A PROPOSAL TO THE OURC/BAKER COMMITTEE

TITLE OF PROJECT: _Comparing Movement Patterns of Experienced vs. Naïve Head-start Diamondback Terrapins using Sonic Telemetry _____
NAME OF APPLICANT: __Willem M. Roosenburg _____
STATUS: _____ Asst. Prof. _____Assoc. Prof. __**X**___Prof. _____ Administrator

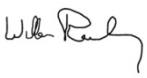
DEPARTMENT: ___Biological Sciences _____
E-MAIL ADDRESS: __roosenbu@ohio.edu _____

RE-SUBMISSION: ___ YES (Original Submission Date _____)
_**X**_ NO
BUDGET: Total Request ____$15,000.00_____
(May not exceed $15,000)

IRB AND IACUC APPROVAL:
To ensure that the University is in compliance with all federal regulations, complete the checklist below. Note: your proposal can be approved prior to IRB or IACUC approval, but funding will be withheld until notification of approval or exemption.

Yes	No	Office of Research Compliance	Policy #
	X	Human Subjects in Research (including surveys, interviews, educational interventions): Institutional Review Board (IRB) Approval #: Expiration Date:	19.052
X		Animal Species: Diamondback Terrapins, *Malaclemys terrapin* Institutional Animal Care & Use Committee (IACUC) Approval #: 13-L-023 Expiration Date: 2 February 2025	19.049

SIGNATURES

Applicant's Signature		**Chair/Director's Signature**	
Signature		Signature	
Name	Willem. M. Roosenburg	Name	Scott L. Hooper
Dept/School	Biological Sciences/CAS	Unit	Biological Sciences
Date	1 February 2023	Date	1 February 2023
Dean's Signature			
Name	Morgan Vis	Signature	
College	Arts and Sciences	Date	1 February 2023

✕ **Optional:**
If selected for funding, I give permission to the Office of the Vice President for Research and Creative Activity to use my proposal as an example during training and workshop exercises.

Signature:  Date:____ 1 February 2023 _____

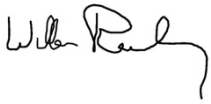
2. OURC/Baker Fund PROPOSAL CHECKLIST

Applicants **must** complete and sign the checklist. The checklist should be included as the second page of the application (following the cover page).

☑ Cover page	use Baker form
☑ Checklist	use Baker form
☑ Abstract*	1 double-spaced page
☒ Introduction (*for continuations or resubmissions only*)*	1 double-spaced page
☑ Discussion	10 double-spaced pages
☑ Durable Impacts & Sustainability*	1 double-spaced page
☑ Glossary/Definition of Terms* (*not required*)	2 double-spaced pages
☑ Bibliography (*not required*)	3 pages
☑ Biographical Information (*applicant(s) and key personnel*)	3 pages per person
☑ Other Support (*applicant(s) and key personnel*)	1 page per person
☑ Budget and Justification	no limit specified
☑ Appended Materials	10 pages; no more than 10 minutes of footage
☑ Recommended Reviewers	5 required
☑ Electronic copy of proposal	Single Acrobat file, containing entire proposal and required signatures

* These sections should be written in language understandable by an informed layperson to assist the committee in its review.

****Please note: The committee has the right to return without review any proposals that do not conform to these format requirements.****

Applicant signature: 

3. ABSTRACT

We will investigate how the movement and dispersal of head-started Diamondback Terrapins (*Malaclemys terrapin*) differs from similar sized individuals raised exclusively in the wild. Head-starting is a conservation tool that accelerates growth through vulnerable life cycle stages to enhance survival. We have head-started hatchling terrapins for 8 months in K-12 schools in Maryland since 2005. During head-starting, terrapins are offered food regularly in an environment that is dramatically different from their natural habitat. The head-starts are released in the spring, but their post-release survival rates are lower than expected for their size. Our goal is to determine if head-starts differ in movement and dispersal from their similar-sized wild counterparts. Collaborating with scientists from NOAA, we will use a **sonic telemetry** antenna array to evaluate the movement patterns of tagged terrapins. We ask 1) do naïve head-starts differ from their similar-sized wild counterparts in movement and dispersal, 2) do mature (recaptured at least 4 years after release) head-starts differ from their similar sized wild counterparts, and 3) can release location affect how naïve head-starts disperse. Questions one and two will compare 10 tagged individuals in four classes, juvenile naïve head-starts, mature post-release head-starts, juvenile wild, and mature wild individuals. Question three will compare 10 tagged naïve head-starts released at the mouth of tidal creeks (same 10 from experiment 1) vs. 10 new naïve head-starts released in the tidal creek headwaters. These comparisons will evaluate how head-starts movement differs from their wild counterparts and explain why their recapture rates are lower than expected. Understanding how behavior may differ because of head-starting will be of great interest to wildlife managers and can help guide the implementation of this conservation practice to make it more effective.

4. INTRODUCTION This is an original submission and thus this section is not applicable.

5. DISCUSSION

Specific Aims: We will use **sonic telemetry** to compare movement and dispersal of head-start vs. wild **Diamondback Terrapins** *(Malaclemys terrapin).* Terrapins are a species of brackish water turtles classified as Vulnerable by the **IUCN** (Roosenburg et al. 2019) throughout their native range in coastal habitats along the Atlantic and Gulf coasts of the U.S. Despite this extensive geographic range, terrapin populations are localized and there is little movement among population and females in particular show fidelity to nesting beaches (Butler et al., 2018; Converse and Kuchta, 2018. We will collect telemetry data of **head-started** and wild terrapins among two distinct size classes to evaluate how head-starts movement and dispersal may differ from their similar-sized wild counterparts both at time of release and after a prolonged period (several years) in the wild. Furthermore, we will investigate the effect of release site on movement by releasing naïve head-starts near the mouth of tidal creeks where they have been traditionally released and releasing naïve head-starts released in the tidal creek headwaters. This work will be completed in association with two existing projects, our ongoing terrapin monitoring/head-starting program and a National Oceanic and Atmospheric Administration (NOAA) fish tracking project that will be installing a static sonic telemetry receiver array and data collection system at our Poplar Island study site. The Baker fund will purchase sonic transmitter that will be attached to terrapins. We will address three research questions. First, do the movement and dispersal behaviors of naïve head-starts differ from those of wild turtles of comparable size? Second, do those same behaviors differ between mature (>4 years since release) head-starts and their wild counterparts? And third, can the site

of release affect the dispersal behavior of head-starts? Answering these questions will help us achieve the goal of understanding how movement and dispersal maybe altered by head-starting and exploring a technique that may improve the tool of head-starting.

Significance: Head-starting is a conservation practice that involves raising some offspring of a species in captivity for a portion of their lives before re-release into the wild, with the goal of protecting them during vulnerable life stages and improving their likelihood of surviving to adulthood (Burke 2015). This practice has been the source of some controversy. Frazer (1991) criticized head-starting as a "halfway technology," pointing out that supplementing the population does nothing to address the threats facing the species in question. Particularly in **chelonians**, population modelling has shown that many species of turtle are much more sensitive to changes in adult and juvenile mortality than hatchling survivorship (Congdon et al. 1993; Heppel 1998), and supplementing a population via head-starting is unlikely to have a significant effect on populations already in decline (Heppel & Crowder 1998). Despite these shortcomings, head-starting is still frequently used, both because it can be a valuable conservation tool when implemented in conjunction with other conservation efforts (Spencer at al. 2017) and because of the high public interest in conservation generated from personal experience with a charismatic wild animal such as a turtle hatchling (Frazer 1991; Burke 2015).

The long-term effects of head-starting on individuals in a population are not well understood. Recent research on Mojave Desert tortoises (*Gopherus agassizii)* indicates that head-starting may improve survivability of hatchlings and juveniles due to the head-starts' well-documented increased size at release compared to their wild counterparts of the same age (Tuberville et al. 2019; McGovern et al. 2020). However, scarcity of literature concerning the

long-term monitoring of head-start supplemented populations means that the potential behavioral effects of time spent in captivity are largely unknown (Seigel & Dodd 2000; Burke 2015).

Preliminary Studies: An ongoing head-start program and experiment focusing on a population of Diamondback Terrapins inhabiting Poplar Island in the Chesapeake Bay was established in 2005 and facilitates the captive rearing of 100-200 hatchlings year. The program has released nearly 3,000 head-starts to date, at sizes much larger than wild-reared, same-age members of the population. Mark-recapture data has documented the survival of many of these head-starts over the years, but despite having a higher recapture rate than wild terrapins, in fact most of the head-starts released are never recaptured (Roosenburg personal observation). Despite the substantial advantage in growth, the anticipated increase in survival associated with larger size is not observed in head-started terrapins on Poplar Island.

This discrepancy may be related to behavioral changes caused by captive-rearing of head-starts. The abrupt transition from aquarium to salt marsh may prove disorienting to young terrapins and lead to unexpected behaviors that affect dispersal and survival rates. Release site may also play a role in dispersal: head-starts are typically released near the bay inlets of wetland cells on the island, which provide access to either the wetland cell or the open ocean. This contrasts with potential release in the headwaters of a wetland cell, which may be a "softer" transition to life in the wild and, crucially, would not provide immediate access to the

Chesapeake Bay.

The dissemination of this work will be twofold. First, the project will be presented as a thesis for a Master of Science degree in ecology and evolutionary biology at Ohio University, and will be submitted for peer-review. Second, conclusions drawn from this research may guide head-starting practices at the Poplar Island study site and effect the efficacy of head-starting as a conservation tool.

Figure 1 – Map of Poplar Island near Sherwood MD. Numbers identify the cells. Green dots identify the proposed locations of the acoustic receivers.

Study site: Our study will be conducted on the Paul S. Sarbanes Ecosystem Restoration Project on Poplar Island (hereafter referred to as Poplar Island), in the middle Chesapeake Bay near Sherwood, Maryland (figure 1). Poplar Island is a more than 700-hectare manmade island placed on the footprint of the original Poplar Island which in 1850 was more than 450 hectares but by 1998 had eroded to less than 3 hectares. The restored Poplar Island is still under construction but upon completion will be approximately 50% tidal saltmarsh wetlands and 50% eastern coastal plain upland habitat. More than 140 hectares of wetlands have been completed in 8 cells (figure 1). The wetland cells have been engineered and built to replicate the geophysical and ecological processes characteristic of natural wetlands in

the area. As a result, many local organisms, including Diamondback Terrapins, have populated these wetland cells and their populations have increased in response to increased habitat created on Poplar Island.

Ongoing research by applicant(s): Diamondback Terrapin monitoring on Poplar Island was established in 2002 and in 2005 a terrapin head-start program was initiated raising terrapins in K-12 schools throughout MD. The head-starts are released in the spring after approximately 8 months of accelerated growth. Many of the head-starts at time of release weigh more than 100-200 grams and while similarly aged, wild terrapins weigh 8-12 grams. As of the spring of 2022, 16,349 wild hatchlings and 2,973 head-starts have been released on Poplar Island. A group of 151 hatchlings currently are being raised during the 2022-23 academic year with a targeted release in the spring of 2023. The proposed research will be performed in conjunction with the existing Poplar Island terrapin monitoring project and head-start program.

Animal Sourcing: All wild animals and the mature head-starts will be trapped on PI using fyke nets or capture by hand on land. We have extensive experience trapping terrapins and capture between 1000-1500 individuals annually. Head-starts are collected as hatchlings from PI and reared in K-12 classrooms throughout Maryland. We currently have 150 head-starts in classrooms in MD that will provide the 20 naïve animals to be telemetered in this study.

Methods: *Acoustic Array and Transmitters:* We will assist collaborators to install an array around Poplar Island. At least 77 stationary receivers (Innovasea VR2W -69 KHz receiver) will be anchored to the substrate in the waters throughout Poplar and nearby islands and in the completed wetland cells (figure 1). The receivers continuously accumulate the signals from tagged animals that pass within close (100-150m) line of sight proximity of receivers. The array

is designed to identify when tagged individuals enter and leave wetland cells via the inlets. Terrestrial movement between cells can be assessed by detections between cells without detection at the cell's inlet. Therefore, the movement among wetland cells and in the open water in Poplar Harbor can be documented. Furthermore, time between detections of receivers can be used to roughly estimate both rate and distance of movement of terrapins. Terrapins weighing between 100-200 g will be equipped with Innovasea V9-2X transmitters (wt. in air 3.6-4.9 g) with a battery life of more than 400 days (two active seasons – attached in spring 2023 with anticipated life through summer 2024). Large adult females will be equipped with a Innovasea V13 (wt. in air 9.2-11g) transmitters with a battery life in excess of 2 years. All transmitters will transmit at a frequency of 69 KHz and the pulse frequency and interval will vary to allow for unique identification of individuals. Ideal targeted weight of transmitters is less than 5% of animal mass. Transmitter mass will meet the weight criteria and their mass will be even less in water. Transmitters will be attached to the posterior edge of the carapace using cable ties and 5-minute epoxy. Two small holes (1 mm) will be drilled in the marginal **scutes** to attach the cable ties. Electrical tape will be placed over the scute sutures and then 5-minute epoxy will glue the transmitter to the shell and cover any sharp or protruding parts that might impede the turtles movement or potentially could get caught on vegetation or other stationary objects. After testing transmitters to make sure they are functioning properly, wild turtles will be released near point of capture; head-starts will be released in locations according to the design identified below.

Experimental Design: Questions one and two compare the movement and behavior of wild individuals vs head-starts and also naïve vs experienced animals. We will monitor four groups of turtles in a **2X2 factorial design** (table 1). The two classes are size and source. Source classes are head-starts vs. wild individuals; size classes will be adult vs. juvenile females. The juvenile head-starts will be naïve because they have never lived in the wild and therefore are experiencing a dramatic change in their environment from an 80L aquarium to the natural environment on Poplar Island. Juvenile wild animals will be individuals trapped on PI that are the same size as the head-starts (125-200 g) experiencing their initial release. Adult head-starts are 4+ years post release, mature females (>1000 g), that will be captured by trapping within the PI archipelago. Adult wild animals will be mature females that also will be trapped on PI. We intend to tag 10 individuals in each group for a total of 40 animal in this experiment. We are including mature head-starts because this allows us to evaluate if their behavior changes in the post release environment. Unfortunately, hatchlings are too small to support the weight of the smallest transmitter and therefore cannot be used in this study.

Table 1		**Source**	
		Head-start	Wild
Size	Juvenile	10	10
	Adult	10	10

Table 1: 2X2 factorial design with the number of individuals within each treatment of the experiment

Our third question compares release sites on Poplar Island. Head-starts have usually been released near the inlets to the wetland cells giving turtles the opportunity to enter either into the wetlands or into the open bay. We suggest this is similar to a **hard release**. We will compare these individuals to a 5th group of 10 turtles that will be released in the headwaters of the wetland cells creating a "softer" release into a more suitable juvenile habitat within the

wetland cells (table 2). The 10 head-starts released near the inlet will be the same individuals as the naïve head-starts from experiment 1 because most of the head-starts over the years have been released near the inlets to the wetland cells. These releases will occur in the wetland cells with the highest concentration of receivers to ensure optimal detection ability and more detailed evaluation of terrapin movement.

Table 2	**Release**	
	Headwaters	Inlet
Naïve HS	10	10

Table 2: Experimental design with the number of individuals within each treatment of the experiment. The headwater group will be the same individuals as the juvenile head-starts in experiment 1.

Data analysis: The data collected by the receivers is detection of an individual. Detections among receivers will allow us to identify presence/absence within the archipelago; calculate individual direction, distance, and rate of movement from detections between receivers; and mode of movement, terrestrial or aquatic. Direct comparisons can be made between naïve and experienced head-starts, and head-starts vs wild individuals in both size classes.

Timeline to project completion: Installation of the sonic receiver array will begin in the Spring of 2023, and the array will remain in place for two years. Naïve head-starts from the Fall 2022 cohort currently in captivity will be tagged prior to their scheduled release in Spring 2023. Wild juveniles, wild adults, and experienced head-starts meeting the criteria for each group will be opportunistically tagged upon capture during the active season in Spring 2023. The data collection period is estimated by the projected battery life of the Innovasea V9-2X transmitters used for juvenile terrapins, and thus will occur through Summer 2024. This time frame includes two active seasons for terrapins in the Spring/Summer months of 2023 and 2024. Data analysis will commence after the end of the first active season (Summer 2023) so that data collected

during the second active season (Summer 2024) can be quickly and efficiently analyzed and published. Additional data may be collected after the designated data collection period, as the Innovasea V13 transmitters used on adult terrapin subjects are likely to remain functional after this time frame.

Collaborations: The proposed research will be performed in conjunction with an forthcoming telemetry project initiated by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Coastal Ocean Science (NCCOS), which will focus on evaluating the use of restored wetland habitat on Poplar Island by fishes. We have entered a collaborative agreement with project leader Dr. Matt Kendall of the NOAA (see letter in appendix), a marine biologist with broad experience in applied science and marine conservation, including extensive experience with sonic telemetry. The fish monitoring project has already either purchased or secured funding for all of the sonic receivers needed for the proposed array (figure 1). We will assist with data collection, installation, maintenance of the array as needed for the expected 2-year duration of the fish monitoring project and intend to supply our own sonic transmitter tags compatible with the receivers.

As previously described, the proposed project will occur in conjunction with the ongoing terrapin monitoring project on Poplar Island. Animal subjects will be sourced from the existing head-start and mark-recapture programs, using established fyke net and hand capture methods (Roosenburg and Burke, 2018). Undergraduate field assistant from Ohio University will be hired to participate in the terrapin monitoring project will assist as needed with this study.

Confidentiality

There are no patent or confidentiality considerations for this project.

6. DURABLE IMPACT AND SUSTAINABILITY

1) Part of this project will be the M.S. Thesis for biological sciences graduate student Kelsey Krumm at Ohio University and contribute to her education. Her thesis will be a publication copyrighted at Ohio University. Additionally, each summer at least four Ohio undergraduates will be working with us as research assistants and part of their assigned duties will be to assist in the field work of this project.

2) We will publish the findings of this research in peer-reviewed scientific literature. Appropriate journals include *Conservation Biology, Conservation, Ecological Applic*ations, and *Herpetologica*. The publications will identify Ohio University as the home institution for this research and Baker/OURC funding will be identified in the acknowledgements of the resulting publications.

3) We will use the findings of this work to assist resource managers to develop better head-start methods and programs. By working with resource managers and NGOs interested in developing head-start programs we can help develop a set of best practice guidelines and conservation practices. My lab is actively involved in helping develop conservation strategies for terrapins and turtles in general.

4) Our project will be part of the TERP, Terrapin Education and Research Partnership, which engages K-12 classrooms throughout MD to head-start our turtles. More than 7,500 students annually participate in raising terrapins and being engaged in environmental curriculum with the goal of enhancing environmental literacy. TERP includes Ohio University, Maryland Environmental Services, the National Aquarium, and Calvert, Prince Georges, and Calvert Counties public school system. As the scientist in charge and science liaison with the teachers, each year prior to the arrival of the terrapins in classrooms I meet and present the updated findings of our research and monitoring that we are conducting on Poplar Island, and I will be including the results of this study in the future. The TERP Program is one of the most popular and sought after environmental education programs in MD and services as both a national and international model for using education as a conservation practice.

7. GLOSSARY

Chelonian: Members of the taxonomic order, or evolutionary group, Chelonia. This group consists of turtles, tortoises, and terrapins.

Diamondback Terrapin: *Malaclemys terrapin,* a species of turtle that inhabits coastal wetlands along the Gulf and Atlantic Coasts of the United States. Populations of Diamondback terrapins are currently in decline, and the species is classified as Vulnerable. Known for their unique coloration and natural charisma, Diamondback terrapins have become a key character in conservation education throughout their native range.

Hard release: Releasing animals directly into the wild, with no additional acclimatization.

Head-start/Head-starting: The practice of taking some young offspring of a species from the wild population, raising them in captivity through the most vulnerable stages of their life, and then releasing them back into the wild population, in the hopes of increasing overall population numbers by increasing the number of juveniles who survive to adulthood. Individuals that have received this treatment are sometimes referred to as head-starts.

IUCN – International Union of Conservation of Nature, the international body that governs and identifies the conservation status of species.

Scutes: Keratinized plates that make up the outer layer of most turtle's shell (singular: scute).

Soft release: Releasing animals into the wild with some amount of facilitated acclimation.

Sonic Receiver: A device that detects sound wave signals emitted by a **sonic transmitter**. Data received from the **transmitter** is collected and stored. Receivers must be within "line-of-sight" of **transmitters** to detect these signals, so they are typically installed in a large grouping called an array to maximize the chance that any given signal is detected.

Sonic Telemetry: The use of sound waves for remote data collection. Requires **transmitter** and **receiver** equipment.

Sonic Transmitter: A device that emits a “beam” of sound waves at a regular interval. These signals use slight differences in soundwaves to create a unique “barcode” for each transmitter, which can be detected by a **sonic receiver**.

2x2 Factorial Design: An experimental design method that involves assigning subjects randomly into 1 of 2 groups for one category of data, then additionally assigning those subjects randomly into 1 of 2 groups for a second category of data, creating 4 unique study groups. This method allows for the testing of two hypotheses at once.

8. BIBLIOGRAPHY

Burke, R. L. (2015). Head-starting turtles: learning from experience. *Herpetological Conservation and Biology, 10*(1), 299-308.

Butler, J.A., Burke, R.L., Roosenburg, W.M. (2018). Reproductive behavior and ecology. In W.M. Roosenburg & V.S. Kennedy (Eds.), *Ecology and conservation of the diamond-backed terrapin* (pp 81-92). Johns Hopkins University Press.

Congdon, J.D., Dunham, A. E., Van Loben Sels, R.C. (1993). Delayed sexual maturity and demographics of Blanding's turtles *(Emydoidea blandingii):* implications for conservation and management of long-lived organisms. *Conservation Biology, 7*(4), 826-833. doi: http://www.jstor.org/stable/2386814

Converse, P.E., Kuchta, S.R. (2018). Molecular ecology and phylogeography. In W.M. Roosenburg & V.S. Kennedy (Eds.), *Ecology and conservation of the diamond-backed terrapin* (pp 51-62). Johns Hopkins University Press.

Frazer, N. B. (1992). Sea turtle conservation and halfway technology. *Conservation biology*, *6*(2), 179-184. doi: https://doi.org/10.1046/j.1523-1739.1992.620179.x

Heppel, S.S. (1998). Application of life-history theory and population model analysis to turtle conservation. *American Society of Ichthyologists and Herpetologists, 1998*(2), 367-375. doi: https://doi.org/10.2307/1447430

Heppel, S.S., Crowder, L.B. (1998). Prognostic evaluation of enhancement programs using population models and life history analysis. *Bulletin of Marine Science, 62*(2), 495-507.

McGovern, P.A., Buhlmann, K.A., Todd, B.D., Moore, C.T., Peaden, J.M., Hepinstall-Cymerman, J., Daly, J.A., Tuberville, T.D. (2020). The effect of size on postrelease survival of head-started Mojave Desert Tortoises. *Journal of Fish and Wildlife Management, 11*(2), 494-506. doi: https://doi.org/10.3996/JFWM-20-014

Roosenburg W.M. and R. L. Burke. (2018). Field Techniques. In: W.M. Roosenburg and V. S. Kennedy (eds.) *Ecology and Conservation of the Diamond-backed Terrapin*. (pp 7-25). Johns Hopkins University Press.

Roosenburg, W.M., Baker, P.J., Burke, R., Dorcas, M.E. & Wood, R.C. (2019). *Malaclemys terrapin*. *The IUCN Red List of Threatened Species* 2019: e.T12695A507698. https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T12695A507698.en. Accessed on 01 February 2023.

Seigel, R.A., Dodd, C.K. (2000). Manipulation of turtle populations for conservation: Halfway technologies or viable options? In M.W. Klemens (Ed.), *Turtle conservation* (pp. 218-238). Smithsonian Institute press.

Spencer, R.J., Van Dyke, J.U., Thompson, M.B. (2017). Critically evaluating best management practices for preventing freshwater turtle extinctions. *Conservation Biology, 31*(6), 1340-1349. doi: https://doi.org/10.1111/cobi.12930

Tuberville, T.D., Buhlmann, K.A., Sollmann, R., Nafus, M.G., Peaden, J.M., Daly, J.A., Todd, B.D. (2019). Effects of short-term, outdoor head-starting on growth and survival in the Mojave Desert Tortoise *(Gopherus agassazii)*. *Herpetological Conservation and Biology, 14*(1), 171-184.

9. BIOGRAPHICAL INFORMATION

WILLEM MARTIJN ROOSENBURG

Education

Ph.D. Biology, University of Pennsylvania, Philadelphia, Pennsylvania; 1992;
M.A. Biology, State University College at Buffalo, Buffalo, New York; 1986;
B.S. Zoology, University of Rhode Island, Kingston, Rhode Island; 1981;

Academic Positions

Professor: Department of Biological Sciences, Ohio University, 2012 – present
Associate Professor: Department of Biological Sciences, Ohio University, 2001 - 2012
Adjunct Professor: Voinovich School of Leadership and Public Affairs, Ohio University 2010 - present
Adjunct Professor: Horn Point Environmental Laboratory, University of Maryland, 2007 - present
Director: Ohio University Center for Ecology and Evolutionary Studies 2006- 2007
Visiting Scientist: USGS Patuxent Wildlife Research Center 2003
Assistant Professor: Department of Biological Sciences, Ohio University, 1995 - 2001
Postdoctoral Fellow: Department of Biological Sciences, Ohio University, 1994 - 1995
Visiting Assistant Professor: Department of Biology, Hood College; 1993 - 1994
Visiting Assistant Professor: Department of Biology, East Carolina University; 1992 - 1993

Books (since 2018)

2018 Roosenburg, W.M. and V. S. Kennedy (eds.) Ecology and Conservation of the Diamond-backed Terrapin. Johns Hopkins University Press.

Peer-reviewed Publications (Since 2018)

2022 Bryan S Vorbach, B.S. L.A. Clayton, W.M. Roosenburg, T.M. Norton, L. Adamovicz, C.A. Hadfield, M.C. Allender. Prevalence of multiple reptilian pathogens in the oropharyngeal mucosa, cloacal mucosa, and blood of Diamond-backed Terrapin (*Malaclemys terrapin*) populations from Maryland and Georgia, USA Journal of Wildlife Diseases 58:782–790 **https://doi.org/10.7589/JWD-D-21-00107**.

2021 Temple-Miller, K. G., W. M. Roosenburg and M. M. White. Ouachita Map Turtle *Graptemys ouachitensis ouachitensis* (Cagle 1953). In: J.G. Davis, G. Lipps, Jr., D. Wynn, B. J. Armitage, T. O. Matson, R. A. Pfingston, and C. Caldwell. (eds.) *Reptiles of Ohio*. pages 201-209. Ohio Biological Survey Inc

2021 Richards-Dimitre, T., K. G. Temple-Miller, and W. M. Roosenburg, Northern Map Turtle *Graptemys geographica* (LeSueur 1817). In: J.G. Davis, G. Lipps, Jr., D. Wynn, B. J. Armitage, T. O. Matson, R. A. Pfingston, and C. Caldwell. (eds.) *Reptiles of Ohio*. Pages 179-200. Ohio Biological Survey Inc

2020 Stanford, C.B., J.B. Iverson, A Rhodin, et al. Turtle and tortoises in trouble. Current Biology 30:R721–R735.

2019 Roosenburg, W. M., P. J. Baker, R. Burke, M. E. Dorcas and R. C. Wood. *Malaclemys terrapin* – (Schoepff 1793) Red List Assessment. IUCN Red List Website.

2018 Roosenburg W.M. and R. L. Burke. Field Techniques. In: W.M. Roosenburg and V. S. Kennedy (eds.) *Ecology and Conservation of the Diamond-backed Terrapin*. Johns Hopkins University Press.

2018 Butler, J. A., R. L. Burke, W. M. Roosenburg. Reproductive Behavior and Ecology. In: W.M. Roosenburg and V. S. Kennedy (eds.) *Ecology and Conservation of the Diamond-backed Terrapin*. Johns Hopkins University Press.

Peer-reviewed Publications **(Since 2018)**

2018 Roosenburg, W. M. Habitat restoration and Head-starting. In: W.M. Roosenburg and V. S. Kennedy (eds.) *Ecology and Conservation of the Diamond-backed Terrapin*. Johns Hopkins University Press.
2018 Butler, J.A. and W. M. Roosenburg. The future for Diamond-backed terrapins. In: W.M. Roosenburg and V. S. Kennedy (eds.) *Ecology and Conservation of the Diamond-backed Terrapin*. Johns Hopkins University Press.
2018 Hormoda, S. J., C. A. F. Howey, M. B. Dickinson R. W. Perry and W. M. Roosenburg. Response of reptile and amphibian communities to the reintroduction of fire in an oak/hickory forest. Forest Ecology and Management 428:1-13.
2018 Janzen, F. J., L. A. Hoekstra, R. J. Brooks, D. M. Carroll, J. W. Gibbons, J. L. Greene, J. B. Iverson, J. D. Litzgus, E. D. Michael, S. G. Parren, W. M. Roosenburg, G. F. Strain, J. K. Tucker, G. R. Ultsch. Altered spring phenology of North American freshwater turtles and the importance of representative populations. Ecology and Evolution 8:5815-5827.

Technical Reports **(Since 2018)**

2022 Roosenburg, W. M., D. Cole, and K. Field. Terrapin monitoring on the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island 2019. Final Report submitted to the Army Corps of Engineers. Baltimore District pp. 84.
2022 Roosenburg, W. M., D. J. Legler and K. Field. Terrapin monitoring on the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island 2018. Final Report submitted to the Army Corps of Engineers. Baltimore District pp. 68.
2020 Roosenburg, W. M., A. F. Tokash, and D. J. Legler. Terrapin monitoring on the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island 2017. Final Report submitted to the Army Corps of Engineers. Baltimore District pp. 78.
2018 Hopkins, C. B, J. S. Johnson, S. R. Kuchta, D. S. McAvoy, V. D. Popescu, S. C. Porter, W. M. Roosenburg, G. P. Sisson, B. R. Sperry, M. T. Trainer, R. L. Wiley. Effectiveness of wildlife mitigation treatments along the Nelsonville Bypass. Ohio Department of Transportation http://cdm16007.contentdm.oclc.org/cdm/ref/collection/p267401ccp2/id/16796. pp. 239.
2018 Roosenburg, W. M., and A. F. Tokash. Terrapin monitoring on the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island 2016. Final Report submitted to the Army Corps of Engineers. Baltimore District pp. 71.

Invited Talks **(Since 2018)**

2021 Joint Meeting of Ichthyologist and Herpetologists - Plenary Lecture. Overcoming the curse of Sisyphus: Progress in terrapin conservation. Virtual presentation Phoenix AZ.
2021 Woods Hole Oceanographic Institute, Marine Biological Laboratory: Climate change and head-starting: Influencing life histories turtle speed ahead. Virtual presentation – Woods Hole, MA
2020 University of Georgia – Warnell School of Forestry and Natural Resources: Manipulating turtle life histories using head-starting and implications for citizen science. Athens, Georgia
2019 Ohio University, Rakowski Award Seminar, Athens Ohio. Manipulating turtle life histories: turtle speed ahead.
2019 Ohio Partners in Amphibian and Reptile Conservation symposium. Columbus, Ohio. The Rocky Reality of Roadways and Timber Rattlesnakes*:* Conservation of Small Diffuse Populations. With G. Sisson
2018 The Wildlife Society, Cleveland Ohio. Empirically assessing head-starting as a conservation tool for freshwater turtles with D. Jenkins, A. R. Tokash, N. Smeenk and P. Converse.
2018 Commission for Environmental Cooperation, Miami, Florida. A tale of two populations: Can diamondback terrapins be sustainably harvested?

Contributed presentations and Posters **(Since 2018)**

2022 The 9th Symposium on the Ecology, Status and Conservation of the Diamondback Terrapin. Athens GA. Demographic Comparison of Head-start vs. Natural Release Terrapin Hatchlings Paper with J. Joos, N Smeenk, P. Converse, D, Jenkins, and A. Tokash

2020 Southeastern PARC, Navoo, Alabama Combining environmental restoration with Community science to restore turtle populations. Paper with David Jenkins, Alayna F. Tokash, and Nick A. Smeenk

2019 The 8th Symposium on the Ecology, Status and Conservation of the Diamondback Terrapin. Wilmington NC. Manipulating life histories: turtle speed ahead. With P. Converse, D. Jenkins, A. Tokash, and N. Smeenk.

Contributed presentations and Posters **(Since 2018)**

2019 Joint Meeting of Ichthyologists and Herpetologists. Snowbird, Utah. Using K-12 Classrooms to Head-start Diamond-backed Terrapins and Evaluate Differences in Growth due to Temperature and Behavior. With A. Tokash.

2018 8th Annual Ohio University/John Carroll University Herpetology Symposium. John Carroll University, Cleveland, OH. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs.” Poster with: Hopkins, C. B., S. R. Kuchta.

2018 The Wildlife Society’s 25th Annual Conference. Cleveland, OH. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs.” Talk with: Hopkins, C. B., S. R. Kuchta.

2018 Ohio Transportation Engineering Conference. Columbus, OH. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs." Poster with: Hopkins, C. B., S. R. Kuchta.

2018 Ohio Transportation Engineering Conference. Columbus, OH. “Evaluating effectiveness of an amphibian barrier-ecopassage mitigation structure and designing an improved structure.” Poste withr: Hopkins, C. B., K. E. Harman, & S. R. Kuchta.

2018 Northeastern Transportation and Wildlife Conference. Amherst, MA. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs.” Talk: Hopkins, C. B., S. R. Kuchta.

2018 Joint Meeting of Ichthyologists and Herpetologists. Rochester, NY. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs.” Talk with: Hopkins, C. B., S. R. Kuchta.

2018 Marietta Natural History Society. Marietta College, Marietta, OH. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs.” Talk with: Hopkins, C. B., S. R. Kuchta, & W. M. Roosenburg.

2018 Ohio University Student Research and Creative Activity Expo. Ohio University, Athens, OH. “How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs.” Poster with: Hopkins, C. B., S. R. Kuchta. (First place in group: $150).

2018 Ohio Partners in Amphibian and Reptile Conservation Annual Meeting. Columbus, OH. "How to build a better ecopassage: evaluating amphibian use and preference of various ecopassage designs." Poster with: Hopkins, C. B., S. R. Kuchta.

2018 Ohio University Student Research Expo, Athens, OH. Do non-invasive tagging events induce stress in long-finned pilot whales (*Globicephala melas*)? Poster with: S.C.Cones, L. Sayigh.

2018 The John Carroll University / Ohio University Herpetology Symposium, Cleveland, Ohio. Somatic growth in head-started Diamond-backed Terrapins and their wild counterparts. Poster with: , A.T. Tokash.

2018 Annual Meeting for the Society of Integrative and Comparative Biology, San Francisco, California. Within and among year variation in reproductive output from two populations of the Diamond-backed Terrapin, *Malaclemys terrapin*. Talk with: A.T. Tokash.

2018 Ohio Natural History Conference. Cleveland, OH. “Amphibian Roadway Crossing Behavior and Implications for Population Persistence.” Poster with: Hopkins, C. B., S. R. Kuchta.

2018 58th Ohio Wildlife Conference. Columbus, OH. “Assessment of an amphibian mitigation structure along a two-lane highway.” Talk: Hopkins, C. B., S. R. Kuchta, & W. M. Roosenburg.

KELSEY KRUMM

Education

M.S. Biology, Ohio University, Athens, Ohio, expected 2024

B.A. Biology, Capital University, Bexley, Ohio, 2019

Academic positions

Graduate Research Assistant, Department of Biological Sciences, Ohio University, 2022-present.

Contributed posters

Krumm, K.M., Simonton, E., Thomspon, O. (2018). *Amphibian tissue sampling for* Batrachochytrium dendrobatidis *at Primmer outdoor learning center* [Poster Presentation]. Undergraduate Research Symposium, Capital University, Bexley, Ohio.

Relevant workshop participation

2022 Annual head-start training for participating teachers. St. Michaels, Maryland.

10. OTHER SUPPORT

A. Previous University Funding:

1) I received an Undergraduate Summer Internship grant funded through ORSP during the summer of 2022. Paid the summer stipend for undergraduate field research assistant.

2) Program to Aid Career Exploration (PACE) - Every year during the past three years I have received four PACE positions. Three of the PACE positions are for field research assistant in Maryland to assist in my terrapin research on Poplar Island. I have also held a fourth PACE position that funds an undergraduate to assist with data management and report preparation during the academic year. I plan to apply for the renewal of these positions for the next two academic years.

3) Undergraduate Experiential Learning Stewardship Grant ($5000.00). Offered through the Office of Experiential Learning. Awarded for the summers of 2020 and 2021. This grant funded two undergraduate field research assistant stipends, one each during the summer of 2020 and 2021.

B. External Funding

2022 Maryland Department of Transportation Maryland Port Administration ($72,725) Terrapin Monitoring at Poplar Island – Contract Extension

2021 Maryland Department of Transportation Maryland Port Administration ($72,393) Terrapin Monitoring at Poplar Island – Contract Extension

2020 Maryland Department of Transportation Maryland Port Administration ($66,946) Terrapin Monitoring at Poplar Island – Contract Extension

The fiscal year for these continuing contracts is from July 1-June 30 and I have sustained for my terrapin monitoring on Poplar Island since 2002. I will be submitting a contract renewal for the 23-24 fiscal year in February. This contract will cover travel and living expenses for the personnel involved in this project. It also will cover fuel used to and from the island, docking fees, and maintenance for the boat. NOAA will pay for all the equipment needed to create the sonic telemetry antenna array.

11. BUDGET & JUSTIFICATION

Budget	Source	Total
Sonic transmitters - 50 Innovasea $400/transmitters	**Baker/OURC** **Other**	**$14,600** **$ 6,000**
Expendables – fuel, epoxy, cable ties etc.	**Baker/OURC**	**$ 600**
Travel - Lodging / Food for Research Team	**MDOT-MPA**	**$ 3,000**
Boat travel to and from Poplar Island	**MDOT-MPA**	**$ 3,000**
Equipment for Sonic Antenna Array	**NOAA**	**> $150,000**

Justification

We propose to use a variety of funding sources to deliver this project. First the cost of the stationary array and its installation will be covered by NOAA which has an Engineering with Nature grant to cover the cost for the purchase, installation, and maintenance of the antenna array (please see attached letter from Matt Kendal NOAA, in Appended materials). We have entered into a collaborative agreement with Matt Kendall to move forward with the terrapin telemetry project and they will cover the cost of the array installation and we will assist with the labor of installation. We also will have a boat on site that will assist with the array installation, maintenance, and data downloads when necessary (fuel in expendable supplies above). We will be working on Poplar Island from 1 May until 8 August so will be there through most of the active season when the array needs to be maintained. We are requesting from the Baker/OURC Fund monies to buy transmitters. Transmitters are $400 / transmitter with an estimated total cost of $20,000 for 50 transmitters. We will apply for Ohio University in house funds (Baker Grant) to pay for 36 transmitters plus $600 in expendable supplies (fuel for the boat, epoxy, and other supplies. We hope (with the permission of MDOT-MPA) to raise the money for the additional 20 transmitters ($8,000) using crowd sourcing initiated in the classrooms that are raising the terrapins. This will cover the costs of the transmitters used for the head-starts. We intend this to enhance the educational experience for the students by providing an additional experiential learning opportunity. Finally, travel costs associated with this project will be covered by a contract from MDOT-MPA currently held in my lab.

12. APPENDED MATERIALS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Centers for Coastal Ocean Science
Silver Spring, Maryland 20910

January 20, 2023

Center for Ecology and Evolutionary Studies
Department of Biological sciences
Ohio University
Athens, Ohio 45701

Dear Dr. Roosenberg:

I am providing this letter of support for your Ohio University grant proposal which seeks to understand aspects of diamondback terrapin habitat utilization at Poplar Island, Maryland. Beginning in 2023, my office at NOAA is funded by the U.S. Army Corps of Engineers to conduct a two-year study of fish movements among the restored and man-made creeks, ponds, motes, and interconnected marsh habitats at Poplar Island. We will install an array of ~77 hydroacoustic data loggers (Innovasea model VR2W, >$150,000 of telemetry equipment) throughout the Poplar Island system in order to document the habitat utilization and residency patterns of fishes. The array will detect the movements of aquatic organisms tagged with coded acoustic transmitters. The system enables researchers to determine which habitat types and engineered marsh cells the individual organisms are present in. The array will be installed and maintained by NOAA. Approximate installation date will be April 2023, downloads of the loggers will be conducted approximately every 6 months, and the array will be removed ~2 years after installation.

Although our research is focused on fishes, we are very excited that the unique opportunity provided by the array can be utilized by other researches using the same transmitter types on other organisms such as diamondback terrapins. We enthusiastically support your proposal to investigate habitat utilization patterns of various size classes and rearing histories of terrapins using our array. We will share all data downloads from the array as soon as possible once they are completed.

We look forward to collaborating on this interesting study, sharing resources, and expanding our collective knowledge of the Poplar Island ecosystem. Don't hessite to contact me should you require additional information.

Sincerely,

Dr. Matt Kendall, Ph.D.
Marine Biologist
NOAA/NOS/NCCOS/Marine Spatial Ecology Division/Biogeography Branch
matt.kendall@noaa.gov