roth

- 16:00 Katherine Torrence Seeing the Spectrum: Investigating Color Vision in Freshwater Crayfish
- 16:15 Olivier Raven Habitat use and distribution of freshwater crayfish in response to littoral artificial reefs
- 16:30 Rachel Chaffee Utilizing eDNA to identify associated biodiversity in crayfish burrows
- 16:45 Dusty Swedberg Seasonal Emergence and Habitat Vulnerability of *Procambarus brazoriensis* in Coastal Texas Wetlands
- 17:00 Augusto Huber No Claws, No Catch? Feeding Performance After Claw Loss in the Signal Crayfish
- 17:15 Raymond Bailey The Impacts of Abiotic and Biotic Factors on the Diversity and Abundance of Branchiobdellidans, an Ectosymbiont of the Big Water Crayfish in New York State
- 18:00 **IAA Board Meeting**

Tuesday, June 2nd

8:00 Registration

8:30 **Plenary Speaker:** Christopher Taylor **Southeastern US Crayfish Diversity: a globally unique resource**

Session: Genetics

Moderator: David Foltz

9:00 Patrick Allison Discovery, Delimitation, and Conservation of *Creaserinus* Burrowing Crayfish Species

9:15 Alyssa Oppedisano A taxonomic revision of Atlantic slope *Creaserinus fodiens* (Digger Crayfish) with an emphasis on Virginia populations

9:30 Brooke Grubb Probe efficacy and an initial phylogenomic reconstruction of freshwater crayfish using anchored hybrid enrichment

9:45 Caitlin Bloomer Evaluating the Slenderwrist Burrowing Crayfish, *Fallicambarus petilicarpus*, for Endangered Species Act listing

10:00 Shiyang Wu Toward a Whole-Genome Phylogeny of Missouri Crayfishes: Building Genomic Foundations for an Ecological Radiation

10:15 Keith Crandall The Wonderful World of Freshwater Crayfish - a phylogenetic perspective

10:30 Break

Session: Physiology

Moderator: Tanya Khan

11:00 Jacob Westhoff Integrating diel temperature fluctuation into thermal metric estimation for crayfish

11:15 David Weese Linking Upper Thermal Limits and Long-Term Survival in Freshwater Crayfish

11:30 Stacy Schmidt Thermal stress reveals sublethal disease effects in crayfish plague-exposed *Faxonius virilis*

11:45 Pavel Kozák Heartbeat and respiration of crayfish. Study and possible applications.

12:00 **Lunch**

Session: Movement Ecology

Moderator: Jenny Zimmerman

14:00 Zackary Graham Surface behavior in the Blue Crawfish, *Cambarus monongalensis*

14:15	Wesley Fitzsimmons	Crayfish on the Move: Movement Rates of Invasive Woodland Crayfish in the St. Francis River Basin
14:30	Calvin Rezac	Determining the status, surface activity, and movements of Jackson Prairie Crayfish (<i>Procambarus barbiger</i>)
14:45	Casey Davis	Movements of the Coldwater Crayfish <i>Faxonius eupunctus</i> ; a preliminary study using passive integrated transponder tags
15:00	Break	
	Session: Aquaculture	Moderator: Archis Grubh
15:45	Jay Huner	The Status of the Modern Louisiana Crayfish Aquaculture Industry
16:00	Renee Hintz	Effect of Surface Area on Survival and Growth Rate of <i>Procambarus clarkii</i> Juveniles in a Recirculating Aquaculture System
16:15	Andrew Phipps	Propagation of Big Sandy Crayfish at White Sulphur Springs NFH
16:30	Jordan Holcomb	Evaluating critical oxygen requirements of <i>Procambarus clarkii</i> and implications for aquaculture management
16:45	Jenny Zimmerman	Design of an aquaculture facility to increase conservation success of noble crayfish (<i>Astacus astacus</i>) after restocking to a cold-water stream
17:00	Kaelyn Fogelman	From Tradition to Innovation: Charting the Future of U.S. Crayfish Aquaculture
17:15	Break	
18:00	Poster session	

Wednesday, June 3rd

8:00 Field excursion

Thursday, June 4th

8:30 Plenary Speaker: Susan B. Adams
Beloved native or insidious invasive?
Multidisciplinary approaches to assessing the provenance of Signal Crayfish in Montana, USA

Session: Invasive Species I

Moderator: Jacob Westhoff

9:00 Brian Roth
Adaptive management of red swamp crayfish invasions in Michigan

9:15 Archis Grubh
Morphometric variation and its implications for managing an emerging crayfish invader in Texas

9:30 William Budnick
A successful interjurisdictional effort to assess and communicate about invasive crayfish in the pet trade: Achievements and lessons learned for the Great Lakes region of the United States

9:45 Sandra Hudina
Ornamental Crayfish Trade Regulation in European context: A Cross-Country Comparison

10:00 Jofina Victor
Management and Eradication Efforts to an Occurrence of Invasive Marbled Crayfish (*Procambarus virginalis*) in Ontario, Canada

10:15 Break

Session: Biological Control

Moderator: Augusto Huber

10:45 David Lieb
Keystone species interactions: Can American eels restrict establishment of non-native crayfish?

11:00 William Ota
Crayfish Surveillance and Monitoring in the Great Lakes Basin

11:15 Cody Cretini
Efficacy of invasive carp as bait for wild crayfish in the Atchafalaya River Basin, Louisiana

11:30 Aaron Sullivan
Assessing the Potential of Native Michigan Predatory Fish as Biological Control Agents of the Invasive Red Swamp Crayfish (*Procambarus clarkii*)

11:45 Daniela Ghia
Volunteers control and reduce the spreading of invasive crayfish by pleopod sterilisation

12:00 Lunch

Session: Monitoring

Moderator: Premek Hamr

14:00 Patrik Bohman
Twenty years of monitoring a biological invasion

- 14:15 PJ Torres Widespread detection and establishment of the Australian red-claw crayfish (*Cherax quadricarinatus*) in Puerto Rican reservoirs
- 14:30 Ljudevit Luka Boštjančić Monitoring of freshwater crayfish through passive eDNA collection in major rivers of Hesse (Germany)
- 14:45 Bogna Griffin Where Have All the Yabbies Gone?
- 15:00 **Break**

Session: Invasive Species II

Moderator: Lucian Pârvulescu

- 15:30 Greg Rothman Patterns of host-symbiont associations in native and non-native Red Swamp Crayfishes
- 15:45 Karman Morgan Ecotoxic effect of a soil-stabilizing root-bacterial exopolysaccharide salt on the reproduction of *Procambarus clarkii*
- 16:00 Premek Hamr “Crawfish Eh !?”: First records and distribution of the invasive crayfish *P. clarkii* in Ontario, Canada.
- 16:15 Mackenzie Thompson Using Geometric Morphometrics to Quantify Morphological Divergence of *Procambarus clarkii* in southern Michigan
- 16:30 **Break**
- 18:00 **Social & Auction**

Friday, June 5th

9:00 **Plenary Speaker:** Shasta Crayfish, the last California native crayfish
Maria J. Ellis

Session: Pathogens & Plague I

Moderator: Cheyenne Stratton

9:30 Bogna Griffin Evolution of Ireland's National Crayfish Plague Programme: From Method Validation to Active Species Recovery

9:45 Valentina Paolini Genetic characterisation of *Aphanomyces astaci* from Italian crayfish plague outbreaks in white-clawed crayfish

10:00 Gianluca Fea Transmission of *Astathelohania contejeani* in the Invasive Signal Crayfish *Pacifastacus leniusculus*

10:15 Nadine Bleile Population estimation of invasive crayfish (*Procambarus clarkii* and *Faxonius virilis*) across 124 acres of low-peatland using a mark-recapture and a depletion method

10:30 **Break**

Session: Pathogens & Plague II

Moderator: Bogna Griffin

11:00 Tobia Pretto White-clawed crayfish (*Austropotamobius pallipes* complex) populations co-exist with *Aphanomyces astaci* genotype group A in north-western Italy

11:15 Ljudevit Luka Boštjančić Uncovering the virome of the invasive calico crayfish (*Faxonius immunis*) - CaliVir

11:30 Tin Škugor Host-pathogen dynamics under climate change: Uncovering the potential distribution of crayfish and the crayfish plague pathogen *Aphanomyces astaci* using Species Distribution Modelling

11:45 Cheyenne Stratton More Than Meets the Claw: Hidden Disease Dynamics in a Crayfish Invasion

12:00 **Break**

12:30 **IAA25 General Assembly, Announcements and Closing Ceremonies**

POSTERS

NO.	PRESENTER	TITLE
1	Dora Pavić	Differential susceptibility of <i>Aphanomyces astaci</i> genotypes and developmental stages to temperature
2	Sofia Poludniak	Project Crawdad: A Conservation Outreach Approach for Imperiled Crayfish in Appalachia
3	Kayla Aungst	Using Radio Telemetry to Track <i>Cambarus callainus</i> Movement in Response to Dam Removal
4	Hayley Holbert	Utilizing Morphometrics to Determine Burrowing Type in Fossil Crayfish
5	Robi McGarvey	Distribution and habitat assessment of secondary and tertiary burrowing crayfish in the Pearl River basin, Louisiana
6	Jonathan Eisenhour	Distribution and habitat assessment of primary burrowing crayfish in the Pearl River basin, Louisiana
7	Bogna Griffin	Chasing the plague, one passive filter at a time
8	Augusto Huber	Missing Pieces: Appendage Injury Rates and Vulnerability in Laboratory-Stocked Marbled Crayfish
9	Andrea Basso	Crayfish plague outbreak in a white-clawed crayfish breeding facility caused by broodstock with undetected chronic <i>Aphanomyces astaci</i> infection
10	Elizabeth Croft	Assessing The Conservation Needs of Native Texas Crayfish Species Through Distribution Analysis and Species Distribution Modeling
10	Ljudevit Luka Boštjančić	Preliminary results of the model application of crayfish plague vaccine (immune priming) in the noble crayfish
12	Jenny Zimmerman	Survival of <i>Aphanomyces astaci</i> after treatment with heat, ozone and UV-light
13	Nico Salazar	Crayfish Communities in Near-Estuarine Habitats of Coastal Georgia, USA
14	Pedro Solis	Preliminary Research on <i>Pennides (Procambarus)</i> Crayfish Systematics in Mississippi

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| 15 | Christopher Bonvillain | Life history of the Pontchartrain Painted Crayfish <i>Faxonius hobbsi</i> , a species of greatest conservation need in Louisiana |
| 16 | Evan Wahmhoff | Contemporary Assessment of Crayfish Assemblages in the Altamaha River Basin, Georgia |
| 17 | Kyla Schmitt | Native Population Characteristics of <i>Pacifastacus leniusculus</i> (Dana, 1852) in Tryon Creek, Oregon |
| 18 | Ryan Coates
(presented by
Cheyenne Stratton) | The New Student Has Claws: Eradication Efforts for an Introduced Red Swamp Crayfish Population on a University Campus |
| 19 | Jacob Westhoff | Crayfish movement ecology: a comprehensive literature review |
| 20 | Shiyang Wu | Ecomorphological Divergence in Missouri Crayfishes: Linking Habitat Specialization to Body Shape |
| 21 | David Foltz | Two new crayfish species (Decapoda: Cambaridae) from the James River Basin of Virginia, USA. |
| 22 | Albert “Rusty” Gaude
III | Educational Opportunities in Home Crawfish Production |

STURE ABRAHAMSSON LECTURE

Crayfishes in the USA: what good are they? And what are we doing for them?

Robert J. DiStefano¹

¹*Missouri Department of Conservation (retired), Missouri, USA; distef@tnetmail.net*

Crayfish are important in the U.S. and the state of Missouri, including importance to biodiversity and ecology in and around waterbodies. U.S. crayfishes use a wide variety of aquatic (and some terrestrial) habitats on both macro- and micro-scales. Biodiversity is generally high and valued by Americans. The continent contains more than half of the reported global species; abundances are often high. U.S. crayfish have a wide and varied diet, transferring energy throughout trophic webs. They are prey to many organisms on multiple trophic levels. They are important prey to valuable recreational fisheries. Their ecological importance includes nutrient cycling, ecosystem engineering, while burrowers enhance soil quality and plant growth. Historically neglected, crayfish conservation is now ongoing in the U.S. and Missouri, where they are subject to several threats, including physical habitat loss, pollution, and invasive species. Conservation efforts are increasing and spreading throughout the country.

Southeastern US Crayfish Diversity: a globally unique resource

Christopher A. Taylor¹

¹Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Illinois, USA; cataylor@illinois.edu

The Southeastern United States is a world-renowned freshwater biodiversity hotspot. While fishes and unionid mussels get most of the attention, the region's crayfish fauna is second to none in terms of species richness and endemism. This plenary talk will summarize this unique fauna, highlight important subregions within it, and discuss reasons for such high levels of richness. Conserving this unique crayfish fauna should be a high priority and doing so requires a fundamental understanding of threats. These threats will also be summarized.

PLENARY LECTURE

Beloved native or insidious invasive? Multidisciplinary approaches to assessing the provenance of Signal Crayfish in Montana, USA

Susan B. Adams^{1*}, David A. Schmetterling², Stacy A Schmidt³, Hampton Kennedy^{4,5}, Chaz Hyseni^{4,6}, Iris Arantes⁷, Jared A. Grummer⁸

¹*Center for Bottomland Hardwoods Research, Southern Research Station, USDA Forest Service, Mississippi, USA; Susan.adams@usda.gov*

²*Montana Fish, Wildlife & Parks, Montana, USA*

³*The Miller School of Albemarle, Virginia, USA*

⁵*Colossal Biosciences, Texas, USA*

⁶*University of Mississippi, Biology Department, Mississippi, USA*

⁷*Flathead Lake Biological Station, Wildlife Biology Program and Division of Biological Sciences, University of Montana, Montana, USA*

Knowing a species' native status is fundamental to conservation management and to accurately understanding ecosystem function in an evolutionary context. When historical data are lacking, the default assumption is often that species that were present when data were first collected are native; however, that is not always the reality. We present a case study on using multidisciplinary approaches to investigate the status of the cryptogenic (i.e., species with unknown provenance) signal crayfish (*Pacifastacus leniusculus*) in the state of Montana (MT), USA. Signal crayfish are considered by many to be native throughout the Columbia River basin, but questions have quietly persisted about their status in the upper portions of the basin, including northern Idaho and Montana. If the species is not native, we wondered if it had displaced a possibly undescribed native *Pacifastacus* or if isolated remnant populations of a native species persisted. To address the species' status in MT, we first scoured historical documents looking for Native American or early colonial indications of crayfishes in Montana. Next we examined literature on late-Pleistocene conditions in the region, most notably Glacial Lake Missoula and its repeated catastrophic outburst floods and subsequent barriers to recolonization by riverine species. Finally, we used morphometrics and mtDNA 16s and CO1 sequences to assess where the closest relatives of Montana's present-day *Pacifastacus* resided. We found historical evidence of signal crayfish introduction to MT in the 1930s, and all results were consistent with the species being non-native in the state. We address the broader applicability of these multidisciplinary approaches, highlighting their crucial role in influencing policy, management, and ecological and conservation science.

PLENARY LECTURE

Shasta crayfish, the last California native crayfish

Maria J. Ellis¹, Jeffrey D. Cook¹

¹*Spring Rivers Ecological Sciences LLC, PO Box 153, Cassel, CA 96016, USA; maria@springrivers.com*

Thirty-six years ago, while looking for a project for her doctoral research, Maria Ellis took a summer job as “a biologist who could scuba dive” in the Intermountain Area of rural northeastern California. The job involved comprehensive surveys and habitat mapping for Shasta crayfish (*Pacifastacus fortis*) for a hydroelectric project relicensing. Prior to 1990 when she started, limited work had been done with Shasta crayfish. As she studied the crayfish, its ecology, and its interactions with non-native signal crayfish for her doctoral research on species invasions and replacements, Maria became the Shasta crayfish species expert. In addition to surveying all known Shasta crayfish locations, Maria snorkel or scuba surveyed the entire Fall River, Rising River, and lower Hat Creek drainages and the midreaches of the Pit River to map the distribution of Shasta crayfish. During the first six years of her research, Maria discovered fourteen new subpopulations of Shasta crayfish (very exciting for a biologist), but she also witnessed the rapid and relentless invasion of non-native signal crayfish (*Pacifastacus leniusculus*), who are both competitors and predators of Shasta crayfish. By the early 2000s, the rapid decline and extirpation of several subpopulations made it clear that Shasta crayfish required help to ensure its long-term survival. In 2004, the 501(c)(3) non-profit Spring Rivers Foundation was created to facilitate grant funding for projects to help Shasta crayfish. Although much work has been done to ensure the species’ survival, and notable progress has been made, the species could face extinction within the decade. Captive breeding and rearing are needed to repopulate an existing safe refuge area, and time is critical. A state-run hatchery has raceways fed with water from a lake with Shasta crayfish. These raceways would provide the safest, best facility for a captive breeding/rearing program, but the state has resisted this plan.

ORAL PRESENTATIONS

An integrative conservation assessment of crayfishes in the Coastal Plain of North Carolina, South Carolina, and Georgia

Checo Colon-Gaud¹, Heather Evans², J. Michael Fisk³, Richard C. Harrington⁴, Rachael Hoch², Brena K. Jones⁵, Michael R. Kendrick⁴, Zachary J. Loughman⁶, Tiffany N. Penland⁷, Langston Rimmer³, Gregory Rothman⁴, Graham Wagner⁴, **Bronwyn W. Williams**⁸

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²*North Carolina Wildlife Resources Commission, 1721 Mail Service Center, Raleigh, NC 27699, USA*

³*North Carolina Wildlife Resources Commission, 2430 Turner Rd. Mebane, NC 27302, USA*

⁴*South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC 29412, USA*

⁵*North Carolina Wildlife Resources Commission, Division of Habitat Conservation, 1718 NC Hwy 56 W Creedmoor, NC, 27522, USA*

⁶*West Liberty University, 208 University Drive, West Liberty University, West Liberty WV, 26074*

⁷*Georgia Department of Natural Resources, 2067 US-278, Social Circle, GA 30025, USA*

⁸*North Carolina Museum of Natural Sciences, Research Laboratory, 1671 Gold Star Drive, Raleigh, NC 27699, USA; bronwyn.williams@naturalsciences.org*

The Coastal Plain ecoregion, generally characterized by low-relief and low-elevation areas below the Atlantic seaboard fall line, contains a substantial percentage of crayfish biodiversity in the Southeastern United States. However, crayfishes in these areas have received less research attention than their more inland counterparts. A major objective of this project is to develop a robust conservation assessment of Species of Greatest Conservation Need (SGCN) crayfishes in Coastal Plain habitats of North Carolina, South Carolina, and Georgia using an integrative approach, combining traditional, yet comprehensive, field sampling techniques with extensive genetic analyses systematically applied across the landscape. This framework also allows for a region-wide evaluation of current and near-future threats to crayfishes, and more broadly, Coastal Plain habitats. Critical to the project is the standardization, wrangling, and curation of historical and contemporary data, and developing a means by which these data can be updated rapidly and efficiently. Through close collaboration we are building a foundation for conducting expedient, landscape-scale, integrative surveys to inform partner agencies on how to better manage crayfish species and address urgent conservation needs.

Insights into the Current Distribution of Native Crayfish and Their Future Prospects in Croatia

Ivana Maguire^{1*}, Miha Jurić¹, Luka Katušić², Igor Stanković³, Matej Faller³

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²*Ministry of Environment and Green Transition, Radnička cesta 80, Zagreb, Croatia; luka.katusic@mzozt.hr*

³*Josip Juraj Strossmayer Water Institute, Ulica grada Vukovara 220, Zagreb, Croatia; igor.stankovic@institutjjs.hr, matejfaller@gmail.com*

Native crayfish act as ecosystem engineers and keystone species in freshwater systems, contributing substantially to various ecological processes. However, their populations have experienced marked declines due to human-induced habitat degradation, the spread of non-native crayfish and associated pathogens (such as *Aphanomyces astaci*, which causes crayfish plague), and climate-related pressures, including prolonged droughts. In Croatia, native crayfish species are similarly affected, with noticeable reductions in population size and local extinctions across numerous freshwater habitats.

This work presents preliminary findings on the current distribution of native crayfish in Croatia and examines how these distribution patterns relate to the ecological status and ecological potential of freshwater bodies. It also outlines considerations for their long-term conservation. The analysis included confirmed occurrence records collected after 2019 for three native species (*Astacus astacus*, *Austropotamobius fulcivatus* and *Austropotamobius torrentium*), alongside data on ecological status and ecological potential from the River Basin Management Plan until 2027. In total, more than 800 post-2019 occurrence records were evaluated.

By overlaying crayfish presence data with information on the ecological status and potential of water bodies, the results indicate that approximately 60% of sites supporting crayfish populations are classified as having very good or good ecological status, or good or high ecological potential. Conversely, about 25% of these sites fall into poor or bad ecological status. These findings highlight the strong association between water body condition and crayfish occurrence, and suggest that populations persisting in degraded environments are at considerable risk and may face further decline or disappearance without effective conservation measures.

Resolution of the *Cambarus pristinus* species complex identifies new species amid growing conservation concerns across the Cumberland Plateau in Tennessee

Parker Hildreth¹, Christopher Skelton, and Carl Williams

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²*Skelton Environmental Consulting, 743 Hunter St, Madison, GA 30650, USA*

³*Tennessee Wildlife Resources Agency, 3030 Wildlife Way, Morristown, TN 37814, USA*

Conservation policy in Tennessee is largely species focused, yet insufficient systematic assessment or re-evaluation can obscure true biodiversity. Undescribed or cryptic species may result in inaccurate conservation status designations, limiting effective management and reducing conservation opportunities. We apply an integrative framework to investigate variation within *Cambarus pristinus*, the Pristine Crayfish. Our results support the presence of two distinct species within this complex. We resolve this taxonomic uncertainty by delimiting *C. pristinus* and provide diagnostic evidence for the formal recognition of the new species. We provide updated conservation status recommendations and highlight key observations related to increasing conservation threats across the Cumberland Plateau.

Bridging the Gap Between Occurrence Data and Conservation Action: Automated Workflows, Temporal Awareness, and AI-Ready Evidence

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Biodiversity databases have become essential for conservation assessment, yet most remain optimized for human browsing rather than structured machine consumption. This creates critical bottlenecks: data are fragmented, poorly documented, and systematically disconnected from temporal reality. Using global freshwater crayfish as a model system, we address these limitations through three integrated innovations. We introduce cheCkOVER, an open-source R workflow that automates transformation of occurrence records into standardized species knowledge packages. Processing 465 crayfish species across 97 countries, cheCkOVER harmonizes taxonomy, derives IUCN-aligned spatial metrics (Eoo/Aoo), and performs geospatial contextualization across administrative units, basins, ecoregions, and protected areas. Outputs include publication-ready maps, interoperable exports (GeoJSON, KML, JSON), and canonical geo-narratives combining human-readable summaries with machine-readable structured fields—all maintaining full traceability to source references. These standardized outputs expose a fundamental infrastructure gap: current databases cannot natively represent documented local extinction. This produces temporal inflation—contemporary range products retain legacy presences, obscuring real decline and propagating error into conservation assessment. We demonstrate that treating documented loss as first-class loss_event records linked to historical localities enables time-aware mapping. Implementation with European crayfish extinctions reveals measurable IUCN metric inflation and establishes practical design constraints for spatial matching. Finally, we validate how structured, machine-readable biodiversity data transform AI accessibility through controlled LLM query tests. Comparing closed-book baseline, web search, and manifest-directed retrieval across nine poorly documented endemic crayfish versus one well-documented control, we found dramatic performance gaps. Closed-book queries failed catastrophically (mean 1.72/8, 50% failures), web search improved inconsistently (4.25/8, 19% failures, frequent taxonomic confusion), while manifest-directed retrieval achieved consistent success (6.88/8, zero failures, 56% perfect scores). Critically, improvement scaled inversely with existing documentation: obscure species gained 7+ points versus 2 points for well-documented taxa—directly addressing accessibility gaps where conservation needs are greatest. Together, these advances establish practical infrastructure enabling reproducible, AI-assisted conservation workflows by making occurrence data simultaneously human-interpretable, machine-consumable, and temporally explicit.

Updated Distributions of *Cambarus monongalensis* and *Lacunicambarus thomai* in Western Pennsylvania

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Crayfish are a diverse and important ecological component of freshwater and terrestrial ecosystems within Pennsylvania and across the United States. Previous large-scale burrowing crayfish collection efforts in western Pennsylvania have suggested that *Cambarus monongalensis* and *Lacunicambarus thomai* have limited distributions. Anthropogenic threats such as agriculture, urban development, industrial areas, and invasive species introductions may have increased since the last statewide surveys. The disjunct nature of primary burrowing crayfish exacerbates the anthropogenic effects on populations. This study aimed to reevaluate the distribution and conservation status of *L. thomai* and *C. monongalensis*. A total of 332 sites were sampled during 2024 and 2025 within and around the current known range for both species. Suitable burrowing crayfish habitats such as wetlands, seepages, vernal pools, streambanks, floodplains, and roadside ditches were targeted. Historical sites were compiled from previously collected records from unpublished sources, reports, publications, and museum collections. Historical sites were resampled which contributed to the final conservation assessments and s-rank calculations for the state. Although the results of this study showed no significant changes in the distributions of *L. thomai* and *C. monongalensis* within western Pennsylvania, the information is important for the conservation of primary burrowing crayfish in the state.

Environmentally Informed Clustering Reveals Cryptic Crayfish Community Structure in the Ogeechee River Basin

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Crayfish biodiversity in the southeastern United States is increasingly threatened by rapid land-use change, hydrologic alteration, and the high endemism that characterizes many species restricted to single river systems. Yet, the ecological drivers shaping crayfish assemblages in inter-ecosystem rivers remain poorly understood. We examined crayfish community structure across the Ogeechee River Basin in Georgia, integrating land cover, hydrologic, and spatial predictors within a Hierarchical Modeling of Species Communities (HMSC) framework. The HMSC model incorporated hydrologic subunits (HUC8), wetland cover, and upstream channel length as fixed effects, with a fluvial distance matrix representing spatial structure. Predicted species occurrence probabilities from the model were then reduced using principal components analysis and clustered using a k-medoid (PAM) approach to identify communities of common profile across the basin. The model revealed four distinct crayfish communities whose distributions were strongly shaped by hydrologic and landscape features. Wetland cover emerged as a particularly influential predictor, functioning as critical refugia for several species while acting as dispersal barriers for others. Hydrologic subunits organized assemblages along the river continuum, and upstream channel length captured gradients of connectivity and habitat heterogeneity. Together, these variables structured community turnover across the basin and highlighted associations between certain species and key environmental drivers. Our findings demonstrate that crayfish assemblages in the Ogeechee River are governed by a complex interplay of hydrologic context and landscape configuration. More broadly, this study provides a transferable framework for integrating environmentally informed species occurrence probabilities into clustering analyses to delineate ecologically meaningful communities within large, inter-ecosystem watersheds of the southeastern United States.

Updated Occurrence and Species Accounts of Crayfish in Southeastern Kentucky's Upper Cumberland River Subbasin

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The southeastern United States represents the global center of freshwater crayfish biodiversity. The geological and hydrological heterogeneity of the Appalachian Mountain region creates ideal conditions for narrowly endemic species including numerous crayfish species. Kentucky, situated with the central Appalachia region, supports over 60 species of crayfish. In Kentucky, three large scale crayfish surveys have been conducted since Ortmann's (1931) survey of southern Appalachian crayfishes; however, no study has focused solely on Upper Cumberland River subbasin. In response to this knowledge gap, West Liberty University's Astacology Lab was tasked with conducting field surveys within the Upper Cumberland watershed during the 2024 – 2025 field season. These efforts produced a comprehensive species list, update distribution maps, and new species accounts for the region. Defining species occurrence and geographic range allows local and government agencies to allocate conservation resources more effectively. Historically, broad regional scale crayfish surveys have led to new species discoveries, undocumented range extensions, and taxonomic revisions within the Upper Cumberland River subbasin. Preliminary data collected by the West Liberty University Astacology Lab during the 2022 – 2024 field season have already extended the known ranges of at least 3 species of crayfish and revealed numerous taxonomic uncertainties within southeastern Kentucky.

The Most Important Thing You Collect Isn't the Crayfish: Data Stewardship in Modern Astacology

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Crayfish are among the most imperiled faunal groups on Earth, yet the ecological and collections data that underpin conservation assessments remain fragmented, poorly standardized, and largely invisible to the broader biodiversity informatics community. As a museum curator trained in ecology, systematics, and conservation biology, I sit at the intersection of field-based natural history and collections science. From that perspective, the consequences of the disconnects present in astacology is not abstract—it has resulted in species assessments built on incomplete occurrence records, conservation planning that cannot leverage decades of existing survey effort, and research that becomes more and more obscure as time goes on.

The entire biodiversity data pipeline begins with the boots on the ground. Every georeferenced locality, every measured specimen, every ecological observation is a potential node in a richly connected network—but only if it is recorded in ways the broader community can find, interpret, and build upon. The Extended Specimen Network provides exactly this vision: a framework linking physical vouchers to genetic, phenotypic, environmental, and occurrence data across a standardized, interoperable infrastructure. Adopting established standards and engaging with data aggregators does not diminish the biologist's contribution—it ensures that contribution endures.

Astacologists past and present have generated an enormous body of knowledge. Standardizing how that knowledge is recorded and shared means our field work, our collections, and our general expertise remains visible, usable, and consequential long after any individual effort ends. The wheel has already been invented. We owe it to the crayfish, each other, and the broader scientific community to use it.

Does Forest Type Matter? Assessing Food Resource and Trophic Niche Difference of Stream Crayfishes

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Leaf litter from the terrestrial environment is a critical basal resource in forest streams, but little is known about how litter from different forest types impacts stream food webs. We used stable isotope analyses to examine the functional role of *Procambarus troglodytes* Eastern Red Swamp Crayfish in streams with pine and hardwood dominant riparian zones in the Francis Marion National Forest, Berkeley County, South Carolina. *Procambarus troglodytes* played an omnivorous role in streams with both pine and hardwood dominant riparian zones, serving a role between primary and secondary consumers. There were no trophic position differences between male and female *P. troglodytes* nor among crayfish of different sizes (all p values > 0.05). While crayfish trophic roles may not differ between riparian zone types, their food sources differ, with the presence and abundance of hardwood and pine detritus, aquatic vegetation, and invertebrate food sources differing between streams in hardwood and pine dominant riparian zones. Understanding how the riparian tree community influences freshwater consumers such as crayfish, that regulate the breakdown of organic materials, has broad implications for stream ecosystems. These findings highlight the important role crayfish play in these ecosystems by facilitating energy flow to higher trophic levels.

Plasticity and local adaptation in growth rates across northern populations of crayfish

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Growth rate is a key fitness trait that in ectotherms is strongly dependent on ambient thermal conditions and is often subject to local adaptation. This is particularly relevant in temperate zones with seasonal climates, where organisms must adjust their physiological processes in response to low and variable temperatures. Such adjustments may be especially critical for invasive species, whose success often hinges on their capacity to adapt to novel thermal environments. In two controlled experiments, we examined juvenile growth rates, moulting frequencies, and survival across a range of temperatures, as well as evidence for local adaptation in growth rates across northern fringe populations of two crayfish species: the native noble crayfish (*Astacus astacus*) and the invasive signal crayfish (*Pacifastacus leniusculus*, plasticity experiment only). Our results show that potential growth rates are slightly higher in signal crayfish than in noble crayfish, but that the proportion of individuals with stagnated growth is also higher in the invasive species. Thermal plasticity in growth rate was similar across both species. Using a $Q_{ST} - F_{ST}$ comparison in noble crayfish, we found limited evidence for divergent selection on growth rates across thermal clines, suggesting that growth rate itself may not be a primary target of local adaptation. However, we detected large and significant differences in hatch date between northern and southern populations, pointing to local adaptation in phenology rather than growth physiology. Taken together, these findings suggest that the invasive signal crayfish faces few thermal constraints on growth that would limit its continued northward range expansion. Furthermore, the pattern of local adaptation in noble crayfish hatch date highlights that other traits may be more important than growth rates in determining fitness in northern crayfish populations.

Impact of VIE Tags on *P. clarkii* Juvenile Growth and Survival

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Procambarus clarkii, commonly known as the Red Swamp Crayfish, is native to parts of the Southeastern United States and Northern Mexico, and considered one of the most invasive crayfish species worldwide. Effective management and control strategies often require tracking individuals over time, which depends on reliable tagging methods. However, tagging crayfish is challenging due to their periodic molting. Visible Implant Elastomer (VIE) tags, injected into muscle tissue may provide an effective alternative to external tags if they remain visible through multiple molt cycles and do not affect the survival and growth. In this study, we evaluated the feasibility of VIE tagging in a small size-class of crayfish (7 ± 1 mm carapace length). A total of 20 crayfish were tagged while the same number were untagged and served as controls. Tag retention, visibility, survival and growth, were monitored at 8-day intervals, over an 80-day period. Results showed no significant differences in survival and growth between tagged and untagged animals and tags remained clearly visible for the 80-day duration. VIE tags appear to be an effective tool for tagging and tracking individual crayfish from a small size (7 ± 1 mm carapace length). Final carapace length was 17.31 mm in untagged and 16.46 mm in tagged individuals. Our findings suggest that VIE tagging is a reliable and minimally invasive method for tracking juvenile *P. clarkii* through multiple molt cycles over a period of 80-day. Future studies should evaluate tag visibility over a longer term (> 10 weeks) to determine whether tags remain visible until crayfish reach a reproductive size (> 23-37 mm carapace length for males, > 32-44 mm carapace length for females) or whether periodic re-tagging is required to renew tag visibility.

Range-wide assessment of life history traits in burrowing crayfish *Cambarus monogalensis* (Blue Crawfish).

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Life history traits among burrowing crayfish remain poorly understood, particularly across populations. The life history traits of these species, including fossorial, nocturnal, and seasonal activity, create encumbrances for researchers. Most existing studies of burrowing crayfish focus on single populations, often assuming species-wide consistency in life history characteristics. This study examines multiple populations of the *Cambarus monogalensis* (Blue Crawfish) to evaluate variation and develop a broad understanding of the species' life history. We compiled data from 1,142 individuals between 2020 and 2025 at multiple sites across southwestern Pennsylvania and northern West Virginia. Using this data, we estimated size at maturity, age structure, cohort designation, and reproductive patterns, including breeding seasonality. Analysis shows sexual dimorphism with females growing larger, the largest female was 40.46mm TCL, while the largest male was 36.8mm TCL. Using size frequency there are presumably 6 size cohorts indicating life span of at least 6 years. Ovigerous females were collected in May and June. Majority of Form 1 males were collected in April indicating that reproduction is most prominent in the spring. Our results provide the first range-wide assessment of life history in *C. monogalensis* and offer new insights into intraspecific variation among burrowing crayfish populations.

Juvenile Life History, Growth, and Maternal Behavior of the Little Brown Mudbug (*Lacunicambarus thomai*)

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Primary burrowing species such as the Little Brown Mudbug (*Lacunicambarus thomai*) are often less researched due to difficulty of data collection and observation. Literature suggests that less than 39% of crayfish descriptions cover functional life history information that is necessary for future conservation planning, leading to an unintentional conservation bias towards burrowing crayfish within current efforts. To build upon lacking areas of literature such as growth patterns and maternal behavior and tolerances, 24 ovigerous *L. thomai* were brought into the propagation lab spaces. Daily observations of instar stage change and behavior were taken until instar four, also known as juvenile independence. We then separated juveniles from their mother and kept them in groups (hereafter referred to as cohorts) to collect standard weekly growth data after independence, as well as maternal tolerance after periods of separation. Average growth across the 98-day study was 0.11 mm/day, while the maximum growth rate for any clutch was more than double at 0.25 mm/day. Understanding the standard rate of early life stage development, long term growth, and maternal interaction provides beneficial knowledge on how to implement varying care techniques into ex-situ propagation, such as separating cohorts into smaller groups or individual containers to decrease mortality, and when to expect offspring to reach an independent life stage. Developing a deeper life history understanding can lead to headstarting or propagation of primary burrowing species of concern as restoration actions become more necessary.

The influence of forest type on leaf litter resources and breakdown by freshwater crayfish

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Leaf litter from the terrestrial environment is a critical basal resource in forest streams, but little is known about how the litter from different forest types impacts stream crayfish that regulate leaf litter breakdown. We used a mesocosm experiment to test how leaf litter from different forest types (pine or hardwood) in the coastal plain ecosystem of the southeastern USA influences the growth, excretion, and egestion of two stream crayfish (*Procambarus fallax* and *P. troglodytes*), as well as crayfish effects on litter breakdown. We also tested the influence of these litter types on the growth of an additional crayfish species (*P. zonangulus*) in laboratory aquaria. Hardwood litter broke down at a faster rate than pine litter, and crayfish size and species influenced litter breakdown in the hardwood treatment only. *P. troglodytes* grew substantially on both litter types (25% increase in carapace length, no effect of litter type) and had higher egestion rates in the hardwood litter treatment. *P. fallax* grew little regardless of the litter type (5% increase in carapace length) and excretion and egestion rates for this species were similar between litter treatments. There was a trend suggesting that *P. zonangulus* grew faster on hardwood than pine litter. Overall, the effects of crayfish on leaf litter breakdown and the suitability of leaf litter as a resource for crayfish differed substantially based on the crayfish species in the experiments. While litter type was important for breakdown rates, it often did not have a strong influence on crayfish growth, excretion, or egestion. Understanding how the riparian tree community influences freshwater consumers such as crayfish that regulate the breakdown of organic materials has broad implications for stream ecosystems.

Seeing the Spectrum: Investigating Color Vision in Freshwater Crayfish

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The visual abilities of crayfishes are understudied. In the context of color vision, physiological evidence suggests that crayfishes are either monochromatic or dichromatic. However, there are no behavioral studies that support or refute these findings. Using classical conditioning, we test the hypothesis that crayfish are dichromatic and can differentiate between colored shelters and non-colored shelters. Three trial types were conducted utilizing different combinations of shelters in seven different shades of gray, four shades of orange, and four shades of blue to represent achromatic and chromatic stimuli, respectively. Colors were selected to have variation in reflectance values to prevent the crayfish from using brightness/achromatic cues to differentiate them. The three trial types consisted of Blue/Gray, Orange/Gray, and Blue/Orange: the former two test for differentiation of colored from non-colored shelters, while the latter trial tests for differentiation between the two colors. Each crayfish in each tank was assigned a trial type and provided the associated shelters in a randomized order. Shelters were randomized again every other day for sixteen days. At the same time each day, one commercial crayfish pellet was provided in a randomly chosen colored shelter. On the seventeenth day, the crayfish were no longer provided food, and their location and behavior in the tank was monitored for the next four days. The results of 144 crayfish show high variation in individual behavior patterns, but no evidence of successful conditioning.

Habitat use and distribution of freshwater crayfish in response to littoral artificial reefs

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Aotearoa New Zealand has a rich history of cultural practices, including the harvest and trade of native freshwater crayfish (*Paranephrops planifrons*, kōura) by Māori communities. Over the past two decades, kōura populations have declined by up to 96% in Lake Rotoiti (North Island, New Zealand), making traditional harvesting unviable. This decline is likely driven by multiple stressors, including impaired water quality, intensified lake stratification, and the spread of invasive fish and aquatic weeds. Since 2016, the non-native brown bullhead catfish (*Ameiurus nebulosus*) has become established in the lake and preys on kōura. These threats indicate that restoring habitat is necessary for kōura population recovery.

To restore and protect kōura populations, I deployed artificial reefs mimicking natural rock piles at five sites to increase the availability of complex refuge habitats. In my study lakes, kōura abundances increase with substrate size, the lake beds are dominated by fine sediments. I used a Before-After, Control-Impact (BACI) design with seasonal monitoring to assess kōura abundances in response to the artificial reefs. Kōura abundances at the reefs were compared with nearby control (no reefs) and five rocky areas representing the best natural habitats in the lake.

My results show that kōura abundances in the vicinity of the artificial reefs have remained consistently higher and more stable than at control sites, displaying similar seasonal patterns to those observed in natural rocky areas. My findings suggest that artificial reef structures can provide crayfish with effective protection from predation by non-native predators and thus support kōura population recovery. My future research will focus on identifying optimal reef designs and deployment locations, these aspects of restoration design could play an important role in increasing kōura populations. My research has important implications for maintaining the cultural and ecological significance of this keystone crayfish species in lakes beset by multiple stressors.

Utilizing eDNA to identify associated biodiversity in crayfish burrows

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Burrowing crayfish excavate extensive burrow systems that are occasionally inhabited by various other taxa, including amphibians, reptiles, and insects. Such observations suggest that crayfish burrows are a vital component to wetland ecosystems and their biodiversity. Environmental DNA (eDNA) is a rapidly evolving and increasingly accessible molecular technique that assists in the ongoing efforts to monitor community-wide biodiversity. While this tool is frequently utilized in aquatic ecosystems, few studies have investigated the environmental media of crayfish burrows to identify associated taxa. We investigated the efficacy of eDNA as a tool to examine the effects of wetland restoration activities and crayfish burrow density on associated wetland biodiversity. To assess this, we collected soil scrapes from active crayfish burrows and water samples from wetland pools at 15 different locations across North Central Missouri. We conducted a Phenol-Chloroform-Isoamyl (PCI) alcohol extraction and eDNA metabarcoding using 12S and COI primers for vertebrate and invertebrate taxa. The acquired sequences were identified using the Basic Local Assignment Search Tool (BLAST) in the Geneious Prime software (Geneious Prime® 2024.0.5). We will highlight the organisms inhabiting crayfish burrows based on the sequences identified from soil samples. Additionally, we will report the rarity with which each taxon was recorded in the eDNA samples.

Seasonal Emergence and Habitat Vulnerability of *Procambarus brazoriensis* in Coastal Texas Wetlands

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Procambarus brazoriensis, a narrowly endemic crayfish restricted to freshwater wetlands of Brazoria County, Texas, represents one of the state's most imperiled and least understood aquatic invertebrates. Designated as a G1/S1 species of critical conservation concern, it has an extremely limited distribution, a seasonal life history strategy, and sensitivity to hydrologic variation, making it particularly vulnerable to habitat alteration. As part of a multi-year assessment of rare Texas crayfishes, we conducted targeted surveys from 2022 to 2025 to refine knowledge of this species' range, habitat associations, and current conservation risks. Its detection only during spring 2024 underscores the strong seasonality of its surface activity; historical and current records similarly indicate that emergence is tightly linked to substantial spring rainfall that fills ephemeral wetlands. This phenology likely reflects a part-time fossorial life cycle, with individuals retreating underground during dry periods. Although limited occurrences precluded robust statistical modeling, observational patterns suggest a preference for low-salinity freshwater wetlands that are minimally influenced by coastal saltwater encroachment. The primary threats identified include salinization of wetlands, loss of ephemeral freshwater habitat through agricultural and urban expansion, prolonged drought, and potential hydrologic modifications associated with roadside infrastructure. Continued monitoring, protection of freshwater wetland complexes, and identification of dry-season refugia are essential for safeguarding the species. Improved understanding of emergence cues and reproductive timing will further aid in developing targeted management strategies for this highly specialized and vulnerable crayfish.

No Claws, No Catch? Feeding Performance After Claw Loss in the Signal Crayfish

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Crayfish use their claws in various intra- and interspecific interactions, such as mating, feeding, and agonistic behavior, but can voluntarily detach them through autotomy in stressful or dangerous situations. The claw loss may reduce individual performance and fitness, for instance, by limiting prey-handling capability. This study evaluated the effects of claw loss on the feeding performance of the signal crayfish *Pacifastacus leniusculus* (Dana, 1852) when preying on two prey types: a freshwater mussel (*Sphaerium* sp.) and a fast-swimming aquatic insect (*Notonecta* sp.). A total of 120 adult crayfish (60M | 60F) of similar size and condition were randomly assigned to six groups based on sex and claw status (both-clawed, one-clawed, or clawless individuals). Claw autotomy was induced following established protocols, and after a one-week recovery, feeding trials were conducted under controlled conditions. Each crayfish was offered 12 prey items and allowed to feed overnight for 12 hours. Feeding efficiency was analyzed using generalized linear models (GLMs). Crayfish with two claws consumed more mussels than clawless individuals ($p < 0.01$), and larger individuals also consumed more ($p = 0.01$), while sex had no effect ($p = 0.5$). No differences were observed among claw groups for backswimmer predation ($p > 0.2$). These results suggest that claws are crucial for handling and crushing hard prey, but less important for capturing fast-moving prey, which likely relies on the second and third pair of pereopods for this purpose. This study experimentally demonstrates how autotomy affects foraging capacity and provides insights into the ecological consequences of claw loss.

The Impacts of Abiotic and Biotic Factors on the Diversity and Abundance of Branchiobdellidans, an Ectosymbiont of the Big Water Crayfish in New York State

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A third of the world's crayfish diversity is imperiled, so it is imperative that carcinologists worldwide not only focus on delineating new species of crayfish within species complexes to inform conservation goals, but also on illuminating their complex ecologies. Crayfish worms (Branchiobdellidans) are an ectosymbiont of crayfish, and they remain understudied despite increasing evidence that their commensalist/mutualist roles impact crayfish ecology and behavior. For example, under heavy gill fouling pressure, crayfish with intermediate amounts of Branchiobdellidans have higher growth rates than those without which has implications for crayfish as a game fish food resource. Additionally, Branchiobdellidan infestations reduce aggression and foraging in the invasive Signal Crayfish (*Pacifastacus leniusculus*) which has broader ecosystem level and invasion front effects. This study focuses on delineating the effects of abiotic water parameters, host characteristics, and host population abundance on the abundance of Branchiobdellidans found on the Big Water Crayfish (*Cambarus robustus*) across nine streams in New York State. Additionally, a phylogenetic tree consisting of two Branchiobdellidans taken from the first fifteen crayfish of each site was constructed utilizing the cytochrome oxidase 1 gene region for species level identification and compared against peer-reviewed reference sequences in GenBank to create an updated New York State species list.

Discovery, Delimitation, and Conservation of *Creaserinus* Burrowing Crayfish Species

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Classification of extant biodiversity is a long-standing challenge for biologists. Taxonomic groups with relatively few differences in morphological characteristics are prone to under-splitting of “true species”, whereas considerable phenotypic variation within taxa may result in over-splitting. However, biologically meaningful units (e.g., species) can be delimited by coupling a theoretical framework (e.g., components of a “species concept” such as unique evolutionary trajectory) with quantitative analysis of multiple independent datasets. The genus *Creaserinus* contains several species with taxonomic uncertainty. Two currently recognized species, *Creaserinus danielae* and *C. oryktes*, geographically co-occur in some parts of their range. Both species are phenotypically variable and quite similar to one another. Accordingly, new research is needed to reassess their validity as separate species. Another example of uncertainty about species boundaries within this genus involves two other currently recognized species, *C. burrisi* and *C. byersi*. High intraspecific genetic differentiation and strong spatial partitioning of this variation highlight the possibility of under-splitting. Further, both share similar overall morphology, and so just one trait—their reproductive structures—is mainly used to distinguish between them. Overreliance on a single data type prevents robust inferences and runs the risk of erroneous conclusions. We reassessed the taxonomy of these four *Creaserinus* species using an integrative approach to species delimitation that combines morphological and molecular data. We included three complementary datasets: 1) traditional morphometrics; 2) single-locus mitochondrial DNA sequences; and 3) multi-locus hybrid enrichment single copy nuclear DNA sequences. Here, we provide results from analyses of the DNA sequence datasets.

A taxonomic revision of Atlantic slope *Creaserinus fodiens* (Digger Crayfish) with an emphasis on Virginia populations

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Creaserinus fodiens (Cottle 1863), commonly known as the Digger Crayfish, is a primary burrowing crayfish widely distributed across eastern North America. With its historic broad range, taxonomic uncertainty and geographic isolation among populations, specifically along the Atlantic coast, suggest that the species may represent a complex of multiple taxa. To better understand the taxonomic uncertainty, an integrative taxonomic approach was conducted on *Creaserinus aff. fodiens* populations in Virginia using molecular phylogenetics, morphometrics, and zoogeographic analysis. A total of 186 sites across central and eastern Virginia were sampled in a span of two years using minnow traps, hand excavation, and dipnetting. *Creaserinus aff. fodiens* were found at 32 of those sites, and 241 specimens were used for genetic analysis while 438 specimens were used for morphometrics. Genetic analyses using mitochondrial cytochrome oxidase I (COI) and 16s genes along with the nuclear 28s gene revealed several distinct lineages within Virginia populations that were also distinct from type *C. fodiens*. Morphological variation was assessed using 38 measurements and derived ratios, indicating morphometric difference between the groups. Additionally, geographic distributions of these lineages correspond to distinct physiographic regions within Virginia, suggesting regional isolation and divergence. The combined genetic, morphometric, and geographic evidence supports the recognition of one previously undescribed species within the *Creaserinus* genus and the resurrection of a historically synonymized species. These findings highlight previously unrecognized diversity within the *C. fodiens* complex and demonstrate the importance of an integrative approach for resolving taxonomic uncertainty.

Probe efficacy and an initial phylogenomic reconstruction of freshwater crayfish using anchored hybrid enrichment

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Freshwater crayfishes represent a diverse lineage of ~750 species that play critical ecological roles in freshwater ecosystems worldwide. Functioning as keystone species, crayfishes influence habitat structure and energy flow. Despite their ecological importance, crayfish systematics remains challenging due to limited diagnostic morphological characters, intraspecific morphological plasticity, and poor phylogenetic resolution provided by legacy genes (LG). These challenges have hindered the resolution of species boundaries and constrained conservation action. Improving understanding of crayfish evolutionary relationships is therefore essential for improving crayfish systematics, interpreting ecological and functional diversity and for guiding conservation priorities. We evaluated the efficacy of previously developed anchored hybrid enrichment (AHE) probes designed for broad decapod phylogenetics in resolving crayfish relationships across multiple evolutionary depths. We targeted 114 nuclear loci across 300 individuals representing 51 species spanning the crayfish tree of life. Sequence capture and assembly were conducted using HybPiper, and phylogenetic inference was performed using maximum-likelihood analyses in IQ-TREE. To assess the impact of locus inclusion on phylogenetic resolution, we compared trees generated using strict (100%) and relaxed (75%) locus recovery thresholds and contrasted these with a third maximum-likelihood tree generated using LG. Both AHE thresholds produced highly resolved and largely congruent phylogenies with strong support across multiple taxonomic levels. The 75% threshold increased locus representation while maintaining overall topological stability, whereas the 100% threshold yielded a more conservative dataset with reduced taxon coverage. Minor topological differences between thresholds were largely confined to shallow nodes. Comparisons between AHE and LG trees revealed differing relationships at several taxonomic levels, highlighting the possibility of mito-nuclear discordance across crayfishes. Overall, our results demonstrate that AHE probes perform effectively across crayfishes, providing robust phylogenetic signal and a framework for future studies of systematics, ecological strategies, functional traits, and evolutionary history.

Evaluating the Slenderwrist Burrowing Crayfish, *Fallicambarus petilicarpus*, for Endangered Species Act listing

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The Slenderwrist Burrowing Crayfish, *Fallicambarus petilicarpus*, is a short-range endemic restricted to the Ouachita River drainage in south-central Arkansas and northern Louisiana. U.S. Fish and Wildlife Service is currently evaluating this species for listing as threatened or endangered under the Endangered Species Act (ESA). Since 2021, teams of inter-agency biologists have been collecting data on this species to inform the listing decision. We used species distribution modeling to identify habitat associations and estimate the total available habitat within the known range of this species. We used Restriction-site associated DNA sequencing (RADseq) to establish population structure, genetic differentiation between populations, and effective population size. Here we will present an overview of our data collection and how our results support the evaluation of this species under the ESA. We will also highlight the major data gaps that still exist and how we plan to address them through future field studies.

Toward a Whole-Genome Phylogeny of Missouri Crayfishes: Building Genomic Foundations for an Ecological Radiation

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Missouri is home to at least 40 native crayfish species with diverse ecological specializations. Despite their ecological and conservation significance, their evolutionary relationships need to be understood. Existing phylogenetic studies, based on partial sequence of five genes, have established broad patterns but lack the resolution needed to understand diversification within and among genera, or to evaluate the repeated evolution of specialized habitat types. This limitation is driven largely by the scarcity of genomic resources: of all Missouri-native crayfishes, only *Procambarus clarkii* currently has a whole-genome assembly.

This project aims to generate the first comprehensive genomic dataset for the Missouri crayfishes by producing high-quality whole-genome assemblies for 37 native species. Fresh chelae/walking leg tissue samples will be collected across the state using non-lethal sampling methods. High-molecular-weight DNA will be extracted using an optimized protocol for crayfish tissue, followed by long-read sequencing via Oxford Nanopore Technologies (ONT). Assemblies will be generated using Hifiasm, which enables highly contiguous, near telomere-to-telomere assemblies from ONT reads.

To reconstruct evolutionary relationships, we will employ CASTER, a recently developed whole-genome-scale quartet-based species-tree method that directly analyzes genome-wide site patterns. CASTER is statistically consistent under extensive incomplete lineage sorting, does not require recombination-free loci, and avoids gene-tree estimation error, making it exceptionally well suited for Missouri crayfishes, with potentially complex evolutionary histories and deep genomic discordance.

This work will establish the first complete genomic reference set for Missouri crayfishes, enabling a robust, genome-scale phylogeny that can test long-standing hypotheses about their diversification. We expect that Missouri crayfishes are not monophyletic with convergent ecological specializations evolving repeatedly across the tree. By providing genome assemblies for this entire regional radiation, this project will lay the foundation for future studies of adaptation, biogeography, and conservation genomics in one of North America's most ecologically diverse freshwater clades.

The Wonderful World of Freshwater Crayfish – a phylogenetic perspective

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Since T.H. Huxley's *The Crayfish* published in 1879, freshwater crayfish have served as model organisms for studies across physiology, conservation, evolution, invasive species, vision, etc. Here I explore the wonderful world of freshwater crayfish from a phylogenetic perspective and highlight diverse areas of biological research where crayfish have served as a central feature and where the phylogenetic information of crayfish relationships has been a key element of this research. Phylogenetic research of freshwater crayfish has exploded over the past 30 years and these phylogenies have been foundational for a better organized taxonomy as well as a framework for evolutionary and comparative biology.

Integrating diel temperature fluctuation into thermal metric estimation for crayfish

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There are various metrics used to describe upper thermal tolerance and optimal temperature for crayfish. Most are derived in laboratory settings from organisms exposed to unnatural thermal conditions, resulting in estimates that are difficult to interpret in the context of a natural ecological setting. Our objective was to explore two alternative methodologies that more closely mimic diel fluctuation in water temperature commonly observed in temperate surface water systems. We developed an experimental system with the ability to separately simulate diel temperature fluctuation in each of 35, 9.5 l aquaria. We used a modified acclimated chronic exposure (ACE) method to estimate optimal growth temperature for *Faxonius punctimanus* and a novel dynamic chronic thermal limit (DCTL) method to simulate the effect of riverine heat waves as a method to determine upper thermal tolerance for *Procambarus acutus*. We additionally estimated critical thermal maxima (CTM) using standard methods for both species to serve as a comparison. Our ACE estimate of optimal growth temperature was 24.9 °C, and there was no significant difference between static temperature treatments and fluctuating diel temperature treatments. Estimates of CTM were dependent on species and acclimation temperature, but ranged from 35 – 38 °C. The DCTL results indicated that crayfish exposed to heat waves of 34 – 38 °C or 36 – 40 °C would generally survive less than two days, with less intense heat waves causing lower mortality. These metrics and methodology are largely new and will benefit from additional testing with other taxa and with comparisons to other thermal metrics. However, if these novel approaches prove transferable, the ecological realism from our results can increase manager confidence when comparing empirical water temperature data to laboratory derived metrics.

Linking Upper Thermal Limits and Long-Term Survival in Freshwater Crayfish

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The southeastern United States is a global hotspot of freshwater crayfish biodiversity, yet many species face increasing threats from anthropogenic pressures, the introduction of invasive species and climate warming. Despite their ecological importance as ecosystem engineers, data on crayfish thermal tolerance, particularly across ecological contexts and time scales, remain limited. In this study, we integrate short-term and long-term approaches to evaluate thermal tolerance across time scales in three crayfish species native to Georgia, USA: the tertiary (stream-dwelling) species *Procambarus spiculifer* and *Procambarus enoplosternum*, and one primary burrowing species, *Cambarus latimanus*.

We first quantified upper thermal limits (UTLs) to assess acute tolerance using controlled laboratory trials in which temperature was incrementally increased until individuals lost the ability to right themselves. We hypothesized that open-water *Procambarus* species would exhibit higher thermal limits than the burrowing *Cambarus* species, reflecting differences in thermal exposure across habitats. Consistent with this prediction, *P. enoplosternum* exhibited the highest UTL ($38.8 \pm 0.6^\circ\text{C}$), followed by *P. spiculifer* ($37.3 \pm 1.5^\circ\text{C}$) and *C. latimanus* ($36.4 \pm 0.8^\circ\text{C}$). To evaluate whether short-term tolerance reflects resilience to prolonged warming, we assessed long-term survival of *P. enoplosternum* across a gradient of elevated temperatures (26–36°C) over seven weeks. Despite relatively high acute thermal tolerance, *P. enoplosternum* survival declined rapidly at elevated temperatures, with complete mortality occurring within days at 36°C (mean survival 5 ± 2 days) and within weeks at 34°C (34 ± 4 days). Individuals at $\leq 32^\circ\text{C}$ survived the full seven-week experimental period.

These findings highlight a disconnect between acute thermal limits and chronic thermal tolerance, suggesting that reliance on short-term metrics alone may overestimate species resilience to climate warming. Integrating multiple temporal scales of thermal stress provides a more comprehensive framework for predicting species vulnerability and informing conservation strategies for freshwater crayfish in a rapidly changing environment.

Thermal stress reveals sublethal disease effects in crayfish plague-exposed *Faxonius virilis*

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Crayfish plague, caused by the oomycete, *Aphanomyces astaci*, produces a wide range of disease expression in North American crayfish, from asymptomatic carriers to visible, severe lesions in the cuticle. However, lesion presence alone may not fully capture disease impacts, particularly when environmental stressors alter physiological performance. We examined how temperature interacts with population-level disease history to shape lesion dynamics and stress responses in the crayfish *Faxonius virilis*.

First, we characterized baseline disease expression in crayfish from populations with contrasting lesion prevalence, documenting temporal changes in lesion area and recovery associated with molting. These observations indicated that plague related effects were largely sublethal and dynamic, motivating a second experiment testing how thermal stress modifies disease expression and performance.

Crayfish from low and high lesion prevalence populations were acclimated to 15, 23 or 30 °C and monitored for survival, growth, molting success, lesion progression, and behavioral performance. We quantified stress responses using repeated righting response trials during a chronic exposure experiment and loss of righting response during acute thermal ramps. Survival remained high across temperatures and disease histories, indicating limited lethal effects. In contrast, temperature strongly influenced physiological performance: acclimation temperature structured righting ability under thermal challenge, while disease history primarily determined baseline lesion burden and post-stress lesion dynamics.

Our results demonstrate that thermal stress can reveal sublethal disease effects not apparent from survival metrics alone. By integrating lesion dynamics, molting, and behavioral performance, this study highlights the importance of performance-based metrics for understanding crayfish-pathogen interactions under warming conditions. These findings emphasize that disease impacts in crayfish may manifest primarily through altered physiological tolerance and recovery capacity rather than immediate mortality.

Heartbeat and respiration of crayfish. Study and possible applications.

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Heartbeat and respiration are key physiological indicators of metabolic status, stress, and behaviour in freshwater crayfish, offering powerful tools for monitoring organismal condition and environmental impacts. While cardiac activity has been widely studied, respiration physiology in crayfish remains methodologically underdeveloped.

During the last decade, we developed and refined non-invasive systems for monitoring both cardiac and respiratory activity. Respiration measurements were adapted from fish intermittent respirometry and validated at the University of South Bohemia (České Budějovice) and Auburn University. We identified critical methodological factors, including the need for approximately 12 hours of acclimation to obtain stable metabolic rates and the exclusion of data following light transitions due to short-term artefacts. Quantile-based statistical approaches were found to provide more robust estimates of standard metabolic rate than traditional distribution-based methods. In parallel, we advanced fully contactless near-infrared technology for cardiac monitoring, enabling simultaneous, multi-individual measurements without physical attachment.

These systems were subsequently applied to investigate environmental drivers of crayfish physiology. Artificial light at night altered diel metabolic patterns in *Procambarus clarkii* and *Pacifastacus leniusculus*, revealing species-specific sensitivity to nocturnal illumination. Additionally, crayfish exhibited clear cardiac and behavioural responses to disinfectants, pharmaceuticals, and natural chemical cues, including disrupted cardiac rhythms, altered heart rates, and reduced locomotion.

Together, our results demonstrate that integrating heartbeat and respiration measurements provides a robust framework for studying crayfish physiology and environmental responses. The high sensitivity of these indicators also supports their application in real-time water-quality monitoring, already implemented in industrial practice.

Surface behavior in the Blue Crawfish, *Cambarus monongalensis*

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Burrowing crayfishes are notoriously difficult to study. As a result, surprisingly little is known about their biology and behavior. Surface activity in burrowing crayfishes is usually reported to occur at a population level, particularly during warm, heavy-rain events, where hundreds of individuals have been reported on the surface during a single event. However, few reports of such activities are available in the literature, and no studies have systematically studied burrowing crayfish surface behavior. Here, we examine patterns of surface activity in The Blue Crawfish, *Cambarus monongalensis* using a large, high-density population of this species. Over the course of three years, we conducted repeated nocturnal surveys, particularly during rain events, to document surface movements and record body size, sex, and observed behaviors. In total, we recorded over 1,000 observations of crayfish active above ground at night. Surface activity was observed across all size classes and both sexes, suggesting that these movements are unlikely to be associated with reproduction. Direct surface interactions among individuals were rare and appeared to be incidental. Instead, surface activity may reflect short-distance dispersal rather than specific social, foraging, or reproductive functions. Future research should use video-monitoring or radio telemetry to better understand burrowing crayfish behavior and dispersal.

Crayfish on the Move: Movement Rates of Invasive Woodland Crayfish in the St. Francis River Basin

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The spread of the introduced Woodland Crayfish (*Faxonius hylas*) within the upper St. Francis River drainage has contributed to the decline of native crayfish fauna, including the endemic St. Francis River Crayfish (*Faxonius quadruncus*) and Big Creek Crayfish (*Faxonius peruncus*), leading to their listing as threatened under the Endangered Species Act. Understanding the movement of Woodland Crayfish helps guide effective management strategies and the timing of their implementation. We tagged Woodland Crayfish with passive integrated transponder (PIT) tags at one leading-edge site and two fully invaded sites to investigate dispersal differences between males and females, body size, body condition, population core and leading-edge, directionality, and spring and summer. We tagged approximately 200 Woodland Crayfish in spring 2025 at each site and attempted to relocate them monthly until August 2025. Also, data were collected at two stationary antennas installed at the leading-edge site every two weeks. Across all sites, crayfish moved an average of 158 meters with a median of 102 meters at an average rate of 2.79 m/day and median of 1.70 m/day. Sex, size, body condition, and season had no significant effect on movement rate. Crayfish moved significantly faster at the leading-edge site, averaging 3.62 m/day with a median of 2.43 m/day vs 2.12 m/day average and 0.97 m/day median in fully invaded sites. Crayfish showed a slight preference for faster upstream movement, averaging 4.06 m/day with a median of 1.59 m/day while downstream movement averaged 3.78 m/day with a median of 1.07 m/day. Physical attributes were not significant predictors of crayfish movement rates which may indicate environmental and behavioral factors are stronger drivers of movement. Our data improve understanding of Woodland Crayfish movement and dispersal, the capacity they have for further spread, and improve predictions of the invasion to inform management actions for the invasive and threatened species.

Determining the status, surface activity, and movements of Jackson Prairie Crayfish (*Procambarus barbiger*)

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The Jackson Prairie Crayfish (*Procambarus barbiger*) is a semi-terrestrial burrowing crayfish species that lives most of its life only within deep underground burrows inside of the Jackson Prairie Ecoregion. In addition to living in prairie soil that are difficult to sample in, the Jackson Prairie Crayfish (JPC) and many other burrowing crayfish species have long been understudied in Mississippi. Prior to our efforts only 14 locations were previously reported for JPC via museum specimens located at Mississippi Museum of Natural Science. With little to no current records of the species occurring over the past 35 years, the USFWS needed contemporary data to accurately determine the species status for listing under the Endangered Species Act. The objective of our study was to complete a burrowing crayfish survey within and outside of the species' known range so to provide the necessary locality information to determine current status within the state. Because little to no information on JPC's life history is available, we also aimed to use camera traps at a known location to observe the species' surface behavior in response to season and climate conditions. We sampled crayfish at 125 locations and documented JPC at 54. The species was found at most historically localities and was found in clay soil substrates in a variety of intact and disturbed habitats. JPC was also the most abundant burrowing crayfish found during our study. Over the length of a year, we monitored nine JPC individuals at a single location using three separate camera traps. Images were taken every three minutes and videos were triggered when crayfish moved on the surface during wet spring and summer nights. Peak activity occurred from April-July and surface movement only took place during the largest rain events within the same period.

Movements of the Coldwater Crayfish *Faxonius eupunctus*; a preliminary study using passive integrated transponder tags

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Movement is a critical aspect of the ecology of many animals, and understanding movement can be valuable for conservation or management efforts. The movement ecology of crayfish is poorly understood compared to other taxa, with most research focusing on non-native crayfish, very small streams, or both. To help address this knowledge gap, passive integrated transponder tags, combined with centimeter-precision GPS equipment, were used to examine the movements of the imperiled Coldwater Crayfish *Faxonius eupunctus* in a 5th-order reach of the Eleven Point River in southern Missouri. Coldwater Crayfish were captured, tagged, and released in a 50-m wadable reach of the river, and were tracked during the day using a large handheld antenna 1-2 times weekly, from July 3 to August 12, 2024. Of the 164 tagged crayfish, 93 (57%) were detected at least once, 65 (40%) were detected more than once, and 55 (34%) were observed to move one to six times. For the crayfish that moved, the median distance was 15.8 m, and the median rate was 0.9 m*day⁻¹ over the course of the study. Principal component analysis suggests that crayfish carapace length is positively associated with movement rate and negatively associated with movement frequency. A generalized linear model of movement frequency supported a positive association with carapace length ($P < 0.05$), though models of movement distance and rate contained no significant relationships. Overall, few crayfish moved far, which is consistent with previous studies. The methods used to track crayfish in this study proved to be effective and could be used for larger-scale studies in the future. Such studies could provide extensive novel information about crayfish movements in large stream systems.

The Status of the Modern Louisiana Crayfish Aquaculture Industry

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The modern Louisiana crayfish aquaculture industry is arguably 100 years old. Red and White River Crayfishes (*Procambarus clarkii* and *P. zonagulus*, respectively) are cultivated by stocking adult crayfish into shallow water impoundments, often rice fields, in late spring where they burrow, mostly in levees, reproduce, and emerge with young in the autumn. With at least 120,000 ha of impoundments, annual production is far greater than that from the former main source of crayfish (wild caught), the Atchafalaya Basin swamp. Issues that plagued the industry from the beginning persist: crop predictability, impact of predaceous, omnivorous, and herbivorous birds on crops, harvesting especially seasonal availability of bait used in traps, processing, and glut of product in peak season. Once stocked, there is no way to monitor survival, burrowing and reproduction of brood crayfish. There have been no definitive studies of bird impacts on crayfish production. However, anecdotal observations reflect significant crop reduction and failure in systems with heavy bird utilization. The significance of this habitat for bird conservation is widely acknowledged but little concern has been expressed about crop losses. Crayfish are still harvested with baited traps requiring significant labor costs. The availability of cut fish “trash” fish for bait in cold waters is always a problem. Interestingly, many point to the food web created by decomposing vegetation as the main food source for crayfish systems. Failure to realize that crayfish can easily enter and leave traps means that bait is a major source of crayfish nutrition! Crayfish not sold for boiling whole are hand peeled. This creates a major, seasonal labor problem exacerbated with the problem of securing seasonal foreign labor. Research has shown that meat-bone processing machinery can generate useful crayfish minces and pastes from whole crayfish. These have yet to be introduced into the general market place.

Effect of Surface Area on Survival and Growth Rate of *Procambarus clarkii* Juveniles in a Recirculating Aquaculture System

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Procambarus clarkii is popular in aquaculture due to rapid reproduction and growth, omnivorous feeding, and resilience to environmental changes. Traditional crayfish aquaculture relies heavily on earthen ponds, but recirculating aquaculture systems (RAS) can potentially increase production via increased control of culture conditions. Previous studies have shown an optimal stocking density of 50 juveniles per m² of surface area in RAS. To further optimize production within these systems, we need to determine how much structural surface area can be packed in a given volume of water without compromising growth and survivorship when crayfish are stocked at 50/m². To test this, we provided PVC ribbon in sixteen 49L (13gal) conical tanks to create treatment ratios of 0.01, 0.02, 0.03 and 0.04m² structure per L of water (4 tanks per treatment). Each tank was stocked with newly hatched crayfish at the optimal density of 50 individuals/m². Crayfish were measured and counted every two weeks to monitor growth and survival over 140 days. Crayfish in all treatments were estimated to have reached maturity (~29-35 mm carapace length) within ~126 days. At 140 days, the 0.01 m² structure/L treatment yielded the highest average carapace length and wet weight (~37.8 mm, 12.7 g), but the 0.04 m² structure/L treatment had the highest mean number of individuals surviving to 140 days (~21 individuals). Data is still being analyzed and histology is being used to confirm size at maturity. Initial results indicate optimal structure area per volume of water depends on the goals of the producer. If the goal is to produce larger animals in a given volume of water, the optimal structure to volume ratio would be 0.01 m²/liter. If the goal is to produce the greatest number of mature individuals, the optimal structure to volume ratio would be 0.04 m²/liter.

Propagation of Big Sandy Crayfish at White Sulphur Springs NFH

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The propagation of Big Sandy Crayfish (*Cambarus callainus*) at the White Sulphur Springs National Fish Hatchery began in 2019, aiming to bolster populations of this imperiled species. Advancements in propagation techniques were implemented in 2022, including novel methods for juvenile collection and the development of a specialized diet to improve growth and survival rates. These innovations led to the successful release of the first juvenile crayfish in 2024. Over the past two years, 439 propagated individuals have been released, with an additional 60 scheduled for release in spring 2026. The propagation process has resulted in a 70% survival rate to release and produces taggable individuals within approximately 30 days. This program demonstrates an efficient approach to species recovery, minimizing impact on wild broodstock populations while contributing significantly to conservation efforts.

Evaluating critical oxygen requirements of *Procambarus clarkii* and implications for aquaculture management

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The southeast US is facing increased frequency and magnitude of drought conditions, resulting in high temperatures and low dissolved oxygen (DO) in aquaculture settings, which present persistent challenges for crayfish. High temperatures and low DO can limit crayfish survival, growth, and reproduction in natural and commercial production. However, management of DO in US crayfish aquaculture is limited. Using grow-out trials, we can quantify the effect of hypoxia on growth performance of *Procambarus clarkii* under controlled DO regimes. Juvenile *P. clarkii* were stocked in outdoor tanks and exposed to two treatments: continuous aeration or no aeration. Temperature and DO were measured twice daily with concurrent assessment of molts and mortalities. Biweekly measurements assessed growth and survival. In the initial two weeks of treatment exposure, the average morning DO was 10.43 ± 0.11 and 4.45 ± 2.72 mg/L in aerated and non-aerated tanks, respectively; relative growth was 25% higher in the aerated treatment. Growout will occur from February–May, with final effects of hypoxia on growth and survival pending termination of the study. This study will provide insight into the consequences of hypoxia exposure on *P. clarkii*, providing performance-informed DO targets for aquaculture management. Additionally, this study can provide a methodological framework for evaluating the effects of, and plasticity to, hypoxia in under-studied native crayfishes. Concurrent studies include quantifying crayfish behavioral responses to hypoxia stress and an assessment of gill microbial community patterns in relation to hypoxic conditions of crayfish hosts. Future evaluations of performance and plasticity during this trial will include bomb calorimetry to assess whole-body energy content and closed respirometry to assess hypoxia tolerance through measurements of critical dissolved oxygen and regulation index across treatments. This will inform whether hypoxia sensitivity is modulated by exposure to chronic hypoxic conditions.

Design of an aquaculture facility to increase conservation success of noble crayfish (*Astacus astacus*) after restocking to a cold-water stream

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Freshwater crayfish are traditionally cultivated in ponds with stagnant water or minimal water exchange. After several generations in captivity, there's an increasing risk that genetic strains and important traits of phenotypic plasticity evolved under stream conditions will be lost. Consequently, their offspring may show lower survival rates when restocked to their natural habitat. This is not a major concern when the aquaculture is intended solely for food production. However, when the objective is to conserve biodiversity and support restocking programs, breeding conditions must closely resemble the species natural environment. At the same time these facilities must be designed to enable efficient, large-scale aquaculture of crayfish for restocking.

We have designed a crayfish farm to produce noble crayfish (*Astacus astacus*) for biodiversity conservation and restocking purposes in the River Ljungan of central Sweden. The facility is designed to mimic the environmental conditions in the river, with flowing water and seasonal variations in temperature. However, with one main difference being the temperature, which will be maintained higher than in the natural river habitat. The controlled increase is intended to promote juvenile growth rate and increase their post-released survival in the natural environment.

We want to discuss the challenge of producing large quantities of crayfish in aquaculture while preserving their genetic biodiversity and phenotypic plasticity in the crayfish farm.

From Tradition to Innovation: Charting the Future of U.S. Crayfish Aquaculture

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The United States has a long history of crayfish production, with Louisiana's red swamp crayfish (*Procambarus clarkii*) industry representing one of the most economically important freshwater aquaculture sectors in North America. Despite its scale and cultural significance, the U.S. crayfish industry has seen relatively little coordinated research investment compared to major crustacean aquaculture sectors. As a result, substantial knowledge gaps persist in genetics, reproduction, production efficiency, and environmental performance. We aim to synthesize the current status of U.S. crayfish aquaculture and outline priority directions for research, genetic improvement, and conservation-focused applications. Current production relies almost entirely on unimproved, mixed-source stocks, and there are no established selective breeding programs in the U.S. Key biological uncertainties, including genetic variation, heritability of growth and survival traits, tolerance to changing environmental conditions, and disease susceptibility, constrain progress toward improved yields and industry resilience. As climate instability, hydrologic variability, disease, and pests increasingly threaten production, the need for improved stocks and predictive biological understanding is urgent. Beyond food production, crayfish represent an underdeveloped opportunity for conservation aquaculture. Several imperiled North American crayfish species may benefit from propagation techniques adapted from *P. clarkii* research, yet technical and conceptual frameworks remain limited. Integrating aquaculture science with crayfish conservation biology offers an avenue to support species recovery while advancing fundamental understanding of crayfish physiology, reproduction, and juvenile ecology. By synthesizing the current state of knowledge, we identify key information gaps such as the need for baseline genetic and physiological data for U.S. *P. clarkii* stocks, resources to support selective breeding and genomic tool development, applied research that reflects producer needs, and improved integration between aquaculture and conservation practitioners. This review is intended to provide a foundation that informs and supports future coordinated efforts across the research, industry, and conservation communities.

Adaptive management of red swamp crayfish invasions in Michigan

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Crayfish invasions are a global issue that affect recipient ecosystems and human infrastructure. Over the last decade, a collaborative group that works across federal, state, tribal, and county jurisdictions engaged in an adaptive management experiment to control invasive Red Swamp Crayfish in Michigan. In this presentation, we will highlight these efforts, focusing on collaborative projects to manage nuisance crayfish populations. Our results highlight both the difficulty of eradicating existing invasive crayfish populations and the benefit of collaborative projects to refine management strategies. Through these collaborations, we have developed new understanding of Red Swamp Crayfish reproductive dynamics, genetics, movement, and effects on invaded ecosystems. To date, we have found red swamp crayfish established in over 50 waterbodies in Michigan, and have removed over 130,000 crayfish with baited traps. We also have conducted more than 20 treatments of Pyrethrin pesticides across 12 ponds. Both methods led to inconsistent responses in crayfish populations. We observed declines in crayfish populations at our highest trapping intensities and with Pyrethrin pesticides but failed to eradicate any populations. Pesticide treatments do appear to increase benthic invertebrate diversity and richness, but macrophyte diversity appears to remain static. Evaluation of red swamp crayfish genetics revealed relationships and reproduction within and among individual populations, while telemetry identified clear movement patterns related to season, including documentation of winter movement. The prevention of crayfish population rebound following the cessation of any intensive management remains an area of continued inquiry. We conclude by providing our planned direction for future management actions and highlight where opportunities exist to improve management of nuisance populations.

Morphometric variation and its implications for managing an emerging crayfish invader in Texas

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Non-indigenous crayfish species often spread outside of their native range through accidental or intentional releases from aquaculture and ornamental trade, significantly impacting native taxa and their habitat. *Cherax quadricarinatus* (Australia redclaw crayfish) has been introduced in multiple countries worldwide, with first reports in Texas dating to 2013. This study uses a trait-based ecological approach that links morphometric variation with habitat use and potential management outcomes. Morphometric analysis offers a valuable framework for understanding how crayfish respond to habitat conditions, ecological pressures, and geographic variation across their range. Key morphological traits (carapace, chela, and abdomen dimensions) were selected to serve as functional indicators of growth, foraging strategies, defense capability, locomotion, and reproductive investment. Variation in these traits reflects differences in available habitat, substrate types, vegetation cover, flow regime, and size of waterbody. The current study integrates trait measurements with substrate data for detecting broader ecological patterns within allometric differences, shifts in energy allocation, and degrees of sexual dimorphism across environmental gradients.

The morphometric trait analyses showed strong variations amongst males, females, and intersex individuals, suggesting sex-specific ecological strategies and energy allocation patterns. Comparing morphometric traits of geographically distinct populations further reveals how regional selective pressures such as climate, predator assemblages, and resource availability can shape divergent growth trajectories and multivariate trait profiles. For connecting these findings to management actions, habitat preference and spatial scale response of the *C. quadricarinatus* was explored using side-scan sonar technology, and substrate types were classified to determine where the *C. quadricarinatus* are most likely to occur. The spatial data analysis explored the substrate conditions associated with their presence and provided a practical tool for targeted monitoring, trapping, and population control efforts. From a management perspective, this trait-based and spatial approach is especially relevant in Texas where the Australian redclaw crayfish is an emerging invasive species. It provides critical insight into which environments may support its establishment and spread.

A successful interjurisdictional effort to assess and communicate about invasive crayfish in the pet trade: Achievements and lessons learned for the Great Lakes region of the United States

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In the Great Lakes Basin of the United States, the pet trade has been recognized by regional invasive species managers as a potentially important introduction route for non-native crayfish because they are easily misidentified and store owner capacities to identify crayfish are unknown. However, legislative priorities and budgetary constraints vary greatly among agencies and states, which complicates interjurisdictional coordination and implementation of efforts to document and evaluate prevalence of non-native crayfish in the pet trade. Effective frameworks and insights are sorely needed that can guide large scale, cross-border assessments. In this presentation, we describe our efforts between 2021 and 2024 to develop an interjurisdictional partnership that successfully evaluated the pet trade for prevalence of invasive crayfish and knowledge gaps. We first describe the genesis of our partnership and how we established our primary goals and milestones. We then overview the products of this collaboration, which included a formal review of pathways for crayfish in the region, a regional survey of crayfish prevalence in the region and store owner knowledge, and an industry-informed identification outreach product designed to assist store owners in assessing potential invasive crayfish. We focus this discussion on how we integrated key partnership interests to produce each product, including the diverse interests that needed to be balanced in order to achieve the partnership's desired outcome, and how the products were ultimately planned to be used among partners. Finally, we share multiple insights and recommendations for success based on our collective experience, which we hope will be useful to managers and researchers pursuing similar initiatives.

Ornamental Crayfish Trade Regulation in European context: A Cross-Country Comparison

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The international ornamental pet trade is a major pathway for the introduction of invasive non-native species (INNS). Effective regulation of pet trade, including proper implementation and enforcement of legislation, is essential to reduce the likelihood of releases and establishment of INNS in the wild. Crayfish are among the most successful freshwater invaders and are increasingly popular in aquaristics and widely available across European and global markets. In this study, we assessed the regulatory frameworks governing the ornamental crayfish trade in eleven European countries. Selected countries covered nine European Union members (Belgium, Croatia, Czech Republic, Germany, Hungary, Netherlands, Poland, Romania, and Slovenia) and two EU accession countries (Bosnia and Herzegovina and Serbia). Data were collected via a structured questionnaire distributed to national experts. We performed i) a regulatory assessment by analysing the number of responsible institutions and relevant legislative acts and enforcement strength of existing regulations, ii) analysis of trade-invasion-link to determine how crayfish availability and aquaristic popularity relate to the presence of non-native crayfish, and iii) a cross-country comparison of the presence of non-native crayfish in relation to EU membership, the existence and effectiveness of legislation and enforcement, and awareness of issues associated with INNS and the pet trade. Preliminary results highlight differences in institutional capacities and enforcement strength across examined countries. Countries with higher aquaristic popularity host more established non-native crayfish per unit area, including more species of EU concern, but also tend to have stronger institutional frameworks, better enforcement, and greater awareness of pet-trade risks. Compared to non-EU countries, EU countries exhibit higher aquaristic popularity and greater numbers of established non-native crayfish. This likely reflects both higher trade intensity and more effective monitoring, whereas non-EU countries often lack official lists of non-native crayfish, report fewer species in national monitoring schemes, and demonstrate lower levels of enforcement and awareness regarding pet-trade risks.

Management and Eradication Efforts to an Occurrence of Invasive Marbled Crayfish (*Procambarus virginalis*) in Ontario, Canada

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In 2021, the first North American observation of wild Marbled Crayfish (*Procambarus virginalis*) was reported via iNaturalist near stormwater ponds in Burlington, Ontario. This discovery prompted the formation of the Marbled Crayfish Working Group, a partnership of government agencies, researchers, and non-governmental organizations working towards a goal of containing and eradicating the highly invasive *P. virginalis* population. *P. virginalis* reproduces parthenogenetically, resulting in rapid population expansion and posing risks to native crayfish through competition for food and habitat. Their ability to travel overland further increases the risk of spread to nearby waterbodies. Their introduction into the Burlington ponds was likely linked to the aquarium trade pathway prior to the species being prohibited under Ontario's Invasive Species Act, 2015. Since 2024, intensive trapping efforts have resulted in the removal of over 3000 individuals. Despite three years of winter pond drawdowns and trapping, eradication remains unsuccessful. Although eradication has not yet been achieved, several emerging patterns were seen. Crayfish have been observed surviving sub-zero temperatures during winter drawdowns, and preliminary data from two consecutive years suggest a recurring late-summer increase in activity among smaller size classes. There are also early indications that the only drawdown that coincided with a colder winter (2024-2025) may have reduced population numbers more than drawdowns during milder winters, although further analysis is needed. Currently, there are no registered pesticides, or other eradication tools, to manage invasive crayfish in Ontario, making this a useful case study that showcases the complexities around invasive species control and management. The Marbled Crayfish Working Group is currently pursuing a research authorization from federal and provincial regulators to explore pesticide-based control options, while continuing containment and monitoring efforts. This case highlights the importance of coordinated action, shared expertise, and ongoing public education in invasive species management.

Keystone species interactions: Can American eels restrict establishment of non-native crayfish?

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Non-native crayfishes can imperil native crayfishes and greatly alter ecosystems. We tested the hypothesis that American eel (*Anguilla rostrata*, Lesueur) can inhibit the establishment of non-native crayfish using observations of eels and crayfish in the Delaware River drainage. A contingency analysis using presence and absence of non-native *Faxonius* crayfish and eels showed a highly significant effect, with non-native *Faxonius* much more likely to occur in watersheds without eels. There was also a strong negative relationship between non-native *Faxonius* abundance and eel abundance. Analyses of relationships between native crayfish and eels showed more frequent occurrence of native crayfish in sites with eels and a negative relationship between native crayfish abundance and eel abundance, although native crayfish abundance remained substantial at a number of sites with high eel abundance. This relationship is attributed to the negative response of native crayfish to non-native crayfish such that eel impacts on non-native crayfish indirectly benefit native crayfish. These findings suggest that restoration of eels to stream and river reaches where they have been excluded by dams and other passage blocks may prevent establishment of non-native crayfish and protect native crayfish and the ecosystems they inhabit.

Crayfish Surveillance and Monitoring in the Great Lakes Basin

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Invasive crayfish are a growing concern within the Great Lakes Basin. Invasive crayfish species are demonstrated to negatively affect both the biotic and abiotic components of freshwater ecosystems. Concerns over these crayfish species have led multiple state/provincial governments to regulate the trade, ownership, and/or transport of multiple species, including the red swamp crayfish (*Procambarus clarkii*), rusty crayfish (*Faxonius rusticus*), yabby (*Cherax destructor*), and marbled crayfish (*Procambarus virginalis*). While the impact of these species has been the focus of a variety of research efforts over the last three decades, there have been no systematic efforts to understand surveillance and monitoring for crayfish within the Great Lakes Basin. This has left managers unable to quantify where new crayfish invasions are likely to go undetected and where targeted efforts would best improve the surveillance network for invasive crayfish species. We conducted a survey of researchers, agencies, non-profits, and other natural resource professionals to improve our understanding of crayfish monitoring and surveillance efforts within the Great Lakes. The goal of this survey was to identify as many crayfish survey and monitoring efforts as possible from 2000 to the present. Using this data, we assessed how crayfish surveillance and monitoring efforts were distributed across the Great Lakes Basin and identified potential gaps in sampling effort. Our analyses determined that crayfish surveys in the region are primarily focused on high population density areas (i.e., metropolitan areas). However, at most surveyed locations, crayfish surveys occur once or very infrequently. When we estimated hot spots of survey efforts including temporal frequency there was a decrease in the number of regularly surveyed locations. This work highlights locations where low sampling density could result in undetected invasions, and provides suggestions for locations for new surveys.

Efficacy of invasive carp as bait for wild crayfish in the Atchafalaya River Basin, Louisiana

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Invasive carp are found throughout Louisiana and disrupt aquatic ecosystems through competition with native fishes and reduced habitat quality. Commercial fishing can be an option to control or reduce carp populations in Louisiana waters; however, market demand is needed to incentivize harvest. The use of invasive carp as bait in the wild crayfish fishery could provide an opportunity to increase the commercial market for carp. Therefore, the purpose of this research is to compare the efficacy of invasive carp as bait for wild crayfish in the Atchafalaya River Basin (ARB), Louisiana. Five different bait types were examined, carp artificial bait, carp cut bait, shad cut bait, menhaden cut bait, and Southern Pride artificial bait. Crayfish were sampled every two weeks at seven sample locations in the southeastern ARB during the 2025 crayfish season. At each sample location, 15 crayfish traps, three traps with each bait type, were fished, and catch per unit effort (CPUE) and water quality were recorded at all sites on every sample date. Additionally, all captured crayfish were identified to species, sexed, carapace length measured, and male reproductive form determined. Analyses from March through April 2025 indicated no significant difference in crayfish CPUE among bait types. Shad cut bait (47.9 ± 0.2 mm) caught significantly larger ($F_{4,1981} = 7.65$, $P < 0.001$) crayfish compared to carp cut bait (46.9 ± 0.3 mm), Southern Pride artificial bait (46.4 ± 0.2 mm), and carp artificial bait (46.4 ± 0.3 mm). There was no significant difference between any other bait type. Sampling will continue in the 2026 crayfish season. The results from this study will provide information to commercial fishers and crayfish harvesters about the potential of invasive carp as a viable bait option in the wild crayfish fishery.

Assessing the Potential of Native Michigan Predatory Fish as Biological Control Agents of the Invasive Red Swamp Crayfish (*Procambarus clarkii*)

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The Red Swamp Crayfish (*Procambarus clarkii*) is the world's most invasive crayfish species, exhibiting high ecological plasticity and the ability to thrive across a wide range of environmental conditions. In 2017, established populations of *P. clarkii* were documented in multiple waterbodies in southeastern Michigan, prompting the need for effective management and eradication strategies. One potential, yet largely unexplored, approach in Michigan is the use of native predatory fishes as biological control agents. Despite the widespread ecological impacts of this invasive crayfish, limited research has quantified fish predation on *P. clarkii* under natural conditions, with none conducted in Michigan. We examined the diets of 462 native predatory fishes collected from three invaded sites in southeastern Michigan using gastric lavage and laboratory diet analysis. Prey items were identified to major taxonomic groups, with crayfish identified to species. At two of the three sites, *P. clarkii* comprised 54% and 68% of Largemouth Bass diet biomass by wet weight, indicating substantial incorporation where available. In contrast, *Lepomis* species (Bluegill and *Lepomis* hybrids) primarily consumed aquatic benthic invertebrates (26–42% of diet biomass), with no evidence of crayfish predation. These findings provide the first field-based documentation of native fish predation on invasive *P. clarkii* in Michigan and demonstrate that biological control potential is predator-specific rather than uniform across centrarchid taxa. This work contributes critical empirical evidence to inform integrated management strategies for invasive crayfish in Midwestern freshwater systems.

Volunteers control and reduce the spreading of invasive crayfish by pleopod sterilisation

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Biodiversity loss has been caused by global warming and the spread of invasive alien species. A long-term conservation programme has been performed to improve the populations of the native crayfish *Austropotamobius pallipes* in Italy. This also includes the control of non-native crayfish species, in order to limit their spread. Since 2022, a control action of *Procambarus clarkii* populations has been implemented, primarily involving the participation of volunteers in the trapping of invasive crayfish. The first-year session by massive trapping activities resulted in a total capture of 44,241 crayfish in six ponds, showing different CPUE values per site, but not in terms of trapping trends. Since 2023, trapping has been followed by sterilisation using the pleopod cutting technique, which has been demonstrated to be successful under controlled conditions, both in laboratory and mesocosm settings. After three-year activities by sterilisation, a total of 4,723 crayfish were captured, representing a decline of 89 %. The most successful value was achieved by the juveniles/adults ratio, showing a decrease of juveniles up to 84 % and therefore indicating a population that is progressively ageing. The key to successful eradication includes engaging local communities and ensuring their support to achieve long-term success.

Twenty years of monitoring a biological invasion

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Invasive species threaten biodiversity and ecosystem functioning, yet their success often depends on their ability to establish and persist across a wide range of novel environments. The signal crayfish (*Pacifastacus leniusculus*) was introduced to Europe in the mid-20th century by the Swedish Board of Fisheries, with the intended purpose of replacing the native noble crayfish (*Astacus astacus*), whose populations had by that point been decimated by crayfish plague. Signal crayfish have since spread across most of the continent and become one of Europe's most damaging invasive species. Critically, signal crayfish are the primary vector of crayfish plague, a pathogen that has further reduced native noble crayfish populations by approximately 98%. Today, signal crayfish thrive across a remarkably wide range of environments, from subarctic Fennoscandian lakes to the Mediterranean climates of southern Europe. Here we present data from a long-term monitoring program covering signal crayfish populations in Swedish lakes over approximately twenty years. Population dynamics have been highly variable: many populations have undergone rapid increases followed by substantial crashes. In the Swedish large lakes in particular, signal crayfish abundance has increased sharply since 2015, reaching very high population densities. Notably, these increases have been driven predominantly by smaller size classes, while larger individuals have remained stable or increased disproportionately less. The result has been a marked shift toward smaller body sizes in the population size structure, which has created significant challenges for commercial and recreational fisheries. Whether this disproportionate increase in smaller individuals reflects reduced growth rates due to intraspecific competition, or excessive fishing pressure on larger size classes, remains an open question that we discuss in light of the available data.

Widespread detection and establishment of the Australian red-claw crayfish (*Cherax quadricarinatus*) in Puerto Rican reservoirs

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Freshwater systems are facing continued introductions and spread of crayfish species driven by aquaculture and live trade, including the Australian red-claw crayfish (*Cherax quadricarinatus*). In Puerto Rico, red-claw was introduced in 1998 following a flood-driven escape event during a major hurricane. Our study uses eDNA to assess detection patterns and establishment of red-claw across reservoirs island-wide, 25 years after their original introduction, with attention to potential biotic resistance from native shrimp assemblages. Our dataset shows that detections are mostly associated with reservoirs where native shrimp communities have been completely extirpated, suggesting that establishment may be more likely in systems where this component of the native community is absent. Sampling was based on a single point per reservoir, allowing us to capture island-wide patterns despite limited access to many sites. While this reduces spatial resolution within reservoirs, it provides a practical way to assess broad establishment status under logistical constraints. We also evaluate assay detection limits and limits of quantification within this framework, providing context for interpreting presence and relative signal strength from single samples. To examine within-reservoir variation, we present spatial eDNA data from Toa Vaca reservoir, where detections of red-claw were variable across sampling locations. These results show that detection depends on sampling position within a reservoir, particularly relative to inflow and dam areas, and help identify locations that may improve detection probability. This work highlights a tradeoff between sampling intensity and coverage and shows that strategically designed eDNA surveys can effectively capture invasion status at broad spatial scales, providing a practical approach for monitoring spread and establishment in systems where access is limited and resources are constrained, such as in Puerto Rico.

Monitoring of freshwater crayfish through passive eDNA collection in major rivers of Hesse (Germany)

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Traditional monitoring of freshwater crayfish is often hindered by labor-intensive protocols and bulky field equipment. Consequently, environmental DNA (eDNA) analysis has emerged as a preferred alternative for species detection. Standard eDNA workflows typically rely on active filtration, which remains logistically demanding. In this study, we evaluated a simplified passive eDNA sampling methodology to detect the endangered European noble crayfish (*Astacus astacus*) alongside invasive North American signal crayfish (*Pacifastacus leniusculus*) and spiny-cheek crayfish (*Faxonius limosus*). To this end, we deployed eDNA samplers at 13 locations (with 2-4 replicates) on four major rivers in the Federal State of Hessen (Germany). After 12-16 hours, the samplers containing nylon filter (pore size 0.22 µm) and commercial coffee filter cut to the same 47 mm diameter were collected and placed in either SDS or CTAB lysis buffer. The sample tubes were then transported on ice to laboratory for DNA precipitation-based extraction. Highest DNA yield was achieved in the combination of the CTAB-based protocol with coffee filters (mean = 202.89 ng, SD = 293.72), while the lowest was recorded for the SDS-based protocol with nylon filters (mean = 120.15 ng, SD = 346.95). In the species-specific qPCR assay, noble crayfish was detected at nine, signal crayfish at three and spiny-cheek crayfish at one location. Overall, the results of our study were correlated with the historical records of species distribution in Hesse. As future steps, optimisation of the sampling effort, which includes deployment time, depth and seasonal factors is necessary. Finally, the passive eDNA collection, is a promising low-effort and low-cost methodology that can support freshwater crayfish monitoring programs and citizen science projects.

Where Have All the Yabbies Gone?

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The Common Yabby, *Cherax destructor*, an Australian crayfish species, was first detected in a former quarry lake at Ballyhass, Co. Cork, Ireland, on 22 March 2019. Between 2019 and 14 June 2023, more than 3,500 individuals were captured during 24 overnight trapping events, primarily using Skanemjarden crayfish traps baited with pork liver. These results indicated a well-established and abundant population. A marked change was observed in 2024. On 04 May 2024, no yabbies were captured in five standard traps. On 16 June 2024, additional trapping using smaller mesh traps again yielded no individuals. Environmental DNA (eDNA) samples collected on 17 June 2024 tested negative for crayfish plague but produced a weak positive signal for yabby DNA. By 30 November 2024, repeat eDNA analysis was negative for both crayfish plague and yabby DNA, and an underwater drone survey conducted on the same date failed to detect any individuals. Further survey efforts in 2025 continued to indicate absence. A refuge trap deployed on 23 June 2025 and retrieved on 07 July 2025 captured no specimens, and a nocturnal torchlight survey of shallow littoral zones detected none. On 22 July 2025, a further underwater drone survey of suitable habitat also failed to record any individuals. The substantial population documented between 2019 and 2023 appears to have collapsed by 2024, and available evidence suggests the species is now absent from Ballyhass. The cause of this rapid decline remains unclear. Testing did not indicate crayfish plague, and no toxic spill was reported. Circumstantial evidence suggests cyanobacterial blooms in early summer 2024 and 2025. A dark benthic film, possibly a cyanobacterial mat, was observed during drone surveys; however, a suitable sample for laboratory confirmation was not obtained. Regardless of the cause, the disappearance of *C. destructor* removes a significant invasive threat to Irish freshwater habitats.

Patterns of host-symbiont associations in native and non-native Red Swamp Crayfishes

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Non-native species are one of the greatest threats to native biodiversity, in part, due to their indirect effects on host-symbiont relationships as understood through the frameworks of spillover (e.g., native host used by a non-native symbiont) and spillback (e.g., amplification of a symbiont by novel host). The Louisiana Red Swamp Crayfish, *Procambarus clarkii*, has been introduced globally, with direct impacts of these introductions being well documented. While there has been focus on the co-introduction of their pathogens (e.g., crayfish plague and white spot syndrome virus), the spillover and spillback of crayfish symbionts with complex life cycles deserve further attention, especially given the potential impacts these organisms can have on trophic webs more broadly. Our objectives were to assess potential spillover and spillback associated with introductions of non-native *P. clarkii* by comparing their symbiont communities to those of its congener, the Eastern Red Swamp Crayfish, *P. troglodytes*. This was done via a literature review and screening via dissection and light microscopy of syntopic populations in South Carolina, USA. In the literature, we found nearly 120 eukaryotic symbionts across the native and introduced ranges of *P. clarkii* and 14 from the native range of *P. troglodytes*. Screening of crayfish collected in 2023 and 2024 revealed 10 symbionts associated with *P. clarkii* and 6 with *P. troglodytes*. Results also showed differences in infection by two acanthocephalan worms: one infecting only *P. clarkii* and the other infecting both species, with intensity of infection significantly differing between hosts. These results indicate that these syntopic and congeneric crayfishes interact with the acanthocephalan parasites differently, presenting possible examples of spillover and spillback. Additionally, these results highlight the need for increased surveillance of crayfish symbionts to assess the impacts that non-native species may have on their introduced environments.

Ecotoxic effect of a soil-stabilizing root-bacterial exopolysaccharide salt on the reproduction of *Procambarus clarkii*

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The exopolysaccharide (EPS) produced by *Rhizobium tropici* ATCC 49672[®] has been modified to create a stable salt solution and applied as a soil amendment to reduce erosion. We assessed the ecotoxicity of *R. tropici*-produced EPS on *Procambarus clarkii* (Girard 1852), the red swamp crayfish. Artificial maternal burrowing chambers were used to monitor behavioral responses to biopolymers in the soil and to observe possible effects on oviposition and hatch rates. The study consisted of post-mated mature females held individually in burrowing chambers containing either control soil or soil amended with 1% EPS. For each treatment, five artificial burrows were placed within each of six bins ($n = 3$ per treatment) and maintained for 4 mo. The EPS treatment resulted in complete reproductive inhibition, with no oviposition in any of the treated bin chambers compared to $47\% \pm 23\%$ (mean \pm SD) of crayfish producing eggs in the control bin chambers. Control crayfish produced a total of 1,519 hatchlings compared to no hatchlings by crayfish exposed to EPS. Given the potential for soil stabilizers to control *P. clarkii* populations, a biopolymer salt derived from *R. tropici* represents a promising management tool that combines ecological benefits with the control of invasive crayfishes.

“Crawfish Eh !?”: First records and distribution of the invasive crayfish *P. clarkii* in Ontario, Canada

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Field surveys were conducted from October 2024 to August 2025 to confirm the presence of red swamp crayfish (*Procambarus clarkii*) in Southern Ontario following a suspected report from the general public. The primary objective was to detect and confirm its identification, followed by better understanding its distribution from the reported area. *P. clarkii* is a provincially prohibited species under the Invasive Species Act, 2015, and poses ecological risks to the rest of Ontario, if allowed to establish and spread.

Following the confirmation of *P. clarkii* by the Invading Species Awareness Program in October 2024, a collaborative group of government, non-government, and experts conducted further surveillance in June 2025, and again late August 2025 to further assess the presence, distribution, and establishment status of *P. clarkii*. A total of 40 sites were surveyed accounting for 450 data points using a combination of visual inspection, kick and sweeps, burrow digging, baited minnow traps, and habitat assessment. Overall, 104 *P. clarkii* were captured ranging in size from 7 to 53 mm carapace length. The capture of numerous male and female reproductive individuals as well as young of the year juveniles and an ovigerous female confirm that the population is successfully reproducing, likely for several years now.

A second location, Lake Aquitaine in Mississauga, Ontario, was reported to have *P. clarkii* in August, 2025. Being in a suburb of the Greater Toronto Area, initial surveillance efforts found four *P. clarkii* during the surveys and several more were captured and reported online (iNaturalist/Invading Species Hotline) by naturalists. It is unknown whether the species is successfully reproducing at this location but individuals in several year classes were captured. Future research, monitoring, and containment methods by various government and non-government institutions are discussed.

Using Geometric Morphometrics to Quantify Morphological Divergence of *Procambarus clarkii* in southern Michigan

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The red swamp crayfish (*Procambarus clarkii*) is one of the most pervasive aquatic invaders worldwide. Their invasions have well-documented detrimental effects on human health, infrastructure, and ecosystems. As invaders establish themselves in novel environments, they may experience morphological shifts in response to local selective pressures. This study investigates whether such morphological divergence is occurring in multiple red swamp crayfish invasions in southern Michigan. We digitized specimens using landmark-based geometric morphometrics in tpsUtil and tpsDig in order to quantify variation in body and chelae shape among individuals from different complexes (i.e., genetically distinct populations). We then used MorphoJ to create wireframes for shape analysis. Our analysis shows that body shape changes with crayfish size, but chelae shape does not. We found significant differences in both body and chelae shape among invasion complexes. This indicates there may be founder effects and morphological variation across populations via site- or individual-specific divergence following invasion. This divergence may be a result of environmental factors such as habitat structure, predation pressure (or lack thereof), or resource availability, among others. Ongoing analyses will relate these results to previously collected genetics data as well as across time. These findings may contribute to a broader understanding of phenotypic plasticity and local adaptation in invasive species such as *Procambarus clarkii*, allowing invasive species managers to better predict invasion dynamics and inform management.

Evolution of Ireland’s National Crayfish Plague Programme: From Method Validation to Active Species Recovery

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Ireland’s National Crayfish Plague Surveillance Programme (NCPSP) was established in 2018 under a Memorandum of Understanding between the Marine Institute and the National Parks and Wildlife Service following confirmed outbreaks of crayfish plague (CP) caused by *Aphanomyces astaci*. Based on the Norwegian programme, NCPSP integrated molecular diagnostics with conservation objectives for the White-clawed crayfish (WCC), *Austropotamobius pallipes*. The 2018–2019 phase delivered Ireland’s first coordinated national environmental DNA (eDNA) surveillance across 28 catchments. It demonstrated the suitability of eDNA-based qPCR as a national surveillance tool, established baseline prevalence and confirmed pathogen detection in the absence of visible mortality. During 2020–2021, surveillance progressed beyond presence–absence detection to improve understanding of disease distribution, persistence and seasonal dynamics. Time-series sampling clarified temporal patterns, while multiplex assays strengthened biosecurity capacity through simultaneous detection of CP, WCC, non-indigenous crayfish species and other potential vectors. From 2022 onward, the programme evolved into the National Crayfish Plague Programme (NCP). Method refinement, passive sampling trials, improved CP genotyping and structured recovery case studies were incorporated, and outputs increasingly informed management decisions. A major milestone occurred in 2024 during the Awbeg River CP outbreak, where surveillance data enabled Ireland’s first emergency rescue and translocation of WCC from an actively spreading plague front. In 2025, conservation detection dogs were trialled alongside eDNA to enhance rapid field assessment. Although the programme has evolved over time, these developments reflect deliberate responses to emerging evidence and advancing technology. Rather than operating as a static framework, it has remained adaptive, refining methodology in line with expanding knowledge.

Key questions remain regarding mechanisms of spread, persistence, recovery criteria and potential resistance. The proposed 2026–2030 framework expands into population genomics to inform ARK site designation and translocation strategy.

Genetic characterisation of *Aphanomyces astaci* from Italian crayfish plague outbreaks in white-clawed crayfish

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The crayfish plague is a lethal disease for susceptible freshwater crayfish and caused severe damage to the endangered native European crayfish populations. The aetiological agent is *Aphanomyces astaci*, an oomycete which has been extensively studied using both nuclear and mitochondrial markers to evaluate its genetic diversity in Europe. However, data on the genetic diversity of *A. astaci* across the Italian peninsula are limited. Therefore, IZSve performed molecular analyses to characterise seven previously confirmed crayfish plague outbreaks, which occurred between 2018 and 2025 in *Austropotamobius pallipes* complex populations from northern and central Italian regions. Isolation of the oomycete was possible from two cases, whereas for the other outbreaks only frozen or ethanol-fixed crayfish were available for the analyses. Although the recommended target tissue for crayfish plague diagnosis is the cuticle, we chose to extract the DNA only from the underlying muscle tissue, in which *A. astaci* hyphae penetrate in advanced infections. This approach minimised contamination from other oomycetes present on the external surface of the cuticle, and provided enough genetic material for the molecular analyses. Genotyping and haplotyping were performed using nuclear-specific molecular markers analysed by real-time PCR and mitochondrial markers assessed by endpoint PCR followed by Sanger sequencing, respectively. Four outbreaks were caused by genotype group D, and the corresponding haplotype was d1 in central Italian regions (Emilia-Romagna, Tuscany and Abruzzo), and d2 in northern Italy (Veneto). Genotype group B with haplotype b was identified in northern Italy (Lombardy). In the remaining two cases, from northern and central Italy (Trentino and Umbria), we found the rare combination of genotype group B with haplotype a, which to our knowledge was previously reported only in central Europe and Pennsylvania. These results highlight the importance of combining multiple molecular markers and expand our knowledge about the genetic diversity of *A. astaci* in Italy.

Transmission of *Astathelohania contejeani* in the Invasive Signal Crayfish *Pacifastacus leniusculus*

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The microsporidian parasite *Astathelohania contejeani* is the causative agent of porcelain disease, a chronic condition affecting endangered European freshwater crayfish, specifically the *Austropotamobius pallipes* complex and the vulnerable *Astacus astacus*. The disease is characterized by progressive tissue degeneration, ultimately leading to the death of infected individuals. This study aimed to evaluate the transmission of *A. contejeani* from *A. pallipes* to the invasive signal crayfish, *Pacifastacus leniusculus*, through two experimental trials. The first controlled experiment was conducted using 60 *P. leniusculus*, divided into a treatment group (n = 40; 20 males, 20 females) and a control group (n = 20; 10 males, 10 females). Crayfish were housed individually and the treatment group was challenged by the ingestion of three *A. pallipes* crayfish muscle tissues infected with *A. contejeani*. Infection status was monitored over a nine months period using non-lethal sampling and molecular analysis. A low infection transmission rate was observed relative to the literature reports. The positive results from challenged signal crayfish were detected between three to five months post exposure. The second experiment was performed on 12 *P. leniusculus* individuals (6 males and 6 females). This follow up study involved three administrations of white-clawed crayfish muscle tissues infected with *A. contejeani* within a month, resulting in an infection transmission rate of 50% detected after seven months. These findings suggest that the transmission of *A. contejeani* may be dose dependent. *Pacifastacus leniusculus* may exhibit a different susceptibility or transmission dynamic compared to native species, highlighting the complexity of parasite host interactions in invasive contexts.

Population estimation of invasive crayfish (*Procambarus clarkii* and *Faxonius virilis*) across 124 acres of low-peatland using a mark-recapture and a depletion method

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Invasive North American freshwater crayfish are increasingly impacting water quality in the Netherlands, hindering the achievement of European water quality objectives. Consequently, authorities have expressed a growing need to manage, and monitor crayfish populations. The Molenpolder, a 124-acre low-peatland area, is known to host a large population of *Procambarus clarkii* and *Faxonius virilis*. Over the past decades, the ecosystem has shifted from a clear-water, macrophyte-rich system to a turbid system lacking submerged vegetation and characterized by reduced species richness.

Since 2021, intensive crayfish removal efforts have been carried out in the Molenpolder. In 2023, we estimated the population size across the entire area using a catch-mark-recapture (CMR) and a depletion method. A population estimation of this scale has not previously been conducted in the Netherlands.

A total of 2,020 crayfish were PIT-tagged, and >700 traps of various types were used for depletion and recapture of tagged individuals. Traps were emptied weekly for fourteen weeks between May and August 2023. The total yield was 12,190 kg (98 kg/acre; ~477,000 individuals). Of the 2,020 tagged individuals, 761 (38%) were recaptured after eleven weeks. CMR estimates ranged from 80 ± 12 kg/acre after the first week to 183 ± 13 kg/acre after eleven weeks. The depletion method gave an estimate of 128 kg/acre after fourteen weeks.

Both methods present distinct advantages and limitations for estimating large crayfish populations. CMR requires tagging a substantial number of individuals, and processing large catches is time-consuming. CMR is most reliable when carried out with high fishing effort over a short period, as it is sensitive to changes in population size. Depletion methods require a high, consistent and homogeneous trapping effort over an extended period, but are less sensitive to changes in population size. Both methods are viable, with suitability depending on context and location.

White-clawed crayfish (*Austropotamobius pallipes* complex) populations co-exist with *Aphanomyces astaci* genotype group A in north-western Italy

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Aphanomyces astaci is the oomycete responsible for crayfish plague, a disease that decimated native European crayfish for over a century. Although recent studies suggest that more tolerant European crayfish populations and less virulent *A. astaci* strains may have adapted to co-exist, avoiding the spread of this oomycete is still essential for conservation purposes. Therefore, between 2020-2025, IZSVe performed a sanitary monitoring (supported by LIFE18NAT/IT/000806) to evaluate the presence of *A. astaci* in the endangered *Austropotamobius pallipes* complex populations located in north-western Italy. Cuticular swabbing was chosen as a non-destructive sampling technique, often coupled with water filtering and eDNA analysis for more reliable results. Molecular detection of *A. astaci* was performed through real-time PCR using the assay developed by Vrålstad et al. (2009), but increasing the annealing temperature according to Rusch et al. (2020). To confirm positive results, at least one positive sample for each population was further analysed either through Sanger sequencing of the ITS1 region or with the improved real-time PCR assay of Strand et al. (2023). Genotyping of *A. astaci* was performed by real-time PCR or sequencing, according to the pathogen load. A total of 47 white-clawed crayfish populations were included in the study, and the presence of *A. astaci* was detected in 16 of them (14 confirmed by sequencing, two through the improved real-time PCR assay). In one of these 16 populations, an outbreak of crayfish plague was observed and genotype group D was identified. No further mortalities were reported during the monitoring and all the other 15 populations were thriving despite the presence of *A. astaci*. Genotype group A was identified in three of them through real-time PCR (two confirmed by sequencing). These results expand the knowledge about the presence of white-clawed crayfish populations with chronic *A. astaci* infection and are crucial for planning conservation activities in north-western Italy.

Uncovering the virome of the invasive calico crayfish (*Faxonius immunis*) – CaliVir

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Invasive freshwater crayfish are major drivers of biodiversity loss, yet the role of viruses in their invasion success remains largely unexplored. The calico crayfish (*Faxonius immunis*) is a rapidly expanding North American invader in the Rhine River system. However, its associated virome has not yet been characterised. Here, we present the first insights into the virome of calico crayfish as part of the CaliVir project. Using high-throughput RNA sequencing, we analysed multiple tissue types (gills, gut, and hepatopancreas) from eight individuals collected in the Lauterbourg (France), alongside environmental samples and non-lethal cuticular swabs. Sequencing libraries were generated following rRNA depletion and subjected to comprehensive bioinformatic analysis, including de novo transcriptome assembly, virus identification, and phylogenetic inference. Preliminary results reveal diverse viral sequences, including 18 putative RNA viral contigs, with an average nucleotide sequence identity of 39.93% (range: 29.96–66.16%) to known viruses in the NCBI RefSeq Viral database, suggesting the presence of potentially novel viral taxa. Tissue-specific distribution patterns indicate an enrichment of viral contigs in gill tissue (18 contigs), compared to gut (16 contigs) and hepatopancreas (13 contigs). Within the project, we will further assess the feasibility of non-lethal sampling approaches for virome characterisation, including cuticular swabs, environmental RNA from water samples, and soil samples from crayfish burrows, with the aim of their application in virome monitoring. In addition, we will design specific RT-PCR assays targeting the most abundant viral candidates to evaluate viral prevalence across sample types. These findings provide a crucial first step toward understanding virus diversity in invasive calico crayfish and lay the foundation for investigating the role of viromes in invasion dynamics, host–pathogen interactions, and cross-species transmission in freshwater ecosystems.

Host-pathogen dynamics under climate change: Uncovering the potential distribution of crayfish and the crayfish plague pathogen *Aphanomyces astaci* using Species Distribution Modelling

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Crayfish plague, caused by the oomycete *Aphanomyces astaci* Schikora, 1906, represents one of the most important causes of decline of native crayfish populations in Europe. Ongoing climate change is expected to significantly affect freshwater crayfish worldwide via distribution shifts of both indigenous (ICS) and non-indigenous (NICS) crayfish species. However, the role of climate change in shaping the future distribution and spread of crayfish plague remains unknown. Therefore, we have applied species distribution modelling (SDM) to assess the potential current and future habitat suitability of *A. astaci*, and its crayfish hosts in Croatia (four ICS and two NICS). Input presence data for crayfish plague was compiled by integrating literature records with our own qPCR-based detections of *A. astaci*, obtained by analysing an archived collection of ethanol-preserved crayfish. We modelled the current and future potential distribution of the hosts and pathogen using 15 environmental predictors and the maximum entropy (MaxEnt) approach. Future projections were based on Shared Socioeconomic Pathways (SSP) scenarios for the 2100 period and three different General Circulation Models (GCMs). Environmental niche occupied by *A. astaci* (visualised with PCA based on the environmental variables) overlapped with and encompassed the combined environmental range of all analysed host species. Suitable habitats for both ICS and NICS were projected to decrease and shift north-northwest under future climatic conditions, in line with their current overall adaptation to temperate climatic regimes. Future climatic suitability for *A. astaci* decreased less than suitability for individual host species, although its distribution was also predicted to shift north-northwest, following the potential future distribution of hosts. Overall, our results suggest that climate change alone is unlikely to promote further spread of NICS or crayfish plague, at least among hosts that are adapted to temperate climate as those analysed in our study. Finally, while our models focused on temperate species currently present in Croatia, it would be beneficial to also analyse the environmental niche of thermotolerant hosts and their associate *A. astaci* lineages since they might pose higher climate driven risks. Notably, *Procambarus clarkii*, a thermotolerant NICS, is expanding its range across Europe, with recent reports from neighboring Slovenia.

More Than Meets the Claw: Hidden Disease Dynamics in a Crayfish Invasion

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Invasive species alter freshwater ecosystems and threaten native biodiversity, yet the role of pathogens in shaping invasion outcomes remains poorly understood. Pathogens can influence invasion success by reducing host abundance or altering key traits such as behavior and competitive interactions, but pathogen communities are rarely integrated into invasion ecology. We examined symbiont diversity and prevalence in northern Wisconsin lakes where invasive rusty crayfish (*Faxonius rusticus*) replace native virile crayfish (*Faxonius virilis*). Our goals were to determine whether symbiont communities differed among lakes that vary in rusty crayfish abundance and impacts and to evaluate whether pathogens were associated with changes in host behavior or condition. We dissected and histologically examined over 450 crayfish, with ad hoc use of molecular tools, to assess symbiont prevalence and diversity. We conducted behavioral assays prior to dissection. Symbionts were common, with over 90% of crayfish hosting at least one symbiont. We identified symbionts from nine taxonomic groups shared by both rusty and virile crayfish. Symbiont communities varied with rusty crayfish invasion history and among lakes. Rusty crayfish hosted fewer symbionts in lakes where they had reached high densities and replaced native species, while native virile crayfish exhibited different symbiont assemblages in invaded versus uninvaded lakes. In co-occurring populations, invasive crayfish had lower symbiont richness than their native counterparts, which may give them a competitive advantage. Several pathogens were associated with changes in host behavior. These findings suggest that symbiont communities are linked to invasion success and species replacement. Future research in Missouri will test whether similar disease-invasion dynamics occur within the woodland crayfish (*Faxonius hylas*) invasion, evaluating whether disease-mediated processes shape invasion outcomes more broadly.

POSTER PRESENTATIONS

Differential susceptibility of *Aphanomyces astaci* genotypes and developmental stages to temperature

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Temperature is a key environmental driver that affects wildlife disease emergence. *Aphanomyces astaci*, an aquatic oomycete causing crayfish plague, is a major driver of native crayfish population declines in Europe and elsewhere, yet the effects of temperature on disease spread remain difficult to predict.

We analysed the effects of different temperature regimes on mycelial growth of *A. astaci* genotypes A–E, including constant temperatures (18 to 30 °C), daily fluctuations (22 ± 3 °C) and a heat-wave (22 → 28 → 22 °C). Zoospore motility and cyst germination of genotypes A and D were evaluated at 18, 22, and 26 °C. Temperature, genotype and stage-dependent transcriptional responses were assessed using RNA-seq.

Genotypes B, C, and D maintained stable mycelial growth from 18 to 26 °C, followed by reduced growth at 28 °C. In contrast, genotypes A and E were more sensitive to elevated temperature, showing reduced to abolished growth under increasing constant temperatures as well as under fluctuations and heat-wave exposure. Consistent with mycelial temperature-resilience profiles, zoospore motility persisted significantly longer at 26 °C in genotype D than in genotype A. Interestingly, cyst germination rates were similar at 18, 22 and 26 °C in both genotypes, suggesting high thermal resistance of cysts and implying that infection potential may persist even when zoospore motility and mycelial viability are reduced. Finally, RNA-seq analyses revealed developmental stage-specific transcriptomic profiles and temperature-dependent gene regulation.

Overall, the virulent genotypes B and D, carried by the two most successful invasive crayfish hosts, *Pacifastacus leniusculus* and *Procambarus clarkii*, showed the highest tolerance to elevated and stressful temperature regimes. As such conditions are projected to become more frequent under climate change, these findings raise the possibility of increased crayfish plague risks for susceptible native crayfish populations in Europe and beyond.

Project Crawdad: A Conservation Outreach Approach for Imperiled Crayfish in Appalachia

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Freshwater crayfish play an intrinsic role in aquatic ecosystems throughout the United States. Crayfish often function as important conduits for nutrient and energy transfer in freshwater systems due to their trophic position and omnivorous feeding habits. As ecosystem engineers, crayfish also provide critical habitat for numerous organisms in or around their environment. Despite the ecological importance of crayfish, they are often overlooked in public perception, resulting in comparatively limited outreach and conservation attention relative to more charismatic freshwater taxa. In 2021 the West Liberty University Crayfish Conservation Laboratory piloted a public outreach initiative, “Project Crawdad,” aimed at fostering public conservation support and appreciation for freshwater crayfish. Project Crawdad has occurred four times since 2021 and involves engaging with elementary students within West Virginia’s coalfields through hands-on local stream exploration and classroom lessons focusing on the state’s crayfish fauna. Using a number of collection methods WLU students help the elementary students collect crayfish and other freshwater fauna. Specimens are temporarily kept to allow students to observe and interact with the organisms while WLU students talk about diet and shelter preferences, social interactions, and other topics of interest of the local aquatic organism. Southern West Virginia’s coalfields represent a region ravished by non-ethical removal of the Earth’s natural resources. Project Crawdad’s outreach approach helps build foundational ecological education, and fosters long-term conservation awareness in a historically underserved community of Southern West Virginia.

Using Radio Telemetry to Track *Cambarus callainus* Movement in Response to Dam Removal

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The Big Sandy Crayfish (*Cambarus callainus*) is an endemic species to the Big Sandy River basin in the tripoint of WV, VA, and KY, that is federally listed on the Endangered Species Act. The habitat that Big Sandy Crayfish occupies is affected heavily by habitat degradation and sedimentation due to heavy mining practices. In order to build a better life history for the Big Sandy Crayfish, we are looking at movement patterns before, during, and after dam removal of a low-head dam in Clinchco, VA. Previous studies using radio telemetry examined some diverse movement patterns in contiguous bodies of water of the Big Sandy Crayfish and the Guyandotte River Crayfish (*Cambarus veteranus*). Research will be conducted over 9 months to account for seasonality. In total sixty individuals will be monitored in two month increments before, during, and after dam removal. This is the first time this method will be used to look at movement in a fragmented habitat. Ongoing research is being done on this project to study crayfish movement during and after dam removal using radio telemetry.

Utilizing Morphometrics to Determine Burrowing Type in Fossil Crayfish

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During the early Mesozoic era approximately 300 MYA, freshwater crayfish diverged from marine lobsters. Roughly 200 MYA, Pangea split into two primary landmasses known as Laurasia in the north, and Gondwana in the southern hemisphere. Crayfish living within these continents, specifically Laurasia, may have migrated across the great landmass before the mid-Jurassic, when Laurasia split into the northern continents we know today. Crayfish who had migrated before the split were likely now separated from their ancestors on the Asian continent and were now in North America. This continental migration may be the cause of similar morphometrics between extant North American species with prehistoric fossil crayfish found in China. In this study we collected morphometrics of 10 extant North American species, covering those that exhibit primary, secondary, and tertiary burrowing behaviors. Twelve different measurements were taken from each specimen with ImageJ. Using a Principal Component Analysis (PCA), the morphometrics from extant species were compared to fossil *Paleocambarus licenti* data collected from China. These data will be used to identify what extant species is most morphologically and behaviorally similar to *P. licenti*.

Distribution and habitat assessment of secondary and tertiary burrowing crayfish in the Pearl River basin, Louisiana

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Crayfish are key components in freshwater ecosystems and trophic webs, fundamental in determining ecosystem structure and function, and are indicators of water quality and biodiversity. However, many crayfish species are currently imperiled due to anthropogenic activities and in Louisiana there is a paucity of basic ecological information on most crayfish, including species of greatest conservation need (SGCN). This lack of distribution, population status, and habitat preference information makes conservation actions difficult for scientists and resource managers. Therefore, the purpose of this project is to examine the distribution and habitat requirements for secondary and tertiary burrowing crayfish in the Pearl River basin in Louisiana, a data deficient area. Twenty 1st to 3rd order streams were sampled from June to September 2025 using backpack electrofishing, seines, and dipnets. A total of 709 crayfishes representing nine species and four genera were sampled. The SGCN Pearl Blackwater Crayfish *Procambarus penni* was the most abundant species collected (390 individuals in 13 streams). Multivariate analysis of variance indicated a significant difference in habitat and water quality between streams with and without *P. penni* (Wilks' Lambda = 0.17, $F_{7,12} = 8.65$, $P < 0.001$). Streams with *P. penni* were characterized by sandy substrate and significantly higher dissolved oxygen ($P < 0.001$) and discharge ($P = 0.019$) and lower specific conductance ($P < 0.001$), turbidity ($P < 0.001$), and temperature ($P = 0.012$) compared to streams without *P. penni*. This information will aid state and federal resource managers with species conservation assessments and preservation efforts, help prioritize stream and watershed locations for future sampling efforts, and establish a robust, quantitative biological and ecological data set on crayfish in the Pearl River basin.

Distribution and habitat assessment of primary burrowing crayfish in the Pearl River basin, Louisiana

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Crayfish are key components in aquatic and terrestrial ecosystems and trophic webs. However, many crayfish species are imperiled and extinction rates for crayfish are higher than other freshwater fauna. Additionally, due to the difficulty of sampling subterranean habitat, information on primary burrowing crayfish is especially limited. There is a paucity of basic ecological information on many crayfish in Louisiana, including species of greatest conservation need (SGCN). Therefore, the purpose of this project is to examine the distribution and habitat requirements of primary burrowing crayfish in the Pearl River basin in Louisiana. Twenty-eight sites were sampled in 2025 and included a diversity of habitats including wetlands, floodplains, open or forested fields, and road-side ditches. A total of 220 crayfish representing 10 species and 4 genera were sampled. Future analyses will examine relationships among crayfish species and habitat variables. Sampling from across 2025 and 2026 will inform a map of confirmed species presences and modeled habitat suitability. The relationships among crayfish species and local environmental parameters will also be determined. These results will direct future sampling efforts, improve understanding of habitat requirements for SGCN crayfish, and support state and federal conservation planning and management efforts.

Chasing the plague, one passive filter at a time

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Environmental DNA (eDNA) is a rapidly advancing and powerful sampling tool that enables detection of target species and holds significant potential for large-scale disease monitoring in freshwater and marine environments. It provides a non-invasive alternative to traditional survey methods, relying on water sampling rather than organism capture or sacrifice. While eDNA has proven highly effective within national surveillance programmes, active filtration remains labour-intensive and can be constrained by water turbidity. Filter clogging limits the volume of water processed and may increase the risk of false negatives. To address these limitations, this study trialled in-house designed passive eDNA sampling units fitted with three membrane types of differing pore sizes (GF, MCE 0.45 µm and MCE 0.22 µm). Following a rescue effort for White-clawed crayfish (WCC) in the Awbeg River (Munster Blackwater catchment), passive units were deployed at three sites upstream of the crayfish plague front to monitor potential upstream pathogen spread. Filters were replaced weekly. Results were compared with active sampling consisting of 3 × 5 L monthly water collections processed by standard filtration. DNA from all sample types was analysed using species-specific duplex real-time PCR targeting WCC and *Aphanomyces astaci*, the causative agent of crayfish plague. High concordance was observed between passive and active sampling approaches. All three membrane types proved suitable for passive deployment. While active filtration has formed the backbone of Ireland's National Surveillance Programme since 2018, passive sampling offers a less labour-intensive alternative that facilitates larger-scale, longer-term monitoring. Extended deployment and combined membrane use enhanced detection reliability. Importantly, passive sampling data directly informed management decisions regarding additional rescue actions for the affected WCC population in the Awbeg River, demonstrating the operational value of this approach in outbreak response.

Missing Pieces: Appendage Injury Rates and Vulnerability in Laboratory-Stocked Marbled Crayfish

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In crayfish, the function of the first three clawed pairs of pereopods is well documented, which facilitate foraging, defense, and environmental modification. However, the integrity and roles of the posterior walking legs and sensory structures are often overlooked in ecological and aquaculture contexts. While claw loss due to injuries or autotomy is a common occurrence in high-density stocking conditions, with reported rates exceeding 45%, the injury rates of other appendages and their correlation with the presence of chelipeds (claws) remain poorly understood. This study evaluated a laboratory stock of marbled crayfish (*Procambarus virginalis*) to determine injury frequency and distribution across antennae, claws, and pereopods 2–5. We assessed how these injuries correlate with body size and specific reproductive stages (non-reproductive, glair gland, and egg-carrying). In total, 483 specimens were analysed (\bar{x} CL: 20.35 ± 4.01; 13.70–34.80 mm) and observed an anterior-to-posterior vulnerability gradient. Antennae were the most frequently injured structures (47.6%), followed by the claws (23.4%). Among the walking legs, the fifth pair of pereopods exhibited the highest injury rate (13.7%), likely due to their exposed posterior position and lack of defensive reach. We also found that individuals missing one or both claws exhibited significantly higher injury rates on their remaining appendages, up to 4.8 times higher in clawless individuals, indicating the claw's defensive role. Furthermore, injury rates were significantly correlated with the reproductive stage: individuals actively caring for eggs or in non-reproductive phases had roughly 3.6 times as many injuries as those with glair glands, possibly due to the longer interval since their last moult. Interestingly, larger individuals did not exhibit fewer injuries; in fact, one-clawed individuals were significantly larger than both-clawed. These findings highlight the claw loss frequency in stocking conditions and show its effects on crayfish's overall vulnerability.

Crayfish plague outbreak in a white-clawed crayfish breeding facility caused by broodstock with undetected chronic *Aphanomyces astaci* infection

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Aphanomyces astaci is the etiological agent of crayfish plague, a disease responsible for mass mortalities in freshwater crayfish populations across Eurasia. However, strains of this oomycete belonging to genetic group A have recently been observed to coexist with native European crayfish, and reports of the circulation of *A. astaci* in healthy wild populations are increasing. In 2014, a crayfish plague outbreak occurred in a breeding facility in Friuli-Venezia Giulia region (Northeast Italy). The facility hosted white-clawed crayfish collected for conservation purposes from thriving wild populations located in the region considered free of the pathogen. In the present study, the IZSve aimed to investigate the causes of this outbreak. Molecular analyses were performed using qPCR on the dead crayfish collected at different stages of the mortality event. The presence of *A. astaci* was detected and subsequently confirmed through Sanger sequencing. Additionally, the strain responsible for this outbreak was isolated and identified as belonging to genetic group A using RAPD-PCR, mtDNA analysis and genotype-specific nuclear markers. Epidemiological evaluations suggested that crayfish with undetected chronic infection were likely introduced in the facility; subsequently, a combination of biotic and abiotic stressors triggered the mortality event. To support this hypothesis and verify the presence of the *A. astaci* genetic group A in Friuli-Venezia Giulia region, we applied non-destructive sampling techniques in 2023 to assess five thriving white-clawed crayfish populations in the area. Approximately 30 cuticular swabs were collected from each population and tested using qPCR. *Aphanomyces astaci* was detected in three sites; this result was confirmed by sequencing in one population, and genetic group A was identified through nuclear markers. This study highlights the importance of assessing the presence of *A. astaci* in wild crayfish populations through sensitive and specific diagnostic methods before collecting broodstock for ex situ breeding, in order to prevent aphanomycosis-related mortalities.

Assessing The Conservation Needs of Native Texas Crayfish Species Through Distribution Analysis and Species Distribution Modeling

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Crayfish have essential roles in ecosystems since they are ecosystem engineers and keystone species. However, crayfish species are threatened by degradation of habitats, introduction of invasive species, and high levels of endemism. Unlike many other states, Texas provides no legal protections for *specific* crayfish species, despite its high diversity. The absence of protections hinders targeted conservation efforts, such as designating critical habitat tailored to the ecological needs of vulnerable species. The overall goal of this study is to clarify the distributions of native Texas crayfish species using literature records, citizen science, and field sampling data, and propose species in need of more conservation research. For the study, time interval maps for crayfish in Texas were created using all available data to understand the species data throughout time. Crayfish species were tested for significant range shifts by splitting their occurrence records into two time periods to further analyze distribution changes. Species distribution models using soil data, and current and future climate data were created for three crayfish species with different burrowing types, *Creaserinus hedgpethi*, *Lacunicambarus ludovicianus*, and *Procambarus acutus*. Results reveal that between 51-56 crayfish species occur in Texas. A total of 51 species of crayfish had time interval maps made because all species had one specific occurrence record. The range shift maps presented 23 out of 34 species with significant shifts in a variety of directions. Data deficient species were emphasized by both maps like *Procambarus brazoriensis*, *P. ceruleus*, *P. incilis*, *Faxonella blairi*, *F. beyeri*, and *F. clypeata*. Physiological and targeted field studies are needed to determine if the data deficient species are truly rare or not. Species distribution models found only *P. acutus* experienced decreasing habitat suitability in Texas. More research is needed on all species that are data deficient, possibly range shifting, or experiencing decreasing habitat suitability.

Preliminary results of the model application of crayfish plague vaccine (immune priming) in the noble crayfish

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The noble crayfish is a native European species of high conservation value that is severely threatened by the crayfish plague pathogen. There is no long-term, heritable protection against the diseases which, once introduced, has devastating consequences for the natural populations and restocking efforts. Here, we aimed to develop and assess the feasibility of maternal transgenerational immune priming (mTGIP) as a novel conservation tool, previously not applied to noble crayfish. Building on our previous findings, we focused on inducing enhanced immunity in breeding females with a non-infectious crude hyphal extract of the pathogen, with a goal of transferring increased disease resistance to the offspring. We established a safe and reproducible vaccination protocol optimising the timing and dosage of the vaccine administration based on the individual immune responses. An increase in total haemocyte count was observed 4 hours after the administration of the first dose, in both high-dose (10x) and low-dose (1x) groups. At the gene expression, we detected an increased expression of CCAAT/enhancer-binding protein following the administration of the second dose in the high-dose group. Following vaccination protocol optimisation, a large-scale main experiment was initiated involving 91 female and 21 male noble crayfish across seven experimental groups under near-natural breeding conditions. Vaccinated females showed normal mating success and high proportions of egg-bearing individuals, indicating that immune priming did not negatively affect their reproductive performance. In the next phase, we will sample the F1 generation (eggs, stage 2 larvae and juveniles) and conduct controlled infection experiments to evaluate whether the heritable disease resistance is conferred. Our current results demonstrate that immune priming of breeding females is feasible, compatible with reproduction, and suitable for integration into conservation breeding and restocking programmes.

Survival of *Aphanomyces astaci* after treatment with heat, ozone and UV-light

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The enhancement of the long-term survival of native crayfish in Europe, by maintaining crayfish in ark sites and to produce crayfish for restocking, means that facilities for crayfish with a water supply free of *Aphanomyces astaci* are needed.

Industrial symbiosis with heated water from production of hydrogen gas or ozonated and UV-light treated wastewater from production of fish might be a convenient and available solution to the water supply.

We have measured the survival of spores of *Aphanomyces astaci* in water, after treatment with heat, ozone and UV-light. The survival was measured as germination of the spores on plates after treatments, and germination in the liquid media with addition of CaCl₂.

We would like to present our results so far and discuss the opportunities with heat, ozone and UV-light for disinfection of water infected with spores of *Aphanomyces astaci*.

Crayfish Communities in Near-Estuarine Habitats of Coastal Georgia, USA

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Crayfish are an ecologically important yet historically understudied freshwater taxon, with the Southeastern United States supporting disproportionately high diversity. Georgia alone harbors approximately 77 species, but contemporary assessments of their distributions and life histories remain scarce. Across the region, crayfish populations face multiple anthropogenic pressures, including land-use change, hydrologic alteration, saltwater intrusion, and the spread of non-native species. As part of a larger multi-state effort across the lower Southeastern Coastal Plain, we surveyed crayfish communities in coastal Georgia to document species diversity, distribution, and environmental constraints, with particular emphasis on spatially isolated barrier-island habitats. Using a combination of active and passive sampling approaches, we conducted surveys across eleven of Georgia's fourteen coastal HUC-10 watersheds. We detected five crayfish species, with *Procambarus lunzi* (Hummock Crayfish) representing the most frequently encountered taxon. Crayfish were absent from sites where salinity exceeded 0.30 ppt, underscoring the physiological limitations of freshwater crayfishes in near-estuarine environments and highlighting the vulnerability of these communities to ongoing and future salinization. These findings provide contemporary baseline data for a region where crayfish diversity has been poorly documented for decades. When integrated with forthcoming results from the broader project framework, this work will help clarify the environmental drivers shaping crayfish communities across the southeastern Coastal Plain. Such understanding is essential for informing conservation strategies for one of the region's most diverse and imperiled aquatic groups.

Preliminary Research on *Pennides* (*Procambarus*) Crayfish Systematics in Mississippi

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Crayfish are decapod crustaceans of the infraorder Astacidea and the superfamily Astacoidea for North America. The continent is home to most of astacoidean diversity, with the Southeastern United States being particularly diverse. Mississippi houses an impressive roster of crayfish species with more than 65 known species. Despite this, its crayfish populations are understudied, with uncertainty surrounding their taxonomy, species boundaries, and more. This study seeks to examine population biology and cryptic speciation in the genus *Procambarus*, with focus on the members of the subgenus *Pennides*. Many members of this subgenus are cryptic, such as *Procambarus vioscai* complex, *P. clemmeri*, *P. penni*, *P. lagniappe*, *P. ouachitae*, *P. lylei*. Some of these crayfish have significant population overlap despite disjunct distributions across the state of Mississippi and neighboring states, along with morphologically putative species that are nearly identical. While field surveys, genetic analyses, and morphometric analyses are underway, here we examine existing knowledge of the group's biology, morphology, and ecology to highlight the ongoing need for further work.

Life history of the Pontchartrain Painted Crayfish *Faxonius hobbsi*, a species of greatest conservation need in Louisiana

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Crayfish extinction rates are higher than other freshwater fauna, and Louisiana lacks basic ecological information on most crayfish including species of greatest conservation need (SGCN). To improve crayfish conservation and preservation efforts, information on ecological and life history characteristics is critical to determine crayfish conservation status assignments. Therefore, the purpose of this project was to examine the life history characteristics of the Pontchartrain Painted Crayfish *Faxonius hobbsi*, a SGCN in Louisiana. Crayfish were sampled monthly from August 2023 – August 2025 in two streams in the Tangipahoa and Tchefuncte River basins. A total of 256 *F. hobbsi* were collected. Peak *F. hobbsi* capture occurred from May through August and *F. hobbsi* were documented mating in September and October 2023 and September 2024, suggesting a fall mating period. Additionally, a berried female *F. hobbsi* was documented in the Tchefuncte River in February 2025. These are the first records of *F. hobbsi* mating and a berried female. Multivariate analysis of variance indicated a significant difference in morphometric characteristics between male and female *F. hobbsi* (Wilks' Lambda = 0.83, $P < 0.001$), with larger female characteristics. However, the larger female size was likely an artifact of larger female collections. Analysis of covariance indicated significantly different slopes ($F_{1,204} = 871.72$, $P = 0.005$) for the palm width and carapace length relationship between sexes, with a higher positive slope for males compared to females. During the spring and summer *F. hobbsi* peak capture period, two (May-July) to three (August) cohorts were present with a mean monthly carapace length growth between 3-6 mm. The results from this study will provide the first comprehensive life history information for *F. hobbsi*. This information can aid resource managers with species management and conservation efforts and be incorporated into Louisiana's future ecosystem, watershed, and stream management decisions.

Contemporary Assessment of Crayfish Assemblages in the Altamaha River Basin, Georgia

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Crayfish are widespread, low-trophic consumers that play disproportionate roles in shaping freshwater ecosystems. As ecosystem engineers, they influence bank stability, sediment dynamics, and habitat structure through burrowing, while simultaneously recycling nutrients and supporting higher trophic levels. Despite their ecological importance, many crayfish species remain poorly understood due to cryptic diversity, variable life histories, and limited historical survey effort. In Georgia, the last comprehensive crayfish assessments were conducted in the 1980's, leaving major gaps in our understanding of species distributions, community structure, and conservation status. This project seeks to update and expand baseline knowledge of crayfish assemblages within the Altamaha River Basin (ARB), Georgia's largest drainage and a historically diverse center of crayfish endemism. We are conducting systematic sampling across all 41 HUC10 watersheds in the ARB using a combination of passive trapping, active hand and net collection, and burrow excavation. At each site, we are also quantifying environmental variables, including water quality metrics and habitat structure, to evaluate the abiotic drivers shaping crayfish community composition. Although still in early stages, this work contributes to a broader regional effort to reassess crayfish diversity across Atlantic-draining basins in the southeastern United States. By generating contemporary, basin-wide data on species distributions and habitat associations, this project will provide essential context for understanding how crayfish influence watershed resilience and will inform future management and conservation strategies for native crayfish communities.

Native Population Characteristics of *Pacifastacus leniusculus* (Dana, 1852) in Tryon Creek, Oregon

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Pacifastacus leniusculus (Dana 1852), the signal crayfish, is a freshwater astacid native to the Pacific Northwest and introduced in western Europe and Japan. Though *P. leniusculus* populations have been well-studied abroad, where they degrade local habitat and biodiversity, their ecology and natural history are less understood within their native range, where they fill key roles and risk out-competition by exotic crayfish. The present study describes density, morphology, and behavior of resident crayfish in a fourth-order Oregon stream, Tryon Creek, via surveys of nine sites from June–September 2022. A smaller set of four sites was sampled July–September 2023. Across sites, there was an estimated average *P. leniusculus* population density of 0.08 m⁻², and no exotic crayfish were detected. Amongst crayfish collected (n = 162), total body length (TL) ranged from 13–90 mm, $\mu = 53$ mm. Branchiobdellidans colonized one in four crayfish throughout Tryon Creek, damage to appendages occurred at a rate of 0.45, and the likelihood of both increased with TL. In a case study of Tryon’s Hwy-43 Culvert, crayfish showed potential signs of stress; across numerous sites, young juveniles resided gregariously. Despite the present study’s novel strides toward native-range *P. leniusculus* population characterization, further research is encouraged to establish a well-rounded regional baseline.

The New Student Has Claws: Eradication Efforts for an Introduced Red Swamp Crayfish Population on a University Campus

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Invasive crayfish threaten native biodiversity and can have substantial economic consequences. Red Swamp Crayfish (RSC; *Procambarus clarkii*) are among the most widespread invasive crayfish globally and can affect multiple trophic levels. Despite their impacts, there is currently no effective method for successfully eradicating invasive crayfish populations. In Missouri, RSC are native to the southeastern portion of the state but now occur in various introduced locations around the state. One of these introduced populations was discovered in a 150 m² ornamental pond on the University of Missouri campus. After becoming aware of the population in May 2025, we implemented a combination of mechanical and chemical removal techniques to eradicate the population. Nearly 6,000 individuals were removed during an eight-week intensive trapping and removal effort. Following this reduction, a chemical treatment was applied to the pond to target any remaining individuals. Although this treatment further reduced the population, complete eradication has not been achieved. Current efforts are focused on evaluating next steps, including whether additional eradication attempts are feasible or whether management should transition to long-term suppression to minimize the risk of secondary spread from this location. This invasion also highlights the value of citizen science in early detection. The population was initially reported by a student on campus, and observations from iNaturalist helped estimate the approximate age of the invasion. Moving forward, we plan to implement an educational campaign across campus, including signage at the pond, to increase awareness and reduce the likelihood of future introductions near the University of Missouri. These efforts highlight the challenges of invasive crayfish eradication while also emphasizing the importance of early detection and rapid response.

Crayfish movement ecology: a comprehensive literature review

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Crayfish movement underpins essential ecological processes, enabling individuals to meet life-history needs, locate food and shelter, evade predators, find mates, and establish new populations. Understanding movement patterns and rates is therefore critical for interpreting crayfish ecology and for informing conservation and management actions, particularly where invasive species are concerned. The spread of invasive individuals is a major component of the invasion process and is closely linked to crayfish movement. However, no comprehensive review of crayfish movement and dispersal exists, which makes it difficult to contextualize individual studies, and limits our ability to understand movement behaviors and capacities across crayfish taxa.

Our objective was to synthesize the global literature on crayfish movement and summarize the methods and findings of published studies. We extracted information on methodological approaches, movement modes and pathways, movement distances, rates and frequencies, biotic factors associated with movement, and environmental variables influencing movement. After an initial screening, we examined 292 papers in detail and extracted data from 138.

Most studies were conducted in Europe (53%) and North America (29%). Three genera—*Procambarus*, *Pacifastacus*, and *Faxonius*—comprised over 80% of movement research, with *Procambarus* being the most studied (31%). Two invasive species, *Pacifastacus leniusculus* and *Procambarus clarkii*, accounted for more than half of all studies, while *Faxonius rusticus*, *Astacus astacus*, and *Faxonius limosus* each comprised an additional 7–10%. Overall, approximately 65% of movement studies focused on non-native crayfishes. These patterns suggest that our understanding of crayfish movement is strongly shaped by a small number of invasive taxa. We note opportunities for advancing crayfish movement ecology through clearer conceptual framing, improved methodological standardization and reporting, and expanded taxonomic and geographic representation.

Ecomorphological Divergence in Missouri Crayfishes: Linking Habitat Specialization to Body Shape

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Ecological specialization is often characterized by predictable morphological adaptations that enable organisms to efficiently exploit specific habitats. Missouri crayfishes occupy a wide range of freshwater environments and can be categorized into four non-mutually exclusive ecomorphs: cave dwellers, stream dwellers, swamp dwellers, and burrowers. These groups differ markedly in habitat structure, hydrology, and behavioral ecology. Despite these clear ecological distinctions, quantitative assessments of morphological variation across crayfish ecomorphs remain understudied, leaving a gap in our understanding of how morphology reflects ecological specialization in this diverse system.

Here, we examine whether body shape variation in Missouri crayfishes reflects adaptation to different habitat types. We quantified variation in carapace, rostrum, abdomen, tail, and chela morphology using geometric morphometric approaches. Two-dimensional landmarks and semi-landmarks were digitized and analyzed following generalized Procrustes alignment to remove size and orientation effects. Principal component analyses of allometry-corrected shape coordinates were used to characterize the major axes of morphological variation across species and to assess whether species cluster according to ecomorph.

We predict that burrowers and swamp dwellers will exhibit wider chelae, broader carapaces, and shorter, more robust rostra suited for excavation. In contrast, stream and cave species are expected to display more elongated abdomens, narrower chelae, and more tapered rostra, traits that may enhance velocity during fast escape responses, a behavior critical for predator.

By linking morphology with habitat type, this study evaluates whether ecological specialization consistently predicts body shape in crayfishes and provides a quantitative framework for understanding morphological convergence and diversification across freshwater habitats.

Two new crayfish species (Decapoda: Cambaridae) from the James River Basin of Virginia, USA.

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Cambarus longulus was formally described by Charles Girard in 1852. Upon its naming, uncertainty already accompanied the species as Girard stated the initial labels were lost but noted it was collected from “the Middle States of the Union”. Over the next century, various treatments and names were applied to the species as it was absorbed and re-elevated to species level despite the original type specimen being lost in the Great Chicago fire. Treatments by James (1966) and Hobbs (1967) appeared to delineate the species and provide a new formal type locality; however, James noted considerable variation within the species across its range and described *Cambarus chasmodactylus* out of it. Recent work with the species throughout its known range has led to the understanding that it is a species complex requiring further taxonomic revision and that the name *Cambarus longulus* is not a valid taxon. Herein we present morphometric, genetic, and geographic evidence for two new species from the complex that occur within the James River Basin of Virginia with one species restricted to the forks of the Rivanna River and the second species occurring throughout the Middle James River.

Educational Opportunities in Home Crawfish Production

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Louisiana has long been recognized as a major crawfish production state. Composed of primarily Red Swamp Crawfish (*Procambarus clarkii*), commercial tonnage comes from wild and cultured sources. Of the cultured sources, most are relatively large (10 + hectares).

There is an opportunity for small landowners to likewise incorporate a crawfish production program on less than 0.02 hectares. Since 2014, such a small-scale crawfish production plot has been operated in St. Bernard Parish (Southeast Louisiana). Initially constructed as a demonstration pond for lower elementary school children, the pond eventually became the focus as an educational asset for high school aquaculture interns. Rotating annually, these interns work with the managing Louisiana Sea Grant staff on items such as crawfish biology, water quality, remedial actions, vegetation maintenance, crawfish harvest and seasonal, unflooded measures. As an incentive, these interns then receive four years of scholarship funds to be used for college expenses.

The educational benefits of a small-scale crawfish pond for single family operation are even more enriching to the individual children of the family. These small ponds are easily managed by a garden hose water system, coupled with a basic aeration mechanism (either forced air or agitated water). With the guidance of the parents and a counselor, school children can obtain a firm appreciation of elemental biology, home food production, and diligence in their work ethics. Crawfish produced within these systems can augment the family dinner table options, with 3-4 traditional Louisiana crawfish “boils” during the spring of each year. These small crawfish ponds on family property serve not only as an invaluable educational tool for the resident children but also provide an exciting experience in home food production that will stay in the memory of the children for a lifetime.