BI 509 Metapopulation Ecology

CONTACT INFORMATION

Peter Buston, Department of Biology
Phone: 617-358-5412
E-mail: buston@bu.edu

MEETING TIMES (with some exceptions)

Foundational Knowledge: Lecture

Wednesday, 11:15 – 12:05, Department of Biology, BRB 219.

Foundational Knowledge: Discussion

Friday, 11:15 – 12:05, Department of Biology, BRB 219.

Application & Integration: Concept Mapping & Thought Experiments

Monday, 11:15 – 12:05, Department of Biology, BRB 219.

Learning to Learn: Student Presentations & Peer Feedback

Monday, 15:35 – 16:25, Department of Biology, BRB 219.

OFFICE HOURS

M 16:30 - 17:00, W 16:00 - 17:00 & F 16:00 - 17:00, Department of Biology, BRB 531 (with some exceptions)

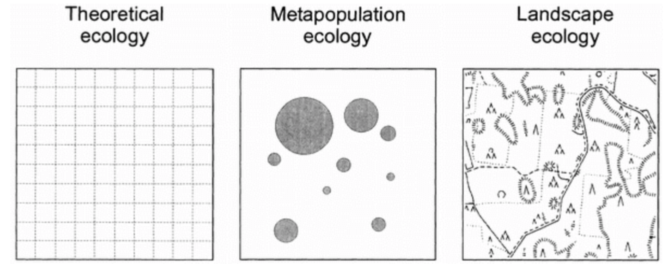
PREREQUISITES

First year writing seminar, e.g., WR 100 or WR120. BI107 (Introductory Biology) and at least one more intermediate level course in Ecology, Evolution or Behavior, e.g., BI225 Behavioral Biology, BI260 Marine Biology, BI303 Evolutionary Ecology, BI306 Biology of Global Change, BI309 Evolution, or BI407 Animal Behavior.

ENROLLMENT LIMIT

30

COURSE DESCRIPTION



This course introduces students to Metapopulation Ecology, through the lens of propagule dispersal and population connectivity. Each week, students will dive deeply into one topic, considering terrestrial ecology, marine ecology and theoretical ecology perspectives. By the end of the semester, students will have an integrated understanding of the patterns, causes and consequences of propagule dispersal and population connectivity, and a deeper appreciation for Metapopulation Ecology.

Through the course, students will grapple with several big picture questions. What is the motivation for studying Metapopulation Ecology, propagule dispersal and population connectivity? What is the spatial scale of dispersal and connectivity? What are the physical and biological causes of variation in dispersal and connectivity? What are the ecological and evolutionary consequences of variation in connectivity? What are the conservation and management implications of our knowledge of connectivity?

Each week, students will gain foundational knowledge via reading two or three papers from the primary literature, via a lecture given by the professor and via a small group discussion with their peers. Every other week, students will apply their new found knowledge, via tackling case studies, developing research questions and doing thought experiments. Every other week, students will integrate their knowledge, via comparing and contrasting terrestrial, marine and theoretical literature and via concept mapping.

Students will develop and give three oral presentations during the semester, with the aims of becoming a better learner, by inquiring and constructing knowledge and teaching others. Students will develop three written papers during the semester, with the aims of becoming a better learner, by developing thinking and writing skills, and clearly communicating ideas in writing. This will be enhanced by students learning to provide and receive constructive, critical peer feedback.

Students will be evaluated based on acquisition of foundational knowledge [attendance and thoughtful participation in discussion (approx 20%)], application and integration of knowledge [concept mapping, thought experiments and teamwork (approx 20%)], oral communication [3 oral presentations (approx 30%)] and written communication [3 written papers (approx 30%)]. The exact breakdown of grading will be determined by students themselves at the start of the semester.

This course builds on courses such as BI225 (Behavioral Biology), BI260 (Marine Biology), BI303 (Evolutionary Ecology), BI306 (Biology of Global Change), BI309 (Evolution) and BI407 (Animal Behavior). The course complements courses such as BI448 (Biodiversity and Conservation Biology), BI504 (Evolutionary Analysis), BI506 (Phenotypic Plasticity), BI 508 (Behavioral Ecology), BI519 (Theoretical Evolutionary Ecology) and BI530 (Ecosystem Ecology) within the Department of Biology.

(Figure from Hanski I. 1998. Metapopulation dynamics. *Nature* 396: 41-49).

FINK'S & BLOOM'S LEARNING OBJECTIVES (see Appendix I & II for more details)

Fink's Category	Learning Objective:
Foundational 1	Students will understand and be able to define the concepts of population, metapopulation, dispersal and connectivity
Foundational 1	Students will understand extinction-colonization dynamics, and the roles of patch number, patch area and patch isolation in those dynamics
Foundational 1	Students will understand and be able to contrast the concepts of ecological (demographic) and evolutionary (genetic) connectivity
Foundational 1	Students will appreciate and be able to explain how metapopulation thinking might impact conservation and management decisions
Foundational 2	Students will appreciate the concept of a paradigm shift, a fundamental change in basic concepts / assumptions driven by changes in methods
Foundational 2	Students will understand and be able to explain how views on the spatial scale of marine larval dispersal and population connectivity have changed
Foundational 2	Students will understand and be able to explain how evidence from population genetics and population persistence contributed to paradigm shift
Foundational 2	Students will understand and be able to explain how evidence from oceanography and behavior contributed to paradigm shift
Foundational 3	Students will appreciate that when we say we are measuring "dispersal" we are really measuring dispersal and some post-recruitment processes
Foundational 3	Students will understand and be able to explain how we can estimate dispersal distance distributions when sources are not known
Foundational 3	Students will understand and be able to explain how we can estimate dispersal distance distributions when sources are known
Foundational 3	Students will appreciate how sampling biases, landscape and seascape can effect simple metrics such as self-recruitment
Foundational 4	Students will understand and be able to articulate the difference between dispersal kernels, dispersal curves and dispersal distance distributions
Foundational 4	Students will appreciate and be able to describe variation in the scale and shape of marine and terrestrial dispersal kernels
Foundational 4	Students will appreciate and be able to explain what causes variation in the scale and shape of marine and terrestrial dispersal kernels
Foundational 4	Students will understand the challenges associated with measuring long distance dispersal
Foundational 5	Students will appreciate and be able to explain the difference between phenomenological and mechanistic models of dispersal
Foundational 5	Students will understand and be able to explain the assumptions, variables and predictions of the simplest mechanistic models
Foundational 5	Students will understand and be able to explain the basic difference between Eulerian and Lagrangian models
Foundational 5	Students will appreciate the role of mechanistic models in generating and testing hypotheses
Foundational 6	Students will appreciate the reasons for the debate regarding whether dispersal is for dispersal
Foundational 6	Students will understand and be able to define the concepts of evolution, natural selection, adaptation and non-adaptive effect

Foundational 6	Students will understand the basic logic and predictions of Hamilton & May's classic model for the evolution of dispersal
Foundational 6	Students will be able to describe empirical evidence for the evolution of dispersal, both adaptations and adaptive plasticity
Foundational	Students will understand and be able to explain major consequences (ecological and evolutionary) of variation in population connectivity
Foundational	Students will understand and be able to explain the major implications of variation in population connectivity for conservation and management
Foundational	Students will improve their ability to read, understand and critically evaluate the primary literature, via reading assignments
Foundational	Students will improve their ability to listen and respond to others, stimulate and engage in discussion, via small group discussion
Application	Students will improve their ability to apply their knowledge, thinking critically and analyzing case studies, thinking creatively and developing research questions, thinking practically and developing proposals
Integration	Students will improve their ability to integrate knowledge, by comparing and contrasting terrestrial, marine and theoretical perspectives, by concept mapping throughout semester, and via a synthetic term paper.
Human Dimension	Students will improve their ability to work as a member of a small group / team, via case studies, development of research questions and proposals
Caring	Students will commit to a growth mindset, wanting to improve their understanding throughout the semester and ultimately master material.
Learning how to learn	Students will learn how to inquire and construct knowledge, and how to engage in self-regulated learning and deep learning, throughout semester
Learning how to learn	Students will appreciate and be able to explain the motivation for reading theoretical, terrestrial and marine literature

HUB LEARNING OUTCOMES

Writing Intensive

Writing is fundamental, the most important form of expression that BU undergraduates must develop. In the academy and in almost every professional setting, BU graduates must be able to express their ideas in clear, coherent prose. Effective writing demands the honing of skills, but it also cultivates ways of thinking, evaluating evidence, constructing responsible and convincing arguments, and generating creative ideas. As effective writers, BU graduates will pay close attention to the potential readers of their writings; as responsible writers, they will take ownership of their message and the means of communicating it, and hold their writing to high standards of truth, accuracy, validity, and humaneness.

Writing-intensive courses enable students to build on and practice skills learned in the First-Year Writing Seminar and, in some instances, those learned in Writing, Research, and Inquiry courses. Writing-intensive courses must, therefore, have at least outcomes 1 and 2 below, and must have "First-Year Writing Seminar" (e.g., CAS WR 120) as a pre-requisite.

1. Students will be able to craft responsible, considered, and well-structured written arguments, using media and modes of expression appropriate to the situation.
2. Students will be able to read with understanding, engagement, appreciation, and critical judgment.
3. Students will be able to write clearly and coherently in a range of genres and styles, integrating graphic and multimedia elements as appropriate.

Oral and/or Signed Communication

BU students should be able to communicate information in a clear and coherent formal oral and/or signed presentation, to engage responsibly with others, and to make use of a range of disciplinary-appropriate informal oratory. As with writing, effective oral/signing communicators should prepare remarks with an awareness of their purpose and their audience. Because oral and/or signed communication is generally interactive, students should be able to attend and respond thoughtfully to others. They should also understand that public presentation serves an essentially civic function as a means of participating in collective debate and decision-making.

Courses and cocurricular activities in this area must have all outcomes.

1. Students will be able to craft and deliver responsible, considered, and well-structured oral and/or signed arguments using media and modes of expression appropriate to the situation.
2. Students will demonstrate an understanding that oral/signed communication is generally interactive, and they should be able to attend and respond thoughtfully to others.
3. Students will be able to speak/sign effectively in situations ranging from the formal to the extemporaneous and interact comfortably with diverse audiences.

Research and Information Literacy

Scholarly research—the process of posing problems, designing effective investigative strategies, collecting and evaluating information, drawing conclusions, and presenting findings—drives the creation and dissemination of new knowledge in and across all academic disciplines, professions, and walks of life. Today's information explosion places a particular requirement on anyone doing research to develop the abilities associated with information literacy—knowing how to locate needed information, assess the accuracy of sources, and use them to good effect. BU's mission as a research university embraces the conviction that research and information literacy should be central to an undergraduate university education. By learning from scholars on the BU faculty how new knowledge is created and disseminated, and by conducting or participating in research, BU students join a community of inquiry with a commitment to the pursuit of knowledge that crosses borders and connects generations.

Courses and cocurricular activities in this area must have all outcomes.

1. Students will be able to search for, select, and use a range of publicly available and discipline-specific information sources ethically and strategically to address research questions.
2. Students will demonstrate understanding of the overall research process and its component parts, and be able to formulate good research questions or hypotheses, gather and analyze information, and critique, interpret, and communicate findings.

INSTRUCTIONAL FORMAT, COURSE PEDAGOGY & APPROACH TO LEARNING

Books & Other Course Materials

All readings will come from the primary literature and will be posted on Blackboard Learn. Each week, there will be 3 papers posted: 1 for Lecture; 1 for Discussion; and 1 for Application & Integration Sessions (see Table 1). All are required reading.

Courseware

Students in the course will develop a Wikipedia page (TBD).

ASSIGNMENTS & GRADING (first teamwork assignment)

Foundational Knowledge: Lecture & Associated Readings (13 lectures)

Student vote: 0.6% per lecture; would be 8% total but 1% subtracted to make things add up to 100; 7% total

Foundational Knowledge: Discussion & Associated Readings (13 discussions)

Student vote: 1.1% per discussion; would be 14% total but 1% subtracted to make things add up to 100; 13% total

Application & Integration: Concept Mapping & Thought Experiments (13 sessions)

Student vote: 1.6% per session; would be 21% total but 1% subtracted to make things add up to 100; 20% total

Research and Information Literacy: Selection/Use of Research Materials; Understanding of Research Process

Selection/Use of Materials for Presentation/Papers; Understanding of Process in Presentations/Papers

Oral Communication: Student Presentations & Peer Feedback (3 oral talks per student)

Student vote: 7.5, 10, 12.5% for first, second and third talks (one 5, 10, 15 balanced out by one 10, 10, 10); 30% total

Writing Communication: Student Papers & Peer Feedback (3 written papers per student)

Student vote: 7.5, 10, 12.5% for first, second and third paper (two 5, 10, 15 balanced out by two 10, 10, 10); 30% total

RESOURCES, SUPPORT, HOW TO SUCCEED IN THIS COURSE

Office Hours (the most underutilized resource at BU)

M 16:30 - 17:00, W 16:00 - 17:00 & F 16:00 - 17:00 Department of Biology, BRB 531 (with some exceptions)

Accommodations for Students with Documented Disabilities

If you are a student with a disability or believe you might have a disability that requires accommodations, please contact the Office for Disability Services (ODS) at (617) 353-3658 or access@bu.edu to coordinate any reasonable accommodation requests. ODS is located at 19 Deerfield Street on the second floor (19 Buick Street as of September 1, 2018).

COMMUNITY OF LEARNING: CLASS & UNIVERSITY POLICIES

Positive Learning Environment

Students will commit to a growth mindset, working to improve their understanding throughout the semester, being responsive to feedback from the professor and their peers, with the ultimate goal of mastering material. Students will commit to learning via teamwork and collaboration, listening and responding thoughtfully to others, working together to deepen their understanding.

Attendance & Absences

Attendance of the lecture series, discussion series, application and integration sessions, and all student presentations is essential to facilitate learning of the material and transferable skills. In the event that one of these sessions must be missed, students must provide a valid university excuse (e.g., religious observances, varsity sports, flu).

Assignment Completion & Late work

Assignments must be handed in on time. Late work will not be accepted if it is not well justified. Similarly, there will be no opportunities for make-ups that are not well justified. If you have questions regarding the grading, you must resolve the issue within two weeks of the session or assignment that you are querying. Extra credit assignments are not available.

Anticipated Workload

This is a 4 credit course, so you should anticipate spending 8-12 hours per week outside of class time on this course (150 hours total). A reasonable breakdown might be: 4 hours per week reading the papers, reviewing lectures and prepping for discussion (50 hrs); 16 hours preparing and practicing each oral presentation (50 hours); 16 hours thinking about and writing each written paper (50 hrs). The workload is anticipated to be heavy, but manageable. We will work hard, cover a lot of material, and learn A LOT!

Academic Conduct

All students are expected to know and understand the provisions of BU’s Academic Conduct Code:
https://www.bu.edu/academics/policies/academic-conduct-code/
All cases of suspected academic misconduct will be referred to the appropriate Dean’s Office.

TABLE 1. OUTLINE OF CLASS MEETINGS: DATE, TOPIC, MEETING TYPE, READINGS AND ASSIGNMENTS

Date	Topic	Meeting type	Reading	Assignments
Monday, January 21	MLK Jr. Day Holiday	MLK Jr. Day Holiday	MLK Jr. Day Holiday	MLK Jr. Day Holiday
Wednesday, January 23	0. Introductions, Syllabus & Policies	Tools	Buston PM. 2019. Metapopulation Ecology Syllabus.	
Friday, January 25	1 – Motivation for studying metapopulation ecology and population connectivity	Lecture	Cowen RK, Gawarkiewicz G, Pineda J, Thorrold S, Werner F. 2007. Population connectivity in marine systems: an overview. *Oceanography* 20: 14-21	
Monday, January 28	1 – Motivation for studying metapopulation ecology and population connectivity	Discussion (Metapopulation Thinking)	Hanksi I. 1998. Metapopulation dynamics. *Nature* 396: 41-49	
Monday, January 28	0. How to search for, select, and use information sources ethically and strategically	Tools	https://www.bu.edu/library/help/how-to/	
Move to later date	0. How to give a good scientific conference presentation	Tools	McGraw Center for Teaching and Learning, Princeton University. 2019. Teaching oral presentation skills to undergraduates (https://mcgraw.princeton.edu/node/1261)	
Wednesday, January 30	2 – A paradigm shift regarding the spatial scale of dispersal & Methods for measuring dispersal	Lecture	Roberts CM. 1997. Connectivity and management of Caribbean coral reefs. *Science* 278: 1454-1457	
Friday, February 1	2 – A paradigm shift regarding the spatial scale of dispersal & Methods for measuring dispersal	Discussion (Metapopulation Thinking)	Jones GP, Milicich MJ, Emslie MJ, Lunow C. 1999. Self-recruitment in a coral reef fish population. *Nature* 402: 802-804.	
Monday, February 4	2 – A paradigm shift regarding the spatial scale of dispersal & Methods for measuring dispersal	Application & Integration (Statistical Thinking)	Jones, GP, Planes, S and Thorrold, SR (2005). Coral reef fish larvae settle close to home. *Current Biology* 15(14): 1314-1318.	
Monday, February 4	2 – A paradigm shift regarding the spatial scale of dispersal & Methods for measuring dispersal	Student Presentations	1. Thorrold SR, Zacherl DC, Levin LA. 2007. Population connectivity and larval dispersal using geochemical signatures in calcified structures. *Oceanography* 20: 80-89. 1. Swearer SE, Caselle JE, Lea DW, Warner RR. 1999. Larval retention and recruitment in an island population of coral-reef fish. *Nature* 402:799-802. 2. Hedgecock D, Barber PH, Edmands S. 2007. Genetic approaches to measuring connectivity. *Oceanography* 20: 70-79. 2. Taylor MS, Hellberg ME (2003) Genetic Evidence for Local Retention of Pelagic Larvae in a Caribbean Reef Fish. Science, 299, 107–109.	Oral Presentations 1-2
Wednesday, February 6	3 – Quantitative patterns, Sampling biases & The effects of landscape and seascape on measurements	Lecture	Garcia C, Jordano P, Godoy JA. 2007. Contemporary pollen and seed dispersal in a *Prunus mahaleb* population: patterns in	

			distance and direction. *Molecular Ecology* 16:1947-1955.	
Friday, February 8	3 – Quantitative patterns, Sampling biases & The effects of landscape and seascape on measurements	Discussion (Statistical Thinking)	D'Aloia CC, Bogdanowicz SM, Majoris JE, Harrison RG, Buston PM. 2013. Self-recruitment in a Caribbean reef fish: a method for approximating dispersal kernels accounting for seascape. *Molecular Ecology* 22: 2563-2572.	
Monday, February 11	3 – Quantitative patterns, Sampling biases & The effects of landscape and seascape on measurements	Application & Integration (Concept Mapping 1)	Nathan R & Muller-Landau H. 2000. Spatial patterns of seed dispersal, their determinants and consequences for recruitment. *Trends in Ecology and Evolution* 15: 278-285.	
Monday, February 11	3 – Quantitative patterns, Sampling biases & The effects of landscape and seascape on measurements	Student Presentations	3. Planes S, Jones G, Thorrold S. 2009. Larva dispersal connects fish populations in a network of marine protected areas. *Proceedings of the National Academy of Sciences* 106: 5693-5697. 4. Nanninga G, Saenz-Agudelo P, Zhan p, Hotei I, Beruumen M. 2015. Not finding Nemo: limited reef-scale retention in a coral reef fish. *Coral Reefs* 34: 383-392.	Oral Presentations 3-4
Wednesday, February 13	4 – Measuring dispersal kernels, Dissecting dispersal kernels & Long distance dispersal	Lecture	Jordano P, Garcia C, Godoy JA, Garcia-Castaño. 2007. DIfferential contribution of frugivores to complex seed dispersal patterns. *Proceedigs of the National Academy of Sciences USA* 104: 3278-3282	
Friday, February 15	4 – Measuring dispersal kernels, Dissecting dispersal kernels & Long distance dispersal	Discussion (Statistical Thinking)	D'Aloia CC, Bogdanowicz SM, Francis RK, Majoris JE, Harrison RG, Buston PM. 2015. Patterns, causes and consequences of marine larval dispersal. *Proceedings of the National Academy of Sciences* 112: 13940-13945.	
Monday, February 18	President's Day Holiday	President's Day Holiday	President's Day Holiday	President's Day Holiday
Tuesday, February 19 (Monday)	4 – Measuring dispersal kernels, Dissecting dispersal kernels & Long distance dispersal	Student Presentations	5. Hameed SO, Wilson White J, Miller SH, Nickols KJ, Morgan SG. 2016. Inverse approach to estimating larval dispersal reveals limited population connectivity along 700 km of wave-swept coastline. *Proceedings of the Royal Society of London, Series B.* 283. 6. Siepielski AM, Benkman CW. 2008. A seed predator drives the evolution of a seed dispersal mutualism. *Proceedings of the Royal Society of London, Series B.* 275: 1917-1925.	Oral Presentations 5-6
Tuesday, February 19 (Monday)	4 – Measuring dispersal kernels, Dissecting dispersal kernels & Long distance dispersal	Student Presentations	7. Almany GR, Hamilton RJ, Bode M, Matawai M, Potuku T, Saenz-Agudelo P, Planes S, Berumen ML, Rhodes KL, Thorrold SR, Russ GR, Jones GP. 2013. Dispersal of grouper larvae drives local resource sharing in a coral reef fishery. *Current Biology* 23: 626-630.	Oral Presentations 7-8

			8. Almany GR, Planes S, Thorrold SR, Berumen ML, Bode M, Saenz-Agudelo P, Bonin MC, et al. 2017. Larval fish dispersal in a coral-reef seascape. *Nature Ecology and Evolution* 1: 1-17	
Wednesday, February 20	• Class cancelled due to illness	-	-	Written Paper: Proposal
Friday, February 22	• Class cancelled due to illness	-	-	
Monday, February 25	5 – Physical causes of variation in dispersal and population connectivity: winds & currents	Lecture	Kuparinen A. 2006. Mechanistic models for wind dispersal. *Trends in Plant Science* 11: 296-301	
Monday, February 25	0 – How to write a good scientific review paper	Tools	Kirshner, J. 1996. Alfred Hitchcock and the art of research. Political Science and Politics 29: 511-513.	
Wednesday, February 27	5 – Physical causes of variation in dispersal and population connectivity: winds & currents	Discussion	Cowen RK, Paris CB, Srinivasan A. 2006. Scaling of connectivity in marine populations. *Science* 311: 522-527.	
Friday, March 1	5 – Physical causes of variation in dispersal and population connectivity: winds & currents	Student Presentations	9. Bonte D, Bossuyt B, Lens L. 2007. Aerial dispersal plasticity under different wind conditions in a salt marsh wolf spider. *Behav Ecol*. 18: 438-443. 10. Thomas L, Kennington WJ, Stat M, Wilkinson SP, Kool JT, Kendrick GA. 2015. Isolation by resistance across a complex coral reef seascape. *Proceedings of the Royal Society of London, Series B*. 282.	Oral Presentations 9-10
Monday, March 4	6 – Evolutionary causes of variation in dispersal and population connectivity: ESS	Lecture	Burgess SC, Baskett ML, Grosberg RK, Morgan SG, Strathmann RR. 2016. When is dispersal for dispersal? Unifying marine and terrestrial perspectives. Biological Reviews 91:867-882	
Monday, March 4	4 – Measuring dispersal kernels, Dissecting dispersal kernels & Long distance dispersal	Student Presentations	5. Hameed SO, Wilson White J, Miller SH, Nickols KJ, Morgan SG. 2016. Inverse approach to estimating larval dispersal reveals limited population connectivity along 700 km of wave-swept coastline. *Proceedings of the Royal Society of London, Series B*. 283. 8. Almany GR, Planes S, Thorrold SR, Berumen ML, Bode M, Saenz-Agudelo P, Bonin MC, et al. 2017. Larval fish dispersal in a coral-reef seascape. *Nature Ecology and Evolution* 1: 1-17	Oral Presentations 5 & 8 (Make-up)
Wednesday, March 6	6 – Evolutionary causes of variation in dispersal and population connectivity: ESS	Discussion	Hamilton WD, May RM. 1977. Dispersal in stable habitats. Nature 269:578-581	Written Paper 1: Patterns
Friday, March 8	6 – Evolutionary causes of variation in dispersal and population connectivity: ESS	Student Presentations	11. Cheptou PO, Carrue O, Rouifed S, Cantarel A. 2008. Rapid evolution of seed dispersal in an urban environment in the weed *Crepis sancta*. *Proceedings of the National Academy of Sciences USA* 105: 3796-3799.	Oral Presentations 11-12

			12. Williams JL, Kendall BE, Levine JM. 2016. Rapid evolution accelerates plant population spread in fragmented experimental landscapes. *Science 353:* 482-485	
Monday, March 11	Spring Recess	Spring Recess	Spring Recess	Spring Recess
Wednesday, March 13	Spring Recess	Spring Recess	Spring Recess	Spring Recess
Friday, March 15	Spring Recess	Spring Recess	Spring Recess	Spring Recess
Monday, March 18	• Class cancelled for invited talk	-	-	
Monday, March 18	• Class cancelled for invited talk	-	-	
Wednesday, March 20	7 – Phenotypic causes of variation in dispersal and population connectivity 1: adults	Lecture	Thomson FJ, Moles AT, Auld TD, Kingsford RT. 2011. Seed dispersal distance is more strongly correlated with plant height than with seed mass. *Journal of Ecology* 99:1299-1307	
Friday, March 22	7 – Phenotypic causes of variation in dispersal and population connectivity 1: adults	Discussion	Saenz-Agudelo P, Jones GP, Thorrold SR, Planes S. 2015. Mothers matter: contribution to local replenishment is linked to female size, mate replacement and fecundity in a fish metapopulation. *Marine Biology* 162: 3-14	
Monday, March 25	0 – How to write a good scientific review paper	Tools	Gopen GD, Swan JA. 1990. The science of scientific writing: if the reader is to grasp what the writer means, the writer must understand what the reader needs. In: *Exploring Animal Behavior* 5th edition, pp 17-25.	
Monday, March 25	7 – Phenotypic causes of variation in dispersal and population connectivity 1: adults	Student Presentations	13. Buston PM. 2003. Forcible eviction and prevention of recruitment in the clown anemonefish. *Behav Ecol* 14: 576-582. 14. Luiz OJ, Allen AP, Robertson DR, Floeter SR, Kulbicki M, Vigliola L, Madin J. 2013. Adult and larval traits as determinants of geographic range size among tropical reef fishes. *PNAS* 110: 16498-16502.	Oral Presentations 13-14
Wednesday, March 27	8 – Phenotypic causes of variation in dispersal and population connectivity 2: propagules	Lecture	Nanninga GB, Manica A. 2018. Larval swimming capacities affect genetic differentiation and range size in demersal marine fishes. *Marine Ecology Progress Series* 589: 1-12.	
Friday, March 29	8 – Phenotypic causes of variation in dispersal and population connectivity 2: propagules	Discussion	Pires MM, Guimaraes PR, Galetti M, Jordano P. 2018. Pleistocene megafaunal extinctions and the functional loss of long-distance seed dispersal services. *Ecography* 41: 153-163	
Monday, April 1	8 – Phenotypic causes of variation in dispersal and population connectivity 2: propagules	Application & Integration (Concept Mapping 2)	TBD	

Monday, April 1	8 – Phenotypic causes of variation in dispersal and population connectivity 2: propagules	Student Presentations	15. Donelson JM, McCormick MI, Munday PL. 2008. Parental condition affects early life-history of a coral reef fish. *Journal of Experimental Marine Biology and Ecology.* 360: 109-116. 16. Bode M, Bode L, Armsworth PR. 2011. Different dispersal abilities allow reef fish to coexist. *Proceedings of the National Academy of Sciences* 108: 16317-16321.	Oral Presentations 15-16
Wednesday, April 3	9 – Consequences of dispersal and connectivity for population ecology and community ecology	Lecture	Gaines SD, Gaylord B, Gerber LR, Hastings A, Kinlan B. 2007. Connecting places: the ecological consequences of dispersal in the sea. *Oceanography* 20: 90-99	Written Paper 2: Causes
Friday, April 5	9 – Consequences of dispersal and connectivity for population ecology and community ecology	Discussion	Stier AC, Hein AN, Parravicini V, Kulbicki M. 2014. Larval dispersal drives trophic structure across Pacific coral reefs. *Nature Communications* 5: 5575	
Monday, April 8	9 – Consequences of dispersal and connectivity for population ecology and community ecology	Application & Integration (Facebook 1)	Frugivores & Seed Dispersal (https://www.facebook.com/FSD2020/)	
Monday, April 8	9 – Consequences of dispersal and connectivity for population ecology and community ecology	Student Presentations	17. Chase JM, Burgett AA, Biro EG. 2010. Habitat isolation moderates the strength of top-down control in experimental pond food webs. *Ecology* 91: 637-643 18. McCauley SJ. 2006. The effects of dispersal and recruitment limitation on community structure of odonates in artificial ponds. *Ecography* 29: 585-595.	Oral Presentations 17-18
Wednesday, April 10	10 – Consequences of dispersal and connectivity for microevolution and macroevolution	Lecture	D'Aloia CC, Bogdanowicz SM, Harrison RG, Buston PM. 2014. Seascape continuity plays an important role in determining patterns of spatial genetic structure in a coral reef fish. Molecular Ecology 12: 2902-2913.	
Friday, April 12	• Class cancelled due to illness	-	-	
Monday, April 15	Patriot's Day Holiday	Patriot's Day Holiday	Patriot's Day Holiday	Patriot's Day Holiday
Wednesday, April 17 (Monday)	10 – Consequences of dispersal and connectivity for microevolution and macroevolution	Discussion	Ascher A. 2017. A test of alternative hypotheses for the traits that predict the number of species in three coral reef fish families. *Undergraduate Honors Thesis, Marine Science, Boston University*.	
Wednesday, April 17 (Monday)	10 – Consequences of dispersal and connectivity for microevolution and macroevolution	Student Presentations	19. Purcell JFH, Cowen RK, Hughes CR, Williams DA. 2006. Weak genetic structure indicates strong dispersal limits: a tale of two coral reef fish. *Proceedings of the Royal Society of London, Series B*273: 2483-1490. 20. Puill-Stephan E, van Oppen MJH, Pichavant-Rafini K, Willis BL 2012. High potential for formation and persistence of chimeras following aggregated larval	Oral Presentations 19-20

			settlement in the broadcast spawning coral *Acropora millepora* 279: 699-708.	
Friday, April 19	11 – Consequences of dispersal and connectivity for behavioral ecology and social evolution	Lecture	Grosberg RK, Quinn JF. 1986. The genetic control and consequences of kin recognition by the larvae of a colonial marine invertebrate. *Nature* 322: 456-459.	
Monday, April 22	11 – Consequences of dispersal and connectivity for behavioral ecology and social evolution	Discussion	Torices R, Gomez JM, Pannell JR. 2018. Kin discrimination allows plants to modify investment towards pollinator attraction. *Nature Communications* 9	
Monday, April 22	11 – Consequences of dispersal and connectivity for behavioral ecology and social evolution	Student Presentations	21. Toth E, Duffy JE. 2005. Coordinated response to nest intruders in a social shrimp. *Biology Letters* 1: 49-52. 22. Butler MJ, Paris CB, Goldstein JS, Matsuda H, Cowen RK. 2011. Behavior constraints the dispersal of long-lived spiny lobster larvae. *Marine Ecology Progress Series* 422: 223-237.	Oral Presentations 21-22
Wednesday, April 24	12 – Implications of dispersal and connectivity for conservation and fisheries management	Lecture	Jones GP, Srinivasan M, Almany GR. 2007. Population connectivity and conservation of marine biodiversity. *Oceanography* 20: 100-111	
Friday, April 26	12 – Implications of dispersal and connectivity for conservation and fisheries management	Discussion	Almany GR, Hamilton RJ, Bode M, Matawai M, Potuku T, Saenz-Agudelo P, Planes S, Berumen ML, Rhodes KL, Thorrold SR, Russ GR, Jones GP. 2013. Dispersal of grouper larvae drives local resource sharing in a coral reef fishery. *Current Biology* 23: 626–630	
Monday, April 29	12 – Implications of dispersal and connectivity for conservation and fisheries management	Application & Integration (Topic TBD)	TBD	
Monday, April 29	12 – Implications of dispersal and connectivity for conservation and fisheries management	Student Presentations	23. Harrison HB, Williamson DH, Evans RD. 2012. Larval export from marine reserves and the recruitment benefit for fish and fisheries. *Current Biology* 22: 1023–1028. 24. Saura S, Estruil C, Mouton C, Rodriguez-Freire M, 2011. Network analysis to assess landscape connectivity trends: Application to European forests (1990-2000). *Ecological Indicators* 11: 407-416	Oral Presentations 23-24
Wednesday, May 1	Wrap-up, Review & Evaluations	Lecture	TBD	Written Paper 3: Consequences

ASSIGNMENTS 1: LECTURE; DISCUSSION; APPLICATION & INTEGRATION

General Goal: Research and Information Literacy (Hub Learning Outcome)

Scholarly research—the process of posing problems, designing effective investigative strategies, collecting and evaluating information, drawing conclusions, and presenting findings—drives the creation and dissemination of new knowledge in and across all academic disciplines, professions, and walks of life. Today's information explosion places a particular requirement on anyone doing research to develop the abilities associated with information literacy—knowing how to locate needed information, assess the accuracy of sources, and use them to good effect. BU's mission as a research university embraces the conviction that research and information literacy should be central to an undergraduate university education. By learning from scholars on the BU faculty how new knowledge is created and disseminated, and by conducting or participating in research, BU students join a community of inquiry with a commitment to the pursuit of knowledge that crosses borders and connects generations.

Courses and cocurricular activities in this area must have all outcomes.

1. Students will be able to search for, select, and use a range of publicly available and discipline-specific information sources ethically and strategically to address research questions.
2. Students will demonstrate understanding of the overall research process and its component parts, and be able to formulate good research questions or hypotheses, gather and analyze information, and critique, interpret, and communicate findings.

Specific Goals: Selection and Use of Research Materials for, and Understanding of Research Process in, Presentations and Papers

To maximize utility, we will learn how to select and use discipline-specific information, by selecting papers and using them as the basis of our 3 oral presentations and 3 written papers (see below). Selection of discipline-specific information is a skill that is limited in scope, but all of the skills learned, e.g., navigation of BU's library system and evaluation of quality of materials, are transferable to other contexts.

After an introduction to the research process (see syllabus), based on BU Libraries' "How-To Guides' (https://www.bu.edu/library/help/how-to), students will select their own materials for giving their presentations and writing their papers. Materials and their rationale for selection will be sent to me before the oral presentation or written paper, and I will provide feedback on the materials and the selection process.

Scientific conference presentations commonly reflect the content of a single scientific paper — indeed they are often given before the paper is published, so that people can get feedback on their work. The week before you speak, you will find three potential papers to present on, send them to me before Friday at noon, along with a description of how you found them and which paper you think is the best fit.

Scientific review papers commonly reflect the content of many papers — they are commonly the synthesis of work published by other people, looking for emerging themes or new ideas. In the weeks before you write each paper, you will find 6-12 potential papers to review, send them to me, along with a description of how you found them and why you think they are relevant for your review.

In both your oral presentations on a single paper and written review of multiple papers, you will demonstrate an understanding of the research process used in those papers: hypothesis formulation, data collection, data analysis, and data interpretation. You will constructively critique, thoughtfully interpret, and clearly communicate the findings of others to me and your peers.

Grading: Scores will be provided for each selection and use of research materials (3 talks; 3 papers), and for each demonstration of understanding of the research process (3 talks; 3 papers). Scores will make up some portion of final grade (TBD).

ASSIGNMENTS 2: ORAL PRESENTATIONS

General Goal: Oral and/or Signed Communication (Hub Learning Outcome)

BU students should be able to communicate information in a clear and coherent formal oral and/or signed presentation, to engage responsibly with others, and to make use of a range of disciplinary-appropriate informal oratory. As with writing, effective oral/signing communicators should prepare remarks with an awareness of their purpose and their audience. Because oral and/or signed communication is generally interactive, students should be able to attend and respond thoughtfully to others. They should also understand that public presentation serves an essentially civic function as a means of participating in collective debate and decision-making.

Courses and cocurricular activities in this area must have all outcomes.

1. Students will be able to craft and deliver responsible, considered, and well-structured oral arguments using media and modes of expression appropriate to the situation.
2. Students will demonstrate an understanding that oral/signed communication is generally interactive, and they should be able to attend and respond thoughtfully to others.
3. Students will be able to speak/sign effectively in situations ranging from the formal to the extemporaneous and interact comfortably with diverse audiences.

Specific Goal: Scientific Conference Presentations (Course Learning Objective)

To maximize utility, we will learn how to give good scientific conference presentations and improve our ability to give these presentations, by giving 3 conference presentations each over the semester. Scientific conference presentations are limited in scope, but all of the skills you learn in this context are transferable to other contexts, e.g., teaching, business, law.

Scientific conference presentations commonly reflect the content of a single scientific paper — indeed they are often given before the paper is published, so that people can get feedback on their work. The week before you speak, you will find three potential papers to present on, send them to me before Friday at noon, and I will suggest which one I think will work best.

Scientific conference presentations are commonly given using Powerpoint. Presentations are commonly 12 minutes long (12-15 slides) with 3 minutes for questions (15 minutes total). How colleagues view the presentation depends on many factors, including content, organization of material, effective use of Powerpoint, presentation skills and facility with answering questions.

Because conference presentations are reviewed by our peers, these presentations will be reviewed by your peers. At the end of each presentation, everyone will have a couple of minutes to jot down some notes and overall score on the peer feedback form. We will then discuss feedback, what worked and what didn't work, so that all might benefit.

To give you an example of what we are looking for, I will give an old conference presentation on a topic unrelated to the course (though it could be a later topic on behavioral consequences of dispersal). As I present, think about what we've just learned about how to give a good talk, think about how to best use the peer feedback form, and think about how to deliver your feedback.

Grading: Score for each of your conference presentations will be the average of scores from all of your peers and me. You voted to weight the talks as 7.5%, 10% and 12.5% of final grade. The three talks will make-up 30% of the final grade.

ASSIGNMENTS 3: WRITTEN PAPERS

General Goal: Writing Intensive (Hub Learning Outcome)

Writing is fundamental, the most important form of expression that BU undergraduates must develop. In almost every professional setting, BU graduates must be able to express their ideas in clear, coherent prose. Effective writing demands the honing of skills, but it also cultivates ways of thinking, evaluating evidence, constructing responsible and convincing arguments, and generating creative ideas. As effective writers, BU graduates will pay close attention to the potential readers of their writings; as responsible writers, they will take ownership of their message and the means of communicating it, and hold their writing to high standards of truth, accuracy, validity, and humaneness.

Writing-intensive courses enable students to build on and practice skills learned in the First-Year Writing Seminar and, in some instances, those learned in Writing, Research, and Inquiry courses. Writing-intensive courses must, therefore, have at least outcomes 1 and 2 below, and must have "First-Year Writing Seminar" (e.g., CAS WR 120) as a pre-requisite.

1. Students will be able to craft responsible, considered, and well-structured written arguments, using media and modes of expression appropriate to the situation.
2. Students will be able to read with understanding, engagement, appreciation, and critical judgment.
3. Students will be able to write clearly and coherently in a range of genres and styles, integrating graphic and multimedia elements as appropriate.

Specific Goal: Scientific Review Papers (Course Learning Objective)

To maximize utility, we will learn how to write good scientific review papers and improve our ability to write these papers, by writing and revising 3 papers over the semester. Scientific review papers are limited in scope, but all of the skills that you learn in this context are transferable to other contexts, e.g., see *Trends in Ecology and Evolution* (https://www.cell.com/trends/ecology-evolution/home).

The three papers will build on each other over the semester, allowing you to respond to constructive criticism as you add new material. The first paper will be on the general topic of patterns of dispersal (Topics 1-4), the second will be on the general topic of patterns and causes of dispersal (Topics 1-8), and the third paper will be on the general topic of patterns, causes and consequences of dispersal (Topics 1-12).

All paper will be written in Arial 11 point font (or equivalent) and double-spaced. The first paper will be 3-5 pages with 5-10 references; the second paper will be 6-9 pages with 10-20 references; the third paper will be 9-10 pages with 15-30 references. You will receive timely feedback on the first and second papers, enabling you to revise old material as you add new material.

Scientific review papers always have a central thesis that they address (see Alfred Hitchcock and the Art of Research). The first thing you will need to decide is what the focus of your review paper will be. It could be marine larval dispersal, terrestrial seed dispersal, a comparison of marine and terrestrial perspectives, or a single model system. I can help you fine-tune the focus of your paper, if you need help.

Due Dates: Paper 1 — Wednesday, March 6; Paper 2 — Wednesday, April 3; Paper 3 — Wednesday, May 1

Grading: Score for each of your written papers will be based on quality (not quantity) of writing, scientific content, your accurate evaluation of evidence and your construction of logical arguments and creative ideas. You voted to weight the papers as 7.5%, 10% and 12.5% of final grade. The three papers will make up 30% of the final grade.

FEEDBACK

This course is always developing. I welcome your feedback on the course, constructive criticism and suggestions for improvements. This is especially true this year while this is a Topics course, as I aim to run the course as a full-fledged, 4-credit, hub course in future years.

ACKNOWLEDGEMENTS

This course has been developed with the input of Katrina Catalano, Cassidy D'Aloia, Andrew Lacqua, John Majoris, E Schlatter and Colleen Webb. I am grateful to the many students and colleagues with whom I have had the pleasure of discussing ideas on metapopulation ecology, propagule dispersal and population connectivity over the years.

Pete Buston was supported by two National Science Foundation awards during the development of this course: 1) An integrative investigation of population connectivity using a coral reef fish (NSF OCE 1260424); and 2) The role of larval behavior in determining population connectivity (NSF OCE 14595456).

APPENDIX I: FINK'S TAXONOMY FOR STUDENTS

Fink LD. 2003. Creating significant learning experiences: an integrated approach to designing college courses. Published by Jossey-Bass

A FINK Table 3: Teaching/Learning Strategies Best Suited for Each Dimension of Learning

Desired Dimension	Suggested Teaching/Learning Strategies
Foundational Knowledge (understanding, remembering)	Presentation, lecture, question-and-answer, large and small group discussion, development of learning issues, independent study, review session, teaching others, game, web-based instruction
Application (critical & practical thinking, creativity, managing projects, performance skills)	Hands-on procedure, lab, live or video demonstration, simulation, case study, role-play, action plan, teaching others, question-and-answer, brainstorming, problem-solving, trouble-shooting, journal club, developing research questions, theory and model building, project, critical review, direct patient contact, precepting, guided practice with feedback
Integration (connecting ideas, disciplines, people, realms)	What if…, compare and contrast, concept mapping, cross-disciplinary teams, cross-disciplinary cases, multiple examples within & across contexts, theory & model building, integrated curriculum
Human Dimension (leadership, ethics, teamwork; social, cultural, political, environmental implications)	Case study, simulated patients, patient presentations, working in diverse teams, authentic project, group project, direct patient contact, assigned leadership role, debate, journal club (e.g., using ethics articles)
Caring (wanting to succeed, developing a keen interest, making a commitment)	Authentic project, role modeling, self-selection activity, debate, reflective writing, positive reinforcement, learning prescription
Learning to Learn (becoming a better learner, inquiring & constructing knowledge, being self-directed)	Self-assessment, self- and peer-feedback, teaching others, reflective writing, formative assessment, self-awareness exercise/inventory

APPENDIX II: BLOOM'S TAXONOMY FOR STUDENTS

Crowe A, Dirks C, Wenderoth MP. 2008. Biology in Bloom: implementing Bloom's taxonomy to enhance student learning in biology. *CBE — Life Sciences Education* 7: 368-381.

Table 3. Bloom's-based Learning Activities for Students (BLASt)[1]

Bloom's level	Individual activities	Group activities
Knowledge (LOCS)	• Practice labeling diagrams • List characteristics • Identify biological objects or components from flash cards • Quiz yourself with flash cards • Take a self-made quiz on vocabulary • Draw, classify, select, or match items • Write out the textbook definitions	• Check a drawing that another student labeled • Create lists of concepts and processes that your peers can match • Place flash cards in a bag and take turns selecting one for which you must define a term • Do the above activities and have peers check your answers
Comprehension (LOCS)	• Describe a biological process in your own words without copying it from a book or another source • Provide examples of a process • Write a sentence using the word • Give examples of a process	• Discuss content with peers • Take turns quizzing each other about definitions and have your peers check your answer
Application (LOCS/HOCS)	• Review each process you have learned and then ask yourself: What would happen if you increase or decrease a component in the system or what would happen if you alter the activity of a component in the system? • If possible, graph a biological process and create scenarios that change the shape or slope of the graph	• Practice writing out answers to old exam questions on the board and have your peers check to make sure you don't have too much or too little information in your answer • Take turns teaching your peers a biological process while the group critiques the content
Analysis (HOCS)	• Analyze and interpret data in primary literature or a textbook without reading the author's interpretation and then compare the authors' interpretation with your own • Analyze a situation and then identify the assumptions and principles of the argument • Compare and contrast two ideas or concepts • Create a map of the main concepts by defining the relationships of the concepts using one- or two-way arrows	• Work together to analyze and interpret data in primary literature or a textbook without reading the author's interpretation and defend your analysis to your peers • Work together to identify all of the concepts in a paper or textbook chapter, create individual maps linking the concepts together with arrows and words that relate the concepts, and then grade each other's concept maps
Synthesis (HOCS)	• Generate a hypothesis or design an experiment based on information you are studying • Create a model based on a given data set • Create summary sheets that show how facts and concepts relate to each other • Create questions at each level of Bloom's Taxonomy as a practice test and then take the test	• Each student puts forward a hypothesis about biological process and designs an experiment to test it. Peers critique the hypotheses and experiments • Create a new model/summary sheet/concept map that integrates each group member's ideas.
Evaluation (HOCS)	• Provide a written assessment of the strengths and weaknesses of your peers' work or understanding of a given concept based on previously determined criteria	• Provide a verbal assessment of the strengths and weaknesses of your peers' work or understanding of a given concept based on previously described criteria and have your peers critique your assessment

[1] Students can use the individual and/or group study activities described in this table to practice their ability to think at each level of Bloom's Taxonomy.

APPENDIX III: QUESTIONS TO THINK ABOUT WHILE YOU READ A SCIENTIFIC PAPER (NOT ALWAYS APPLICABLE)

What is the central research question?

What are the specific hypotheses?

What methods are used (observational or experimental; genetical or mathematical) and how do they address the hypotheses?

What are the key results?

What are the conclusions and how well are they supported by the data?

How does the study fit into a larger conceptual framework?

What are the strengths and weaknesses of the study?

What questions remain and what additional research should come next?

APPENDIX IV: ORAL PRESENTATION PEER REVIEW FORM

Presenter's Name: ____

Title of Presentation: ____

Feedback on Presentation. Presentations should be reviewed as you would like someone to review your own, i.e, constructively. Please be as explicit and as kind as possible in your feedback on how the talk fairs in the areas listed below. Please assign an overall score of 1-5 for the presentation, with 1 being "this is a foundation to build from", 3 being "this is a good presentation to improve on", and 5 being "this was an outstanding presentation".

Content: Articulating the gap in knowledge the research fills, or the "hook", early on in the talk

____

Content: Use of the scientific method: hypotheses, predictions, methods, results, conclusions

____

Organization: Outline of the talk; Flow of the talk, from one slide to the next; Timing of talk

____

Visual aids: Effective use of text, illustrations, font, color

____

Presentation style: speaker volume and clarity; eye contact and body language; pace

____

What is the best part of presentation?

____

Where could the most improvement be made?

____

Overall score (circle one):

1	2	3	4	5
A foundation to build from…		A good talk to improve on…		An outstanding presentation

Please return forms to me at the end of the session. THANKS FOR YOUR HELP!

APPENDIX V: OUTLINE OF CLASS TOPICS AND INSTRUCTOR READING LISTS

PATTERN

TOPIC 1: MOTIVATION FOR STUDYING METAPOPULATION ECOLOGY AND POPULATION CONNECTIVITY

TOPIC 2: A PARADIGM SHIFT REGARDING THE SPATIAL SCALE OF MARINE DISPERSAL AND CONNECTIVITY

TOPIC 3: QUANTITATIVE PATTERNS OF DISPERSAL, SAMPLING BIASES & THE EFFECTS OF LANDSCAPE/SEASCAPE

TOPIC 4: DISPERSAL KERNELS, DISSECTION OF DISPERSAL KERNELS & LONG DISTANCE DISPERSAL

CAUSES

TOPIC 5: PROXIMATE (PHYSICAL) CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY

TOPIC 6: ULTIMATE (EVOLUTIONARY) CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY

TOPIC 7: PHENOTYPIC CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY — PARENTS

TOPIC 8: PHENOTYPIC CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY — PROPAGULES

CONSEQUENCES

TOPIC 9: CONSEQUENCES OF DISPERSAL AND CONNECTIVITY FOR POPULATION AND COMMUNITY ECOLOGY

TOPIC 10: CONSEQUENCES OF DISPERSAL AND CONNECTIVITY FOR MICROEVOLUTION & MACROEVOLUTION

TOPIC 11: CONSEQUENCES OF DISPERSAL AND CONNECTIVITY FOR BEHAVIORAL ECOLOGY & SOCIAL EVOLUTION

TOPIC 12: IMPLICATIONS OF DISPERSAL AND CONNECTIVITY FOR CONSERVATION & FISHERIES MANAGEMENT

TOPIC 1: MOTIVATION FOR STUDYING METAPOPULATION ECOLOGY AND POPULATION CONNECTIVITY
Keywords: ***metapopulation ecology; landscape ecology; extinction & colonization; patch area & isolation; island biogeography***
(Required readings in black; Optional readings in gray)

Theoretical / General
Levin S. 1989. The problem of pattern and scale in ecology. *Ecology* 73:1943-1967. (Reading for Lecture 1 in 2021?)
Hanksi I. 1998. Metapopulation dynamics. *Nature* 396: 41-49 *(Reading for Discussion 1 in 2021)*
Hanski I. 1999. Metapopulation Ecology. Chapter 1, pp 1-21. Oxford University Press. (Reading for Lecture 1 in 2021?)
Terrestrial
Husband BC, Barrett SCH. 1996. A metapopulation perspective in plant population biology. *Journal of Ecology* 84: 461-469.
Nathan R & Muller-Landau H. 2000. Spatial patterns of seed dispersal, their determinants and consequences for recruitment. *Trends in Ecology and Evolution* 15: 278-285.
Ozinga WA et al. 2005. Predictability of plant species composition from environmental conditions is constrained by dispersal limitation. *OIKOS* 108: 555-561.
Marine
Cowen RK, Gawarkiewicz G, Pineda J, Thorrold S, Werner F. 2002. Population connectivity in marine systems. *Report of a workshop to develop science recommendations for the National Science Foundation*. November 4-6, 2002, Durango, Colorado. NSF website.
Sala E, Aburto-Oropeza O, Paredes G, Parra I, Barrera JC, Dayton PK. 2002. A general model for designing networks of marine reserves. Science 298: 1991-1993.
Gell FR, Roberts CM. 2003 Benefits beyond boundaries: the fishery effects of marine reserves. Trends in Ecology and Evolution, 18, 448-455.
Gerber LR, Botsford LW, Hastings A, Possingham HP, Gaines SD, Palumbi SR, Andelman S. 2003. Population models for marine reserve design: a retrospective and prospective synthesis. Ecol. Appl. 13: S47-S64
Kritzer JP, Sale PF. 2004. Metapopulation ecology in the sea: from Levin's model to marine ecology and fisheries science. Fish and Fisheries 5: 131-140.
Sale PF, Cowen RK, Danilowicz BS, Jones GP, Kritzer JP, Lindeman KC, Planes S, Polunin NVC, Russ GR, Sadovy YJ, Steneck RS. 2005. Critical science gaps impede use of no-take fishery reserves. *Trends in Ecology and Evolution* 20: 74-80
Cowen RK, Gawarkiewicz G, Pineda J, Thorrold S, Werner F. 2007. Population connectivity in marine systems: an overview. *Oceanography* 20: 14-21
Jones GP, et al. Larval retention and connectivity among populations of corals and reef fishes: history, advances and challenges. *Coral Reefs* 28.2 (2009): 307-325.
Botsford LW, White JW, Coffroth MA, Paris CB, Planes S, Shearer TL, Thorrold SR, Jones GP. 2009. Connectivity and resilience of coral reef metapopulations in marine protected areas: matching empirical efforts to predictive needs. *Coral Reefs* 28: 327-337.

TOPIC 2: A PARADIGM SHIFT REGARDING THE SPATIAL SCALE OF MARINE DISPERSAL AND CONNECTIVITY
Keywords: null hypothesis; connectivity; self-recruitment; recruitment limitation; the problem of pattern and scale
(Required readings in black; Optional readings in gray)

Theoretical / General
Levin S. 1989. The problem of pattern and scale in ecology. *Ecology* 73:1943-1967.
Terrestrial
Clark JS et al. 1999. Interpreting recruitment limitation in forests. *American Journal of Botany* 86:1-16.
Marine
Bell LJ, Moyer JT, Numachi K. 1982. Morphological and genetic variation in Japanese populations of the anemonefish *Amphiprion clarkii. Marine Biology* 72: 99-108.
Hourigan TF, Reese ES. 1987. Mid-ocean isolation and the evolution of Hawaiian reef fishes. *Trends in Ecology and Evolution* 2: 187-191.
Sammarco PW, Andrews JC. 1988. Localized dispersal and recruitment in Great Barrier Reef Corals: the helix experiment. *Science* 239: 1422-1424.
Wolanski E, Hamner W 1988. Topographically-controlled fronts in the ocean, and their influence on the distribution of organisms. *Science* 241: 177-181.
Planes S. 1993. Genetic differentiation in relation to restricted larval dispersal of the convict surgeonfish *Acanthurus triostegus* in French Polynesia. *Marine Ecology Progress Series* 98: 237-246.
Schultz ET, Cowen RK 1994. Recruitment of coral reef fishes to Bermuda: local retention or long distance transport? *Marine Ecology Progress Series* 109: 15-28.
Doherty PJ, Carleton JM. 1997. The distribution and abundance of pelagic juvenile fish near Grub Reef, Central Barrier Reef. *Proc 8th Int Coral Reef Symposium* 2: 1155-1160.
Roberts CM. 1997. Connectivity and management of Caribbean coral reefs. *Science* 278: 1454-1457 (Reading for Lecture 2 in 2021)
Stobutzki IC, Bellwood DR. 1997. Sustained swimming abilities of the late pelagic stages of coral reef fishes. *Marine Ecology Progress Series* 149: 35-41
Stobutzki IC, Bellwood DR. 1998. Nocturnal orientation to reefs by later pelagic stage coral reef fishes. *Coral Reefs* 17: 103-110.
Jones GP, Milicich MJ, Emslie MJ, Lunow C. 1999. Self-recruitment in a coral reef fish population. *Nature* 402: 802-804. (Reading for Discussion 2 in 2021)
Swearer SE, Caselle JE, Lea DW, Warner RR. 1999. Larval retention and recruitment in an island population of coral-reef fish. *Nature* 402:799-802.
Warner RR, Cowen RK. 2002. Local retention of production in marine populations: evidence, mechanisms and consequences. *Bull. Mar. Sci.* 70: 245-249
Taylor MS, Hellberg ME. 2003. Genetic Evidence for Local Retention of Pelagic Larvae in a Caribbean Reef Fish. Science, 299, 107–109.
Jones, GP, Planes, S and Thorrold, SR 2005. Coral reef fish larvae settle close to home. *Current Biology* 15(14): 1314-1318. (Reading for Application & Integration in 2021)
Hedgecock D, Barber PH, Edmands S. 2007. Genetic approaches to measuring connectivity. *Oceanography* 20: 70-79.
Thorrold SR, Zacherl DC, Levin LA. 2007. Population connectivity and larval dispersal using geochemical signatures in calcified structures. *Oceanography* 20: 80-89.

TOPIC 3: QUANTITATIVE PATTERNS OF DISPERSAL, SAMPLING BIASES & THE EFFECTS OF LANDSCAPE/SEASCAPE

***Keywords:** sampling bias; Janzen-Connell hypothesis; open vs closed populations; corridors; retention*

(Required readings in black; Optional readings in gray)

Theoretical
Urban D, Keitt T. 2001. Landscape connectivity: a graph-theoretic perspective. Ecology 82: 1205-1218.
Kinlan B, Gaines SD. 2003. Propagule dispersal in marine and terrestrial environments: a community perspective. *Ecology* 84:2007-2020.
Levin SA, Muller-Landau HC, Nathan R, Chave J. 2003. The ecology and evolution of seed dispersal: a theoretical perspective. *Annual Review of Ecology, Evolution and Systematics* 34: 575-.
Levey DJ, Tewksbury JJ, Bolker BM. 2008. Modelling long-distance seed dispersal in heterogeneous landscapes. Journal of Ecology 96: 599-608.
Treml E, Halpin PN, Urban DL, Pratson LF. 2008. Modeling population connectivity by ocean currents, a graph-theoretic approach for marine conservation. *Landscape Ecology* 23:19-36.
Pinsky ML, Palumbi SR, Andrefouet S, Purkis SJ. 2012. Open and closed seascapes: where does habitat patchiness create populations with high fractions of self-recruitment? Ecological Applications 22:1257-1267.
Terrestrial
Janzen DH. 1971. Seed predation by animals. *Annual Review of Ecology and Systematics* 2:465-492.
Ribbens E, Silander JA, Pacala SW. 1994. Seedling recruitment in forests: calibrating models to predict patterns of tree seedling dispersion. *Ecology* 75: 1794-1806.
Schupp EW, Fuentes M. 1995. Spatial patterns of seed dispersal and the unification of plant population ecology. *Ecoscience* 2:267-275.
Clark JS et al. 1999. Interpreting recruitment limitation in forests. *American Journal of Botany* 86:1-16.
Nathan R & Muller-Landau H. 2000. Spatial patterns of seed dispersal, their determinants and consequences for recruitment. *Trends in Ecology and Evolution* 15: 278-285.
Garcia C, Jordano P, Godoy JA. 2007. Contemporary pollen and seed dispersal in a *Prunus mahaleb* population: patterns in distance and direction. *Molecular Ecology* 16:1947-1955.
Marine
Jones, GP, Planes, S and Thorrold, SR 2005. Coral reef fish larvae settle close to home. *Current Biology* 15(14): 1314-1318.
Almany GR, Berumen ML, Thorrold SP, Planes S, Jones GP. 2007. Local replenishment of coral reef fish populations in a marine reserve. *Science* 316: 741-744.
Planes S, Jones GP, Thorrold SR. 2009. Larval dispersal connects fish populations in a network of marine protected areas. *PNAS, USA* 106: 5693-5697.
Christie MR, Tissot BN, Albins MA, Beets JP, Jia Y, Ortiz DM, Thompson SE, Hixon MA. 2010. Larval Connectivity in an Effective Network of Marine Protected Areas. PLoS ONE 5: e15715.
Saenz-Agudelo, GP Jones, SR Thorrold, S Planes. 2011. Connectivity dominates larval replenishment in a coastal reef fish metapopulation. *Proceedings of the Royal Society B:* 278 2954-2961
Harrison HB, Williamson DH, Evans RD. 2012. Larval export from marine reserves and the recruitment benefit for fish and fisheries. *Current Biology* 22: 1023–1028.
Buston PM, Jones GP, Planes S, Thorrold SR. 2012. Probability of successful larval dispersal declines fivefold over 1 km in a coral reef fish. Proc B 279:1883-1888.
D'Aloia CC, Bogdanowicz SM, Majoris JE, Harrison RG, Buston PM. 2013. Self-recruitment in a Caribbean reef fish: a new method for approximating dispersal kernels. *Mol EcoL* 22: 2563-2572
Hameed SO, Wilson White J, Miller SH, Nickols KJ, Morgan SG. 2016. Inverse approach to estimating larval dispersal reveals limited population connectivity along 700 km of wave-swept coastline. *Proceedings of the Royal Society of London, Series B.* 283.

TOPIC 4: DISPERSAL KERNELS, DISSECTION OF DISPERSAL KERNELS & LONG DISTANCE DISPERSAL
Keywords: ***long-distance dispersal***
(Required readings in black; Optional readings in gray)

Theoretical
Austerlitz F, Dick CW, Dutech C, Klein EK, Oddu-Muratorio S, Smouse PE, Sork VL. 2004. Using genetic markers to estimate the pollen dispersal curve. *Molecular Ecology* 13: 937-954.
Robledo-Arnuncio JJ, Garcia C. 2007. Estimation of the seed dispersal kernel from exact identification of host plants. *Molecular Ecology* 16: 5098-5109.
Broquet T, Petit EJ. 2009. Molecular estimation for dispersal ecology and population genetics. *Annual Review of Ecology, Evolution and Systematics* 40: 193-216.
Nathan R, Klein E, Robeldo-Arnuncio JJ, Revilla E. 2012. Dispersal kernels: a review. In: *Dispersal Ecology and Evolution* first edition. Ed. Clobert J, et al. Oxford University Press.
Harrison HB, Saenz-Agudelo P, Planes S, Jones GP, Berumen ML. 2013. Relative accuracy of three common methods of parentage analysis in natural populations. *Molecular Ecology* 22: 1158.
Bode M, Williamson DH, Harrison HB, Outram N, Jones GP. 2017. Estimating dispersal kernels using genetic parentage data. *Methods in Ecology and Evolution* 9: 490-501.
Terrestrial
Nathan, R. 2006. Long distance dispersal of plants. *Science* 313: 786-788
Jordano P, Garcia C, Godoy JA, Garcia-Castaño. 2007. DIfferential contribution of frugivores to complex seed dispersal patterns. *PNAS* 104: 3278-3282
Schupp EW, Jordano P, Gomez JM. 2010. Seed dispersal effectiveness revisited: a conceptual review. *New Phytologist* 188: 333-353.
Steinitz O, Troupin D, Vendramin GG, Nathan R. 2011. Genetic evidence for a Janzen-Connell recruitment pattern in reproductive offspring of *Pinus halepensis* trees. *Molecular Ecology* 20: 4152-4164.
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Jordano P. 2017. What is long distance dispersal? And a taxonomy of dispersal events. J. Ecol 105: 75-84
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Almany GR, Planes S, Thorrold SR, Berumen ML, Bode M, Saenz-Agudelo P, Bonin MC, et al. 2017. Larval fish dispersal in a coral-reef seascape. *Nature Ecology and Evolution* 1: 1-17.

TOPIC 5: PROXIMATE (PHYSICAL) CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY

Keywords: wind; flow; isolation by distance and its extensions

(Required readings in black; Optional readings in gray)

Theoretical
Terrestrial
Horn HS, Nathan R, Kaplan SR. 2001. Long-distance dispersal of tree seeds by wind. *Ecological Research* 16: 877-885
Nathan R, Safriel UN, Noy-Meir I. 2001. Field validation and sensitivity analysis of a mechanistic model for tree seed dispersal by wind. *Ecology* 82: 374-388.
Nathan R, Katul GG, Horn HS, Thomas SM, Oren R, Avissar R, Pacala SW, Levin SA. 2002. Mechanisms of long-distance dispersal of seeds by wind. Nature 418: 409-413. (Discussion 5)
Soons MB, Heil GW, Nathan R, Katul GG. 2004. Determinants of long-distance seed dispersal by wind in grasslands. *Ecology* 85: 3056-3068. (Reading for Discussion 5)
Kuparinen A. 2006. Mechanistic models for wind dispersal. *Trends in Plant Science* 11: 296-301. (Reading for Lecture 5)
Wright SJ, Trakhtenbrot A, Bohrer G, Detto M, Katul GG, Horvitz N, Muller-Landau HC, Jones FA, Nathan R. 2008. Understanding strategies for seed dispersal by wind under contrasting atmospheric conditions. PNAS 105: 19084-19089.
Marine
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Cowen RK, Paris CB, Srinivasan A. 2006. Scaling of connectivity in marine populations. Science 311: 522–527.
Pineda J, Hare JA, Sponaugle S. 2007. Larval transport and dispersal in the coastal ocean and consequences for population connectivity. *Oceanography* 20: 22-39
Gawarkiewicz G, Monismith S, Largier J. 2007. Observing larval transport processes affecting population connectivity: progress and challenges. *Oceanography 20:* 40-53.
Werner FE, Cowen RK, Paris CB. 2007. Coupled biological and physical models: present capabilities and necessary developments for future studies of population connectivity. Oceanography 20: 54-69.
Paris CB, Chérubin LM, Cowen RK. 2007. Surfing, spinning or diving from reef to reef: effects on population connectivity. *Marine Ecology Progress Series* 347: 285-300.
Treml EA, Halpin PN, Urban DL, Pratson LF. 2008. Modeling population connectivity by ocean currents: a graph-theoretic approach for marine conservation. Landscape Ecology 23:19-36.
Sponaugle S, Paris C, Walter KD, Kourafalou V, D'Alessandro E. 2012. Observed and modeled larval settlement of a reef fish to the Florida Keys. *Marine Ecology Progress Series* 453: 201-212.

TOPIC 6: ULTIMATE (EVOLUTIONARY) CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY

Keywords: game theory; evolutionarily stable strategies

(Required readings in black; Optional readings in gray)

Theoretical
Hamilton WD, May RM. 1977. Dispersal in stable habitats. Nature 269:578-581.
Hovestadt T, Messner S, Poethke HJ. 2001. Evolution of reduced dispersal mortality and "fat-tailed" dispersal kernels in autocorrelated landscapes. *Proceedings of the Royal Society of London, Series B* 268: 385-391.
Strathmann RR, Hughes TP, Kuris AM, Lindeman KC, Morgan SG, Pandolfi JM, Warner RR (2002) Evolution of local recruitment and its consequences for marine populations. Bull Mar Sci 70:377–396
Baskett ML, Weitz JS, Levin SA. 2007. The evolution of dispersal in reserve networks. The American Naturalist 170: 59-78.
Phillips BL, Brown GP, Travis MJ, Shine R. 2008. Reid's paradox revisited: the evolution of dispersal kernels during range expansion. American Naturalist 172: S34-S48.
Burgess SC, Baskett ML, Grosberg RK, Morgan SG, Strathmann RR. 2016. When is dispersal for dispersal? Unifying marine and terrestrial perspectives. Biological Reviews 91:867-882.
Shaw A, D'Aloia CC, Buston PM. 2019. The evolution of marine larval dispersal kernels in spatially structured habitats: analytical models, individual-based simulations, and comparisons with empirical estimates. American Naturalist 193: online
Terrestrial
Riba M et al. 2009. Darwin's wind hypothesis: does it work for plant dispersal in fragmented habitats? New Phytologist 183: 667-677.
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Haag CR, Saastamoinen M, Marden JH, Hanski I. 2005, A candidate locus for dispersal rate in a butterfly metapopulation. *Proceedings of the Royal Society of London, Series B* 272: 2449-2456
Bonte D, Bossuyt B, Lens L. 2007. Aerial dispersal plasticity under different wind conditions in a salt marsh wolf spider. *Behav Ecol*. 18: 438-443.
Siepielski AM, Benkman CW. 2008. A seed predator drives the evolution of a seed dispersal mutualism. *Proceedings of the Royal Society of London, Series B*. 275: 1917-1925.
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Marine
Johnson DW, Christie MR, Moye J. 2010. Quantifying evolutionary potential of marine fish larvae: heritability, selection and evolutionary constraints. *Evolution* 64: 2614-2628
Krug PJ, Gordon D, Romero MR. 2012. Seasonal polyphenism in larval type: rearing environment influences the development mode expressed by adults in the sea slug *Alderia willowi.Integrative and Comparative Biology*
Staaterman E, Paris CB, Helgers J. 2012. Orientation behavior in fish larvae: a missing piece to Hjort's critical period hypothesis.*Journal of Theoretical Biology* 304: 188-196.
Nanninga GB, Berumen ML. 2014. The role of individual variation in marine larval dispersal. *Frontiers in Marine Science*1, Article 71.
Pringle JM, Byers JE, Pappalardo P, Wares JP, Marshall D. 2014. Circulation constrains the evolution of larval development modes and life histories in the coastal ocean. Ecology 95:1022-1032.

TOPIC 7: PHENOTYPIC CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY — PARENTS

***Keywords:* tradeoffs; dispersal syndromes; life history traits**

(Required readings in black; Optional readings in gray)

Theoretical
Matthysen E. 2012. Multicausality of dispersal: a review. In: *Dispersal Ecology and Evolution* first edition. Ed. Clobert J, et al. Oxford University Press.
Terrestrial
Weisser WW, Braendle C, Minoretti N. 1999. Predator-induced morphological shift in the pea aphid. *Proceedings of the Royal Society of London, Series B.* 266: 1175-1181
Sloggett JJ, Weisser WW. 2002. Parasitoids induce production of the dispersal morph of the pea aphid *Acyrthosiphon pisum*. *Oikos* 98: 323-333.
Cheptou PO, Carrue O, Rouifed S, Cantarel A. 2008. Rapid evolution of seed dispersal in an urban environment in the weed *Crepis sancta*. *Proceedings of the National Academy of Sciences USA* 105: 3796-3799.
Good acre SL et al. 2009. Microbial modification of host long-distance dispersal capacity. *BMC Biology* doi:10.1186/1741-7007-7-32
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Bullock JM, Mallada Gonzalez L, Tamme R, Gotzenberger L, White SM, Partel M, Hooftman DAP. 2017. A synthesis of empirical plant dispersal kernels. *Journal of Ecology* 105: 6-19
Hegstad RJ, Maron JL. 2019. Productivity and related soil properties mediate the population-level consequences of rodent seed predation on Blanketflower *Gaillardia aristata. Journal of Ecology* 107: 34-44
Marine
Buston PM. 2003. Forcible eviction and prevention of recruitment in the clown anemonefish. *Behavioral Ecology* 14: 576-582.
Krug PJ, Gordon D, Romero MR. 2012. Seasonal polyphenism in larval type: rearing environment influences the development mode expressed by adults in the sea slug *Alderia willowi.Integrative and Comparative Biology*
Saenz-Agudelo P, Jones GP, Thorrold SR, Planes S. 2015. Mothers matter: contribution to local replenishment is linked to female size, mate replacement and fecundity in a fish metapopulation. *Marine Biology* 162: 3-14.
Salles O et al. 2016. First genealogy for a wild marine fish population reveals multigenerational philopatry. *Proceedings of the National Academy of Sciences* 113: 13245-13250
Salles O et al. 2016. Genetic tools link long-term demographic and life history traits of anemonefish to their anemone hosts. *Coral Reefs* DOI 10.1007/s00338-016-1485-1
Majoris JE, D'Aloia CC, Francis RK, Buston PM. 2018. Differential persistence favors habitat preferences that determine the distribution of a reef fish. *Behav Ecol* doi:10.1093/beheco/arx189

TOPIC 8: PHENOTYPIC CAUSES OF VARIATION IN DISPERSAL AND CONNECTIVITY — PROPAGULES
Keywords: tradeoffs; dispersal syndromes; life history traits
(Required readings in black; Optional readings in gray)

Theoretical
Burgess SC, Treml EA, Marshall DJ. 2012. How do dispersal costs and habitat selection influence realized population connectivity? *Ecology* 93: 1378-1387.
Terrestrial
Viana DS, Santamaria L, Figuerola J. 2016. Migratory birds as global dispersal vectors. TREE 31:763-775.
Cummins C, Seale M, Macente A, Certini D, Mastropaolo E, Viola IM, Nakayama N. 2018. A separated vortex ring underlies the flight of the dandelion. *Nature* 562: 414-417.
de Jager M, Kaphingst B, Janse EL, Buisman R, Rinzema SGT, Sooms MB. 2018. Seed size regulates plant dispersal distances in flowing water. *Journal of Ecology*: DOI 10.1111/1365-2745.13054
Pires MM, Guimaraes PR, Galetti M, Jordano P. 2018. Pleistocene megafaunal extinctions and the functional loss of long-distance seed dispersal services. *Ecography* 41: 153-163.
Marine
Gerlach G, Atema J, Kingsford MJ, Black KP, Miller-Sims V. 2007. Smelling home can prevent dispersal of reef fish larvae. PNAS 104: 858-863.
Dixson DL, Jones GP, Munday PL, Planes S, Pratchett MS, Srinivasan M, Syms C, Thorrold SR. 2008. Coral reef fish smell leaves to find island homes. *Proceedings of the Royal Society*275: 2831-2839
Mouritsen H, Atema J, Kingsford MJ, Gerlach G. 2013. Sun compass orientation helps coral reef fish larvae return to their natal reef. PLOS One 8.
Dixson DL, Abrego D, Hay ME. 2014. Chemically mediated behavior of recruiting corals and fishes: a tipping point that may limit reef recovery. *Science* 345: 892-897.
Van Tussenbroek BI, Villamil N, Marquez-Guzman J, Wong R, Monroy-Velazquez LV, Solis-Weiss V. 2016. Experimental evidence of pollination in marine flowers by invertebrate fauna. Nature Communications 7:12980
Nanninga GB, Manica A. 2018. Larval swimming capacities affect genetic differentiation and range size in demersal marine fishes. *Marine Ecology Progress Series* 589: 1-12.
Hamel JF, Sun J, Gianasi BL, Montgomery EM, Kenchington EL, Burel B, Rowe S, Winger PD, Mercier A. 2019. Active buoyancy adjustment increases dispersal potential in benthic marine animals. Journal of Animal Ecology. Online.
Nanninga GB, Manica A. 2018. Larval swimming capacities affect genetic differentiation and range size in demersal marine fishes. *Marine Ecology Progress Series* 589: 1-12.
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TOPIC 9: CONSEQUENCES OF DISPERSAL AND CONNECTIVITY FOR POPULATION ECOLOGY AND COMMUNITY ECOLOGY
Keywords: metacommunities; neutral theory; diversity and richness indices
(Required readings in black; Optional readings in gray)

Theoretical
Botsford LW, Hastings A, Gaines SD. 2001. Dependence of sustainability on the configuration of marine reserves and larval dispersal distance. *Ecology Letters* 4: 144-150.
Hastings A, Bostford LW. 2006. Persistence of spatial populations depends on returning home. PNAS 2006: 6067-6072.
Leibold MA et al. 2004. The metacommunity concept: a framework for multi-scale community ecology. Ecology Letters 7:601-613. (Lecture - Spring 2021)
Gilbert B. 2012. Joint consequences of dispersal and niche overlap on local diversity and resource use. Journal of Ecology 100: 287-296.
Terrestrial
Gilbert fF Gonzalez A, Evans-Freke I. 1998. Corridors maintain species richness in the fragmented landscapes of a microecosystem. *Proceedings of the Royal Society of London, Series B.* 165: 577-582.
Gonzalez A., Lawton JH, Gilbert FS, Blackburn TM, Evans-Freke I. 1998. Metapopulation dynamics, abundance, and distribution in a microecosystem. *Science* 281: 2045-2047.
Levine JM, Murrell DJ. 2003. The community-level consequences of seed dispersal patterns. Annual Review of Ecology, Evolution and Systematics 34:549-574.
Alexander HM, Foster BL, Ballantyne F, Collins CD, Antonovics J, Hold RD. 2012. Metapopulations and metacommunities: combining spatial and temporal perspectives in plant ecology. Journal of Ecology 100: 88-103.
Schleuning M, Bohning-Gaese K, Dehling DM, Burns KC. 2014. At a loss for birds: insularity increases asymmetry in seed dispersal networks. *Global Ecology and Biogeography* 23: 285-394.
Jones NT et al. 2015. Dispersal mode mediates the effect of patch size and patch connectivity on metacommunity diversity. Journal of Ecology 103: 935-944.
Marine
Kinlan BP, Gaines SD, Lester SE. 2005. Propagule dispersal and the scales of marine community process. Diversity and Distributions 11: 139-148.
Gaines SD, Gaylord B, Gerber LR, Hastings A, Kinlan B. 2007. Connecting places: the ecological consequences of dispersal in the sea. *Oceanography* 20: 90-99.
Watson JR, Mitarai S, Siegel DA, Caselle JE, Dong C, McWilliams JC. 2010. Realized and potential larval connectivity in the Southern California Bight. Marine Ecology Progress Series 401: 31-48.
Bode M, Bode L, Armsworth PR. 2011. Different dispersal abilities allow reef fish to coexist. *Proceedings of the National Academy of Sciences* 108: 16317-16321.
Carson HS, Cook GS, Lopez-Duarte PC, Levin LA. 2011. Evaluating the importance of demographic connectivity in a marine metapopulation. Ecology 92:1972-1984.
Watson JR, Hays CG, Raimondi PT, Mitarai C, Dong C, McWilliams JC, Blanchette CA, Caselle JE, Siegel DA. 2011. Currents connecting communities: nearshore community similarity and ocean circulation. *Ecology* 92: 1193-1200.
Stier AC, Hein AN, Parravicini V, Kulbicki M. 2014. Larval dispersal drives trophic structure across Pacific coral reefs. Nature Communications 5: 5575.

TOPIC 10: CONSEQUENCES OF DISPERSAL AND CONNECTIVITY FOR MICROEVOLUTION AND MACROEVOLUTION
***Keywords:** spatial selection; spatial genetic structure; collective dispersal*
(Required readings in black; Optional readings in gray)

Theoretical
Broquet T, Viard F, Yearsley JM. 2013. Genetic drift and collective dispersal can result in chaotic genetic patchiness. Evolution 67: 1660-1675.
Terrestrial
Vekemans X, Hardy OJ. 2004. New insights from fine-scale spatial genetic structure analyses in plant populations. *Molecular Ecology* 13: 921-935
He T, Lamont BB, Krauss SL, Enright NJ. 2010. Genetic connectivity and inter-population seed dispersal of *Banksia hookeriana* at the landscape scale. *Annals of Botany* 106: 457-466
Karubian J, Ottewell K, Link A, DiFiore A. 2016. Genetic consequences of seed dispersal to sleeping trees by white-bellied spider monkeys. *Acta Oecologica*
Gelmi-Candusso TA, Heymann EW, Heer K. 2017. Effects of zoochory on the spatial genetic structure of plant populations. *Molecular Ecology* 2017: 1-15
Fonrturbel FE, Bruford MW, Slazar DA, Cortes-Miranda J, Vega-Retter C. 2019. The hidden costs of living in a transformed habitat: ecological and evolutionary consequences in a tripartite mutualistic system with a keystone mistletoe. *Science of the Total Environment* 651: 2740-2748.
Marine
Riginos C, Nachman MW. 2001. Population subdivision in marine environments: the contributions of biogeography, geographical distance and discontinuous habitat to genetic differentiation in a blennoid fish *Axoclinus nigricaudus. Molecular Ecology* 10: 1439-1453.
Riginos C, Victor BC. 2001. Larval spatial distributions and other early life-history characteristics predict genetic differentiation in eastern Pacific blennoid fishes. *Proceedings of the Royal Society of London, Series B.* 268: 1931-1936.
Baums IB, Miller MW, Hellberg ME. 2005. Regionally isolated popoulations of an imperiled Caribbean coral *Acropora palmata*. *Molecular Ecology* 14: 1377-1390.
Purcell JFH, Cowen RK, Hughes CR, Williams DA. 2006. Weak genetic structure indicates strong dispersal limits: a tale of two coral reef fish. *Proceedings of the Royal Society of London, Series B*273: 2483-1490.
Hedgecock D, Barber PH, Edmands S. 2007. Genetic approaches to measuring connectivity. Oceanography 20:70-79.
Alberto F, Raimondi PT, Reed DC, Watson JR, Siegel DA, Mitarai S, Coelho N, Serrao EA. 2011. Isolation by oceanographic distance explains genetic structure for Macrocystis pyrifera in the Santa Barbara Channel. Molecular Ecology 20: 2543-2554.
D'Aloia CC, Bogdanowicz SM, Harrison RG, Buston PM. 2014. Seascape continuity plays an important role in determining patterns of spatial genetic structure in a coral reef fish. Molecular Ecology 12: 2902-2913.
Riginos C, Buckley YM, Blomberg SP, Treml E. Dispersal capacity predicts both population genetic structure and species richness in reef fishes. *American Naturalist* 184: 52-64
Giles EC, Saenz-Agudelo P, Hussey NE, Ravasi T, Berumen ML. 2015. Exploring seascape genetics and kinship in the reef sponge Stylissa carteri in the Red Sea. Ecology and Evolution 13:2487-2502.
Thomas L, Kennington WJ, Stat M, Wilkinson SP, Kool JT, Kendrick GA. 2015. Isolation by resistance across a complex coral reef seascape. *Proceedings of the Royal Society of London, Series B.* 282.
Truelove BP et al. 2016. Biophysical connectivity explains population genetic structure in a highly dispersive marine species. Coral Reefs 36: 233-244.

TOPIC 11: CONSEQUENCES OF DISPERSAL AND CONNECTIVITY FOR BEHAVIORAL ECOLOGY AND SOCIAL EVOLUTION

Keywords:

(Required readings in black; Optional readings in gray)

Theoretical
Queller DC, Strassman JE. 1998. Kin selection and social insects. *BioScience* 48: 165-175
Terrestrial
Schuster WSF, Mitton JB. 1991. Relatedness within clusters of a bird-dispersed pine and the potential for kin interactions. *Heredity* 67: 41-48.
Donohue K. 2003. The influence of neighbor relatedness on multilevel selection in the Great Lakes sea rocket. *American Naturalist* 162: 77-92
Donohue K. 2004. Density dependent multilevel selection in the Great Lakes sea rocket. *Ecology* 85: 180-191.
Dudley SA, File AL. 2007. Kin recognition in an annual plant. *Biology Letters* 3: 435-438.
Sezen UU, Chazdon RL, Holsinger KE. 2009. Proximity is not a proxy for parentage in an animal dispese Neotropical canopy palm. *Proceedings of the Royal Society of London* 276: 2037-2044
Biernaskie JM. 2011. Evidence for competition and cooperation among climbing plants. *Proceedings of the Royal Society of London, Series B.* 278: 1989-1996.
Torices R, Gomez JM, Pannell JR. 2018. Kin discrimination allows plants to modify investment towards pollinator attraction. *Nature Communications* 9
Marine
Grosberg RK, Quinn JF. 1986. The genetic control and consequences of kin recognition by the larvae of a colonial marine invertebrate. *Nature* 322: 456-459.
Duffy JE. 1996. Eusocialtiy in a coral-reef shrimp. *Nature* 381: 512-514
Duffy JE, Morrison CL, Macdonald KS. 2002. Colony defense and behavioral differentiation in the eusocial shrimp *Synalphaeus regalis. Behavioral Ecology and Sociobiology* 51: 488-495
Toth E, Duffy JE. 2005. Coordinated response to nest intruders in a social shrimp. *Biology Letters* 1: 49-52.
Buston PM, Bogdanowicz SM, Wong A, Harrison RG. 2007. Are clownfish groups composed of close relatives? An analysis of microsatellite DNA variation in *Amphiprion percula. Molecular Ecology* 16: 3671-3678
Buston PM, Fauvelot C, Wong MYL, Planes S. 2009. Genetic relatedness in groups of the humbug damselfish *Dascyllus aruanus*: small, similar-sized individuals may be close kin. *Molecular Ecology* 18: 4707-4715.
Kamel SJ, Grosberg RK. 2013. Kinship and the evolution of social behaviours in the sea. *Biology Letters* 9

TOPIC 12: IMPLICATIONS OF DISPERSAL AND CONNECTIVITY FOR CONSERVATION & FISHERIES MANAGEMENT
Keywords: resource sharing; cooperation; conflict; individual trade quotas
(Required readings in black; Optional readings in gray)

Theoretical
Terrestrial
Marine
Fogarty MJ, Botsford LW. 2007. Population connectivity and spatial management of marine fisheries. *Oceanography* 20: 112-123.
Jones GP, Srinivasan M, Almany GR. 2007. Population connectivity and conservation of marine biodiversity. *Oceanography* 20: 100-111
Pelc RA, Warner RR, Gaines SD, Paris CB. 2010. Detecting larval export from marine reserves. *Proceedings of the National Academy of Sciences* 107: 18266-18271.
Almany GR, Hamilton RJ, Bode M, Matawai M, Potuku T, Saenz-Agudelo P, Planes S, Berumen ML, Rhodes KL, Thorrold SR, Russ GR, Jones GP. 2013. Dispersal of grouper larvae drives local resource sharing in a coral reef fishery. *Current Biology*23: 626–630.
Edgar GJ, et al. 2014. Global conservation outcomes depend on marine protected areas with five key features. *Nature* 506: 216-220
D'Aloia CC, Bogdanowicz SM, Francis RK, Majoris JE, Harrison RG, Buston PM. 2015. Patterns, causes and consequences of marine larval dispersal. *PNAS* 112: 13940-13945.
Williamson DH, Harrison HB, Almany GR, Berumen ML, Bode M, Bonin MC, Choukroun S, et al. 2016. Large-scale multidirectional connectivity among coral reef fish populations in the Great Barrier Reef Marine Park. *Molecular Ecology* 25: 6039-6054.
D'Aloia CC, Bogdanowicz SM, Harrison RG, Buston PM. 2017. Cryptic genetic diversity and spatial patterns of admixture within Belizean marine reserves. *Conservation Genetics* 18: 211-223.