

COURSE: Spring 2018, FISH 7350, Meta-analysis, 2 credit hours

LECTURE: Wednesdays, 12-2pm CT, Upchurch 301

OFFICE HOURS: Available by appointment

REQUIRED PREREQUISITES: Graduate students, postdocs, faculty; via instructor approval

INSTRUCTOR: Dr. Alan Wilson, Swingle 321, wilson@auburn.edu, 334-246-1120

ZOOM: We will use Zoom for remote course participants. You can access the Zoom room here - <https://auburn.zoom.us/j/9922610946>

FIELD OF STUDY:

Meta-analysis is a quantitative approach for synthesizing results from diverse research studies that address a similar hypothesis. Effect sizes calculated from individual studies are combined to elucidate general patterns across studies. Like most approaches, meta-analysis has limitations (e.g., file drawer problem, dealing with varying publication quality). However, the technique can be a powerful option for identifying patterns in disciplines where the availability of large, under-analyzed datasets is common, such as ecology, psychology, medicine, and education.

COURSE OBJECTIVES & STUDENT LEARNING PHILOSOPHY:

The course objectives represent a variety of tasks and skills that I expect students to have developed and mastered by the end of the course. Through participating in this course, you will (1) practice and develop your critical thinking skills (through in-class group discussions and presentations), (2) learn how to read and interpret the scientific literature, (3) broaden your understanding of meta-analysis, and (4) conduct your own meta-analysis.

REQUIRED MATERIALS (PROVIDED BY INSTRUCTOR AND STUDENTS):

- (1) Articles from the peer-reviewed literature (see complete list at end of syllabus)
- (2) R software (download it here <https://www.r-project.org/>); web-based version of R for meta-analysis: <http://www.cebm.brown.edu/openmee/>

GRADING:

Course grades are based on each student's cumulative performance for the following assignments:

<u>Activity</u>	<u>Points</u>	<u>Grading scale</u>
Attendance	10	A = 90-100%
Participation	10	B = 80-89%
Paper discussion	25	C = 70-79%
Project presentation	25	D = 60-69%
Paper	30	F = 0-59%
Total points	100	

STUDENT EXPECTATIONS:

The course grade will be based on participation in lecture, discussion leading of important papers in meta-analysis, and a final project presentation as described below:

- (1) ATTENDANCE: Participation is critical to success in this course. In order to participate, you need to be at class on-time and prepared (i.e., perused readings, practice with software).
- (2) PARTICIPATION: Discussion is vital to an effective learning environment and participation grades will reflect involvement during classroom activities. Student need to think about papers and lectures critically and provide thoughtful questions and comments during each lecture.
- (3) PAPER DISCUSSION: All students will be required to lead the discussion of a series of articles from the peer-reviewed literature during one class period.
- (4) PROJECT PRESENTATION: All students will be required to present a 10-minute lecture describing a meta-analysis that they conduct during the course. Brief 1 page outlines of the project will be due by the sixth week of the course so that I can assist with project development. The students are expected to use the primary literature as references and data sources for this presentation. Students producing successful projects will be strongly encouraged to submit their papers to a peer-reviewed journal.
- (5) PAPER: All students will be required to submit a ~10 page paper associated with their meta-analysis project. The paper should be prepared with submission to a journal in mind. Formatting should be specific to the target journal.

FEEDBACK & EVALUATION:

This course is for you to learn important fundamental concepts and ideas on which to build your understanding of meta-analysis. Course evaluations will be completed by students at the end of the semester so that course changes can be made to enhance the learning experience for this class and future classes. Finally, students are always welcome to schedule a meeting with me to talk more about topics discussed in class.

COURSE CHANGES:

Although I expect to cover all the topics described in the syllabus, course changes will likely occur - especially based on feedback from the students. Consequently, I reserve the right to modify the course to enhance the learning experience where I deem appropriate. Course changes will be described verbally during class and/or in writing via email and/or handouts.

ACADEMIC HONESTY:

The Auburn University Student Academic Honesty Code (available at <https://sites.auburn.edu/admin/universypolicies/Policies/AcademicHonestyCode.pdf>) clearly defines the university's honesty code. I expect all students to conduct themselves in my class with this Code in mind

ACCOMMODATIONS FOR DISABILITIES:

If you have a disability and/or a special need that requires accommodations, please inform me immediately so that I can develop a plan to work with you and arrange an appointment with a campus disabilities counselor.

LECTURE SCHEDULE AND ASSOCIATED READINGS (CITATIONS FOLLOW):

- | <u>Day</u> | <u>Lecture topic</u> |
|---------------|---|
| Jan 10 | Introduction to meta-analysis; historical overview
Discussion leader – Alan
Glass 1976; Gurevitch et al. 2001 ; Arnqvist and Wooster 1995, Cooper et al. 1990; Finney 1995; Osenberg and St. Mary 1998 |
| Jan 17 | Limitations of meta-analysis
Discussion leaders – Riley Buley, Clint Lloyd, Tyler Coleman
Eysenck 1994; Walker et al. 2008; Hillebrand and Cardinale 2010; Møller and Jennions 2001; Marshall et al. 2004; Bailar 1997; Eysenck 1984; Lecky et al. 1996; |
| Jan 24 | Where to find data? How to choose data?
Discussion leaders – Josh Hall, Meredith Ayers, Jingyi Qi
Englund et al. 1999; Bown and Sutton 2010; Arnqvist and Wooster 1995; Kissling and Davis 2009; Nelson and Kennedy 2009; Neber et al. 2001; Slavin 1995 |
| Jan 31 | How to choose an effect size metric? How to calculate an effect size?
Student project outlines due and brief intro
Discussion leaders – Alan and Elizabeth Spitzer, Leanna McConnell, Kaelyn Fogelman
Nakagawa and Cuthill 2007; Maher et al. 2013; Mengerson and Gurevitch 2013; Harrison 2011; Borenstein et al. 2009 (chaps3-8); Hedges et al. 1999; Osenberg et al. 1997; Osenberg et al. 1999 |
| Feb 7 | Standard statistics and meta-analysis; (ir)relevance of null hypotheses & P-values
Discussion leaders – Alan and Matt Powers, Putter Tiatragul, Caitlin Redak, Josh Osborn
Murtaugh 2014; Burnham et al. 2014; Cohen 1994; Johnson 1999; Fernandez-Duque 1997; Borenstein et al. 2009 (chapter 16); Gurevitch and Hedges 1999 |
| Feb 14 | Introduction to R for Meta-Analysis and advanced meta-analysis statistics
Discussion leader – Ash Abebe
Readings to be determined by discussion leaders |
| Feb 21 | Advice from students who successfully published their meta-analysis project
Discussion leaders – Ryan Weaver, Justin Havird, Sam Logan, Althea ArchMiller
Readings to be determined by discussion leaders |
| Feb 28 | Meta-analysis examples
Discussion leaders – Natasha Benfer, Hisham Abdelrahman, Alex Tigie
Readings to be determined by discussion leaders
Complete online evaluation |
| Mar 7 | Meta-analysis examples
Discussion leaders – Jingping Guo, Kyle Heine, Aundrea Westfall
Readings to be determined by discussion leaders |

- Mar 14** **SPRING BREAK**
- Mar 21** **Meta-analysis examples**
Discussion leaders – Edna Fernandez, Nicholas Justyn, Victoria Prunte, Rhoda Mae Simora
Readings to be determined by discussion leaders
- Mar 28** **Meta-analysis examples**
Discussion leaders – Sarah Wilson, Austin Haney, Kyle David, Zoe Nichols
Readings to be determined by discussion leaders
- Apr 4** **Meta-analysis examples**
Discussion leaders – Alex Kaeppler, Ryan Fluharty, Jessica Norton, Gwendolyn Bird
Readings to be determined by discussion leaders
- Apr 11** **Meta-analysis examples**
Discussion leaders – Jaileen Perez Aponte, Kayleigh Chalkowski, Jenna Pruett
Readings to be determined by discussion leaders
- Apr 18** **Final student presentations**
- Apr 25** **Final student presentations; Final paper due; *course evaluation***

EXAMPLE READINGS (ALSO GO LOOK IN “PAPERS” FOLDER IN DROPBOX):

- ArchMiller, A. A., E. F. Bauer, R. E. Koch, B. K. Wijayawardena, A. Anil, J. J. Kottwitz, A. S. Munsterman, and A. E. Wilson. 2015. Formalizing the definition of meta-analysis in *Molecular Ecology*. *Molecular Ecology* 24(16):4042-4051.
- Arnqvist, G., and D. Wooster. 1995. Meta-analysis - synthesizing research findings in ecology and evolution. *Trends in Ecology and Evolution* 10:236-240.
- Bailar, J. C. 1997. The promise and problems of meta-analysis. *New England Journal of Medicine* 337:559-561.
- Balvanera, P., A. B. Pfisterer, N. Buchmann, J. S. He, T. Nakashizuka, D. Raffaelli, and B. Schmid. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. *Ecology Letters* 9:1146-1156.
- Benayas, J. M. R., A. C. Newton, A. Diaz, and J. M. Bullock. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: a meta-analysis. *Science* 325:1121-1124.
- Borenstein, M., L. V. Hedges, J. P. T. Higgins, and H. R. Rothstein. 2009. Introduction to meta-analysis. John Wiley and Sons.
- Bown, M. J. and A. J. Sutton. 2010. Quality control in systematic reviews and meta-analyses. *European Society for Vascular Surgery* 40:669-677.
- Brett, M. T., and C. R. Goldman. 1996. A meta-analysis of the freshwater trophic cascade. *Proceedings of the National Academy of Sciences of the United States of America* 93:7723-7726.
- Burnham, K. P. and D. R. Anderson. 2014. P values are only an index to evidence: 20th vs. 21st century statistical advice. *Ecology* 95(3):627-630.
- Caporaso, J. G., C. L. Lauber, W. A. Walters, D. Berg-Lyons, C. A. Lozupone, P. J. Turnbaugh, N. Fierer, and R. Knight. 2011. Global patterns of 16S rRNA diversity at a depth of millions of sequences per sample. *Proceedings of the National Academy of Sciences of the United States of America* 108:4516-4522.
- Cardinale, B. J., D. S. Srivastava, J. E. Duffy, J. P. Wright, A. L. Downing, M. Sankaran, and C. Jouseau. 2006. Effects of biodiversity on the functioning of trophic groups and ecosystems. *Nature* 443:989-992.
- Carmona, D., M. J. Lajeunesse, and M. T. J. Johnson. 2011. Plant traits that predict resistance to herbivores. *Functional Ecology* 25:358-367.
- Castanho, C. D., C. J. Lortie, B. Zaitchik, and P. I. Prado. 2015. A meta-analysis of plant facilitation in coastal dune systems: responses, regions, and research gaps. *Peerj* 3.
- Chamberlain, S. A., S. M. Hovick, C. J. Dibble, N. L. Rasmussen, B. G. Van Allen, B. S. Maitner, J. R. Ahern, L. P. Bell-Dereske, C. L. Roy, M. Meza-Lopez, J. Carrillo, E. Siemann, M. J. Lajeunesse, and K. D. Whitney. 2012. Does phylogeny matter? Assessing the impact of phylogenetic information in ecological meta-analysis. *Ecology Letters* 15:627-636.
- Civitello, D. J., E. Rynkiewicz, and K. Clay. 2010. Meta-analysis of co-infections in ticks. *Israel Journal of Ecology & Evolution* 56:xx-xx.
- Conord, C., J. Gurevitch, and B. Fady. 2012. Large-scale longitudinal gradients of genetic diversity: a meta-analysis across six phyla in the Mediterranean basin. *Ecology and Evolution* 2:2595-2609.
- Cooper, S. D., S. J. Walde, and B. L. Peckarsky. 1990. Prey exchange-rates and the impact of predators on prey populations in streams. *Ecology* 71:1503-1514.

- Downing, J. A., C. W. Osenberg, and O. Sarnelle. 1999. Meta-analysis of marine nutrient-enrichment experiments: variation in the magnitude of nutrient limitation. *Ecology* 80:1159-1167.
- Elser, J. J., M. E. S. Bracken, E. E. Cleland, D. S. Gruner, W. S. Harpole, H. Hillebrand, J. T. Ngai, E. W. Seabloom, J. B. Shurin, and J. E. Smith. 2007. Global analysis of nitrogen and phosphorus limitation of primary producers in freshwater, marine and terrestrial ecosystems. *Ecology Letters* 10:1135-1142.
- Englund, G., O. Sarnelle, and S. D. Cooper. 1999. The importance of data-selection criteria: Meta-analyses of stream predation experiments. *Ecology* 80:1132-1141.
- Evangelou, E. and J. P. A. Ioannidis. 2013. Meta-analysis methods for genome-wide association studies and beyond. *Nature Reviews Genetics* 14:379-389.
- Eysenck, H. J. 1984. Meta-Analysis - an Abuse of Research Integration. *Journal of Special Education* 18:41-59.
- Eysenck, H. J. 1994. Systematic Reviews - Metaanalysis and Its Problems. *British Medical Journal* 309:789-792.
- Fernandez-Duque, E. 1997. Comparing and combining data across studies: Alternatives to significance testing. *Oikos* 79:616-618.
- Finney, D. J. 1995. A Statistician Looks at Met-Analysis. *Journal of Clinical Epidemiology* 48:87-103.
- Glass, G. V. 1976. Primary, secondary, and meta-analysis of research. *Educational Researcher* 5:3-8.
- Gomez-Aparicio, L., and C. J. Lortie. 2014. Advancing plant ecology through meta-analyses. *Journal of Ecology* 102:823-827.
- Guo, L. B. and R. M. Gifford. 2002. Soil carbon stocks and land use change: a meta-analysis. *Global Change Biology* 8:345-260.
- Gurevitch, J., P. S. Curtis, and M. H. Jones. 2001. Meta-analysis in ecology. *Advances in Ecological Research*, Vol 32 32:199-247.
- Gurevitch, J., and L. V. Hedges. 1999. Statistical issues in ecological meta-analyses. *Ecology* 80:1142-1149.
- Gurevitch, J., J. A. Morrison, and L. V. Hedges. 2000. The interaction between competition and predation: A meta-analysis of field experiments. *American Naturalist* 155:435-453.
- Gurevitch, J., L. L. Morrow, A. Wallace, and J. S. Walsh. 1992. A METAANALYSIS OF COMPETITION IN FIELD EXPERIMENTS. *American Naturalist* 140:539-572.
- Halaj, J., and D. H. Wise. 2001. Terrestrial trophic cascades: how much do they trickle? *American Naturalist* 157:262-281.
- Harpole, W. S., J. T. Ngai, E. E. Cleland, E. W. Seabloom, E. T. Borer, M. E. S. Bracken, J. J. Elser, D. S. Gruner, H. Hillebrand, J. B. Shurin, and J. E. Smith. 2011. Nutrient co-limitation of primary producer communities. *Ecology Letters* 14:852-862.
- Hedges, L. V., J. Gurevitch, and P. S. Curtis. 1999. The meta-analysis of response ratios in experimental ecology. *Ecology* 80:1150-1156.
- Hillebrand, H. 2004. On the generality of the latitudinal diversity gradient. *American Naturalist* 163:192-211.
- Hillebrand, H., and B. J. Cardinale. 2010. A critique for meta-analyses and the productivity-diversity relationship. *Ecology* 91:2545-2549.
- Hillebrand, H., and J. Gurevitch. 2014. Meta-analysis results are unlikely to be biased by differences in variance and replication between ecological lab and field studies. *Oikos* 123:794-799.

- Hua, K. 2013. Estimating maintenance amino acids requirements of fish through a nonlinear mixed modelling approach. *Aquaculture Research* 44:542-553.
- Johnson, D. H. 1999. The insignificance of statistical significance testing. *Journal of Wildlife Management* 63:763-772.
- Koricheva, J., and J. Gurevitch. 2014. Uses and misuses of meta-analysis in plant ecology. *Journal of Ecology* 102:828-844.
- Kollock, R., K. Games, A. E. Wilson and J. Sefton. 2015. Effects of vehicle-ride exposure on cervical pathology: a meta-analysis. *Industrial Health* 53:197-205.
- Kollock, R., C. Andrews, A. Johnston, T. Elliott, A. E. Wilson, K. Games, and J. Sefton. 2016. A meta-analysis to determine if lower extremity muscle strengthening should be included in military knee overuse injury prevention programs. *Journal of Athletic Training* 51(4):xx-xx.
- Koricheva, J., H. Nykänen, and E. Gianoli. 2004. Meta-analysis of trade-offs among plant antiherbivore defenses: are plants jacks-of-all-trades, masters or all? *American Naturalist* 163:E64-E75.
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- Lortie, C. J. 2014. Formalized synthesis opportunities for ecology: systematic reviews and meta-analyses. *Oikos* 123:897-902.
- Lortie, C. J., and R. M. Callaway. 2006. Re-analysis of meta-analysis: support for the stress-gradient hypothesis. *Journal of Ecology* 94:7-16.
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- Maher, J. M. M., J. C. Markey, and D. Ebert-May. 2013. The other half of the story: effect size analysis in quantitative research. *CBE-Life Science Education* 12:345-351.
- Mengerson, K. and J. Gurevitch. 2013. Using other metrics of effect size in meta-analysis. In Koricheva et al. 2013. Pages 72-85.
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- Møller, A. P., and M. D. Jennions. 2001. Testing and adjusting for publication bias. *Trends in Ecology & Evolution* 16:580-586.
- Montero-Castano, A. and M. Vila. 2012. Impact of landscape alteration and invasions on pollinators: a meta-analysis. *Journal of Ecology* 100:884-893.
- Murtaugh, P. A. 2014. In defense of *P* values. *Ecology* 95(3):611-617.

- Nado, L. and P. Kanuch. 2015. Roost site selection by tree-dwelling bats across biogeographical regions: an updated meta-analysis with meta-regression. *Mammal Review* 45:215-226.
- Nakagawa, S., and R. Poulin. 2012. Meta-analytic insights into evolutionary ecology: an introduction and synthesis. *Evolutionary Ecology* 26:1085-1099.
- Nakagawa, S., R. Poulin, K. Mengersen, K. Reinhold, L. Engqvist, M. Lagisz, and A. M. Senior. 2015. Meta-analysis of variation: ecological and evolutionary applications and beyond. *Methods in Ecology and Evolution* 6:143-152.
- Nakagawa, S., and E. S. A. Santos. 2012. Methodological issues and advances in biological meta-analysis. *Evolutionary Ecology* 26:1253-1274.
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- Normand, S.-L. T. 1999. Tutorial in biostatistics, Meta-analysis: formulating, evaluating, combining, and reporting. *Statistics in Medicine* 18:321-359.
- Osenberg, C. W., O. Sarnelle, and S. D. Cooper. 1997. Effect size in ecological experiments: the application of biological models in meta-analysis. *American Naturalist* 150:798-812.
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PUBLICATIONS FROM PAST META-ANALYSIS (FISH 7350) COURSES (2010, 2012, 2014, 2016)

(student authors in **bold**; Google Scholar citations, where available, as of **15 September 2017**)

19. **Weaver, R. J.**, E. S. A. Santos, **A. M. Tucker**, A. E. Wilson, and G. E. Hill. In press. Carotenoid metabolism strengthens the link between feather coloration and quality. Nature Communications.

<https://www.nature.com/ncomms/articles>

(CITATIONS = 0) (Impact factor = 12.124)

18. **Novriadi, R.** 2018. A meta-analysis approach toward fish meal replacement with fermented soybean meal: effects on growth performance and feed conversion ratio. Asian Fisheries Science Journal 30:1-17.

<https://www.asianfisheriessociety.org/publication/>

(CITATIONS = 0) (Impact factor = N/A)

17. **Merkle, J.** and M. Phillips. 2018. The wage impact of teachers unions: a meta-analysis. Contemporary Economic Policy 36(1):93-115.

<http://onlinelibrary.wiley.com/doi/10.1111/coep.12234/full>

(CITATIONS = 0) (Impact factor = 0.602)

16. **Willoughby, J. R.**, M. Sundaram, **B. K. Wijayawardena**, M. C. Lamb, S. J. A. Kimble, Y. Ji, N. B. Fernandez, J. D. Antonides, N. J. Marra, and J. A. DeWoody. 2017. Biome and migratory behavior significantly influence vertebrate genetic diversity. Biological Journal of the Linnean Society 121(2):446-457.

<https://doi.org/10.1093/biolinnean/blw040>

(CITATIONS = 0) (Impact factor = 1.984)

15. **Hrycik, A. R.**, **L. Z. Almeida**, and T. O. Höök. 2017. Sub-lethal effects on fish provide insight into a biologically-relevant threshold of hypoxia. Oikos 126(3):307-317.

<http://onlinelibrary.wiley.com/doi/10.1111/oik.03678/full>

(CITATIONS = 0) (Impact factor = 3.586)

14. Kollock, R., **K. Games**, A. E. Wilson, and J. Sefton. 2016. Vehicle exposure and spinal musculature fatigue in military warfighters: a meta-analysis. Journal of Athletic Training. 51(11):981-990.

<http://natajournals.org/doi/pdf/10.4085/1062-6050-51.9.13>

(CITATIONS = 0) (Impact factor = 2.017)

13. **Munsterman, A. S.**, **J. J. Kottwitz**, and R. R. Hanson. 2016. Meta-analysis of the effects of adhesion barriers on adhesion formation in the horse. Veterinary Surgery 45:587-595.

<http://onlinelibrary.wiley.com/doi/10.1111/vsu.12494/abstract>

(CITATIONS = 1) (Impact factor = 1.041)

12. Kollock, R., C. Andrews, A. Johnston, T. Elliott, A. E. Wilson, **K. Games**, and J. Sefton. 2016. A meta-analysis to determine if lower extremity muscle strengthening should be included in military knee overuse injury prevention programs. Journal of Athletic Training 51(11):919-926.

<http://natajournals.org/doi/pdf/10.4085/1062-6050-51.4.09>

(CITATIONS = 2) (Impact factor = 2.017)

11. **McGill, J.**, F. Adler-Baeder, and P. Rodriguez. 2016. Mindfully in love: A meta-analysis of the association between mindfulness and relationship satisfaction. Journal of Human Sciences and Extension 4(1):89-101.

http://media.wix.com/ugd/c8fe6e_65448e5da9754a6c8676f179d07067d1.pdf

(CITATIONS = 0) (Impact factor = N/A)

10. **Koch, R. E.**, A. E. Wilson, and G. E. Hill. 2016. The importance of carotenoid dose in supplementation studies with songbirds. Physiological and Biochemical Zoology 89(1):61-71.

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