**Institutional Effectiveness**
**2019-2020**

**Program:** Environmental Sciences Ph.D.

**College and Department:** College of Interdisciplinary Studies – School of Environmental Studies

**Contact:** Dr. Hayden Mattingly

**Mission:** The Environmental Sciences (EVS) doctoral program's mission is to advance the knowledge and promote the leadership necessary to understanding natural environments by incorporating perspectives from social sciences, humanities, and environmental sciences in the program's teaching and research in the fields of natural resources and the environment.

Concentrations: There are five concentrations available within the EVS Ph.D. program:

(1) Agriculture; (2) Biology; (3) Chemistry; (4) Geosciences; and (5) Integrated Research.

The Agriculture, Geosciences, and Integrated Research concentrations were officially added in Spring 2018.

**Program Goals:**

1. Environmental Sciences students will receive detailed interdisciplinary training and experience to enable them to address complex environmental problems with greater effectiveness.

2. EVS student research projects will be peer-reviewed and widely recognized for their innovation and relevance to environmental concerns.

3. Add new concentrations to the Environmental Sciences PhD program.

**Student Learning Outcomes**

1.1. Students will demonstrate understanding of the interdisciplinary nature of environmental sciences such that they are aware of a wide range of environmental concerns beyond the boundaries of any single, specific discipline.

2.1**.** Students will improve oral and written communication skills by giving technical presentations at symposia, conferences, and similar venues where abstracts are peer-reviewed for acceptance.

2.2. Students will improve written communication skills by submitting manuscripts to peer-reviewed publications such as scholarly journals, conference proceedings, books, or similar outlets.

A departmentally developed curriculum map can be found in Appendix 1 that shows the connections between courses and student learning outcomes.

**Assessment Methods:**

1. *Comprehensive Exams - Outcome 1.1:* The EVS faculty will monitor student understanding of the interdisciplinary nature of environmental science by the administration of oral and written comprehensive exams. The comprehensive exam is interdisciplinary and is comprised of questions written by each member of the graduate advisory committee. The results of these exams are kept on file by the EVS Director.

   The timing of the comprehensive exams represents an ideal opportunity for assessment because the student has just completed all or nearly all of his/her coursework. The exams are provided in two different formats (written and oral) that allow better insight into the student's interdisciplinary knowledge and proficiency. The student's graduate advisory committee discusses the results and provides paper copies of the exams to the Director, who monitors the results to maintain integrity and consistency.

2. *Student Annual Reports - Outcomes 2.1 and 2.2:* In December of each year, the program Director requests annual reports from each student that cover the previous 12-month period. Reports are due by the end of January. For example, student reports received in January 2019 covered the reporting period of January-December 2018. Students are provided with a template to follow when preparing reports. The Director and academic staff members review each report and tally the total number of presentations and publications generated by students during the reporting period.

   EVS students are required to submit an annual report to allow direct assessment of student productivity and development of written and communication skills in terms of presentations and publications. The report template also requires additional details regarding the nature of the presentation or publication. For example, the presentation might be at an international conference rather than a state meeting, or the publication might be in a high-impact journal as opposed to a regional journal. These details can be used to generate a more refined analysis of the TTU EVS program's impact on the wider discipline of environmental sciences. Annual reports have the added benefit of student professional development because their CVs are current and updated with each successive year's accomplishments.

3. *Annual count of number of concentrations - Program Goal 3:* Once per year (at the end of the state fiscal year in June) the SOES Director will tally the number of available concentrations and track them longitudinally through time.

   The EVS Ph.D. program historically only had two concentrations available for students, Biology or Chemistry. Future growth in enrollment and interdisciplinary development was limited; therefore, the EVS Executive Committee voted on September 15, 2017, to approve three additional concentrations: Agriculture; Geosciences; and Integrated Research. Furthermore, in the upcoming 5-year period, we will be discussing the addition of a Low-Residency option for the EVS Ph.D. program. Increasing the number of concentrations will increase the number of students whose background and interests are closely aligned with agriculture and earth sciences, those who have a strong interdisciplinary research focus, as well as those who live and work at a distance.

**Results:**

*1.1. Students will demonstrate understanding of the interdisciplinary nature of environmental sciences such that they are aware of a wide range of environmental concerns beyond the boundaries of any single, specific discipline.*

All six of the EVS students taking their comprehensive exams successfully passed during the 2019-2020 reporting period. Student performance and interdisciplinary proficiency on both written and oral aspects were approved by the EVS faculty graduate advisory committees.

*2.1. Students will improve oral and written communication skills by giving technical presentations at symposia, conferences, and similar venues where abstracts are peer-reviewed for acceptance.*

*2.2. Students will improve written communication skills by submitting manuscripts to peer-reviewed publications such as scholarly journals, conference proceedings, books, or similar outlets.*

Student productivity related to written and oral communication in 2019 was similar to data from the previous two years for conference attendances and poster and oral presentations (Table 1). In 2019, students made 32 conference attendances and gave 15 poster presentations and 16 oral presentations. However, the number of manuscripts submitted (*n* = 27) was nearly twice the number submitted in 2018 and set a new high point for manuscript production. Furthermore, the number of manuscripts published reached a new high mark of 16 publications in 2019, again exceeding the written productivity achieved during previous reporting periods. Productivity in written and oral communication was present in most EVS concentrations but was especially evident in the Biology Concentration which currently houses the greatest number of enrolled students (Table 2). One EVS-Biology student submitted 10 journal manuscripts in 2019, which obviously accounts for some of the increase in manuscript submissions. However, increased manuscript productivity could also reflect overall enrollment growth of the EVS program, which has seen enrollment increase from 17 students in 2017 up to 20 in 2018 and again up to 24 in 2019. The 16 manuscripts published in 2019 appeared in a wide range of journals. EVS students were first authors on seven of the 16 publications.

Table 1. Scholarly activity related to oral and written communication skills shown by EVS Ph.D. students in the current (2019) and previous five calendar-year reporting periods. EVS enrollment ranged from 14 to 17 students during 2014–2017 and then climbed to 20 students in 2018 and 24 students in 2019.

| Type of scholarly activity | Student annual report period | | | | | |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Conference attendances | 13 | 15 | 25 | 22 | 32 | 32 |
| Poster presentations | 8 | 14 | 17 | 14 | 15 | 15 |
| Oral presentations | 8 | 8 | 9 | 26 | 19 | 16 |
| Manuscripts submitted | 6 | 12 | 10 | 13 | 14 | 27 |
| Manuscripts published | 6 | 8 | 12 | 14 | 10 | 16 |

Table 2. EVS student activities during the reporting period of January-December for 2018 and 2019 in the Agriculture, Biology, Chemistry, Geosciences, and Integrated Research concentrations.

| Year | Conference Attendances | Technical Presentations | | | Manuscripts | |
|---|---|---|---|---|---|---|
| | | Poster | Oral | | Submitted | Published |
| *Agriculture Concentration* | | | | | | |
| 2018 | 0 | 0 | 0 | | 0 | 0 |
| 2019 | 2 | 0 | 0 | | 0 | 1 |
| *Biology Concentration* | | | | | | |
| 2018 | 18 | 9 | 9 | | 11 | 9 |
| 2019 | 23 | 8 | 15 | | 24 | 12 |
| *Chemistry Concentration* | | | | | | |
| 2018 | 9 | 6 | 5 | | 1 | 1 |
| 2019 | 5 | 5 | 0 | | 2 | 0 |
| *Geosciences Concentration* | | | | | | |
| 2019 | 0 | 0 | 0 | | 0 | 0 |
| *Integrated Research Concentration* | | | | | | |
| 2018 | 5 | 0 | 5 | | 2 | 0 |
| 2019 | 2 | 2 | 1 | | 1 | 1 |
| *Total* | | | | | | |
| 2018 | 31 | 15 | 19 | | 14 | 10 |
| 2019 | 32 | 15 | 16 | | 27 | 16 |

Table 3. Sixteen journal publications from 2019 co-authored by EVS Ph.D. students (names shown in bold text).

- **Applegate, R.D.**, S.E. Hayslette, B.A. Robinson, C.M. Rhoden, and J. J. Morgan. 2019. First documentation of feather fault bars in the northern bobwhite. Northeastern Naturalist 26(1):116–118.
- **Brown, R.S.** and A.E. Hershey. 2019. Potential effects of the invasive bivalve, *Corbicula fluminea*, on methane cycling processes in an urban stream. Biogeochemistry 144:181–195. doi: 10.1007/s10533-019-00578-1
- **Godwin, C.D.**, J.S. Doody, D. Rhind, S. Clulow, K.F. Soennichsen, C.M. Murray, B. Bartek, S. Severin, and L. Severin. *In Press*. Natural History Note: *Varanus gouldii* (Gould's monitor) diet and cannibalism. Herpetological Review.
- Green, M.W., **W. Blum**, S.C. Sellers, M.M. Gangloff, L.M. Jacobus, S.R. Tuberty. 2019. Mesohabitat current velocity effects on *Didymosphenia geminata* and macroinvertebrates in a SE USA hypolimnetic tailwater. Freshwater Ecology 53:607–628. doi:10.1007/s10452-019-09712-5
- Hurt, C.R., Thoma, R.F., Withers, D.I., Williams, C.E., and **Paine, R.T.R.** Extensive regional endemism and cryptic diversity in Tennessee and Kentucky, USA populations of the burrowing crayfish *Cambarus deweesae* (Bouchard & Etnier, 1979) (Decapoda: Astacidae: Cambaridae) as revealed by molecular genetics. Journal of Crustacean Biology 39(4):440–449. https://doi.org/10.1093/jcbiol/ruz027
- Kluber, L.A., **A. Allen**, J.N. Hendershot, P.J. Hanson, and C.W. Schadt. *In Press*. Constraints on microbial communities, decomposition and methane production in deep peat deposits. PLOS

One. Preprint at https://www.biorxiv.org/content/10.1101/787895v1.article-metrics. doi: https://doi.org/10.1101/787895

- Lancaster, J.D., S.E. McClain, M.C. Gross, C.N. Jaques, **M. Masto**, R.M. Kaminski, and H.M. Hagy. 2019. Assessment of excreta collection methods to estimate true metabolizable energy of waterfowl foods in wild ducks. The Wildlife Society Bulletin 43:282–290.
- McKay, T., **P. Bowombe-Toko**, L.A. Starkus, F.H. Arthur, and J.F. Campbell. 2019. Monitoring of *Tribolium castaneum* (Coleoptera: Tenebrionidae) in Rice Mills using Pheromone-baited Traps. Journal of Economic Entomology 112(3):1454–1462. https://academic.oup.com/jee/article/112/3/1454/5306467
- Rhind, D., J.S. Doody, S. Clulow, **Godwin**, B. Bartek, C. Murray. 2019. Natural History Note: *Varanus giganteus* (Perentie) diet. Herpetological Review 50(2):382.
- Schwarz, M., B.D. Byrd, B.F., Marayati, **W. Blum**, M.B. Wells, A.D. Greene, M. Taylor, and G. Wasserberg. *In press*. Horizontal distribution affects the vertical distribution of native and invasive container-inhabiting *Aedes* mosquitoes within an urban landscape. Journal of Vector Ecology.
- Soennichsen, K.F., B. Bartek, **Godwin**, S. Clulow, D. Rhind, C.M. Murray, J.S. Doody. *In Press*. Natural History Note: *Varanus giganteus* (Perentie) arboreal activity/climbing behavior. Herpetological Review.
- **Vannatta, J.M.**, D.R. Istvanko, and M. Klukowski. *In Press*. An estimate of home range size and temporal aspects of hibernation for the Eastern Box Turtle (*Terrapene carolina carolina*) in a suburban wetland habitat in middle Tennessee. The Tennessee Journal of Herpetology 3:4–14.
- **Vannatta, J.M.**, and M. Klukowski. *In Press*. A review of thread-trailing devices for Eastern Box Turtles (*Terrapene carolina carolina*). The Tennessee Journal of Herpetology 3:26–36.
- Walker, D.M., **Hill, A.J.**, Albecker, M.A., McCoy, M.W., Grisnik, M., Romer, A., Grajal-Puche, A., Camp, C, Kelehear, C., Wooten, J., Rheubert, J., and Graham, S.P. 2019. Variation in the slimy salamander (*Plethodon*) skin and gut microbial assemblages is explained by geographic distance and host affinity. Microbial Ecology 79:985–997.
- **Wells, W.G.** and H.T. Mattingly. *In Press*. Evaluation of benthic fish communities in the Clinch and Duck rivers as habitat indicators for the endangered pygmy madtom, *Noturus stanauli*. Southeastern Fishes Council Proceedings.
- **Wells, W.G.** and H.T. Mattingly. 2019. Preliminary analysis of age-class structure and longevity for the endangered pygmy madtom, *Noturus stanauli*. Copeia 107(3):447–450.

**Modifications for Improvement**

*Outcome 1.1 (student understanding of interdisciplinary nature of environmental sciences):*

Currently, the existing assessment approach for interdisciplinary evaluation of comprehensive exams is recognized as being too coarse (i.e., we can only say how many students passed the exams and provide a qualitative description of the exams). Therefore, a more quantitative rubric was drafted by the EVS Curriculum Committee in 2017-2018 to provide a refined, commonly used tool for assessing student interdisciplinary performance on their exams. The EVS Curriculum Committee suggested minor changes to the rubric prior to its presentation to the EVS Executive Committee. The rubric was approved by the executive committee, but the addition of the three new concentrations in Spring 2018 will necessitate further revisions to the rubric. In short, the rubric is still in a phase of revision and has not been implemented as an assessment tool. We plan to pilot the rubric in 2021-22.

As part of emphasizing the interdisciplinary nature of environmental sciences, the EVS Curriculum Committee presented a short narrative to the EVS Executive Committee for approval in 2018. The narrative was designed to inform students about interdisciplinary learning and to better communicate faculty expectations about interdisciplinary learning associated with the comprehensive exams. The approved narrative is now posted on the EVS program website: https://www.tntech.edu/cis/pdf/soes/InterdisciplinaryLearningforAnInterdiscpinaryDegree.pdf.

In Spring 2021, the EVS Executive Committee will be discussing the possibility of creating a small test bank of interdisciplinary learning questions that could be used during the comprehensive exams. Student performance can be more effectively tracked if all students are being asked questions from a common pool. A further topic that will be discussed includes the creation of Teams groups for each student's dissertation committee to facilitate interdisciplinary collaborations and collegiality among committee members. The Teams group can also be a location where the comprehensive exam questions, answers, and grades can be uploaded for easy access and viewing in a secure fashion. The Teams site would also provide a consistent mechanism for the Director to access comprehensive exam data for institutional effectiveness purposes. In December 2020, the first Teams dissertation committee was established, and the effectiveness of this trial run will be communicated to the Executive Committee during Spring 2021 as they consider pros and cons of wider implementation.

In Fall 2020, the Executive Committee discussed the strengths and weaknesses of the current EVS interdisciplinary core curriculum. It was decided that the EVS Curriculum Committee, which also include student representatives, would study the matter more carefully and bring recommendations back to the Executive Committee in Spring 2021. Tentative recommendations from this group have involved a 3-course core curriculum instead of the current 4-course core, with one of the three courses being an interdisciplinary seminar-based course in environmental sciences. These efforts are targeted to produce more consistent and effective understanding of the interdisciplinary aspects of the degree program.

*Outcome 2.1 (student technical presentations and communication skills):*

The School of Environmental Studies often supports student travel to meetings for the purposes of making presentations, in order to augment the support that students might already have from their external grants, faculty advisors, or concentration departments. Several students and their faculty advisors made formal requests to the School of Environmental Studies for travel support, and most of those requests were honored up to an amount of $1,000 per request. The School will continue to place a priority on supporting student travel to scientific conferences. Conference travel in 2020 has been less expensive due to decreased registered costs for most conferences due to Covid-19 travel restrictions and virtual-style conference presentations.

*Outcome 2.2 (student publications and communication skills):*

The EVS 7900 Scientific Writing and Grantsmanship course was altered in 2016 to allow students the option to develop a journal manuscript (instead of only allowing a grant proposal). In 2018 through 2020, many of the EVS 7900 students elected to prepare a journal manuscript and worked one-on-one with the instructors during editing sessions. In addition, the EVS Executive Committee created a new policy, effective for students starting the program on or after August 1, 2017, to require doctoral students to submit at least a portion of their dissertation for peer review before they can defend their dissertation. The new policy was submitted to GSEC and has now been approved and finalized. The implementation date for the peer-review policy was August 2, 2017. We expect this new policy to

further increase student proficiency in their scientific writing and publication skills. It is possible that some of the observed increase in journal manuscript submission and publications (Tables 1-2) are partially due to this newly implemented requirement.

The EVS Curriculum Committee is also tentatively recommending that EVS 7900 be one of the three required courses in the newly revamped core curriculum. If approved, then nearly every student in the program would be exposed to a writing course, which is expected to have a widespread effect on quantity and quality of manuscripts from students in the EVS program.

*Program Goal 3 (adding new concentrations):*

The EVS Executive Committee has set a future goal of having a total of six concentrations. Discussions will occur in 2020-2021 to determine how to move forward with adding one or more new concentrations to support the growth and health of the EVS program. The committee will also continue to address the possible addition of a low-residency option to make the program available to those students living some distance away from Cookeville. The recent development or conversion of more courses to an online format (due to the Covid-19 pandemic) should also support rapid implementation of a low-residency option should the Executive Committee decide to approve such an initiative.

**Appendices**

1. Curriculum Map